SENSIBILIDAD DE PILARES VITALES DESPUÉS DE LA CEMENTACIÓN DE RESTAURACIONES INDIRECTAS: UNA REVISIÓN SISTEMÁTICA.

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“La Universidad El Bosque, no se hace responsable de los conceptos emitidos por los investigadores en su trabajo, solo velará por el rigor científico, metodológico y ético del mismo en aras de la búsqueda de la verdad y la justicia”.

GUÍA DE CONTENIDO

RESUMEN

Sensibilidad post-cementación en pilares vitales de restauraciones indirectas: revisión sistemática

Objetivo: El objetivo de esta revisión sistemática fue evaluar qué tipo de agente de cementación presenta más hipersensibilidad post-cementación en pilares vitales de restauraciones indirectas.

Métodos: MEDLINE (Sistema de Análisis y Recuperación de Literatura Médica en Línea) y EMBASE (Excerpta Medical Database) sin restricciones de idioma. Las bases de datos se buscarán hasta el 31 de mayo de 2018, utilizando los términos MeSH (Medical Subject Headings), palabras clave, otros términos gratuitos y operadores booleanos (OR, AND). Se combinaron y se desarrollaron estrategias detalladas de búsqueda para cada base de datos siguiendo la estrategia de búsqueda presentada para MEDLINE. Se incluyeron ensayos clínicos aleatorizados y ensayos clínicos controlados de al menos una semana de duración.

Resultados: De 33 artículos potencialmente elegibles se incluyeron 11, nueve no contestaron a la pregunta de investigación y 13 fueron eliminados por título o resumen. En general, todos los cementos mostraron cierto grado de sensibilidad post-cementación durante los tiempos de seguimiento con cualquiera de las pruebas térmicas o de masticación.

Conclusiones: Todos los cementos reportaron sensibilidad a las pruebas térmicas en diferentes tiempos de seguimiento; Los cementos RC, GIC, ZnPO4, RMGIC y SARC presentaron sensibilidad inmediata post cementación. Los cementos RC ZnPO4, SARC y RMGIC mostraron sensibilidad durante la semana posterior a la cementación y los cementos RC, GIC, ZnPO4, RMGIC y SARC presentaron sensibilidad durante un período mayor de dos semanas después de la cementación. De todos los cementos evaluados que contenían matriz de resina como RMGIC, RC y SARC presentaron sensibilidad estadísticamente significativa menor a las pruebas térmicas en comparación con otros cementos durante la semana posterior a la cementación.

El cemento ZnPO4 mostró el mayor grado de sensibilidad post cementación durante diferentes tiempos de seguimiento. El diseño de la restauración o el material no son aparentemente factores determinantes en la presencia o ausencia de sensibilidad post cementación.

Este artículo se preparó para publicación en la revista Operative dentistry, el cual fue aceptado por los editores pero rechazado por los pares evaluadores, por lo que el artículo fue nuevamente se preparó para publicación en las revistas Brazilian Dental Reserarch

PALABRAS CLAVE (según la documentación de MeSH): Sensibilidad dentinaria, hipersensibilidad, cementos dentales, post-cementación, cementación de la corona, ensayo clínico aleatorizado, ensayo clínico controlado.

ABSTRACT

Post-cementation sensitivity in vital abutments of indirect restorations: a systematic review

Aim: The aim of this systematic review was to evaluate the type of luting agent that has more post-cementation hyper-sensitivity in vital abutments of indirect restorations.

Methods: Medical Literature Analysis and Retrieval System Online (MEDLINE) and Excerpta Medical Database (EMBASE) were searched without language restrictions. Databases were searched up to and including May 31, 2018 using Medical Subject Headings (MeSH) terms, key words, other free terms and Boolean operators (OR, AND). These combined and detailed search strategies were developed for each database following the search strategy presented for MEDLINE. Randomized clinical trials and controlled clinical trials of at least one-week duration were also included.

Results: There were 648 potentially eligible articles from which 11 were included. In general, all cements reported sensitivity to thermal tests at different follow-up times; ZnPO4, conventional glass-ionomer cement [GIC], resin modified glass-ionomer [RMGIC], conventional resin cement [RC] and self-adhesive resin cement [SARC] cements had immediate post-cementation sensitivity. The RC, ZnPO4, SARC and RMGIC cements showed sensitivity during the post-cementation week; and RC, GIC, ZnPO4, RMGIC and SARC cements had sensitivity over a period greater than two weeks after cementation. All evaluated cements containing a resin matrix, such as RMGIC, RC and SARC had significantly lower sensitivity to thermal tests when compared to other cements during the post-cementation week.

Conclusions: The ZnPO4 cement showed the highest degree of post-cementation sensitivity during different follow-up times. The design of the restoration or the material are apparently not determining factors of the presence or absence of post-cementation sensitivity.

The present article was prepared for publication in Operative Dentistry. It was accepted by the editors but rejected by the evaluating peers. Therefore, it was prepared again for publication in Brazilian Dental Research and Brazilian Dental Journal.

Key words: dentin sensitivity, hyper-sensitivity, dental cements, post-cementation, crown cementation, randomised clinical trial, controlled clinical trial

1. Introducción

Las coronas y las prótesis fijas parciales son los procedimientos de restauración más comunes en odontología. Éstos requieren la preparación del tejido dental que implica el esmalte y la dentina antes de ser cementado definitivamente. La hiper-sensibilidad es una de las complicaciones más frecuentes durante la unión de los dientes vitales [Jokstad, 2004].

La afección se caracteriza por dolor agudo transitorio de la dentina expuesta como resultado de la deshidratación de los dientes, cambios osmóticos, estímulos térmicos, químicos y táctiles. Se presenta después de cementar una restauración definitiva en un diente vital y no puede describirse como ningún otro tipo de patología dental [Jokstad, 2004, Bebermeyer & Berg., 1994, Hu & Zhu, 2010].

Varios estudios sugieren que la hiper-sensibilidad post cementación tiene múltiples causas, tales como bacterianas, mecánicas, químicas e inherentes al cemento. Las de origen bacteriano se relacionan con la microfiltración marginal debida a desadaptación de restauraciones provisionales o por un sello de corona defectuoso que permite una degradación hidrolítica del cemento. Los orígenes mecánicos están relacionados con el calor de fricción generado durante la preparación dental, el secado al aire, la presión mecánica del cemento sobre el líquido dentinario de los túbulos expuestos y las discrepancias oclusales. Las causas químicas se generan por la exposición de la dentina a desinfectantes cavitarios, ácidos, adhesivos o agentes homeostáticos. Los inherentes al agente de cementación están relacionados con características físicas y biológicas tales como pH y biocompatibilidad [Johnson et al., 1993, Brännström, 1996, Quarnstrom et al., 1998, Rosenstiel et al. , 1998, Hilton et al., 2004].

Se ha observado que la frecuencia de hiper-sensibilidad post cementación oscila entre 3,1% y 32% con grados de gravedad: ligeros, moderados y severos [Jokstad, 2004, Brännström, 1996, Hilton et al ., 2004, Gupta et al., 2013, Brackett, 1992]. Además, se ha informado que la hiper-sensibilidad se mantiene entre el 3% y el 6% de los casos después de una post-cementación de dos y tres años, respectivamente [Maghrabi, 2011]. También hay reportes de incidencia de género en los cuales las hembras presentan mayor hipersensibilidad antes y después de la preparación dental.

El análisis de ensayos clínicos aleatorios ha dado como resultado que el factor determinante en la hiper-sensibilidad post-cementación es el tipo de cemento. Uno de los más utilizados desde hace décadas es el fosfato de zinc, considerado el patrón oro, debido a su bajo pH inicial y solubilidad, [Jokstad, 2004, Sensat et al., 2002] ha caído en desuso. Otro cemento es el ionómero de vidrio que

se utiliza ampliamente, debido a su efecto cariostático por la liberación de fluoruro y excelentes propiedades físicas y mecánicas. Sin embargo, la hiper-sensibilidad producida puede compararse con la del fosfato de zinc Zinc [Hilton et al., 2004] o mayor [Kern et al., 1996, Smales et al., 2002]. Esto también puede estar relacionado con su bajo pH inicial [Denner et al., 2007], que ha llevado a muchos dentistas a no usarlo [Yoneda et al., 2005]. Las opciones más recientes son los cementos de resina que presentan baja solubilidad y su pH inicial es mayor que el fosfato de zinc y el ionómero de vidrio. También se ha reportado hiper-sensibilidad post-cementación que puede estar relacionada con la contracción de la polimerización del material, generando defectos de sellado marginal de las restauraciones [Kuijs et al., 2006, Maghrabi, 2011, Shetty et al; 2012].

La hiper-sensibilidad post-cementación es evidentemente una entidad multifactorial y uno de los factores más evaluados es el tipo de cemento. No obstante, en los resultados del estudio no hay consenso, metaanálisis o revisiones sistemáticas con resultados concluyentes que permitan al dentista tomar decisiones clínicas informadas y precisas basadas en evidencia para evitar esta complicación.

Por tal razón se realiza una revisión sistemática con el fin de determinar – a partir de la evidencia existencia, la aparición de sensibilidad dentinal después de la cementación de restauraciones indirectas sobre pilares con vitalidad pulpar con diferentes tipos de cementos definitivos utilizados para tal fin.

2. Objetivos del estudio

2.1 Objetivo General

- Determinar qué tipo de cementación definitiva presenta mayor hipersensibilidad posoperatoria en restauraciones indirectas sobre dientes vitales

2.2 Objetivos Específicos

- Comparar el grado de sensibilidad poscementación presentado por los distintos agentes cementantes.
- Establecer el grado o aparición de sensibilidad poscementación a diferentes tiempos de seguimiento de las restauraciones.

3. Metodología para el desarrollo de la revisión

1. Pregunta de la revisión

¿Hay alguna diferencia entre cementación convencional o cementación adhesiva en dientes vitales de pilar en prótesis fija?

¿Hay algún desenlace de sensibilidad post cementación en ambas técnicas?

2. Estructura de la revisión

- Introducción
- Materiales y métodos
- Criterios de inclusión
- Estrategia de Búsqueda
- Validación de la extracción de datos
- Calidad metodológica de los estudios (Citation evaluation form)
- Resultados
- Efecto de las intervenciones
- Tipo y material de restauración utilizados.
- Calidad de la evidencia
- Limitaciones y sesgos potenciales en el proceso de revisión
- Discusion
- Acuerdos o desacuerdos con otros estudios.

3. Búsqueda de información:

a. Selección de palabras claves por temática

Se establecen las variables para cada temática a ser tratada en la revisión a partir de las de las cuales se establecen las palabras claves para poder elaborar estrategias de búsqueda de cada una de las temáticas propuestas: definición de los términos Mesh, Decs y Sinónimos o términos relacionado para lo cual se diligencia la Tabla 1.

Tabla 1.- SELECCIÓN DE PALABRAS CLAVES POR TEMÁTICA DE REVISIÓN		
Temática	**Sensibilidad post-cementación en pilares vitales de restauraciones indirectas: revisión sistemática**	
Variable	**Palabras claves**	
Hipersensibilidad dentinal	Palabra clave	**Hipersensibilidad dentinal**
	Términos [MeSH] ingles	Dentin Sensitivity
	Términos [DeSC] español/ inglés/ portugués	Dentin Sensitivity / Sensibilidad de la Dentina Sensibilidade da Dentina
	Sinónimos / Términos relacionados	Hipersensibilidad de la Dentina
Dental Cements	Palabra clave	Cementos dentales
	Términos [MeSH] ingles	Dental cements
	Términos [DeSC] español/ inglés/ portugués	Dental Cements Cementos Dentales Cimentos Dentários
	Sinónimos / Términos relacionados	Adhesivos Dentales Adhesivos Dentarios Agentes Cementadores Agentes Fijadores Cementos Dentarios Adhesivos Ortodónticos

b. Estructuración de estrategia de búsqueda por temática

A partir de la tabla 2 se seleccionan las palabras claves más pertinentes para estructurar los algoritmos de las estrategias de búsqueda por tematica y se diligencia en la tabla 2.

Tabla 2. ESTRATEGIA DE BUSQUEDA	
Temática	**Descripción del Biodentine™ y del MTA**
#1	**#1 dentin sensitivity OR dentin hypersensitivity OR dentinal tubules OR dentin, pain OR dentinal hypersensitivity OR tooth, hypersensitivity OR root hypersensitivity OR vital tooth OR pulp sensitivity**
#2	**cements OR dental cements OR dental adhesives OR resin cements OR crown cementation OR resin cements OR luting agents OR bonding**
#3	**# 1 AND #2**
#4	**Early hypersensitivity OR post-cementation hypersensibily OR Crown cementation / hypersensitivity OR cementation**
#5	**#3 AND #4**

c. Resultados de aplicación de estrategia de búsqueda por temática en bases de datos (Pubmed -Embase)

Se aplica la estrategia de búsqueda en las diferentes bases de datos y se registran los resultados en la tabla 3 en la que hay un ejemplo

Tabla 3. Resultados aplicación de Estrategia de búsqueda por Temática Pubmed o EMBASE Sort by: Relevance Fecha:			
Temática	**Descripción del Biodentine™ y del MTA**		
Búsqueda	**Algoritmos**	**Cantidad de artículos encontrados**	**Cantidad seleccionada por Titulo/ abstract**
#1	dentin sensitivity OR dentin hypersensitivity OR dentinal tubules OR dentin, pain OR dentinal hypersensitivity OR tooth, hypersensitivity OR root hypersensitivity OR vital tooth OR pulp sensitivity	9281	
#2	cements OR dental cements OR dental adhesives OR resin cements OR crown cementation OR resin cements OR luting agents OR bonding	145740	
#3	# 1 AND #2	1588	
#4	Early hypersensitivity OR post-cementation hypersensibily OR Crown cementation / hypersensitivity OR cementation	21399	
#5	#3 AND #4	132	

d. Preselección de artículos por temática

Los artículos encontrados y preseleccionados por título o abstract se registran en la siguiente tabla. ***(Tabla 4)***

Tabla 4. Preselección de artículos por temática	
TEMATICA	**Hipersensibilidad postcementación en dientes vitales con restauraciones totales y parciales**
BASE DE DATOS	**PUBMED**
ALGORITMO FINAL	**((((((((((dentin sensitivity[MeSH Terms]) OR dentin hypersensitivity[MeSH Terms]) OR dentinal tubules[MeSH Terms]) OR dentin, pain[MeSH Terms]) OR dentinal hypersensitivity[MeSH Terms]) OR tooth, hypersensitivity[MeSH Terms]) OR root hypersensitivity[MeSH Terms]) OR vital tooth[MeSH Terms]) OR pulp sensitivity[MeSH Terms])) AND Randomized Controlled Trial**
artículos preseleccionados Referencia -estilo Vancouver y abstract	
Bebermeyer RD1, Berg JH.Comparison of patient-perceived postcementation sensitivity with glass-ionomer and zinc phosphate cements. Quintessence Int. 1994 Mar;25(3):209-14. Abstract Numerous investigators have reported patients' postcementation sensitivity with glass-ionomer luting agents. This information has been predominantly anecdotal and unsupported by data. This paper reports on the actual perceptions of patients who had restorations cemented with both glass-ionomer and zinc phosphate luting agents. Forty-five patients were randomly selected and received two cast restorations, one cemented with glass-ionomer cement and the other with zinc phosphate cement, also by random assignment. After 1 week, patients returned to complete a self-administered evaluation of perceived sensitivity. Neither luting agent resulted in greater sensitivity when used according to its manufacturer's instructions.	

Blatz MB1, Mante FK, Saleh N, Atlas AM, Mannan S, Ozer F. Postoperative tooth sensitivity with a new self-adhesive resin cement--a randomized clinical trial. Clin Oral Investig. 2013 Apr;17(3):793-8.

Abstract

OBJECTIVES:

This study evaluated and compared sensitivity of teeth after cementation of full-coverage crowns with a new self-adhesive resin cement (SARC). A resin-modified glass ionomer cement (RMGIC) served as control.

MATERIALS AND METHODS:

Eighty-eight full-coverage crowns were cemented to vital teeth with either the self-adhesive cement iCem (Heraeus Kulzer; n = 44) or the RMGIC GC Fuji PLUS (GC, n = 44). Before preparations, patients were questioned for sensitivity (patient sensitivity, PS). In addition, air was blown for 2 s onto the buccal cementoenamel junction (air sensitivity, AS), and ice spray was applied in the cementoenamel junction area (ice sensitivity, IS). Patient responses were recorded with a visual analog scale. After cementation of the crowns, patients were recalled for follow-up (f/u) visits at 1 day, 1 week, and 3 weeks. PS, AS, and IS were recorded during each visit. Data were analyzed with Mann-Whitney U tests.

RESULTS:

The two groups revealed comparable sensitivity scores at baseline. SARC showed significantly lower PS sensitivity scores at 1 day ($p = 0.02$) and significantly lower AS scores at 1-week follow-up ($p = 0.01$). IS generally produced the highest sensitivity scores with SARC revealing significantly lower scores at all follow-up visits.

CONCLUSION:

Cementation of crowns with the SARC tested in this study resulted in overall lower postoperative sensitivity than with the RMGIC.

CLINICAL RELEVANCE:

Among other clinical advantages, some self-adhesive resin cements seem to lower postoperative sensitivity of crowned teeth.

Chandrasekhar V. Post cementation sensitivity evaluation of glass Ionomer, zinc phosphate and resin modified glass Ionomer luting cements under class II inlays: An in vivo comparative study. J Conserv Dent. 2010 Jan;13(1):23-7.

Abstract

OBJECTIVE:

This study aims to compare the patient-perceived post-cementation sensitivity of class II metal restorations preoperatively, immediately after cementation, one week after cementation and one month after cementation with (1) Glass Ionomer luting cement (2) Zinc Phosphate cement and (3) Resin-modified Glass Ionomer luting cement.

MATERIALS AND METHODS:

A total of 60 patients, irrespective of sex, in the age group of 15-50 years were selected and the teeth were randomly divided into three groups of 20 each. Twenty inlay cast restorations were cemented with three different luting cements. The criteria adapted to measure tooth sensitivity in the present study were objective examination for sensitivity. (1) Cold water test (2) Compressed air test and (3) Biting pressure test.

RESULTS:

The patients with restorations cemented with Resin-modified Glass ionomer demonstrated the least postoperative sensitivity when compared with Glass Ionomer and zinc phosphate cement at all different intervals of time evaluated by different tests.

CONCLUSION:

The patients with restorations cemented with resin-modified Glass ionomer demonstrated the least postoperative sensitivity.

KEYWORDS:

Cementation; glass ionomer cement; inlay; sensitivity; zinc phosphate cement

Denner N, Heydecke G, Gerds T, Strub JR. Clinical comparison of postoperative sensitivity for an adhesive resin cement containing 4-META and a conventional glass-Ionomer cement. Int J Prosthodont. 2007 Jan-Feb;20(1):73-8.

Abstract

PURPOSE:

The aim of this clinical 2-year follow-up study was to compare the postoperative sensitivity of abutment teeth restored with full coverage restorations retained with either conventional glass-ionomer cement or a new adhesive resin cement containing 4-methacrylolyloxyethyl trimellitate anhydride (4-META).

MATERIALS AND METHODS:
Sixty patients received 120 full-coverage restorations on vital abutment teeth, cemented with either a glass-ionomer cement (Ketac-Cem) or a new adhesive resin cement (Chemiace II). A randomized split-mouth design and a patient double-blind data acquisition protocol were used. The teeth were examined before cementation, after 1 week, and after 6, 12, and 24 months.
RESULTS:
With regard to postcementation sensitivity, a low incidence was observed for both groups. With the adhesive resin cement, little postoperative hypersensitivity was observed after 1 week (13.3%), 6 months (5.9%), 12 months (2.1%), and 24 months (none); results were similar with the conventional glass-ionomer cement Ketac-Cem after 1 week (5.9%), 6 months (5.9%), 12 months (6.4%), and 24 months (none). After 6 months, 2 teeth of the Chemiace II group showed no sensitivity. Endodontic treatment was carried out for these 2 abutment teeth. After 24 months, no cases of postoperative hypersensitivity were recorded for either group.
CONCLUSION:
In this study, the incidence of postoperative hypersensitivity after cementation of full-crown restorations with a conventional glass-ionomer cement and a new adhesive resin cement was similar.

Hassan SH, Azad AA, Niaz O, Amjad M, Akram J, Riaz W. Post cementation sensitivity in vital abutments of metal-ceramic fixed partial dentures.Pakistan Oral & Dental Journal. 2011 Jun;31(1): 210-3

ABSTRACT
This randomized clinical trial was carried out to compare post cementation sensitivity in vital abutments of metal-ceramic fixed partial dentures using glass ionomer luting cement and resin based luting cement. It analyzed the results of 182 patients whose records were completed during study
duration of 09 months at Department of Prosthodontics, AFID, Rawalpindi. Cold sensitivity tests were used to compare post cementation sensitivity in vital abutments of fixed partial dentures using resin based luting cement and glass ionomer luting cement. Sensitivity was assessed on a modified visual
analogue scale of 0-10; scores of 1-4 signified mild sensitivity, 5-7 moderate sensitivity, 8-10 severe sensitivity and score of 0 signified no response. The sensitivity results were checked at base line, at 1 week, at 1 month, at 3 months. Data of 182 subjects of mean age 26.15±3.15 was evaluated. Chi-sqaure test was used to see the association of type of cement used and the postoperative sensitivity. The p values for the chi square test were insignificant P- values (P>0.05) at all appointments in abutments of fixed partial denture with either resin based or glass ionomer luting cement. The study showed that there is no significant difference between resin based luting cements and glass ionomer luting cements in terms of post cementation sensitivity in vital teeth.
Key words: Sensitivity, Abutments, Fixed partial denture, Luting cement.

Hilton T, Hilton D, Randall R, Ferracane JL. A clinical comparison of two cements for levels of post-operative sensitivity in a practice-based setting.
Oper Dent. 2004 May-Jun;29(3):241-8.

Abstract
This study compared the post-operative results of cementing full crowns (all metal or PFM) with either a conventional (Fuji I, GC; n=102) or a resin modified GI luting cement (Rely X, 3M/ESPE; n=107).
METHODS:
Ten private practitioners fabricated 209 crowns using standardized preparation/luting criteria and randomly assigned cements. Patients self-reported temperature and biting sensitivity, on a 0-10 scale at 24 hours, one week, one month and three months post-cementation. Data were analyzed using t-tests, confirmatory Mann-Whitney tests and Pearson correlations, with a significance level of $p < or = 0.05$.
RESULTS:
Of all patients, 50.7% reported any sensitivity at any time period. Mean sensitivity for all patients on the 10-point scale was 0.52 for temperature and 0.23 for biting. Cements did not differ in cold or biting sensitivity at any time. There were many significant (though low) correlations between the sensitivity measures and age (inverse relationship) and dentin area of preparation (direct). The practice-based format provided a viable alternative to performing clinical research.

Johnson GH, Powell LV, DeRouen TA. Evaluation and control of post-cementation pulpal sensitivity: zinc phosphate and glass ionomer luting cements. J Am Dent Assoc. 1993 Nov;124(11):38-46.

Abstract
Many studies have documented pulpal sensitivity after crown cementation, but none have determined its cause. By controlling technique variables in a large-scale clinical trial, the authors evaluated the contribution of zinc phosphate and glass ionomer luting cements in causing pulpal sensitivity or necrosis.

Piwowarczyk A, Schick K, Lauer HC. Metal-ceramic crowns cemented with two luting agents: short-term results of a prospective clinical study.
Clin Oral Investig. 2012 Jun;16(3):917-22.

Abstract
A prospective, randomized, controlled, split-mouth trial was performed to evaluate the cementation modes for metal-ceramic crowns. A total of 40 fully veneered metal-ceramic crowns were delivered in the posterior jaw segments of 20 patients using either a self-adhesive resin cement (RelyX Unicem Aplicap, 3M ESPE; n = 20) or a zinc oxide phosphate cement (Hoffmann's Cement, Hoffmann; n = 20). Thirteen parameters related to the abutment teeth and their periodontal status were evaluated. A visual analog scale was used to assess the sensitivity of the abutment teeth by patient-based outcomes. Data were statistically analyzed by a single-classification ANOVA ($\alpha = 0.05$) and logistic regression analysis. The results presented were obtained after a mean observation period of 1.8 years. The dropout rate was 0%. None of the abutment teeth exhibited secondary caries at the restoration margins. No significant differences were demonstrated between the luting agents based on visual analog scale ($p > 0.05$), hypersensitivity (OR = 1.31), abutment mobility ($p > 0.05$), or probing depths ($p > 0.05$). Based on the sulcus fluid flow rates, a significantly greater mean difference was obtained with zinc oxide phosphate cement than with self-adhesive resin cement (9.2 units; $p = 0.0006$). Significant differences between the baseline examination and the follow-up examinations for sulcus bleeding index ($p = 0.0013$) and plaque index ($p < 0.0001$) were observed regardless of the luting agent used. The two cement types showed scarcely any differences between the parameters investigated. The outcomes of cementing fully veneered metal-ceramic crowns were equally good with self-adhesive resin cement as with the clinically proven zinc oxide phosphate cement.

Shetty RM1, Bhat S, Mehta D, Srivatsa G, Shetty YB. Comparative analysis of postcementation hypersensitivity with glass ionomer cement and a resin cement: an in vivo study. J Contemp Dent Pract. 2012 May 1;13(3):327-31.

Abstract
AIM:
The aim of this clinical study was to compare the postoperative sensitivity of abutment teeth restored with full coverage restorations retained with either conventional glassionomer cement (GIC) or resin cement.

MATERIALS AND METHODS:
Fifty patients received full-coverage restorations on vital abutment teeth. Of these, 25 were cemented with GIC (GC Luting and Lining cement) and the other 25 using an adhesive resin cement (Smartcem 2). A randomized single blind study was undertaken for acquiring and evaluating the data. The teeth were examined before cementation, after cementation, 24 hours postcementation and 7 days postcementation. A visual analog scale was used to help the patient rate hypersensitivity.

RESULTS:
The statistical analysis of the result was done using students paired t-test. No statistically significant difference between Smartcem 2 and GIC was observed, when tested immediately and 24 hours after cementation. Statistically significant difference was seen between Smartcem 2 and GIC when tested 7 days postcementation with a significance level of 0.05. Higher postoperative sensitivity was seen with GIC when compared to resin cement.

CONCLUSION:
In this study, the incidence of postoperative hypersensitivity after cementation of full-crown restorations with GIC and resin cement was similar when tested immediately. However, 7 days postcementation, abutments with GIC showed higher response compared to resin cement.

CLINICAL SIGNIFICANCE:
A self-adhesive resin cement can be the material of choice for luting if presence of postoperative sensitivity is of prime consideration. In case GIC is being used, patient should be informed about the presence of sensitivity for a more prolonged period than with resin cement.

Smales RJ, Gale MS. Comparison of pulpal sensitivity between a conventional and two resin-modified glass ionomer luting cements. Oper Dent. 2002 Sep-Oct;27(5):442-6.

Author information

Abstract

This clinical study compared handling and any short-term tooth sensitivity associated with using one conventional and two resin-modified glass ionomer cements marketed for luting gold and ceramometal crowns. The patient's response to a 10-second blast of air applied to the vital tooth was scored pre-operatively and again within a one-to-four week post-cementation recall period. A score was also recorded for any sensitivity present at the time of cementation of the crown on the unanesthetized tooth. All three cements were easy to mix and place. Most of the teeth had no response to pulpal stimulation pre-operatively, associated with the cementation procedure or post-cementation, and there were no instances of severe sensitivity recorded. For all cements, the level of post-cementation tooth sensitivity was similar, and less than that found pre-operatively.

Taschner M, Krämer N, Lohbauer U, Pelka M, Breschi L, Petschelt A, Frankenberger R. Leucite-reinforced glass ceramic inlays luted with self-adhesive resin cement: a 2-year in vivo study. Dent Mater. 2012 May;28(5):535-40

Abstract

OBJECTIVES:

Aim of the present prospective controlled clinical study was to compare the clinical performances of two different cementation procedures to lute IPS Empress inlays and onlays.

METHODS:

Eighty-three IPS Empress restorations (70 class-II inlays, 13 onlays/47 premolars, 36 molars) were placed in 30 patients (19 females/11 males, mean age=39 years). Two cementation procedures were tested: group 1: forty-three restorations were luted with a self-adhesive resin cement (RelyX Unicem, RX, 3M ESPE); group 2: forty restorations were luted with an etch-and-rinse multistep adhesive (Syntac Classic, Ivoclar-Vivadent) and Variolink II low (SV, Ivoclar-Vivadent). All restorations were evaluated after 2 weeks (baseline=1st recall=R1, n=83), 6 months (R2, n=83), 1 year (R3, n=82), and 2 years (R4, n=82) by two independent blinded calibrated examiners using modified USPHS criteria.

RESULTS:

From R1 to R4, one failure occurred in the SV group (at R2) due to marginal enamel chipping. After 2 years of clinical service (R4), better marginal and tooth integrity ($p<0.05$) was found in group 2 (SV) compared to the use of the self-adhesive cement (RX, group 1), while no differences were found for all remaining investigated criteria ($p>0.05$). The absence of enamel in proximal boxes (10% with no enamel and 51% of the restorations with less than 0.5mm enamel width at the bottom of the proximal box) did not affect marginal performance ($p>0.05$).

SIGNIFICANCE:

The self-adhesive resin cement RelyX Unicem showed clinical outcomes similar to a conventional multi-step cementation procedure after 2 years of clinical service for most of the tested criteria.

artículos relacionados encontrados

Listado de artículos Referencia -estilo Vancouver y abstract

Gupta N, Reddy UN, Vasundhar PL, Ramarao KS, Varma KP, Vinod V. Effectiveness of desensitizing agents in relieving the pre- and postcementation sensitivity for full coverage restorations: a clinical evaluation. J Contemp Dent Pract. 2013 Sep 1;14(5):858-65.

Abstract

Patients frequently report sensitivity of prepared abutment teeth during the temporization period and after the fnal cementation of full coverage restoration. Purpose of this clinical investigation was to evaluate the effectiveness of desensitizing agents in reducing the pre- and postcementation sensitivity for full coverage restorations and to compare the relative effcacy of three in offce applied desensitizing agents in relieving the postcementation sensitivity with the use of glass ionomer luting cement.

MATERIALS AND METHODS:

This study consisted of 30 patients requiring either full coverage restoration or 3 unit fxed partial denture. Total of 40 restorations (n = 40) were made and were randomly assigned into four groups comprising 10 restoration (n = 10) in each

group. Group C control where no desensitizer application was done, group BB applied with BisBlock dentin desensitizer (Bisco Inc.), group ST applied with Systemp desensitizer (Ivoclar Vivadent), group GC applied with GC Tooth Mousse desensitizer (GC Asia). Desensitizer application was done immediately after the tooth preparation. Sensitivity of the tested abutment was determined by the patient response to cold, hot and bite stimuli and were recorded on visual analog scale (VAS). Sensitivity level scores was evaluated at 4 time intervals, i.e. 1 week after desensitizer application at baseline precementation appointment and others at 5 minutes, 1 day and 1 week postcementation appointment. VAS score data was statistically analyzed using one-way ANOVA followed by post hoc Tukey's test.

RESULTS:

BisBlock and GC Tooth Mousse desensitizer resulted in statistically signifcant ($p < 0.01$) reduction in postcementation sensitivity of glass ionomer cement in comparison to Systemp desensitizer at 5 minutes, 1 week postcementation time interval with no statistical difference was seen between all desensitizer groups at 1 day postcementation. Application of BisBlock and GC Tooth Mousse desensitizer resulted in highly signifcant ($p < 0.01$) reduction in sensitivity level at the end of 1 week.

CLINICAL SIGNIFICANCE:

Desensitizer's application on the prepared abutment teeth is considerably effective in relieving both pre- and postcementation sensitivity for full coverage restoration over the short duration of time. Immediate reduction in postoperative sensitivity relatively in a short time period may be benefcial in terms of patient's comfort. Nonetheless, multicenter long-term clinical trials should be conducted to confrm the results.

CONCLUSION:

Efficacy of BisBlock and GC Tooth Mousse desensitizer was more in relieving the postcementation sensitivity of glass ionomer cement at various time intervals in comparison to Systemp desensitizer. In conclusion, application of desensitizers was beneficial to reduce the pre- and postcementation abutment sensitivity.

Felton DA, Bergenholtz G, Kanoy BE. Evaluation of the desensitizing effect of Gluma Dentin Bond on teeth prepared for complete-coverage restorations. Int J Prosthodont. 1991 May-Jun;4(3):292-8.

Abstract

This clinical trial assessed the ability of Gluma Dentin Bond to inhibit dentinal sensitivity in teeth prepared to receive complete cast restorations. Twenty patients provided 76 teeth for the study. Following tooth preparation, dentinal surfaces were coated with either sterile water (control) or two 30-second applications of Gluma Dentin Bond (test) on either intact or removed smear layers. Patients were recalled after 14 days for a test of sensitivity of the prepared dentin to compressed air, osmotic stimulus (saturated CaCl2 solution), and tactile stimulation via a scratch test under controlled loads. A significantly lower number of teeth responded to the test stimuli for both Gluma groups when compared to the controls (P less than .01). No difference was noted between teeth with smear layers intact or removed prior to treatment with Gluma.

Hu J, Zhu Q. Effect of immediate dentin sealing on preventive treatment for postcementation hypersensitivity. Int J Prosthodont. 2010 Jan-Feb;23(1):49-52.

Abstract

PURPOSE:

The aim of this study was to investigate the effect of Prime and Bond adhesive on preventing postcementation hypersensitivity of vital abutment teeth restored with a full-coverage restoration using the immediate dentin sealing (IDS) technique.

MATERIALS AND METHODS:

Twenty-five male patients received 25 three-unit fixed partial dentures. A split-mouth design was used and two vital abutment teeth in each patient were allocated randomly into Groups A or B. Teeth in Group A were treated with Prime and Bond using the IDS technique while teeth in Group B were used as a control and left untreated. The discomfort interval scale, ranging from 0 to 4, was adopted to evaluate hypersensitivity. The double-blind method was applied during the operation so that neither the patient nor the clinician knew which abutment had been treated. The sensitivity assessment was performed 1 week, and 1, 6, 12, and 24 months after cementation. RESULTS were analyzed using the sign test.

RESULTS:

Scores for teeth in Group A were statistically significantly lower than those in Group B at 1 week and 1 month postcementation ($P < .05$), whereas there was no significant difference between Groups A and B at the end of 6, 12, and 24 months ($P > .05$).

CONCLUSION:
Preventive treatment with Prime and Bond using the IDS technique can significantly reduce postcementation hypersensitivity. Int J Prosthodont 2010;23:49-52.

Jalalian E, Meraji N, Mirzaei M. A comparison of the efficacy of potassium nitrate and Gluma desensitizer in the reduction of hypersensitivity in teeth with full-crown preparations. J Contemp Dent Pract. 2009;Jan 1(10(1):66-73.

Abstract
AIM:
The aim of this clinical investigation was to compare the efficacy of Gluma Desensitizer and potassium nitrate desensitizing agents on the reduction of hypersensitivity of teeth prepared for full coverage crowns.
METHODS AND MATERIALS:
This study included 75 vital teeth in 25 patients in need of fixed prosthesis treatment. After completing routine examinations, hypersensitivity of the teeth was measured using an air sensitivity test. The measurement of sensitivity was using a Visual Analog Scale (VAS) before preparation, after preparation, before using desensitizers, after using desensitizers, and before cementation. Each tooth was randomly put into one of the three groups of 25 teeth according to the desensitizing agent used (potassium nitrate, Gluma, and the control). In each patient potassium nitrate was used on one of the abutments and Gluma was used on the other abutment and on the third abutment (the control) no substance was used.
RESULTS:
Both desensitizers decreased dentinal hypersensitivity in vital teeth prepared for full-coverage crowns, but potassium nitrate was more effective when applied before cementation. In 88% of the teeth to which Gluma was applied a vascular pain (with pulse) was present.
CONCLUSION:
The results of this investigation suggest the application of potassium nitrate to dentin in full crown preparations prior to cementation reduces post-operative sensitivity.
CLINICAL SIGNIFICANCE:
Clinical experiments show the preparation of vital teeth for full coverage crowns can cause sharp, transient pain as a result of dentinal hypersensitivity in the majority of cases. Several different substances and methods have been suggested for reducing such hypersensitivity including costly laser treatments. However, the findings of this study indicate the use of desensitizer substances such as potassium nitrate can reduce tooth hypersensitivity efficiently with less expense.

Jefferies S, Pameijer C, Appleby D, Boston D, Lööf J, Glantz P. One year clinical performance and post-operative sensitivity of a bioactive dental luting cement--a prospective clinical study. Swed Dent J. 2009;33(4):193-9

Abstract
A one-year clinical study was performed on the efficacy of a bioactive dental cement (Ceramir C&B) with calcium aluminate and glass ionomer components. The study was performed on 38 crown and bridge abutments in 17 patients. Preparation parameters were recorded, as well as working-times, setting-times, and other handling characteristics. Baseline data were also recorded for gingival inflammation (GI) and pre-cementation sensitivity. Post-cementation parameters included sensitivity, gingival tissue reactions, marginal integrity and discolorations. All patients were seen for recall examinations at 30 days, and 6 months. For sixteen patients one-year recall data were collected on retention and subjective sensitivity. Fifteen subjects were available for one year clinical examinations. Three independent examiners found the working and setting time of the cement to be well within expected limits and that cement removal was easy. Four patients reported low-grades of immediate post-cementation sensitivity, however, this disappeared after an occlusal adjustment or without intervention within one month. At 12 months no retentive failures were recorded and no subjective sensitivity reported. All crowns were rated in the "Excellent" quality category for marginal integrity. Both GI-scores and scores for tooth sensitivity decreased during the course of the study. One year recall data yielded no incidence of secondary caries and no visible marginal discoloration. The new cement was thus found to perform favorably as a luting agent for permanent cementation.

Jokstad A. A split-mouth randomized clinical trial of single crowns retained with resin-modified glass-ionomer and zinc phosphate luting cements.Int J Prosthodont. 2004 Jul-Aug;17(4):411-6.
Abstract
PURPOSE:
This study compared the influence of two luting cements on the clinical performance of single crowns.
MATERIALS AND METHODS:
Twenty patients received 39 pairs of metal-ceramic and Procera crowns cemented with zinc phosphate and resin-modified glass-ionomer luting cement (Vitremer) in a split-mouth randomized pattern blinded to the recipient. The crowns were

examined immediately after cementation, after 2 weeks, after 6 months, and then yearly. Clinical performance was scored according to CDA criteria, Silness and Loe criteria, patient satisfaction, and operator-appraised general clinical criteria. Three clinicians in private general practice carried out all procedures.
RESULTS:
During the observation period, which varied between 80 and 104 months, seven clinical events were recorded. Two abutments fractured vertically, two underwent retrograde endodontic surgery, and one developed pulp necrosis. Two crowns were recemented. Estimated survival, defined as no negative events observed, was 89% at 102 months (85% for crowns cemented with zinc phosphate and 93% for crowns cemented with resin-modified glass-ionomer). Estimated survival, defined as no recementation or loss of pulp vitality, was 96% at 102 months (95% with zinc phosphate and 97% with resin-modified glass-ionomer). The differences between cements were not statistically significant.
CONCLUSION:
A resin-modified glass-ionomer luting cement was at least as good as zinc phosphate cement to retain single crowns over a 102-month observation period.

Kern M, Kleimeier B, Schaller HG, Strub JR. Clinical comparison of postoperative sensitivity for a glass ionomer and a zinc phosphate luting cement. J Prosthet Dent. 1996 Feb;75(2):159-62.

Abstract
In 60 patients, 120 partial and full-coverage restorations were cemented on vital abutment teeth with either a glass ionomer or a zinc phosphate luting cement. A split-mouth design and a patient blind data acquisition protocol were used. During an average observation period of 17.3 months there were no differences between the two types of luting cements in regard to subjective and clinical parameters. A high incidence of postoperative hypersensitivity, which is often said to accompany the use of glass ionomer luting cements, was not observed. With the cementation method used in this study, the glass ionomer cement Ketac-Cem Maxicap was an acceptable alternative to conventional zinc phosphate cement. Capsule systems make the clinical handling of glass ionomer luting cements safe and easy and should be used routinely in dental practice.

Maghrabi AA. Effect of dentin sealers on postoperative sensitivity of complete cast crowns cemented with glass ionomer cement. J Prosthodont. 2011 Jul;20(5):385-90. Epub 2011 May 31.

Abstract
PURPOSE:
The purpose of this study was to clinically evaluate the effects of pretreatments with copal/ether varnish and dentin bonding system on postoperative sensitivity of complete cast crowns cemented with glass ionomer cement.
MATERIALS AND METHODS:
Three posterior teeth with no pain symptoms were selected from each of 17 patients, totaling 51 teeth, for which a crown was indicated. Rexillium III complete cast crowns were prepared using conventional laboratory techniques. For each patient, the first tooth, which served as the control, received only glass ionomer cement (Ketac-Cem). Copal/ether varnish (Bosworth Copaliner) was applied to the second tooth preparation prior to cementation. Dentin bonding agent (OptiBond Solo Plus) was used on the third tooth before cementation. Sensitivity to different stimuli (cold, heat) was assessed at 7 days, 1 month, and 6 months following restorative procedures by questionnaire.
RESULTS:
There were no statistically significant differences between the three groups regarding applied stimulus and day of the study ($p > 0.05$). No statistically significant differences were found between the postoperative sensitivity responses from 7 days to 1 month, and from 1 month to 6 months ($p > 0.05$).
CONCLUSIONS:
Postoperative sensitivity resulting from glass ionomer cement with complete cast crowns cannot be completely eliminated with the prior use of a cavity varnish or bonding agent.

Pramod-Kumar AV, Rohit SabnisVT K, Gilsa K,Vasunni, Dhanya Krishnan PC.Effect of inmediate dentin sealing in prevention of post cementation hypersensitivity in full coverage restorations. OSR-JDMS. 2015 May; 14 (5):80-4.

Abstract:
Aim:The aim of this study is to investigate the effect of immediate dentin sealing with dentin bonding agent on preventing post-cementation hypersensitivity in vital abutment teeth restored with a full-coverage restoration.
Method:A total of 50 patients were enrolled in this study who received three unit fixed dental prosthesis on vital abutments in mandibular posterior region, 25 each in the age ranges of 21-30 and 31-40 years. Sixth generation bonding agent was applied after tooth preparation and before impression making. Final prosthesis was luted using GlassIonomer luting cement. The sensitivity assessment was done after 1 week, 1 month and 6
months. Results: There was statistically significant difference in the reduction of sensitivity with the use of a dentin bonding agent at 1 week and 1 month but not at 6 months. There was no significant difference between the age groups.

Conclusion: Preventive treatment with immediate dentin sealing using a dentin bonding agent significantly reduces immediate post-cementation hypersensitivity.

Hodosh AJ, Hodosh S, Hodosh M. Potassium nitrate-zinc oxide eugenol temporary cement for provisional crowns to diminish postpreparation tooth pain. J Prosthet Dent. 1993 Dec; 70(6):493-5.

Abstract

Pulpal injury commonly occurs with tooth preparation for complete fixed partial dentures. This can be documented by the substantial incidence of pain after tooth preparation. In this study, a 4% potassium nitrate-zinc oxide eugenol temporary cement was used to secure provisional crowns over recently prepared teeth and it significantly reduced the incidence and severity of pain after tooth preparation and impression taking.

Kuijs RH, Fennis WM, Kreulen CM, Roeters FJ, Creugers NH, Burgersdijk RC. A randomized clinical trial of cusp-replacing resin composite restorations: efficiency and short-term effectiveness. Int J Prosthodont. 2006 Jul-Aug;19(4):349-54.

Abstract

PURPOSE:

This study aimed to assess the efficacy and short-term effectiveness of the morphology and function of direct and indirect cusp-replacing resin composite restorations.

MATERIALS AND METHODS:

In 94 patients, 106 cusp-replacing restorations for maxillary premolars were fabricated to restore Class II caries lesions with 1 cusp missing. Fifty-four direct (Clearfil AP-X) and 52 indirect (Estenia) resin composite restorations were placed following a strict protocol. The treatment technique and operator were assigned randomly. Treatment time was recorded for all restorations. One-month postoperative evaluation included assessment of postoperative sensitivity and presence of occlusal and proximal contacts.

RESULTS:

Treatment time for the indirect technique (68 +/- 17 min) was longer than for the direct technique (45 +/- 13 min). Regression analysis revealed that the restorative method, operator, and location of the preparation outline had a statistically significant effect on the total treatment time. Occlusal contacts were observed in 94% of the direct restorations and in 98% of the indirect restorations (chi-square, P>.05). Mesial proximal contacts were present in 98% of the direct and in 97% of the indirect restorations (chi-square, P > .05). Distal contacts were present in 100% of the restorations for both techniques. Postoperative sensitivity within 1 week posttreatment was reported for 11% of the direct restorations and for 13% of the indirect restorations, but decreased to 4% and 6%, respectively, after 1 month (chi-square, P > .05).

CONCLUSION:

The results of this study suggest that in the short term, both direct and indirect adhesive techniques are adequate to restore the morphology and function of premolars presenting with Class II caries lesions and a missing cusp.

Lockard MW. A retrospective study of pulpal response in vital adult teeth prepared for complete coverage restorations at ultrahigh speed using only air coolant. J Prosthet Dent. 2002 Nov;88(5):473-8.

Abstract

STATEMENT OF PROBLEM:

The dental literature has shown a 3% to 25% pulpal necrosis rate as a result of tooth preparation for complete coverage restorations.

PURPOSE:

The purpose of this retrospective study was to examine clinical and radiographic records for evidence of pulpal necrosis in teeth prepared for complete coverage restorations at ultrahigh speed when air coolant alone was used.

MATERIAL AND METHODS:

The 1847 teeth in this study (182 fixed partial denture abutment teeth and 1665 single teeth restored with 21 all-ceramic, 1095 metal-ceramic, and 731 all-metal restorations) were prepared with diamond instruments (burs) in a sweeping or painting motion with the use of light pressure (1-3 oz) at ultrahigh speed with air coolant alone from the handpiece. New burs were used for each patient and then discarded. Each bur was used on no more than 4 teeth. All impressions were made with reversible hydrocolloid. Provisional restorations were fabricated on a stone cast and cemented with zinc oxide and eugenol cement. Provisional restorations were removed at 3 to 4 weeks and definitive restorations placed. Between 1970 and 1989, 6 different luting agents (zinc phosphate, resin, glass ionomer, ortho-ethoxybenzoic acid, carboxylate, and polycarboxylate) were used to place definitive restorations. All patients were questioned about symptoms of tooth sensitivity, tenderness, or pain at their regular (4- to 6-month) hygiene recall appointments. Success was defined as any definitively restored teeth that remained free of radiographic evidence of periapical radiolucency and clinical signs and symptoms of pulpal sensitivity or pain recorded in the clinical record. The results were compared with rates of pulpal necrosis for teeth prepared with water coolant as reported in the dental literature published between 1970 and 1997.

RESULTS:

Of 638 teeth prepared between 1970 and 1979, the pulpal necrosis rate was 2.19% (14 teeth: 12 single teeth and 2 fixed partial denture abutment teeth) (97.81% success rate). Of 1209 teeth prepared between 1980 and 1989, the pulpal necrosis rate was 0.66% (8 teeth: 7 single crown teeth and 1 partial denture abutment tooth) (99.34% success rate). Of 1825 teeth prepared between 1970 and 1989, radiographic evidence of pulpal necrosis was found in 0% (100% success rate). No clinical symptoms of pain or sensitivity were recorded in the patient records for the surviving teeth during the time period of this study, which was conducted in May 2001. No crowns were repaired or removed as a result of carious lesions. No higher incidence of pulpal necrosis relative to the type of luting agent was observed.

CONCLUSION:

Within the limitations of this retrospective study, it is suggested that tooth reduction procedures can be completed with minimal damage to the pulp when only air coolant from the dental handpiece is used.

Pousette Lundgren G, Morling Vestlund GI, Trulsson M, Dahllöf G. A randomized controlled trial of crown therapy in young individuals with amelogenesis imperfecta. J Dent Res. 2015 Aug;94(8):1041-7. Epub 2015 Apr 29

Abstract

Amelogenesis imperfecta (AI) is a rare, genetically determined defect in enamel mineralization. Existing treatment recommendations suggest resin-composite restorations until adulthood, although such restorations have a limited longevity. New crown materials allow for minimal preparation techniques. The aim of this study was to compare the quality and longevity of 2 crown types-Procera and IPS e.max Press-in adolescents and young adults with AI. A secondary aim was to document adverse events. We included 27 patients (11 to 22 y of age) with AI in need of crown therapy in a randomized controlled trial using a split-mouth technique. After placing 119 Procera crowns and 108 IPS e.max Press crowns following randomization, we recorded longevity, quality, adverse events, and tooth sensitivity. After 2 y, 97% of the crowns in both crown groups had excellent or acceptable quality. We found no significant differences in quality between Procera and IPS e.max Press crowns. Tooth sensitivity was significantly reduced after crown therapy ($P < 0.001$). Endodontic complications occurred in 3% of crowns. The results show that it is possible to perform crown therapy with excellent results and without severe complications in young patients with AI. The study is registered at http://www.controlled-trials.com (ISRCTN70438627).

Quarnstrom F, Collier N, McDade E, McLean K, Munk A, Nicholls J. A randomized clinical trial of agents to reduce sensitivity after crown cementation. Gen Dent. 1998 Jan-Feb;46(1):68-74.

Abstract

Three desensitizing agents were evaluated for the control of sensitivity after cementation of 77 crowns. Information was collected on pain in response to hot, cold, or bite preoperatively; and postoperatively with temporary crowns at one week and at one month after cementation of crowns. No medicament was clearly better than the placebo.

Rosenstiel SF, Land MF, Crispin BJ. Dental luting agents: A review of the current literature. J Prosthet Dent. 1998 Sep; 80(3):280-301

Abstract

STATEMENT OF PROBLEM:

The practice of fixed prosthodontic has changed dramatically with the introduction of innovative techniques and materials. Adhesive resin systems are examples of these changes that have led to the popularity of bonded ceramics and resin-retained fixed partial dentures. Today's dentist has the choice of a water-based luting agent (zinc phosphate, zinc polycarboxylate, glass ionomer, or reinforced zinc oxide-eugenol) or a resin system with or without an adhesive. Recent formulations of glass ionomer luting agents include resin components (resin-modified glass ionomers), which are increasingly popular in clinical practice.

PURPOSE:

This review summarizes the research on these systems with the goal of providing information that will help the reader choose the most suitable material.

MATERIAL:

The scientific studies have been evaluated in relation to the following categories: (1) biocompatibility, (2) caries or plaque inhibition, (3) microleakage, (4) strength and other mechanical properties, (5) solubility, (6) water sorption, (7) adhesion, (8) setting stresses, (9) wear resistance, (10) color stability, (11) radiopacity, (12) film thickness or viscosity, and (13) working and setting times. In addition, guidelines on luting-agent manipulation are related to available literature and include: (1) temporary cement removal, (2) smear layer removal, (3) powder/liquid ratio, (4) mixing temperature and speed, (5) seating force and vibration, and (6) moisture control. Tables of available products and their properties are also presented together with current recommendations by the authors with a rationale.

Saad Del-D, Atta O, El-Mowafy O.The postoperative sensitivity of fixed partial dentures cemented with self-adhesive resin cements: a clinical study. J Am Dent Assoc. 2010 Dec; 141(12):1459-66

Abstract

BACKGROUND:

The authors investigated the postcementation sensitivity associated with self-adhesive resin cements used with fixed partial dentures (FPDs).

METHODS:

The authors recruited 20 patients who needed posterior porcelain-fused-to-metal FPDs and divided them randomly into three groups. They prepared 50 abutments, then cemented FPDs with one of two self-adhesive resin cements (Breeze Self-Adhesive Resin Cement, Pentron Clinical Technologies, Wallingford, Conn., and RelyX Unicem Self-Adhesive Universal Resin Cement, 3M ESPE, Seefeld, Germany) or an etch-and-rinse resin cement (RelyX ARC Adhesive Resin Cement, 3M ESPE, St. Paul, Minn.). The authors measured participants' tooth sensitivity to cold water, air blast and biting at 24 hours and at two, six and 12 weeks after FPD cementation by using a continuous visual analog scale (VAS). Data were analyzed statistically by means of the Mann-Whitney test.

RESULTS:

For cold tests, the highest VAS scores occurred 24 hours after cementation. The mean VAS scores associated with RelyX ARC were significantly higher than those associated with Breeze and RelyX Unicem ($P < .001$) at all test intervals. The mean cold-test VAS scores associated with Breeze and RelyX Unicem were not significantly different ($P > .05$). With all cements, sensitivity to cold decreased significantly after two to six weeks; however, with RelyX ARC, VAS scores stayed above the 30 percent level even after 12 weeks. The biting sensitivity associated with RelyX ARC was significantly higher than that associated with Breeze and RelyX Unicem ($P < .001$), and it remained above the 20 percent level even after 12 weeks. Those with Breeze-cemented FPDs had no sensitivity to biting, whereas those with RelyX Unicem-cemented FPDs had a mean biting sensitivity value of less than 5 percent at two weeks only.

CONCLUSIONS:

and

CLINICAL IMPLICATIONS:

Breeze and RelyX Unicem were associated with significantly lower postoperative tooth sensitivity values than was RelyX ARC. With Breeze and RelyX Unicem, postoperative tooth sensitivity disappeared after two to six weeks; however, with RelyX ARC it remained even after 12 weeks. Clinicians may use self-adhesive resin cements, and benefit from their bonding potential, without fear of patients' developing tooth sensitivity.

Schenke F, Federlin M, Hiller KA, Moder D, Schmalz G. Controlled, prospective, randomized, clinical evaluation of partial ceramic crowns inserted with RelyX Unicem with or without selective enamel etching. 1-year results. Am J Dent. 2010 Oct;23(5):240-6.

Abstract

BACKGROUND:

The authors investigated the postcementation sensitivity associated with self-adhesive resin cements used with fixed partial dentures (FPDs).

METHODS:

The authors recruited 20 patients who needed posterior porcelain-fused-to-metal FPDs and divided them randomly into three groups. They prepared 50 abutments, then cemented FPDs with one of two self-adhesive resin cements (Breeze Self-Adhesive Resin Cement, Pentron Clinical Technologies, Wallingford, Conn., and RelyX Unicem Self-Adhesive Universal Resin Cement, 3M ESPE, Seefeld, Germany) or an etch-and-rinse resin cement (RelyX ARC Adhesive Resin Cement, 3M ESPE, St. Paul, Minn.). The authors measured participants' tooth sensitivity to cold water, air blast and biting at 24 hours and at two, six and 12 weeks after FPD cementation by using a continuous visual analog scale (VAS). Data were analyzed statistically by means of the Mann-Whitney test.

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CONCLUSIONS:

and

CLINICAL IMPLICATIONS:

Breeze and RelyX Unicem were associated with significantly lower postoperative tooth sensitivity values than was RelyX ARC. With Breeze and RelyX Unicem, postoperative tooth sensitivity disappeared after two to six weeks; however, with RelyX ARC it remained even after 12 weeks. Clinicians may use self-adhesive resin cements, and benefit from their bonding potential, without fear of patients' developing tooth sensitivity.

Sensat ML, Brackett WW, Meinberg TA, Beatty MW. Clinical evaluation of two adhesive composite cements for the suppression of dentinal cold sensitivity. J Prosthet Dent. 2002 Jul;88(1):50-3.

Abstract

STATEMENT OF PROBLEMS:

Postoperative cold sensitivity after the cementation of indirect restorations with composite cements has been reported frequently but not scientifically documented.

PURPOSE:

This controlled clinical study was designed to simulate the dentin/composite cement interface immediately after cementation of a cast restoration. The desensitizing capabilities of a composite cement that contains a self-etching, dual-polymerizing resin adhesive system were compared with those of a composite cement that use phosphoric acid etching followed by a single-bottle, light-activated primer/resin-based adhesive.

MATERIAL AND METHODS:

The hypersensitive root surfaces of selected teeth were randomized to receive 1 of 3 treatments: coating with a self-etching adhesive (Linkmax) and its respective cement, coating with a conventionally etched adhesive (RelyX ARC) and its cement, or no treatment (negative control). The sample size was 22. Dentin sensitivity was ascertained with an accurate cold testing device that slowly decreased in temperature. Tooth sensitivity was measured both immediately and at 7 days after placement. Two-way analysis of variance and Fisher's least significant difference test ($P<.05$) were used to determine whether significant differences existed as a function of treatment type or time.

RESULTS:

Immediately after placement, the self-etching adhesive and its respective cement resulted in more suppression of cold sensitivity than no treatment (control); with Linkmax treatment, the temperature at which teeth responded was reduced by 8.4 degrees C. The conventionally etched adhesive and its cement reduced the temperature at which teeth responded by 9.4 degrees C. After 1 week, these temperature reductions were 7.0 degrees C and 4.3 degrees C, respectively. Untreated controls at the 2 intervals showed a mean decrease in sensitivity to cold of 3.6 degrees C and 4.1 degrees C. Statistical analysis showed type of composite cement to be a significant factor.

CONCLUSION:

Within the limitations of this study and in comparison to untreated control teeth, Linkmax treatment resulted in a significant reduction in tooth root sensitivity over 1 week ($P=.02$), whereas RelyX ARC did not ($P=.066$).

Van Dijken JW. Resin-modified glass ionomer cement and self-cured resin composite luted ceramic inlays. A 5-year clinical evaluation. Dent Mater. 2003 Nov;19(7):670-4.

Abstract

OBJECTIVE:

This study evaluated IPS Empress ceramic inlays luted with two chemical-cured luting agents, a resin-modified glass ionomer cement (Fuji Plus (F)) and a resin composite (RC) (Panavia 21 (P)).

METHODS:

Seventy-nine ceramic inlays were placed in Class II cavities in 29 patients. At least two inlays were placed in each patient to compare the luting techniques intra-individually. In each patient half of the inlays were luted with F and the other half with P. The inlays were evaluated clinically, according to modified USPHS criteria (van Dijken, 1986), at baseline, after 6 months, and yearly during 5 years.

RESULTS:

At 5 years, 71 inlays were evaluated. Two small partial fractures were observed at 3 years (1P, 1F). One inlay showed recurrent root caries at 4 years (P). Four inlays, two in each group showed non-acceptable color match (2P, 2F). Small defects were observed in 4 inlays (2P, 2F). A slight ditching of the cement margins was observed in both luting groups

but did not seem to increase during the second half of the evaluation. No significant difference in durability was observed between the two luting agents.

SIGNIFICANCE:

IPS Empress inlays luted with the chemical-cured RC and the resin-modified glass ionomer cement functioned satisfactory during the 5 years follow-up.

Yoneda S, Morigami M, Sugizaki J, Yamada T. Short-term clinical evaluation of a resin-modified glass-ionomer luting cement. Quintessence Int. 2005 Jan;36(1):49-53

Abstract

OBJECTIVES:

Resin-reinforced glass-ionomer cements were developed by adding resin components to conventional glass-ionomer cement. This improved physical properties and bonding characteristics. FujiCEM is the first paste-paste-type resin-modified glass-ionomer lutingcement that enables consistent mixture. The purpose of this study was to evaluate the short-term clinical performance of FujiCEM, which was used for final cementation of indirect restorations, such as inlays, crowns, and fixed partial dentures.

METHOD AND MATERIALS:

A total of 290 restorations (165 crowns, 71 inlays, 15 onlays, 36 fixed partial dentures, 3 implant superstructures) were placed in 268 patients (137 males, 131 females) with a mean age of 54.4+/-13.0 years. Restorations were luted with FujiCEM mixed for 10 seconds after the teeth surfaces were treated with a conditioner containing 10% citric acid and 2% ferric chloride for 20 seconds, washed, and dried with gentle air flow. Out of the investigated 337 teeth, 99 (29%) teeth were vital, and 238 (71%) were nonvital. These restorations were followed up for a period of 21 months. All the restorations were evaluated for postoperative sensitivity, secondary caries, gingival condition, and pocket depth.

RESULTS:

No clinical failures (eg, dislodgment, secondary caries, irritation of soft tissue, and postoperative sensitivity) were observed.

CONCLUSION:

FujiCEM had promising clinical performance with inlays, crowns, onlays, fixed partial dentures, and implant superstructures at 21 months after service.

e. Selección final de artículos por temática (criterios de selección e inclusión de artículos)

Los artículos preseleccionados se obtendrán en texto completo y se les aplicarán los siguientes criterios de selección de los artículos de acuerdo a cada temática para la revisión final.

Criterios de selección de artículos

- Se seleccionarán todos los artículos publicados desde 1990 hasta la fecha
- Se aplicaron las estrategias de búsqueda en la base de datos de PubMed y EMBASE.
    - Se seleccionaron ensayos clínicos aleatorizados.
    - Artículos con reporte y tiempo de seguimiento a una semana como mínimo.

4. Registro en Prospero

Registro en P2016: ID=CRD42016038883
Centro de revisiones y diseminación.
Universidad de York

UNIVERSITY of York
Centre for Reviews and Dissemination

NHS
National Institute for Health Research

PROSPERO International prospective register of systematic reviews

Post-cementation sensitivity in vital abutments of indirect restorations: a systematic review

Leandro Chambrone, Juan Carlos Uribe, Martha Cecilia Tamoyo, Cecilia Ruiz, Alfonso Cuadro, Madelline Mayo

Citation
Leandro Chambrone, Juan Carlos Uribe, Martha Cecilia Tamoyo, Cecilia Ruiz, Alfonso Cuadro, Madelline Mayo. Post-cementation sensitivity in vital abutments of indirect restorations: a systematic review. PROSPERO 2016:CRD42016038883 Available from http://www.crd.york.ac.uk/PROSPERO_REBRANDING/display_record.asp?ID=CRD42016038883

Review question(s)
What type of luting agent presents greater post-operative hypersensitivity in indirect restorations on vital teeth?

Searches
Detailed search strategies will be developed for MEDLINE (Medical Literature Analysis and Retrieval System Online) and EMBASE (Excerpta Medica Database) without language restrictions.

Databases will be searched up to and including Jun 30, 2016 using MeSH (Medical Subject Headings) terms, key words, other free terms and Boolean operators (OR, AND). These will be combined and detailed search strategies will be developed for each database following the search strategy presented for MEDLINE:

#1: Dentin sensitivity OR dentin hypersensitivity OR dentinal tubules OR dentin, pain OR dentinal hypersensitivity OR tooth, hypersensitivity OR root hypersensitivity OR vital tooth OR pulp sensitivity

#2: Cements OR dental cements OR dental adhesives OR resin cements OR crown cementation OR resin cements OR luting agents OR bonding

#3: #1 AND #2

#4: Early hypersensitivity OR post-cementation hypersensitivity OR crown cementation / hypersensitivity OR cementation

#5: #3 AND #4

Types of study to be included
Randomised clinical trials and controlled clinical trials will be considered eligible for inclusion.

Condition or domain being studied
Crowns and partial-fixed prostheses are some of the most common restoration procedures in restorative dentistry. These require preparation of dental tissue involving enamel and dentin before being definitely cemented. Hyper-sensibility is one of the most frequent complications during vital teeth bonding [Jokstad, 2004].

The condition is characterised by transient, acute pain of the exposed dentin as a result of tooth dehydration, osmotic changes, thermal, chemical and tactile stimuli. It presents itself after cementing a definitive restoration on a vital tooth and cannot be described as any other type of dental pathology [Jokstad, 2004, Bebermeyer et al., 1994, Hu & Zhu, 2010].

Various studies suggest that post-cementing hyper-sensibility has multiple causes such as bacterial, mechanical, chemical and inherent to the cement. Those of bacterial origin are related with marginal microfiltration due to disadaptation of provisional restorations or by a defective crown seal, which allows a hydrolytic degradation of the cement. Mechanical origins are related with friction heat generated during dental preparation, air-drying, the

mechanical pressure of cement on dentinal fluid of exposed tubules and occlusal discrepancies. Chemical causes are generated by the exposure of dentin to cavitary disinfectants, acids, adhesives or haemostatic agents. Those inherent to the cementing agent are related to physical and biological characteristics such as pH and biocompatibility [Johnson et al., 1993, Brännström, 1996, Quarnstrom et al., 1998, Rosenstiel et al., 1998, Hilton et al., 2004].

It has been observed that post-cementing hyper-sensibility frequency ranges from 3.1% to 32% with degrees of severity: light, moderate and severe [Jokstad, 2004, Brännström, 1996, Hilton et al., 2004, Gupta et al., 2013, Brackett, 1992]. Additionally, it has been reported that hyper-sensibility is maintained between 3% and 6% of cases following a post-cementation of two and three years respectively [Maghrabi, 2011]. There are also reports of genre incidence in which females present greater hyper-sensibility before and after dental preparation [Safeer-Jaweed et al., 2015].

The analysis of randomised clinical trials has yielded that the determining factor in post-cementation hyper-sensibility is the type of cement. One of the most used for decades now is zinc phosphate, considered the gold standard, due to its initial low pH and solubility, [Jokstad, 2004, Sensat et al., 2002] has fallen out of use. Another cement is the glass ionomer which is widely, used due to its cariostatic effect by the release of fluoride and excellent physical and mechanical properties [Saad et al., 2010]. However, the hyper-sensibility produced can be compared to that of zinc phosphate [Hilton et al., 2004] or greater [Kern et al., 1996, Smales et al., 2002].

This can also be related to its low initial pH [Denner et al., 2007], which has led many dentists to not use it [Yoneda et al., 2005]. The most recent options are the resin cements, which present low solubility, and its initial pH is higher than zinc phosphate's and glass ionomer. It has also been reported post-cementation hyper-sensibility, which may be related with the material's polymerisation contraction generating marginal seal defects of the restorations [Kuijs et al., 2006, Maghrabi, 2011, Shetty et al., 2012].

Post-cementation hyper-sensibility is evidently a multifactorial entity and one of the most evaluated factors is the type of cement. None-the-less, in study results there is no consensus, and there are no meta-analysis or systematic revisions about this topic, which allow the dentist to take informed and accurate clinical decisions based on evidence in order to avoid this complication.

Participants/ population

Adult patients – male and female – who required newly cemented indirect fixed restorations such as inlays, onlays, single full coverage restorations and fixed partial denture with at least one week follow-up.

Intervention(s), exposure(s)

Indirect fixed restorations cemented with the following lutings agents:

- Conventional glass-ionomer
- Resin modified glass-ionomer
- Conventional resin cement
- Self-adhesive resin cement

Comparator(s)/ control

Indirect fixed restorations cemented with the following lutings agents:

- Zinc phosphate
- Conventional glass-ionomer
- Resin modified glass-ionomer
- Conventional resin cement

• Self-adhesive resin cement

Outcome(s)

Primary outcomes

Post-cementation sensitivity evaluated after thermal and mechanical stimulation by visual analogue scale or dichotomic scale with at least one week follow-up.

Secondary outcomes

None.

Data extraction, (selection and coding)

Two independent reviewers will screen the titles, abstracts and full texts of the papers. Disagreement between the reviewers will be resolved by means of discussion. In the event that an agreement cannot be reached, a third reviewer will be consulted. Where important data for a review is missing, an attempt to contact the authors will be made in order to resolve the ambiguity in the trials.

The following data will be collected and recorded in duplicate: citations, publication status and year of publication, location of the trial, study design, characteristics of the participants, outcome measures, methodological quality of the trials and conclusions.

Risk of bias (quality) assessment

For RCTs and controlled clinical trials, the methodological quality will be evaluated following the Cochrane Collaboration's tool for assessing risk of bias (Higgins and Green, 2011), as adapted by Chambrone et al., (2010a). Briefly, the randomisation and allocation methods will be classified as adequate, inadequate, unclear, or not applicable. The thoroughness of the follow-up period, masking of examiners, selective reporting and other sources of bias will be coded as yes/no responses. Based on these answers, the risk of bias was categorised according to the following classifications:

1. A low risk of bias if all criteria have been met (i.e., adequate methods of randomisation and allocation concealment and a yes answer to all questions about completeness of follow-up questions and masking of examiners);

2. An unclear risk of bias if one or more criteria have been partly met (i.e., unclear criteria have been set); or

3. A high risk of bias if one or more criteria have not been met.

Additionally, stars/points will be given for each methodological quality criterion, and each included study could be given a maximum of 14 points. Studies with 11 to 14 points (approximately 80 % or more of the domains satisfactorily fulfilled) will be arbitrarily considered to be of high quality; studies with 8 to 10 stars will be of medium quality and studies with fewer than 8 stars will be of low methodological quality.

Strategy for data synthesis

Data will be pooled into evidence tables and a descriptive summary will be composed to determine its quantity and study variations (characteristics and results). Random effects meta-analyses will be performed throughout the review using dichotomous or continuous data if considered viable and these will be expressed as pooled risk (RR), odd ratios (OR) or mean difference (MD) and associated 95% confidence intervals (CIs). The significance of discrepancies in the estimates of the treatment effects from the different trials will assessed by means of the Cochrane test for heterogeneity and the I-squared statistic (Higgins and Green, 2011). Any analyses will be performed using Review Manager statistical analysis software (Version 5.1, Nordic Cochrane Centre, Copenhagen, Denmark).

Analysis of subgroups or subsets

The analysis of subgroups will be carried out according to:

• The type of restoration: 1) inlays and onlays, 2) single full coverage restorations, fixed partial denture.

• The type of luting agent.

09 May 2016

Stage of review at time of this submission	Started	Completed
Preliminary searches	Yes	No
Piloting of the study selection process	Yes	No
Formal screening of search results against eligibility criteria	No	No
Data extraction	No	No
Risk of bias (quality) assessment	No	No
Data analysis	No	No

PROSPERO
International prospective register of systematic reviews
The information in this record has been provided by the named contact for this review. CRD has accepted this information in good faith and registered the review in PROSPERO. CRD bears no responsibility or liability for the content of this registration record, any associated files or external websites.

5. Evaluación por evidencia

Para evaluar por evidencia a cada artículo se le aplico los criterios de ***Citation Form and publication status.*** Los cuales fueron sometidos a evaluación y fueron realizados por los autores en pares, para luego ser discutidos y consolidados. Los formatos de ***Citation Form and publication status*** consolidados se encuentran en anexos. El Formato Original se presenta a continuación:

CITATIONS FORMS DE ARTICULOS SELECCIONADOS

Citation and publication status

Titule:

Location of trial

1. ( ) private practice
2. () university/hospital
3. Country: _____

I. Type of Study

1. ( ) Observational studies (case-control, prospective cohort studies)
2. () Interventional - ( )

II. Type of Participants (proceed bellow if Step I met inclusion criteria)

1. Assessment of patients with permanent vital teeth restored inlays/onlays, single crowns, or fixed partial dentures. **( ) Yes ( ) No**.
2. Use of modified resin glass ionomer, resin cements or zinc-phosphate cement. **( ) Yes ( ) No**
3. At least 1 week follow-up **( ) Yes ( ) No**.

III. Types of interventions (proceed below if Step I and II met inclusion criteria)

1. Sample size [Per group]: ( ) #Male ( ) #Female( ) Age rage ( ) Mean age ( )
2. Control Group

3. Test Group

IV. Types of outcome measures and quality assessment

1. Outcome measures:
   - *Control group:* # of teeth with dental hypersensitivity : ( ) Yes ( ) No
   - *Test group:* # of teeth with dental hypersensitivity : ( ) Yes ( ) No

   Note: (Reported by patient when Patient=tooth: *por cada paciente es un diente- no aplica a boca dividida)*
   - Test group: # of Patients=teeth with dental hypersensitivity : ( ) Yes ( ) No

- Control group: # of Patients=teeth with dental hypersensitivity : ( ) Yes ( ) No

2. Randomization*: ( ) adequate ( ) inadequate ( ) unclear.
3. Allocation*: ( ) adequate ( ) inadequate ( ) unclear.
4. Blindness of patients and examiners ( ) yes ( ) no ( ) unclear.
5. Completeness of the follow-up will be based in the following questions:
   a. Was reported the number of subjects at baseline and at the completion of the follow-up period interval? ( ) yes ( ) no
   b. All patients completed the follow up period ( ) yes ( ) no *[if no answer item c]*
   c. Reasons for drop-outs

6. Selective reporting. Do you think that other important information was designedly not informed in the paper? ( ) yes ( ) no ( ) unclear
7. Others sources of bias. Is there any other visible/potential source of bias?: ( ) yes ( ) no ( ) unclear
8. Source of funding

9. Conflict of interest

10. Notes

Al diligenciarse los formatos correspondientes a cada artículo se resumieron en forma de *Risk of Bias summary,* utilizando el software Review Manager 5.3 generando el siguiente gráfico, el cual hace parte del artículo original.

6. Consideraciones en Propiedad Intelectual

a. Sustento legal

Derechos de Autor

Las denominadas redes digitales, fruto de la combinación de la informática y las telecomunicaciones, no sólo son una novedosa herramienta para la transmisión de datos e información, sino que marcaron el inicio de una nueva sociedad, la denominada sociedad de la información, lo que está causando alteraciones en las relaciones económicas, políticas, sociales y culturales, y está incidiendo definitivamente en el desarrollo de las naciones: "estas superautopistas de la información -o más exactamente, redes de inteligencia distribuida- permitirán compartir la información, conectar y comunicar a la comunidad global…la Infraestructura Global de la Información es el prerrequisito esencial para el desarrollo sostenido".

La tecnología digital que permite la transmisión de información a costos más bajos y de manera más veloz, comparados con los medios tradicionales, hace posible la comunicación interactiva entre millones de usuarios conectados a la red. En razón a que gran parte de la información que circula a través de las redes digitales, está constituida por obras protegidas por el derecho de autor, la comunidad internacional ha volcado su atención sobre las adecuaciones que debe emprender el derecho de autor, de manera que sea el sistema apto para responder a los desafíos que las tecnologías de la comunicación y la información le han planteado, con el fin de garantizar la libre circulación de bienes culturales, su divulgación y acceso, y a la vez, asegurar a los autores y demás titulares de derechos una protección adecuada a sus obras y a las inversiones en su producción.

Se hace imperativa una respuesta legislativa, acorde con el marco internacional que al efecto ha establecido el Tratado de la Organización Mundial de la Propiedad intelectual "OMPI" de 1996 sobre Derecho de Autor –TODA- para la adecuada protección de las obras en el entorno digital.

Implicaciones para el derecho de autor de nuevas creaciones y de nuevos derechos

Todos estos avances de la tecnología digital tienen sus implicaciones para el derecho de autor, que aún no se acaban de conocer con certeza, en razón a la dinámica misma de la tecnología. El libro es quizás uno de los sectores más afectados por las nuevas tecnologías y que ha traído mayores repercusiones para el derecho de autor, en razón a que otros sectores ya habían experimentado y

solucionado los problemas derivados de su divulgación a través de soportes intangibles, mientras que el libro todavía no lo ha hecho.

Existen los sistemas anti-copia, que justamente impiden copiar una obra; los sistemas de acceso, para garantizar la seguridad y adecuado acceso a la información y a los contenidos protegidos, como la criptografía, la firma digital, el sobre electrónico; los sistemas de marcado y tatuaje, en los que se inscribe cierta información en un código digital, como la marca de agua.

En relación con este tema, la normativa internacional a través de los Tratados Internet ha establecido la obligación para los Estados miembros de proporcionar protección jurídica adecuada y recursos jurídicos efectivos contra la acción de eludir las medidas tecnológicas efectivas que sean utilizadas por los autores en relación con el ejercicio de sus derechos en virtud del presente Tratado o del Convenio de Berna y que, respecto de sus obras, restrinjan actos que no estén autorizados por los autores concernidos o permitidos por la Ley.

En este propósito de garantizar una efectiva protección de las obras en el entorno digital, la gestión colectiva de derechos de autor adecuada a este mundo digital podrá, mediante la aplicación de dispositivos de identificación y rastreo de obras, controlar su uso de las obras a través de las transmisiones digitales

El derecho de autor, como derecho de propiedad sui generis, tiene una función social que se ha expresado a través de los casos en que se restringe su ejercicio exclusivo, en aras de alcanzar propósitos de orden educativo, cultural y de información.

Los casos de libre utilización pretenden crear un equilibrio entre el derecho de autor y el derecho a la cultura, a la educación, a la información, los cuales deben enmarcarse dentro de parámetros internacionales, conocidos como usos honrados, en razón a que su uso masivo a nivel universal causaría graves perjuicios a la producción y comercialización de bienes intelectuales. Estos casos de libre utilización deben ser expresamente establecidos en la ley y son de interpretación restrictiva.

Esto significa que la libre utilización de obras en el entorno digital con fines de enseñanza y las establecidas para las bibliotecas deberán revisarse para establecer si deben ser ampliadas en el entorno digital o no, para adecuarse a los parámetros internacionales señalados por el TODA en su artículo 10, según los cuales debe tratarse de casos especiales, que no atenten contra la normal

explotación de la obra y no causen un perjuicio injustificado a los intereses del autor. En qué casos la digitalización, el almacenamiento o la transmisión digital de fondos bibliográficos, o de material educativo, está permitida y en qué casos no lo está.

Desde las técnicas analógicas ya se anotaba que no se justificaba más como caso de restricción al derecho exclusivo del autor. Evidentemente las técnicas digitales agravan la situación puesto que, como lo afirma André Lucas se aumenta la oferta y mejora la calidad.....hasta tal punto que es de temer que, gracias a la difusión de las técnicas digitales, al autor no le quede ya nada que explotar, agregamos: si no se controla su explotación a través de los mismos medios tecnológicos que pueden permitir un seguimiento riguroso de la explotación de obras. Mantener la copia privada como libre reproducción no tiene justificación alguna en el ámbito digital, donde tendría un impacto mucho más negativo para la economía, en razón a que su difusión sería muy superior.

7. Proceso de estructuración del artículo

7.1. Resultados

a. Selección de artículos

Por medio de la estrategia PICO se realizó una estrategia de búsqueda en bases de datos EMBASE y PUBMED, de los cuales se identificaron 648 Publicaciones potencialmente relevantes. Fueron excluidas 615 publicaciones basados por título y abstract. En esta etapa fueron pre-seleccionados 33 artículos en texto completo por presentar potencialmente relevancia para el estudio, de los cuales fueron excluidos 22 por no cumplir con la totalidad de los criterios de inclusión. Arrojando un total de 11 artículos finalmente seleccionados para el estudio.

b. Artículos seleccionados

Los artículos finalmente seleccionados fueron 1. Bebermeyer & Berg, 1994 2. Blatz et al., 2013 3.Chandrasekhar, 2010 4. Denner et al., 2007 5. Hassan et al., 2001 6. Hilton et al., 2004 7. Johnson et al., 1993 8. Piwowarczyk et al., 2012. 9. Shetty. et al., 2012 10. Smales et al., 2002. 11. Taschner et al., 2012

c. Evaluación por evidencia

Utilizando el citation form se evaluó la evidencia de los 11 estudios seleccionados y se encontró que: Al comparar todos los estudios con respecto a los diferentes parámetros metodológicos que se analizaron, se observó que el que tuvo mayor cantidad de parámetros con bajo riesgo de sesgo fue el estudio Piwowarczyk et al., (2012) en el que además se observó que solo el reporte selectivo y otras fuentes de sesgo, tuvieron alto riesgo de sesgo y el método de aleatorización no fue claro. Piwowarczyket al., 2012 [Fig. 2].

La mayoría de estudios reportaron haber hecho procesos de asignación con bajo riesgo de sesgo ((Johnson *et al*., 1993; Bebermeyer & Berg, 1994; Smales *et al*., 2002; Hassan *et al*., 2011; Taschner et al., 2012; Piwowarczyket al., 2012; Blatz *et al*., 2013; Hilton *et al*. 2013) y solo 3 no la reportaron de manera clara (Denner *et al*., 2017; Chandrasekhar *et al*., 2010; Shetty *et al*., 2012). En cuanto a la aleatorización se observó que seis de los estudios la realizaron con bajo riesgo de sesgo (Johnson *et al*., 1993; Bebermeyer& Berg, 1994; Smales et al., 2002; Hassan et al., 2011; Blatz et al., 2013; Hilton et al. 2013) y en 5 de los estudios ésta no fue clara (Denner *et al*., 2007;

Chandrasekhar *et al*., 2010; Piwowarczyket al., 2012; Shetty et al., 2012; Taschner et al., 2012). Tanto la aleatorización como la asignación de la muestra no tuvieron alto riesgo de sesgo en ningún estudio [Fig. 2].

La mayoría de los estudios mostraron alto riesgo de sesgo tanto en el cegamiento de los pacientes como en de los examinadores (Johnson *et al*., 1993; Smales et al., 2002; Denner *et al*., 2017; Chandrasekhar *et al*., 2010; Shetty *et al*., 2012; Taschner et al., 2012; Blatz et al., 2013; Hilton et al. 2013), algunos de ellos también mostraron alto riesgo de sesgo en el tiempo de seguimiento (Smales et al., 2002; Piwowarczyk et al., 2012;Shetty et al., 2012), Taschner et al., 2012), y en el reporte selectivo (Johnson et al., 1993; Bebermeyer& Berg, 1994;Chandrasekhar et al., 2010; Hassan et al., 2011;Piwowarczyket al., 2012; Hilton et al. 2013;Blatz et al., 2013) [Fig. 2].

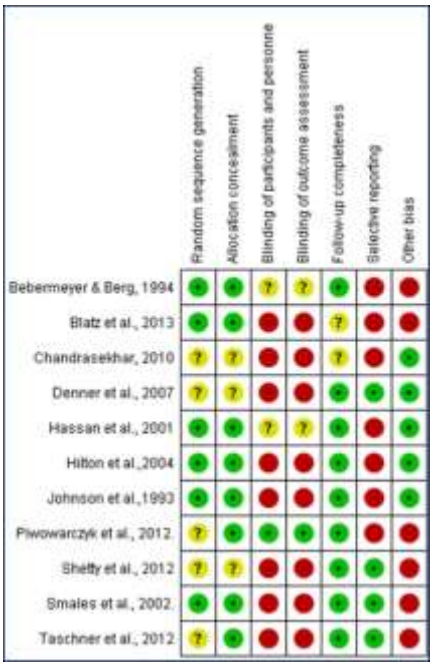

Figura 2. *Resumen de riesgo de sesgos para los artículos seleccionados en la revisión*

Extracción de datos

Table 2: Characteristics of included studies

Study	Participants /Type of restauration/ study design	Test/ control groups*	Postoperative sensitivity evaluation: Scale and parameters/Test/ Postoperative Follow Up **	Outcome/ Statistical Significance	*Author's main conclusions and notes*
1. Bebermeyer & Berg. 1994 [USA]	45 patients adults 45 Cast Complete Crown, 3/4 or 7/8 Crown or Onlay per group Randomised Clinical Trial. Split-Mouth	Test Group: GIC [Ketac™ Cem] Control Group: $ZnPO_4$ [FLECK'S® Cement]	**Perception ordinal scale** 1 No sensitivity 5: Extreme sensitivity Descriptive information about aetiology of sensitivity obtained by questionnaire 1 Wk.	Sensitivity Level (N° of Patients) GIC: 5(3), 1-4(39) $ZnPO_4$: 5(4), 1-4(40) There was no statistically significant difference observed between ZnPO4 and GIC when they were tested 1Wk after cementation. P value was not reported	The results indicate that restorations cemented with glass-ionomer cement did not show any more sensitivity than those cemented with zinc phosphate cement. Mixing conditions of the glass-ionomer materials are strict, it is particularly important to adhere to each manufacturer's recommendations for use to allow maximal benefit and minimal risk of sensitivity.
2. Blatz et al., 2013 [USA]	70 patients adults Age Range 24-65 yrs. Male: 16 CG/ 18 TG Female 29 CG/ 26 TG 88 full-coverage crowns: 44 per group. Randomised Clinical Trial –Open	Test Group: SARC [iCem® Heraeus] Control Group: RMGIC [GC Fuji PLUS®]	**Visual Analog Scale [VAS]** Range 0-10 0: not sensitivity 10: most severe sensitivity Sensitivity reported by patient Compressed air test Ice spray Test After: LB, 1 d., 1 wk. and 3 wks.	**Patient sensitivity report** [Mean (range)] RMGIC: LB 0.43(0-6), 1d 1.30 (0-8); 1 Wk.: 0.50 (0-6); 3Wks:0.43 (0-6) SARC: LB 0.36(0-4), 1d 0.52 (0-7); 1 Wk.: 0.39 (0-7); 3Wks:0.48 (0-9) **Patient sensitivity report** [Me ((IQR)] RMGIC: LB 0(0-0), 1d 0 (0-3); 1 Wk.: 0 (0-0); 3Wks: 0 (0-0) SARC: LB 0.0(0-0), 1d 0 (0-0); 1 Wk.: 0 (0-0); 3Wks: 0 (0-0) **Air sensitivity** [Mean (range)] RMGIC: LB 0.77(0-5); 1d 0.48 (0-4); 1 Wk.: 0.43 (0-3); 3Wks:0.34 (0-3) SARC: LB 0.55(0-4); 1d 0.23 (0-5); 1 Wk.: 0.07 (0-1); 3Wks:0.09 (0-1) **Air sensitivity** [Me ((IQR)] RMGIC: LB 0(0-1); 1d 0 (0-0.75); 1 Wk.: 0 (0-1); 3Wks: 0 (0-0) SARC: LB 0(0-1); 1d 0(0-0); 1 Wk.: 0 (0-0); 3Wks: 0 (0-0) **Ice sensitivity** [Mean (range)] RMGIC: LB 3.91(1.25-6); 1d 3.11 (0-8); 1 Wk.: 2.45 (0-6); 3Wks:1.98 (0-8) SARC: LB 3(0.25-7); 1 d 1.52 (0-9); 1 Wk.: 1.05 (0-8); 3Wks:1.00 (0-9) **Ice sensitivity** [Me ((IQR)] RMGIC: LB 3.21(0-8); 1d 3(1.25-4.75); 1 Wk.: 2 (1-4); 3Wks:2 (0-3) SARC: LB 3.48(0-9); 1 d 1.52 (0-9); 1 Wk.: 1.05 (0-8); 3Wks:1 (0-9) **Patient sensitivity report** Post cementation sensitivity was significantly higher for RMGIC after 1 d (p=0.02). No Statistically significant difference was observed between RMGIC and SARC when they were tested at LB (p=0.78), 1 Wk. (P=0.11) and 3 Wks. (p=0.98) after cementation. **Air Sensitivity**: Post cementation sensitivity was significantly higher for RMGIC at 1 Wk. after (p=0.01). No Statistically significant difference was observed between RMGIC and SARC when they were tested at LB (p=0.38), 1d and 3Wks. after cementation (p >0.05). **Ice sensitivity** Post cementation sensitivity was significantly higher for RMGIC at 1d. (p <.001), 1Wk. (p <.001), and 3 Wks. (p <.001). No Statistically significant difference was observed between RMGIC and SARC when they were tested at LB (p =0.36).	The cementation of crowns with SARC resulted in lower postoperative sensitivity than with RMGIC in the most of intervals of time evaluated by the different tests.

3.Chandrasekhar, 2010 [India]	60 patients adults Age Range 15-50 Yrs.	Test Group: GIC [SHOFU®]	**Scale 0-3** Grade 0 - No sensitivity Grade 1 – Mild sensitivity Grade 2 – Moderate sensitivity Grade 3 – Severe sensitivity	**Biting pressure Mean ± SD** **1 mm** $ZnPO_4$ 0.35±0.59; GIC 0.25±0.44; RMGIC 0.15±0.37 **1 Wk.** $ZnPO_4$ 0.20±0.52; GIC 0.15±0.49; RMGIC 0.00±0.00 **1 Mo.** $ZnPO_4$ 0.10±0.30; GIC 0.50±0.2; RMGIC 0.00±0.00 **Compressed air Mean ± SD** **1 mm** $ZnPO_4$ 1.10±0.8; GIC 0.95±0.82; RMGIC 0.95±0.83 **1 Wk.** $ZnPO_4$ 1.30±1.033; GIC 0.40±0.60; RMGIC 0.05±0.22 **1 Mo.** $ZnPO_4$ 1.35±1.04; GIC 0.00±0.00; RMGIC 0.05±0.22 **Cold water Mean ± SD** **1 mm** $ZnPO_4$ 1.55±1.00; GIC 1.55±1.05; RMGIC 1.55±1.05 **1 Wk.** $ZnPO_4$ 1.85±0.99; GIC 0.80±0.95; RMGIC 0.30±0.47 **1 Mo.** $ZnPO_4$ 1.60±0.99;GIC 0.40±0.82; RMGIC 0.15±0.37	The patients with restorations cemented with Resin-Modified Glass Ionomer demonstrated the least postoperative sensitivity when compared to Glass Ionomer and Zinc Phosphate cement at all intervals of time evaluated by different tests.
	60 Inlay cast restorations, 20 per group	Test Group: RMGIC [Vitremer® 3M ESPE]	Cold water test Compressed air test Biting pressure test Sensitivity reported by patient		
	Randomised Clinical Trial The teeth were randomly divided into three groups of 20 each. Group-I: 20 Inlay cast restorations cemented with Glass Ionomer Luting Cement. Group-II: 20 Inlay cast restorations cemented with Zinc Phosphate Cement. Group III: 20 Inlay cast restorations cemented with Resin-Modified Glass Ionomer cement	Control Group: $ZnPO_4$ [Harvard®]	After 1mm, 1 Wk. and 1 Mo.	There were no significant differences (P>0.05) between all the three cements at different intervals of time for **biting pressure test**. There were no significant differences (P> 0.05) among the three cements immediately after cementation, both with cold water test as compressed air test. After 1Wk. there was significant difference between all three cements with the **cold water test** ZnPO4 Vs. GIC: (P=0.01); ZnPO4 Vs. RMGIC: (P=0.001); GIC Vs. RMGIC: (P=0.05). After 1 Mo. with the same test there were significant differences between ZnPO4 and GIC: (P=0.001) and between ZnPO4 and RMGIC: (P=0.001), but there was not significant difference between GIC and RMGIC: (P>0.05). After 1Wk. there was significant difference between all three cements with the **compressed air test**: ZnPO4 Vs. GIC: (P=0.01); ZnPO4 Vs. RMGIC: (P=0.001); GIC Vs. RMGIC: (P=0.02). After 1 Mo. with the same test there were significant differences between ZnPO4 and GIC: (P=0.001) and between ZnPO4 and RMGIC: (P=0.001), but there was not significant difference between GIC and RMGIC: (P>0.05). The ZnPO4 group reported the highest level of sensitivity values and the RMGIC group reported the least level at these two intervals of time with both tests: cold water and compressed air.	
4. Denner et al., 2007 [Germany]	60 patients adults Age Range 22-65 yrs. Mean age: 44, 4 yrs. Male: 38 Female:22	Test Group: RC [Chemiace II®]	**Perception ordinal scale.** **No Response [N]** **Normal Response [NR]:** Sensation of cold but no pain **Severe Response [SR]:** Increased sensitivity causing a patient reflex.	**RC: Time- Point- Scale [N° of patients]** **1Wk.** NR [45], SR [6], N [0]; **6Mos.** NR [46], SR [3], N [2]; **12Mos.** NR [44], SR [1], N [0]; **24Mos.** NR [46], SR [0], N [0]. **GIC: Time- Point- Scale [N° of patients]** **1Wk.** NR [48], SR [3], N [0]; **6Mos.** NR [48], SR [3], N [0]; **12Mos.** NR [44], SR [3], N [0]; **24Mos.** NR [48], SR [0], N [0].	The incidence of postoperative hypersensitivity after cementation of full-crown restorations with a conventional glass-ionomer cement and a new adhesive resin cement was similar. In the patients observed 24 months after cementation, no cases of hypersensitivity were reported for either group. The percentage of hypersensitivity decreased notably during the follow-up period. There was a significant decrease of hypersensitivity with age. Women showed a significantly higher rate of hypersensitivity than men.
	120 full-coverage crowns independent or in FPD: 60 per group.		Ice spray Test		
	Randomised Clinical Trial- Split-Mouth Double Blind	Control Group: GIC [Ketac-Cem®]	After: 1 Wk., 6 Mos., 12 Mos .and 24 Mos.	**There was not statically significant difference between both cements at all intervals of time evaluated**(P>0.05)	

5. Hassan et al., 2001 [Pakistan]	208 patients adults Age range: 20 – 30 Yrs. Mean Age: 26.16 ± 3.15 208 full-coverage crowns in FPD: 108 per group. Randomised Clinical Trial- Single Blind	Test Group: RC [Panavia® F2] Control Group: RMGIC [Fuji® GC-II]	**Visual Analog Scale** **Range 0-10** 1-4: mild sensitivity 5-7: moderate sensitivity 8-10: severe sensitivity Cold sensitivity test. After: 1 Wk. 1 Mo. 3 Mo.	The sensitivity results showed that 98% of the patients exhibited only mild to moderate sensitivity irrespective of the type of cement used, at all follow up appointments. There was no statically significant difference between the two cements in terms of post cementation sensitivity. (P>0.05)	Majority of the patients exhibited either mild or moderate sensitivity on cold sensitivity tests, with a very small percentage experiencing severe sensitivity. The sensitivity responses mellowed down with time with both the luting cements. There was no significant difference (p>0.05) between the resin based luting cement and glass ionomer luting cement in terms of post cementation sensitivity in vital teeth with fixed restorations.
6. Hilton et al.,2004 [USA]	209 patients adults Male: 102 Female: 107 209 independent full-coverage crowns; 106 [RC] and 103 [GIC] Randomised Clinical Trial	Test Group: RMGIC [Fuji® I, GC] Control Group GIC [Rely X, 3M®/ESPE]	**Visual Analog Scale** **Range 0-10** 0 = no pain 10 = worst imaginable pain Descriptive information about aetiology of sensitivity obtained by questionnaire: Hot, Cold and Biting After: 1 Hr., 1 Wk., 1 Mo. and 3 Mos.	**GI** *Means (SD) Heat [H], Cold [C] and Biting [B] Sensitivity* **N° (absent/present) for Sensitivity at Any Time:** H: 73/30; C: 52/51; B: 77/26 **RMGI** *Means (SD) Heat [H], Cold [C] and Biting [B] Sensitivity* **N° (absent/present) for Sensitivity at Any Time:** H: 84/22; C: 64/42; B: 85/21 There was no statically significant difference between the two cements in hot, cold or biting sensitivity at any time. (P>0.05)	**La intervención fue realizada por odontólogos particulares en su consulta particular con extensa experiencia en prostodoncia fija.** **Los pacientes hacían parte de la práctica clínica de los odontólogos.** **El seguimiento estuvo a cargo de los mismos odontólogos y los examinadores realizaron el diligenciamiento vía telefónica**
7. Johnson et al.,1993 [USA]	86 patients adults 214 independent full-coverage crowns; 101 [ZnPO4] and 113 [GIC] Randomised Clinical Trial	Test Group: GIC [Ketac™ Cem. ESPE Premier] Control Group: ZnPO4 [FLECK'S®Mizzy Cement]	**Visual Analog Scale [VAS]** **Range 0-10** 0 = no pain 10 = severe pain Descriptive information about aetiology of sensitivity obtained by questionnaire. Immediate sensitivity by cemented procedure Direct testing: Air Cold, Biting After: 1mm, 1-2 Wk. and 3 Mos.	**Immediate sensitivity** **ZnPO4:** 32% **GIC:** 19% **Air sensitivity:** **ZnPO4:** 2Wks 0%; 3 Mo.0% **GIC:** 2Wks 0%; 3 Mo.: 0% **Biting sensitivity** **ZnPO4:** 2Wks 0%; 3 Ms.: 0% **GIC:** 2Wks 0%; 3 Mo.: 0% **Cold sensitivity:** **ZnPO4:** 2Wks 34%; 3 Mo.: 0% **GIC:** 2Wks 19%; 3 Mo.: 0% There was statically significant difference between the two cements in Immediate sensitivity (p=0.045), being higher the sensitivity reported for $ZnPO_4$ There was not statically significant difference between the two cements for Air sensitivity and Biting sensitivity - at any time. (P>0.05). There were significant differences between base line at two weeks for cold sensitivity with ZnPO4, which were higher than GIC. (p=0.013)	**Los clínicos fueron estandarizados en las preparaciones para coronas y puentes.** **Hubo reconstrucción de muñones con amalgama y ionómero de vidrio cuando el clínico así lo consideró.** **Se aplicó barniz cavitario a los muñones vitales para los dientes cementados con ZnPO4 y no se removió *smearl Layer* para los cementados con GIC** **En los materiales y métodos los autores reportan que los seguimientos se harían a partir de la primera semana sin embargo los resultados se reportan a partir de la segunda semana.**
8. Piwowarczyk et al., 2012. [Germany]	20 patients adults Mean age: 53 yrs. 40 independent full-coverage crowns; 20(ZnPO4] and 60 [SARC] Randomised Clinical Trial Split-Mouth	Test Group: SARC [RelyX Unicem Aplicap, 3M ESPE] Control Group: ZnPO4 [Hoffmann's Cement]	**Visual Analog Scale [VAS]** **0**= no sensitivity **10**= Extremely **Dichotomous scale** Yes or Not VAS: descriptive information about aetiology of sensitivity obtained by questionnaire (Chewing, air streams or cold temperatures, and hot)temperatures electronic pulp tester **Dichotomous scale** (Yes or Not) for: Cold water test and Air/ compressed Blast test After: 3-10 d, 4 Wks.,6 Mod., 1, 2 and 3 yrs.	**VAS: Mean ± SD** **ZnPO4:** 3-10 d. 1.3±2.1; 4 Wks. 0.6 ±1.5; 6 Mo. 0.2 ±0.8; 1 Yr. 0.04±0.3; 2 Yrs.0.1±0.4; 3 Yr. 0.1±0.2 **SARC:** 3-10 ds.1.0±1.9; 4 Wks. 0.5±1.1; 6 Mo.: 0.1±0.4; 1 Yr. 0.1±0.3; 2 Yrs. 0.3±0.7; 3 Yrs.0.1±0.2 No difference between the luting agents was noted concerning the risk of developing hypersensitivity. (OR=1.31, p>0.05) No significant differences were observed with respect to questions surveyed by a Visual Analog Scale between the two cement types (p>0.05).	The clinical performance of both luting agents (SARC and ZnPO4) scarcely differed with regard to the investigated parameters including postoperative hypersensitivity. The scores obtained from the Visual Analog Scale differed significantly within both groups over the observation period (p<0.0001), they were noted at follow-up examinations compared to the baseline: ZnPO4: at the framework try-in and 1 yr. following cementation SARC at the framework try-in.

9. Shetty. et al., 2012 [India]	50 patients adults Mean age: 33.8 yrs. 100 full-coverage crowns; 50[GIC] and 50 [RC] Randomised Clinical Trial Single – Blind	<u>Test Group</u>: RC [Smartcem *2] <u>Control Group</u>: GIC [GC Gold Label *Luting and Lining Cement]	**Visual Analog Scale** Range 0-10 0 = no pain 10 = worst imaginable pain Ice spray test After: 1 mm, 24 h and 7 ds.	**GIC : Level VAS (N° Patients)** LB(n=25): 1(9); 2(5); 3(7); 4(4) 24h(n=25): 0(2); 1(11); 2(8); 4(4) 7d(n=25): 0(6); 1(12); 2(7) **RC : Level VAS (N° Patients)** LB(n=25): 1(11); 2(9); 4(1); 5(4) 24h(n=25): 0(9); 1(10); 2(2); 3(3); 5(1) 7d(n=25): 0(16); 1(5); 2(4) No Statistically significant difference was observed between RC and GIC when sensitivity was tested immediately and 24 hours after cementation. Post cementation sensitivity was significantly higher with GIC when compared with RC after 7 ds. ($p<0.05$).	None of the patients with either of the cements reported sever response. With RC most patients reported no response after 7 days. With GIC the average response was 1.04 which is not clinically significant.
10. Smales et al., 2002. [Hong Kong]	50 patients adults Mean age: 43, 5 yrs. Male: 24 Female:26 88 full-coverage crowns; 30[RMGIC], 30[RMGIC] and 28[GIC] Randomised Clinical Trial	<u>Test Group1</u>: RMGIC [Fuji DUET] Test Group2: RMGIC [Vitremer® Luting Cement] <u>Control Group</u>: GIC [New Fuji®I]	**Perception ordinal scale. 4 levels** NONE [NR]: no response MILD: slight response MODERATE: obvious response SEVERE: Not tolerate Compressed Blast test After: 1 – 4 Wks	**Cement-LEVEL: N° patients (%)** **GIC:** NR 23 (82.1%), MILD 5 (17.9%) MODERATE 0 (0%) **RMGIC [FUJI DUET]:** NR 25 (83.4%), MILD 3 (10%), MODERATE 2 (6.6%) **RMGIC [VITREMER LC]:** NR 24 (80%), MILD 4 (13.4%), MODERATE 2 (6.6%) No teeth were recorded as having severe sensitivity any time. There were no statistically significant differences between the three luting cements when post cementation sensitivity was evaluated (p=0.64).	Using a conventional glass ionomer cement or two resin-modified glass ionomer cements for cementation of gold or ceramo-metal crowns on vital teeth resulted in less post-cementation sensitivity to air blasts within a one-to-four week recall period than was present pre-operatively. Most teeth showed no postcementation sensitivity, and there were no statistically significant differences found among the three luting cements.
11. Taschner et al., 2012 [Germany]	30 patients adults Age Range 23-64 yrs. Mean age: 39 yrs. Male: 11 Female:19 93 inlays and onlays restorations; 43[SARC] and 40[RC] Randomised Clinical Trial	<u>Test Group</u>: SARC [Breeze] <u>Control Group</u>: RC [RelyX ARC 3M ESPE]	**Modified USPHS [Criteria #8: Changes in sensitivity]** Alpha1: Excellent Alpha2: Good Bravo: Sufficient Charlie: Insufficient Delta: Poor Ice spray test After: 1 Wk., 6 Mos., 1 and yrs.	**2wk (83%): SARC (100%):** Alpha1 RC (100%): Alpha1 **6Mos. (83%): SARC (100%):** Alpha1 RC (100%): Alpha1 **1Yr (82%): SARC (100%):** Alpha1 RC (100%): Alpha1 **2Yr (82%): SARC (100%):** Alpha1 RC (100%): Alpha1 No statistical analysis was performed for Changes in sensitivity because there was not postoperative hypersensitivity reported by any patient in any time	No postoperative hypersensitivity was reported by any patient in any time

* Glass-Ionomer Luting Cement [GIC], Zinc Oxide Phosphate Cement [$ZnPO_4$], Resin Cement[RC], Resin-Modified Glass -Ionomer [RMGIC] , Self-Adhesive Resin Cement [SARC]
** Immediately after (1mm) Hour (hr), Day (d), Week (Wk.), Month (Mo.), Year (Yr.)

8. Articulo orinal

Post-cementation sensitivity in vital abutments of indirect restorations: a systematic Review

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Number of tables: 1

Short running title: Post-cementation Sensitivity of Indirect Restorations.

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ABSTRACT

Aim: The aim of this systematic review was to evaluate the type of luting agent that has more post-cementation hyper-sensitivity in vital abutments of indirect restorations.

Methods: Medical Literature Analysis and Retrieval System Online (MEDLINE) and Excerpta Medical Database (EMBASE) were searched without language restrictions. Databases were

searched up to and including May 31, 2018 using Medical Subject Headings (MeSH) terms, key words, other free terms and Boolean operators (OR, AND). These combined and detailed search strategies were developed for each database following the search strategy presented for MEDLINE. Randomized clinical trials and controlled clinical trials of at least one-week duration were also included.

Results: There were 648 potentially eligible articles from which 11 were included. In general, all cements reported sensitivity to thermal tests at different follow-up times; $ZnPO_4$, conventional glass-ionomer cement [GIC], resin modified glass-ionomer [RMGIC], conventional resin cement [RC] and self-adhesive resin cement [SARC] cements had immediate post-cementation sensitivity. The RC, $ZnPO_4$, SARC and RMGIC cements showed sensitivity during the post-cementation week; and RC, GIC, $ZnPO_4$, RMGIC and SARC cements had sensitivity over a period greater than two weeks after cementation. All evaluated cements containing a resin matrix, such as RMGIC, RC and SARC had significantly lower sensitivity to thermal tests when compared to other cements during the post-cementation week.

Conclusions: The $ZnPO_4$ cement showed the highest degree of post-cementation sensitivity during different follow-up times. The design of the restoration or the material are apparently not determining factors of the presence or absence of post-cementation sensitivity.

Key words: Dentin Sensitivity; Hypersensitivity; Dental Cements; Post Cementation; Crown Cementation; Randomized Clinical Trial, Controlled Clinical Trial.

Clinical Relevance Statement: Postcementation sensitivity in vital teeth is a common clinical complication possibly due to the cements chemical properties. In this systematic review all cements reported postcementation sensitivity but cements containing resin matrix show less sensitivity to thermal tests 1 week after cementation.

INTRODUCTION

Crowns and partially fixed prostheses are some of the most common restoration procedures in restorative dentistry. These require preparation of dental tissue involving enamel and dentin before being cemented. Hyper-sensitivity is one of the most frequent complications during vital teeth bonding.[1]

The condition is characterized by transient, acute pain of the exposed dentin as a result of tooth dehydration, osmotic changes, thermal, chemical and tactile stimuli. It presents after cementing a

definitive restoration on a vital tooth and cannot be described as any other type of dental pathology.[1-3]

Various studies have suggested that post-cementing hyper-sensitivity has multiple causes such as bacterial, mechanical and chemical properties inherent to the cement. Those of bacterial origin are related to marginal microfiltration due to improper adaptation of provisional restorations or by a defective crown seal, which allows a hydrolytic degradation of the cement.[4-8] Mechanical origins are related to friction heat generated during dental preparation, air-drying, the mechanical pressure of cement on dentinal fluid of exposed tubules and occlusal discrepancies. Chemical causes are generated by the exposure of dentin to cavity disinfectants, acids, adhesives or hemostatic agents. Those inherent to the cementing agent are related to physical and biological characteristics, such as pH and biocompatibility. [4-8]

It has been observed that the post-cementing hyper-sensitivity frequency ranges from 3.1% to 32% with varying degrees of severity: light, moderate and severe.[1, 5, 8-10] Additionally, it has been reported that it is maintained between 3% and 6% of cases following a post-cementation of two and three years, respectively.[11] There are also reports of gender incidence in which females present greater hyper-sensitivity before and after dental preparation.

The analysis of randomized clinical trials showed that the determining factor in post-cementation hyper-sensitivity is the type of cement. For decades, one of the most used was zinc oxide phosphate [$ZnPO_4$], considered the gold standard due to its initial low pH and solubility, [1, 12] but it has now fallen out of use. Another widely used cement is the glass-ionomer [GIC] due to its cariostatic effect from the release of fluoride and excellent physical and mechanical properties.[13] However, the hyper-sensitivity produced can be compared to that of zinc phosphate[8] or greater.[14-15]

This can also be related to its low initial pH 1[6], which has led many dentists to avoid it.[17] The most recent option is resin cement [RC], which presents low solubility and its initial pH is higher than that of zinc phosphate and glass ionomer. It has also been reported to have post-cementation hyper-sensitivity, which may be related to the material's polymerization contraction, generating marginal seal defects of the restorations. [11, 18-19]

Post-cementation hyper-sensitivity is a multifactorial entity and one of the most evaluated factors is the type of cement. Nonetheless, in study results, there has been no consensus and no meta-analysis or systematic review about this topic that allow dentists to make informed and accurate

clinical decisions based on evidence to avoid this complication. Therefore, this systematic review aimed to answer the following focused question: What type of luting agent presents greater postoperative hyper-sensitivity in indirect restorations on vital teeth?

MATERIALS AND METHODS

This review was structured in accordance with guidelines from *PRISMA*,[20] the *Cochrane Handbook of Systematic Reviews of Interventions*[21] and the *CheckReview* checklist.[22] In addition, the protocol was registered with the National Institute for Health Research PROSPERO, International Prospective Register of Systematic Reviews (http://www.crd.york.ac.uk/PROSPERO, registration number (ID=CRD42016038883).

Type of Studies and Participants (Inclusion Criteria)

The studies were considered eligible for inclusion if they met the following criteria: randomized clinical trials (RCTs) and controlled clinical trials that assessed the presence of postoperative hyper-sensitivity after cementation of indirect fixed restorations cemented with the following **luting agents:** zinc oxide phosphate cement [ZnPO4], conventional glass-ionomer cement [GIC], resin modified glass-ionomer [RMGIC], conventional resin cement [RC] and self-adhesive resin cement [SARC]. Studies were also included if the participants met the following criteria: adult patients, males and females, who required newly cemented indirect fixed restorations, such as inlays, onlays, single full coverage restorations and fixed partial dentures, with at least one week of follow-up.

Outcome Measures

The primary outcome was post-cementation sensitivity evaluated after thermal and mechanical stimulation with a visual analogue scale or dichotomic scale with at least one week of follow-up.

Search Strategy

Detailed search strategies were developed for Medical Literature Analysis and Retrieval System Online (*MEDLINE*) and Excerpta Medical Database (*EMBASE*) without language restrictions. Databases were searched up to and including July 10, 2018 using Medical Subject Headings (*MeSH*) terms, key words, other free terms and Boolean operators (OR, AND). These were

combined and detailed search strategies were developed for each database following the search strategy presented for *MEDLINE*:

#1: Dentin sensitivity OR dentin hyper-sensitivity OR dentinal tubules OR dentin pain OR dentinal hyper-sensitivity OR tooth hyper-sensitivity OR root hyper-sensitivity OR vital tooth OR pulp sensitivity
#2: Cements OR dental cements OR dental adhesives OR resin cements OR crown cementation OR resin cements OR luting agents OR bonding
#3: #1 AND #2
#4: Early hyper-sensitivity OR post-cementation hyper-sensitivity OR crown cementation/ hyper-sensitivity OR cementation
#5: #3 AND #4

In addition, reference lists of studies considered potentially eligible for inclusion in this review were hand searched as well.

Assessment of Validity Data Extraction (Selection and Coding)

Two independent reviewers (AC and MM) screened the titles, abstracts and full texts of the papers and disagreements between the reviewers was mediated by discussion. In the event an agreement was not reached, a third reviewer (MCT) was consulted. When important data for the review was missing, an attempt to contact the authors was carried out to resolve the ambiguity from the trials.

The following data were collected and recorded in duplicate: citations, publication status and year of publication, location of the trial, study design, characteristics of the participants, outcome measures, methodological quality of the trials and conclusions.

Assessment of Risk of Bias and Quality Assessment in the Included Studies

For RCTs and controlled clinical trials, the methodological quality was evaluated following the Cochrane Collaboration's tool for assessing risk of bias[21] as adapted by Chambrone *et al*. (2010a): randomization and allocation methods (i.e., selection bias), completeness of the follow-up period, incomplete outcome data (i.e., attrition bias), masking of patients (i.e., performance bias) and examiners (i.e., detection bias), selective reporting (i.e., reporting bias) and other forms of bias were classified as adequate (+), inadequate (-), or unclear (?). Based on these answers, the risk of bias was categorized according to the following classifications: (1) a low risk of bias if all criteria were met (i.e., adequate methods of randomization and allocation concealment), a positive answer to all questions about completeness of follow-up questions and masking of examiners, and a negative answer to selective reporting and other sources of bias); (2) an unclear risk of bias if one

or more criteria were partly met (i.e., unclear criteria were set), or (3) a high risk of bias if one or more criteria were not met.

Data synthesis

Data were filed in a table of evidence and a descriptive summary was performed to define the quantity of data by inspection for further study variations in terms of characteristics and results.

RESULTS

Search Results and Excluded Trials

The search was carried out in electronic databases such as *PUBMED* (April 2016 to July 2018) and *EMBASE* (April 2016 to May 2018) as well as manually. A total of 648 studies were found, from which 615 were discarded by title or abstract, pre-selecting 33 articles that could be included in the revision. Twenty-one were discarded afterwards[1, 3, 6, 7, 9, 11-14, 17, 18, 23-33] because they did not comply with the inclusion criteria [Fig. 1] and only 11 were finally included [table 1]. [2, 4, 8, 15, 16, 19, 34-38]

The characteristics of these studies are shown in table 1. They all had a follow-up of at least one-week post-cementation; two studies had only one week,[2,19] and the rest had longer periods of three weeks,[38] up to a month,[15, 35] up to three months,[4, 8, 34] 21 months[36] and two years [16, 37] Four studies were carried out in the United States,[2, 4, 8, 38] two in Germany,[16,37] two in India,[19,35] one in Pakistan[34] and one in Hong-Kong.[15]

Methodological Quality of Included Studies

The comparison of all studies with regard to the different methodological parameters showed that the one with the highest number of parameters with low risk of bias was Piwowarczyk *et al*., (2011). It was also observed that only the selective report and other bias sources had a high risk of such and the randomization method was not clear[Fig. 2].[36]

Most of the studies selected were adequate in the follow-up periods [2, 4, 8, 15, 16, 19, 34, 36, 37] and in the allocation processes.[2, 4, 8, 15, 34, 36-38] six of the studies had an adequate randomization sequence. [2, 4, 8, 15, 34, 36] and, in five, it was not clear.[16, 19, 34, 37, and 38] The randomization and sample allocation were considered adequate for all included studies [Fig. 2]. Most studies did not report patient and examiner masking, [4, 8, 15-16, 19, 34-35, 38] or a selective report [Fig. 2]. [2, 4, 8, 34-37] Thus, all studies were considered to be at a high risk of bias [Fig. 2].

Effect of Interventions

Among the selected studies, there were six in which post-cementation sensitivity of the GIC had been evaluated, [2, 4, 15-16, 19, 35] four studies had assessments of the zinc oxide phosphate cement [$ZnPO_4$], [2, 4, 35-36] four had assessments of the resin cement (RC) [16,19,34,37], four evaluated the resin-modified glass ionomer (RMGIC) [15, 34-35, 38] and, in three, the self-adhesive resin cement (SARC) was evaluated.[36-38]

The GIC was evaluated with regards to the $ZnPO_4$ in three studies[2, 4, 35,] with regards to RMCIG in three, [8, 15, 35] with regards to RC in two[16, 19,] and it was not assessed with regards to SARC in any study. Upon analyzing the studies, it was observed that only three had reports of statistically significant differences. The Johnson *et al*. (1993) and Chandrasekhar *et al*., (2010) showed that the post-cementation sensitivity of $ZnPO_4$ cement was significantly greater than GIC's.

The significant differences in the study of Johnson *et al*. (1993) were present immediately after cementation ($p=0.045$) and remained during the following two weeks ($p=0.013$); in that of Chandrasekhar *et al*., (2010), the differences among cements were observed during the first follow-up week with the cold air and water tests ($p=0.01$), and they persisted for a month of follow-up ($p=0.001$). In the study of Shetty *et al*. (2012), there was a report of a statistically significant higher sensitivity of the GIC with regards to the posterior RC with the spray ice test after a week of cementation ($p<0.05$).

The RC was evaluated with regards to GIC in two studies, [16, 19] with regards to RMGIC in one, [34] with regards to SARC in one, [37] and in none with regards to $ZnPO_4$. It was observed that, in only one of the studies[19], there was a report of statistically significant sensitivity of the GIC compared to RC after one week of cementation ($p<0.005$) and there were no significant differences with regard to the other cements.[16, 34, 37]

The RMGIC was evaluated in five studies: three with regards to GIC, [8, 15, 35] one with $ZnPO_4$, [35] one with RC [34] and one with SARC.[38] Statistically significant lower post-cementation sensitivity was reported only for the RMGIC when compared with $ZnPO_4$ with the cold air and water tests after a week of cementation ($p=0.001$), and after one month of cementation ($p=0.001$).[35]

The $ZnPO_4$ was evaluated with regards to GIC in three studies, [2, 35] with RMGIC in one,[35] and SARC in another.[35] It was not assessed in any study with regards to RC and statistically significant differences were only found in two studies, with regard to GIC[4, 35] and RMGIC.[35] The sensitivity

generated by $ZnPO_4$, as observed in the studies of Johnson *et al*. (1993) and Chandrasekhar *et al.*, (2010) was greater than GIC's with the different thermal tests, such as water[4, 35] and cold air[35], immediately after cementation ($p=0.045$)[4], after one week ($p=0.01$),[35] after two weeks ($p=0.013$)[4], and after one month post-cementation.[35] In the study of Chandrasekhar *et al.*, (2010) the $ZnPO_4$ was compared to RMGIC and there were significant differences with the cold water and air tests after one week ($p=0.001$) and after one-month post-cementation ($p=0.001$) with $ZnPO_4$ showing greater sensitivity.

SARC was compared to $ZnPO_4$ in one study, [36] to RC in one, [3] and to RMGIC in another.[38] It was to be evaluated with regards to GIC in any study and statistically significant differences were reported with respect to RMGIC is the study of Blatz *et al*. (2013), in which SARC was observed to produce lower sensitivity to cold air after one week of cementation ($p=0.01$) and the ice test throughout the follow-up ($p<0.01$) of one day, one week and three weeks. All cements presented some degree of post-cementation sensitivity with one or other of the thermal or masticatory tests, except in the study of Taschner et al. (2012), in which SARC and RC did not present any type of sensitivity during the follow-up period with the spray ice test.

Type and Material of the Restorations Used

The studies reported the type and restoration material used but not the sensitivity results for the assessed cements. However, the following was found:

In two studies, only partial-coverage restorations were used.[35, 37] In another, both complete crowns and partial-coverage restorations were used.[2] In another, complete crowns as part of a fixed partial prostheses[34] were used. Another study had individual crowns and crowns as part of fixed partial prostheses[16] and the remaining studies only had complete individual crowns.[4, 8, 15, 19,36,3]

It was also observed in seven studies that the materials used were metal and metal porcelain; however, it was not specified what type of metal or porcelain.[4, 8, 15-16, 34, 36, 38] Metallic gold were used in two studies[2, 15] and metallic nickel-chrome in another.[19]Another had gold restorations[4], another had metallic restorations in a non-specified metal[35] and in only one were ceramic restorations reported.[37]

DISCUSSION

Summary of the Main Results

The review of the results of most studies showed that almost all cements had sensitivity with thermal tests. [2, 4, 8, 15, 16, 19, 34-36, 38] The analysis of such sensitivity with regards to follow-up time yielded that RC,[19,34] GIC,[4,16,35] $ZnPO_4$,[4,15,35] RMGIC [8,15,34-35,38] and SARC[34,36,38] presented sensitivity immediately after cementation. RC,[16,19,34] GIC,[2,8,16,19,34-36] $ZnPO_4$,[4, 15, 35] SARC[36,38] RMGIC[34] and RMGIC presented sensitivity one week after cementation and RC,[16,34] GIC,[8,16,19,35] $ZnPO_4$,[35] RMGIC,[35] and SARC[34,38] showed sensitivity in a period greater than two weeks after cementation. It is interesting to note that the evaluated cements with resin matrix, such as RMGIC[8, 15, 34-35, 38] RC[16, 19, 34, 37] and SARC[36-38], had a significantly lower sensitivity to thermal tests when compared with other cements one week after cementation. In only one study, which evaluated both resin cements SARC and RC[37], there was no sensitivity present during any of the follow-up periods. The present study had patients with inlay and onlay type restorations made with ceramic and it was the only one in which metallic materials were not used. However, it has been observed in various studies that the restorative material does not influence post-cementation sensitivity. [39-42] No studies were found that evaluated the association between restoration design and sensitivity and this is consistent with the studies of Chandrasekhar et al., (2010) and Bebermeyer and Berg, (1994), in which there was post-cementation sensitivity with partial-coverage restorations.

Quality of the Evidence

None of the studies were considered to be at a low risk of bias because there were inconsistences regarding randomization [16, 19, 35-37], allocation, [16, 19, 35, 37]patient and examiner masking, [2, 4, 8, 15, 16, 19, 34, 35, 37, 38], completeness of follow-up times [35, 38], selection reports [2, 4, 8, 34, 35, 36, 38,] and other sources of bias. [2, 15, 19, 36 -38.]

Limitations and Potential Biases in the Review Process

The studies could not be subjected to a meta-analysis due to differing scales and tests for evaluating sensitivity; additionally, the results were reported with various types of data:

Scales and Sensitivity Tests

The scales used in the selected studies varied; nine used the Visual Analogue Scale (VAS) in which six used a range from zero to ten,[4,8,19,34,36-38] one had a range from one to five,[2] one from one to

three,[35] and another used four ranges, modifying the range nomenclature as: none=no response, mild=slight response, moderate=obvious, and severe=intolerable.[15] Others used scales were the ordinal perception had three ranges: normal response (NR)=sensitivity to cold without pain, severe response (SR)=increased sensitivity causing a reflex[16] and the USPHS criteria modified, which registered a dichotomy sensitivity.[37] Different types of thermal tests were also used in order to evaluate sensitivity: cold water was used in two studies,[35-36] cold air was used in five,[4, 15-16, 37,38] and three used spray ice.[34, 37] Additionally, two more evaluated sensitivity during mastication[8, 35] and, in one, the experience of sensitivity by the patient was assessed.[2]

Type of Data used for Results

Results were reported differently in most studies: three studies had sensitivity reported by the number of patients (absolute frequencies),[2, 16, 19] four used the mean and standard deviations of different values of the scales [8, 35-36, 38] and the remaining four had results with relative frequencies (percentages. [4,15,34,37] Apart from the reported biases, there were other sources as such: the ample age range of the evaluated patients,[2, 3] which determines pulpal age and dentinal tubule size, as well as the application of cavity enamel before the cements.[4] These two factors may lead to varied and heterogeneous pulpal response to cements. In the study of Bebermeyer and Berg, (1994), a lack of experience from the operators and lack of calibration of the examiners, which were undergraduates, was observed that may have affected the final results.

Agreements and Disagreements with Other Studies or Reviews

The comparison of results obtained from articles included in the present review[2, 4, 35] with another study that also compared the GIC and ZnPO4 cements, with follow-up commencing more than one week after cementation[14], yielded similar but contradictory results. In the studies of Kern *et al*. (1996) and Bebermeyer & Berb (1994), it was observed that both cements showed some post-cementation sensitivity, without statistically significant differences. However, the results from Kern *et al*. (1996) are not the same as those reported by Chandrasekhar *et al*., (2010) and Johnson et al. (1993), which did result in statistically significant differences, with ZnPO4 presenting the highest sensitivity. Post-cementation sensitivity of SARC was also evaluated[13, 30] and, as has been reported in the present review, it had the greatest sensitivity among the resin cements[38] or did not present any at all[37] with enamel selective etching[30].

In the present review, any studies in which a dentinal desensitizer agent was used were excluded[9,

[11] because they posed a bias risk in the final results. Nonetheless, the said studies did report a significant reduction in post-cementation sensitivity when compared with the application of GC Tooth Mousse™ [GC-Asia dental Ptd] or Systemp desensitizer® [Ivoclar Vivadent AG]. With regard to a direct application of GIC[9] when other desensitizer were used, such as OptiBond™ SoloPlus, Copal/ether varnish (Bosworth® Copaliner) or BisBlock ™ dentin desensitizer (Bisco Inc, Schaumburg, USA), no differences were observed[9, 11]

CONCLUSIONS

In summary, and within the limitations of the present systematic review, we can conclude that:

1. All analyzed cements generated post-cementation sensitivity in all follow-up periods.
2. Sensitivity usually flared up during the first week after cementation.
3. SARC and GIC cements presented the lowest post-operatory sensitivity during the different follow-up times.
4. $ZnPO_4$ presented the highest degree of post-cementation sensitivity during the different follow-up periods.
5. The restoration design or material apparently are not determinant factors in the presence or absence of post-cementation sensitivity.

Future randomized clinical trials with standardized methodologies (measurement scales, applied thermal tests and same-data reports) could be developed in order to:

1. Provide more consistent conclusions regarding the true effect of cements on post-cementation sensitivity of restorations.
2. Determine if the use of desensitizers agents – not analyzed in the present project – could eliminate post-cementation sensitivity of indirect restorations.

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Table 1. *Characteristics of included studies*

Figure 1. *Flowchart of articles screened in the review process.*

Figure 2. *Risk of bias summary*

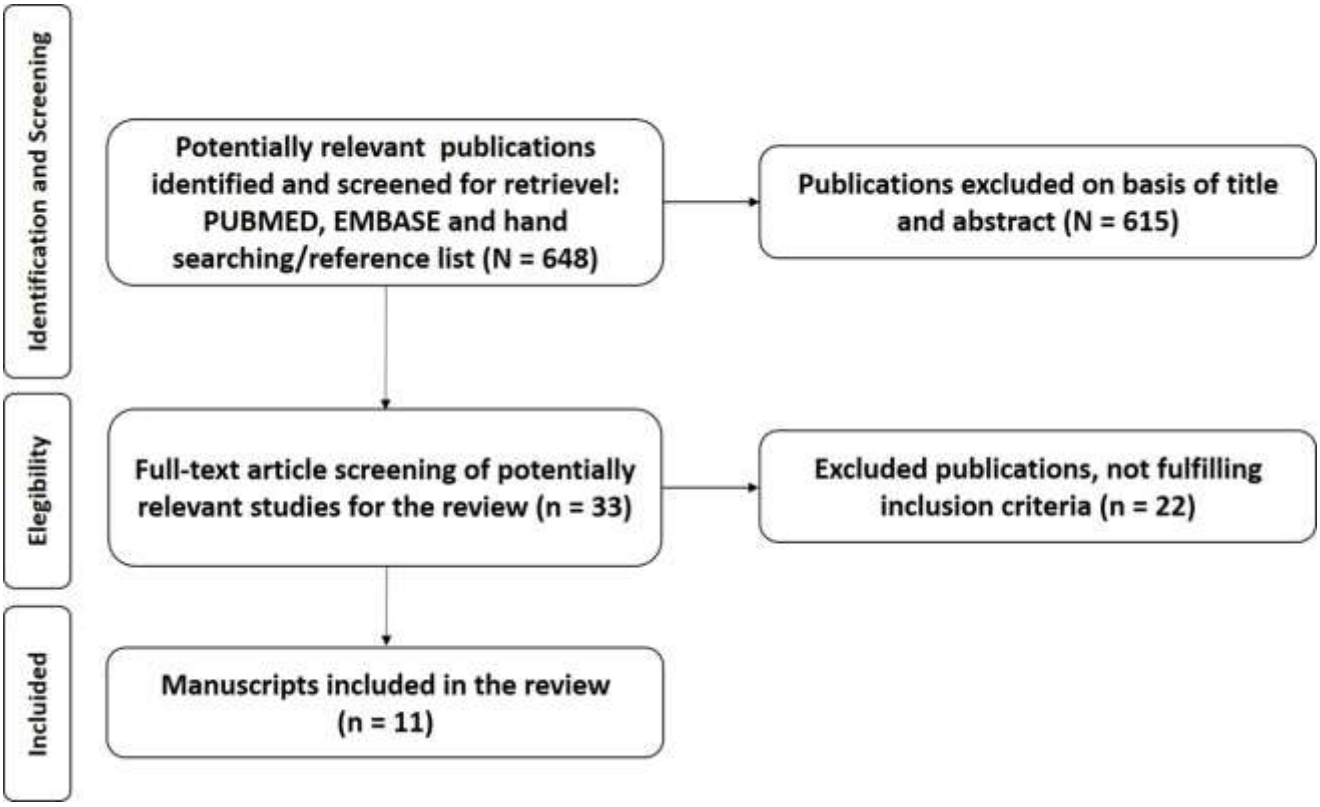

Figure 1. Flowchart of articles screened through the review process.

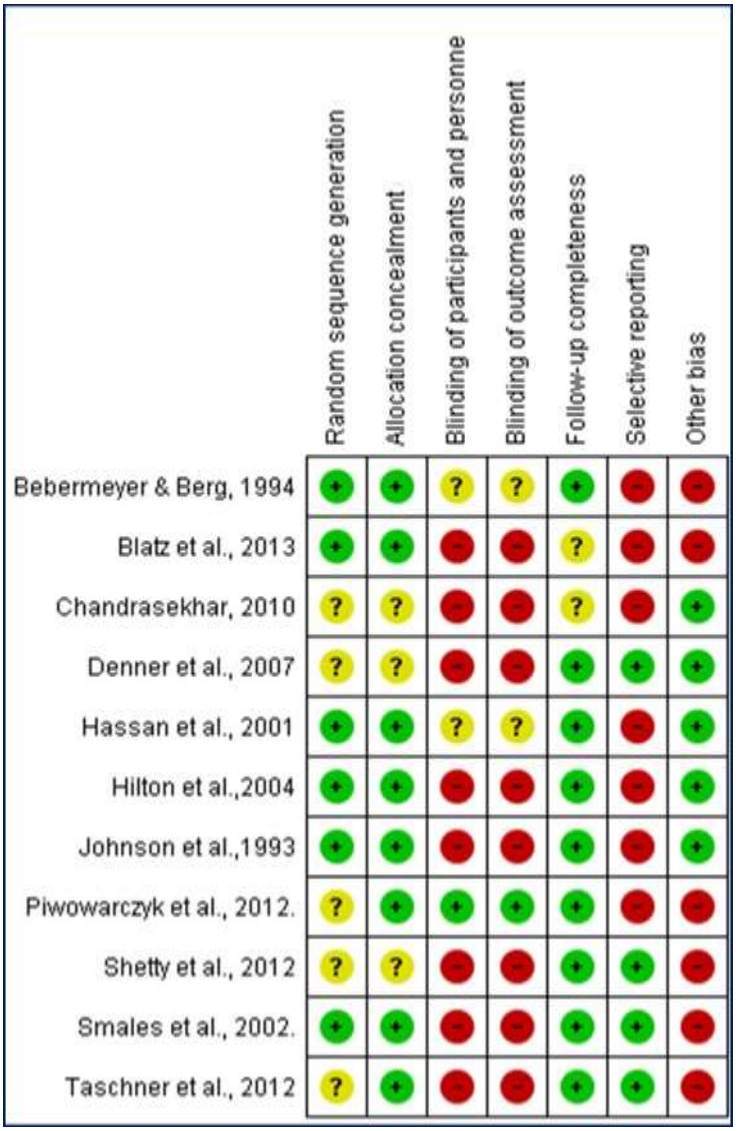

Figure 2. Risk of bias summary

9. Proceso de selección de revista para publicación

Se realizó una búsqueda en **JANE (Journal Author Name Estimator**) donde se incluyó el título de nuestro articulo y los agentes cementantes empleados, esto con el objetivo de obtener un listado de revistas donde se hubieran realizado publicaciones relacionadas con nuestro tema de investigación y de esta manera seleccionar la revista más idónea para publicar nuestro artículo. La búsqueda arrojo como resultado 25 revistas, de las cuales se descartaron 23 por razones que se explican a continuación y escoge 2 como ideal para nuestra publicación.

1. **Revistas seleccionadas para publicación**

- **Operative dentistry:** El artículo fue sometido a revisión en esta revista como primera instancia y fue rechazado. **..\..\INSTRUCCIONES PARA AUTOR\Operative Dentistry - Instructions to Authors.html**
- **Brazilian Oral Research** **E:\Desktop\Braz. oral res. - Instructions to authors.html**

2. **Revistas descartadas porque no se publicar revisiones, son de tópicos diferentes a materiales dentales y restauraciones o solo publican revisiones invitadas:**

- **Journal of investigative and clinical dentistry**: Revisa aspectos de la investigación y la odontología clínica y la investigación craneofacial, incluidos los estudios moleculares relacionados con la salud oral y la enfermedad. Aunque internacional en perspectiva, los editores especialmente alientan los documentos de Asia Pacífico. Además el resumen que se envía debe tener 200 palabras máximo y el nuestro tiene 333..\..\INSTRUCCIONES PARA AUTOR\Journal of Investigative and Clinical Dentistry _.html
- **Clinical oral implants research:** Articulos sobre todo lo realcionado con implnates y rehabilitación sobre implantes.E:\Desktop\Clinical Oral Implants Research - Wiley Online Library.html
- **The International Journal of Periodontics and Restorative Dentistry:** Los artículos de presentación única abarcan la relación entre un periodonto sano y restauraciones precisas, así como la integración de implantes con una planificación integral del tratamiento...\..\INSTRUCCIONES PARA AUTOR\The International Journal of Periodontics and Restorative Dentistry.html
- **Journal of dentistry (Tehran, Iran):** Solo publica revisiones invitadas..\..\INSTRUCCIONES PARA AUTOR\Guide for authors - Journal of Dentistry - ISSN 0300-5712.html
- **The journal of contemporary dental practice:** No publica revisiones sistemáticas, si no revisiones de literatura, investigaciones primarias, reportes de casos y técnicas clínicas Instructions Authors
- **The International journal of prosthodontics:** Los artículos de investigación científica siguen siendo el núcleo, pero la revista ahora abre sus páginas a más

informes clínicos y revisiones de literatura**. No tiene revisiones sistemáticas**. E:\Desktop__JAP__Journal of Advanced Prosthodontics.html

- **The Journal of oral implantology:** Publicaciones sobre impantólogia. .\..\INSTRUCCIONES PARA AUTOR\Journal of Oral Implantology Online - Information.html
- **The Journal of clinical pediatric dentistry Medline-indexed:** Es de odontopediatría.
- **General dentistry:** No encontré información para los autores, además en para publicaciones por odontólogos generales o estudiantes de odontología.
- **Dental materials:** Debió enviarse un correo al autor antes de escribir el artículo, para conocer los alcances de la investigación para que este pudiera invitarnos a realizar la revisión. E:\Desktop\Guide for authors - Dental Materials - ISSN 0109-5641.html
- **Journal of the mechanical behavior of biomedical materials:** Publicaciones sobre comportamiento mecánico de materiales dentales..\..\INSTRUCCIONES PARA AUTOR\Guide for authors - Journal of the Mechanical Behavior of Biomedical Materials - ISSN 1751-6161.html
- **Eur J Paediatr Dent:** Publicaciones sobre odontopediatría ..\..\INSTRUCCIONES PARA AUTOR\E.J.P.D - European Journal of Paediatric Dentistry.html
- **International Journal of Dentistry:** Más importancia a articulo originales tipo ensayos clínicos, el costo es muy elevado para publicación (1950 dólares) ..\..\INSTRUCCIONES PARA AUTOR\Guide for authors - Journal of Dentistry - ISSN 0300-5712.html

3. **Revistas descartadas porque dentro de sus protocolos para revisión del manuscrito exigen el envío de algún tipo de documentación de manera física**

- **Dental Research Journal:** Es una revista la universidad de Isfahan en irán, las instrucciones para el autor son poco claras, no hay información sobre revisiones sistemáticas. ..\..\INSTRUCCIONES PARA AUTOR\Dental Research Journal _ Instructions for authors.html
- **Indian J Dent Res:** La revista le da prioridad a los artículos de investigación primaria, como ensayos clínicos. E:\Desktop\Dental Research Journal _ Instructions for authors.html
- **Contemporary clinical dentistry:** Es de la india y consideramos que el proceso de envió de información física es complicado. E:\Desktop\Contemporary Clinical Dentistry _ Instructions for authors.html
- **Journal of Prosthodontic Research:** Revista Japonesa E:\Desktop\Journal of Prosthodontic Research - Elsevier.html **Journal of the Indian Society of Pedodontics and Preventive Dentistry:** Es de la india y consideramos que el proceso de envió de información física es complicado E:\Desktop\The Journal of Indian Prosthodontic Society _ Instructions for authors.html

4. **Revistas médicas**

- Journal of Clinical and Diagnostic Research: JCDR
- Journal of Pharmacy & Bioallied sciences
- Journal of Materials in medicine Science
- Open Access Macedonian Journal of medical Sciences
- Diving and Hyperbaric medicine

5. **Revistas que requieren invitación del editor**

- **Journal of conservative dentistry: JCD:** Ya se había considerado y no se envió para estudio porque las revisiones sistemáticas deben ser invitadas por los editores.E:\Desktop\Journal of Conservative Dentistry (JCD)_ Instructions for authors.html..\..\INSTRUCCIONES PARA AUTOR\Journal of Conservative Dentistry (JCD)_ Instructions for authors.html
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6. **Revistas con costos de publicación elevados**

- **BioMed research international:** Costo de publicación US1.950 ..\..\INSTRUCCIONES PARA AUTOR\BioMed research international_ Instructions.html

10. Preparación para revistas seleccionadas

10.1. Preparación para Operative Dentistry

Operative Dentistry requiere la presentación electrónica de todos los manuscritos. Todos los envíos deben enviarse a Operative Dentistry utilizando el sitio de carga de Allen Track .
Los manuscritos solo se considerarán presentado oficialmente después de haber sido aprobados a través de un control de calidad inicial. Tendrá 6 días desde el momento en que comience el proceso para enviar y aprobar el manuscrito. Después del límite de 6 días, si no se ha terminado el envío, el envío será eliminado del servidor. Aún puede enviar el manuscrito, pero debe comenzar desde el principio. Los requerimientos para revisiones sistemáticas son:

- un título
- un título en ejecución (corto)
- una declaración de relevancia clínica
- un resumen conciso (resumen)
- introducción, métodos y materiales, resultados, discusión y conclusión
- referencias (ver abajo)
- Figuras: las figuras en color deben tener un tamaño mínimo de 2.5 "x 3.5", y un tamaño máximo de 3.5 "x 5" y una resolución mínima de 300 ppp y un máximo de 400 ppp. y las fotografías en color deben tener un tamaño aproximado de 3.5 "x 5" y una resolución de 300 dpi.
- Gráficos: Se deben proporcionar como archivos TIFF o JPEG
- Tablas: **se** deben proporcionar como archivos de Word

A continuaciónencontraras el link para acceder a las recomendaciones para los autores que someterán sus artículos a publicación en esta revista.
https://www.jopdent.com/authors/authors.html

10.1.1 Pagina del titulo

Title page

Title: Post-cementation sensitivity in vital abutments of indirect restorations: a systematic review

Short running title: Post-cementation Sensitivity of Indirect Restorations.

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CONFLICT OF INTEREST:

The authors report no conflict of interest related to this study.

Clinical Relevance Statement: Postcementation sensitivity in vital teeth is a common clinical complication possibly due to the cements chemical properties. In this systematic review all cements reported postcementation sensitivity but cements containing resin matrix show less sensitivity to thermal tests 1 week after cementation.

10.1.2. Cuerpo del manunscrito

POST-CEMENTATION SENSITIVITY IN VITAL ABUTMENTS OF INDIRECT RESTORATIONS: A SYSTEMATIC REVIEW

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Short running title: Post-cementation Sensitivity of Indirect Restorations.

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ABSTRACT

Aim: the aim of this systematic review was to evaluate what type of luting agent presents more post-cementation hyper-sensitivity in vital abutments of indirect restorations.

Methods: *MEDLINE* (Medical Literature Analysis and Retrieval System Online) and *EMBASE* (Excerpta Medical Database) without language restrictions. Databases will be searched up to - and including - May 30, 2017 using *MeSH* (Medical Subject Headings) terms, key words, other free terms and Boolean operators (OR, AND). These combined and detailed search strategies will be developed for each database following the search strategy presented for *MEDLINE*. Randomised clinical trials and controlled clinical trials of at least one week duration were also included.

Results: There were 648 potentially eligible articles from which 14 were included. In general, all cements reported sensitivity to thermal tests at different follow-up times; ZnPO4, conventional glass-ionomer cement [GIC], resin modified glass-ionomer [RMGIC], conventional resin cement [RC] and self-adhesive resin cement [SARC] cements presented immediate post-cementation sensitivity. The RC $ZnPO_4$, SARC and RMGIC cements showed sensitivity during the post-cementation week, and RC, GIC, $ZnPO_4$, RMGIC and SARC cements presented sensitivity over a period greater than two weeks after cementation. Of all evaluated cements containing resin matrix such as RMGIC, RC and SARC presented statistically significant lower sensitivity to thermal tests when compared to other cements during the post-cementation week.

Conclusions: The $ZnPO_4$ cement showed the highest degree of post-cementation sensitivity during different follow-up times. The design of the restoration or the material are apparently not determinant factors in the presence or absence of post-cementation sensitivity.

Key words: dentin sensitivity, hyper-sensitivity, dental cements, post-cementation, crown cementation, randomised clinical trial, controlled clinical trial.

INTRODUCTION

Crowns and partially-fixed prostheses are some of the most common restoration procedures in restorative dentistry. These require preparation of dental tissue involving enamel and dentin before being definitely cemented. Hypersensitivity is one of the most frequent complications during vital teeth bonding.[1]

The condition is characterised by transient, acute pain of the exposed dentin as a result of tooth dehydration, osmotic changes, thermal, chemical and tactile stimuli. It presents itself after cementing a definitive restoration on a vital tooth and cannot be described as any other type of dental pathology. [1-3]

Various studies suggest that post-cementing hypersensitivity has multiple causes such as bacterial, mechanical and chemical inherent to the cement. Those of bacterial origin are related with marginal microfiltration due to improper adaptation of provisional restorations or by a defective crown seal which allows a hydrolytic degradation of the cement[4-8]. Mechanical origins are related to friction heat generated during dental preparation, air-drying,

the mechanical pressure of cement on dentinal fluid of exposed tubules and occlusal discrepancies. Chemical causes are generated by the exposure of dentin to cavitary disinfectants, acids, adhesives or haemostatic agents. Those inherent to the cementing agent are related to physical and biological characteristics such as pH and biocompatibility [4-8]

It has been observed that post-cementing hypersensitivity frequency ranges from 3.1% to 32% with varying degrees of severity: light, moderate and severe. [1, 5, 8-10] Additionally, it has been reported that it is maintained between 3% and 6% of cases following a post-cementation of two and three years respectively.[11] There are also reports of gender incidence, in which females present greater hyper-sensitivity before and after dental preparation.

The analysis of randomised clinical trials has yielded that the determining factor in post-cementation hypersensitivity is the type of cement. One of the most used for decades was zinc oxide phosphate [$ZnPO_4$], considered the gold standard due to its initial low pH and solubility[1, 12] but it has now fallen out of use. Another widely-used cement is the glass-ionomer [GIC] due to its cariostatic effect from the release of fluoride and excellent physical and mechanical properties[13] However, the hypersensitivity produced can be compared to that of zinc phosphate[8] or greater[14-15].

This can also be related to its low initial pH[16] which has led many dentists to not use it.[17] The most recent options are the resin cement [RC], which present low solubility and its initial pH is higher than that of zinc phosphate and glass ionomer. It has also been reported post-cementation hyper-sensitivity, which may be related with the material's polymerization contraction generating marginal seal defects of the restorations. [11, 18-19]

Post-cementation hypersensitivity is evidently a multifactorial entity and one of the most evaluated factors is the type of cement. Nonetheless, in study results there is no consensus and no meta-analysis or systematic revisions about this topic which allow dentists to make informed and accurate clinical decisions based on evidence in order to avoid this complication. Therefore, this systematic review aimed at answering the following focused question: What type of luting agent presents greater post-operative hypersensitivity in indirect restorations on vital teeth?

MATERIALS & METHODS

This review was structured in accordance with guidelines from *PRISMA*[20] the *Cochrane Handbook of Systematic Reviews of Interventions*[21] and the *CheckReview* checklist.[22] In addition, the protocol was registered with the National Institute for Health Research PROSPERO, International Prospective Register of Systematic Reviews (http://www.crd.york.ac.uk/PROSPERO, registration number (ID=CRD42016038883).

Type of Studies and Participants (Inclusion Criteria)

The studies were considered eligible for inclusion if they met the following criteria: randomised clinical trials (RCTs) and controlled clinical trials that assessed the presence of post-operative hyper-sensitivity after cementation of indirect fixed restorations cemented with the following **luting agents:** zinc oxide phosphate cement [ZnPO4], conventional glass-ionomer cement [GIC], resin modified glass-ionomer [RMGIC], conventional resin cement [RC] and self-adhesive resin cement [SARC]. studies were also included if the participants met the following criteria: adult patients – male and female – who required newly-cemented indirect fixed restorations such as inlays, onlays, single full coverage restorations and fixed partial denture with at least one week of follow-up.

Outcome Measures

The primary outcome was post-cementation sensitivity evaluated after thermal and mechanical stimulation by visual analogue scale or dichotomic scale with at least one week of follow-up.

Search Strategy

Detailed search strategies were developed for *MEDLINE* (Medical Literature Analysis and Retrieval System Online) and *EMBASE* (Excerpta Medical Database) without language restrictions. Databases were searched up to - and including December 30th, 2017 - using *MeSH* (Medical Subject Headings) terms, key words, other free terms and Boolean operators (OR, AND). These were combined and detailed search strategies will be developed for each database following the search strategy presented for *MEDLINE*:

#1: Dentin sensitivity OR dentin hyper-sensitivity OR dentinal tubules OR dentin pain OR dentinal hyper-sensitivity OR tooth hyper-sensitivity OR root hyper-sensitivity OR vital tooth OR pulp sensitivity

#2: Cements OR dental cements OR dental adhesives OR resin cements OR crown cementation OR resin cements OR luting agents OR bonding

#3: #1 AND #2

#4: Early hyper-sensitivity OR post-cementation hyper-sensitivity OR crown cementation/ hyper-sensitivity OR cementation

#5: #3 AND #4

In addition, reference lists of studies considered potentially eligible for inclusion in this review were hand searched, as well.

Assessment of Validity Data Extraction (Selection and Coding)

Two independent reviewers (AC and MM) screened the titles, abstracts and full texts of the papers and disagreements between the reviewers was mediated by discussion. In the event an agreement was not be reached, a third reviewer (MCT) was consulted. When important data for the review was missing, an attempt to contact the authors was carried out in order to resolve the ambiguity from the trials.

The following data was collected and recorded in duplicate: citations, publication status and year of publication, location of the trial, study design, characteristics of the participants, outcome measures, methodological quality of the trials and conclusions.

Assessment of Risk of Bias and Quality Assessment in Included Studies

For RCTs and controlled clinical trials, the methodological quality was evaluated following the Cochrane Collaboration's tool for assessing risk of bias[21] as adapted by Chambrone *et al*., (2010a): randomisation and allocation methods (i.e. selection bias), completeness of the follow-up period, incomplete outcome data (i.e., attrition bias), masking of patients (i.e., performance bias) and examiners (i.e., detection bias), selective reporting (i.e., reporting bias) and other forms of bias were classified as adequate (+), inadequate (-), or unclear (?). Based on these answers, the risk of bias was categorized according to the following classifications: (1) a low risk of bias if all criteria were met (i.e. adequate methods of randomisation and allocation concealment), a positive answer to all questions about completeness of follow-up questions and masking of

examiners, and a negative answer to selective reporting and other sources of bias); (2) an unclear risk of bias if one or more criteria were partly met (i.e., unclear criteria were set) or (3) a high risk of bias if one or more criteria were not met.

Data synthesis

Data was filed in a table of evidence and a descriptive summary was performed to define the quantity of data by inspection for further study variations in terms of characteristics and results.

RESULTS

Search Results and Excluded Trials

A group 648 potentially relevant articles for the present revision were initially selected from an electronic database search. From these, 615 were excluded due to title or abstract and the 34 remaining were reviewed completely, which eliminated a further 23 by lack of inclusion criteria compliance [1, 3, 6, 7, 9, 11, 12-14, 17, 18, 23-33]

A total of 11 articles were finally included. The search was carried out in electronic databases such as *PUBMED* (April 2016 to May 2017) and *EMBASE* (April 2016 to May 2017) as well as manually. A total of 648 studies were found, from which 615 were discarded by title or abstract, pre-selecting 34 articles which could be included in the revision. Twenty three were discarded afterwards because they did not comply with the inclusion criteria [Fig 1] and only 11 were finally included[2,4,8,15,16,19,34-38] [table 1].

The characteristics of these studies are shown in table 1. They all had a follow-up of at least one week post-cementation; two studies had only one week,[2,19] and the rest had longer periods of three weeks,[38] up to a month,[15, 35] up to three months,[4, 8, 34] 21 months[36] and two years [16, 37] Four studies were carried out in the United States,[2, 4, 8, 38] two in Germany,[16,37] two in India,[19,35] one in Pakistan[34] and one in Hong-Kong.[15]

Methodological Quality of Included Studies

The comparison of all studies with regards to the different methodological parameters showed that the one with the highest amount of parameters with low risk of bias was Piwowarczyk *et*

al., (2011). It was also observed that only the selective report and other bias sources had high risk of such and the randomisation method was not clear[36]. [Fig. 2].

Most of the studies selected, presented adequate in the follow-up periods [2, 4, 8, 15, 16, 19, 34, 36, 37] and in the assignation processes[2, 4, 8, 15, 34, 36-38] . Six of the studies presented an adequate randomisation sequence [2, 4, 8, 15, 34, 36] and in five it was not clear[16, 19, 34, 37, and 38]. The randomisation and sample assignation was considered adequate for all including study [Fig. 2]. Most studies did not report patient and examiner masking, [4, 8, 15-16, 19, 34-35, 38] and neither selective report[2, 4, 8, 34-37] [Fig. 2]. Thus, all studies were consider to be at a high risk of bias [Fig. 2].

Effect of Interventions

Among the selected studies there were six in which post-cementation sensitivity of the Glass-Ionomer Luting Cement [GIC] had been evaluated[2, 4, 15-16, 19, 35] four studies had assessments of the zinc oxide phosphate cement [$ZnPO_4$] [2, 4, 35-36] four had assessments of the resin cement (RC) [16,19,34,37] four evaluated the resin-modified glass ionomer (RMGIC) [15, 34-35, 38] and in three the self-adhesive resin cement (SARC) was evaluated[36-38]

The GIC was evaluated with regards to the $ZnPO_4$ in three studies[2, 4, 35] with regards to RMCIG in three[8, 15, 35] with regards to RC in two[16, 19] and it was not assessed with regards to SARC in any study. Upon analysing the studies it was observed that only three had reports of statistically significant differences. The Johnson *et al*. (1993) and Chandrasekhar *et al*., (2010) showed that the post-cementation sensitivity of $ZnPO_4$ cement was significantly greater than GIC's.

The significant differences in the study of Johnson *et al*. (1993) were present immediately after cementation ($p=0.045$) and remained during the following two weeks ($p=0.013$); in that of Chandrasekhar *et al*., (2010), the differences between cements were observed during the first follow-up week with the cold air and water tests ($p=0.01$), and they persisted for a month of follow-up ($p=0.001$). In the study of Shetty *et al*., (2012) there was a report of a statistically significant higher sensitivity of the GIC with regards to the posterior RC with the spray ice test after a week of cementation ($p<0.05$).

The RC was evaluated with regards to GIC in two studies[16, 19] with regards to RMGIC in one,[34] with regards to SARC in one[37] and in none with regards to $ZnPO_4$. It was observed

that in only one of the studies[19] there was a report of statistically significant sensitivity of the GIC compared to RC after one week of cementation ($p<0.005$) and there were no significant differences with regards to the other cements[16, 34, 37].

The RMGIC was evaluated in five studies: three with regards to GIC[8, 15, 35] one with $ZnPO_4$[35], one with RC,[34] and one with SARC[38]. Statistically significant lower post-cementation sensitivity was reported only for the RMGIC when compared with $ZnPO_4$ with the cold air and water tests after a week of cementation ($p=0.001$) and after one month of cementation ($p=0.001$)[35].

The $ZnPO_4$ was evaluated with regards to GIC in three studies[2, 35] with RMGIC in one[35] and SARC in one[35]. It was not assessed in any study with regards to RC and statistically significant differences were only found in two studies: with regards to GIC[4, 35] and RMGIC[35]. The sensitivity generated by $ZnPO_4$ as observed in the studies of Johnson *et al*. (1993) and Chandrasekhar *et al.,* (2010) was greater than GIC's with the different thermal tests such as water[4, 35] and cold air[35], immediately after cementation ($p=0.045$)[4], after one week ($p=0.01$),[35] after two weeks ($p=0.013$)[4], and after one month post-cementation[35]. In the study of Chandrasekhar *et al.,* (2010) the $ZnPO_4$ was compared to RMGIC and there were statistical differences with the cold water and air tests after one week ($p=0.001$) and after one-month post-cementation ($p=0.001$) with $ZnPO_4$ showing greater sensitivity.

SARC was compared to $ZnPO_4$ in one study[36] to RC in one[37] and to RMGIC in another[38]. It was to evaluated with regards to GIC in any studies and statistically significant differences were reported with respect to RMGIC is the study of Blatz *et al*., (2013), where SARC was observed to produce lower sensitivity to cold air after one week of cementation ($p=0.01$) and the ice test throughout the follow-up ($p<0.01$) of one day, one week and three weeks. All cements presented some degree of pots-cementation sensitivity with one or other of the thermal or masticatory tests, except in the study of Taschner et al., (2012) in which SARC and RC did not present any type of sensitivity during the follow-up period with the spray ice test.

Type and Material of the Restorations Used

The studies report the type and restoration material used but not the sensitivity results for the assessed cements. However, the following was found:

In two studies only partial-coverage restorations were used[35, 37] in another both complete crowns and partial-coverage restorations were used[2] in another complete crowns as part of a fixed partial prostheses[34] a further study had individual crowns and crowns as part of fixed partial prostheses[16] and the remaining only had complete individual crowns[4, 8, 15, 19,36,38] .

It was also observed in seven studies that the materials used were metal and metal porcelain; none the less, it was not specified what type of metal or porcelain[4,8,15-16,34,36,38]. Metallic gold were used in two.[2, 15] metallic nickel-chrome in another[19] other had gold restorations[4] another had metallic restorations in a non-specified metal[35] and in only one are ceramic restorations reported[37].

DISCUSSION

Summary of Main Results

The revision of results of most studies shows that almost all cements presented sensitivity with thermal tests [2, 4, 8, 15, 16, 19, 34-36, 38] . The analysis of such sensitivity with regards to follow-up time yielded that RC,[19,34] GIC,[4,16,35] $ZnPO_4$,[4,15,35] RMGIC[8,15, 34-35,38] and SARC[34,36,38] presented sensitivity immediately after cementation. RC,[16,19,34] GIC,[2,8,16,19,34-36] $ZnPO_4$,[4, 15, 35] SARC[36,38] RMGIC[34] and RMGIC presented sensitivity one week after cementation and RC,[16,34] GIC,[8,16,19,35] $ZnPO_4$,[35] RMGIC,[35] and SARC[34,38] in a period greater than two weeks after cementation. It is interesting to note that the evaluated cements with resin matrix such as RMGIC[8, 15, 34-35, 38] RC[16, 19, 34, 37] and SARC[36-38] had a significantly lower sensitivity to thermal tests when compared with other cements one week after cementation. In only one study which evaluated both resin cements – SARC and RC[37] – there was no sensitivity present during any of the follow-up periods. The present study had patients with inlay and onlay type restorations made with ceramic and it was the only in which metallic materials were not used. However, it has been observed in various studies that the restorative material does not influence post-cementation sensitivity poscementación[39-42]. No studies were found which evaluated the association between restoration design and sensitivity and it is consistent with the studies of Chandrasekhar et al., (2010) and Bebermeyer *& Berg*, (1994), in which there was post-cementation sensitivity with partial-coverage restorations.

Quality of the Evidence

None of the studies were considered to be at a low risk of bias because there were inconsistences regarding randomisation [16, 19, 35-37], allocation[16, 19, 35, 37], patient and examiner masking, [2, 4, 8, 15, 16, 19, 34, 35, 37, 38], completeness follow-up times [35, 38], selecting report [2, 4, 8, 34, 35, 36, 38,] and other sources of bias [2, 15, 19, 36 -38].

Limitations and Potential Biases in the Review Process

The studies could not be meta-analysed due to differing scales and test for evaluating sensitivity; additionally, results were reported with various types of data:

Scales and Sensitivity Tests

The scales used in the selected studies varied; nine had the Visual Analogue Scale (VAS) in which six used a range from zero to ten, [4,8,19,34,36-38] one had a range from one to five,[2] one from one to three[35] and another used four ranges modifying range nomenclature as: none = no response, mild=slight response, moderate=obvious, severe=intolerable[15]. Other used scales were the ordinal perception with three ranges: normal response (NR) =sensitivity to cold without pain, severe response (SR) =increased sensitivity causing a reflex[16] and the USPHS criteria modified which registered a dichotomy sensitivity.[37] Different types of thermal tests were also used in order to evaluate sensitivity: cold water was used in two studies[35-36] cold air was used in five[4, 15-16, 37,38] and three used spray ice.[34, 37] Additionally, two more evaluated the sensitivity during mastication[8, 35] and in one the experience of sensitivity by the patient was assessed.[2]

Type of Data used for Results

Results were reported differently in most studies: three studies had sensitivity reported by number of patients (absolute frequencies),[2, 16, 19] four had the mean and standard deviations of different values of the scales used[8, 35-36, 38] and the remaining four had results with relative frequencies (percentages). [4,15,34,,37] Apart from the reported biases, there were other sources as such: the ample age range of the evaluated patients.[2, 38] which determines pulpal age and dentinal tubule size, as well as the application of cavitary enamel before the cements.[4] These two factors may lead to varied and heterogeneous pulpal response to cements. It was observed likewise in the study of Bebermeyer & Berg, (1994) a lack of experience from the operators and lack of calibration of the examiners – which were undergraduates – that may have led to affect the final results.

Agreements and Disagreements with Other Studies or Reviews

The comparison of results obtained from articles included in the present revision[2, 4, 35] with another study which also compared the GIC and ZnPO4 cements – with follow-up commencing more than one week after cementation,[14] yielded similar but contradictory results. In the studies of Kern *et al*. (1996) and Bebermeyer & Berb, (1994) it was observed that both cements presented some post-cementation sensitivity without statistically significant differences. However, results from Kern *et al*. (1996) are not the same as those reported by Chandrasekhar *et al*., (2010) and Johnson et al., (1993) which did resulted in statistically significant differences, with ZnPO4 presenting the highest sensitivity. Post-cementation sensitivity of SARC was also evaluated[13, 30] and as has been reported in the present revision, it has the greatest sensitivity among the resin cements[38] or does not present any at all[37] with enamel selective etching[30].

In the present revision any studies in which a dentinal de-stabilising agent was used were excluded[9, 11] because they posed an important bias risk in the final results. None-the-less, the said studies do report a significant reduction of post-cementation sensitivity when compared with the application of GC Tooth Mousse™ [GC-Asia dental Ptd] or Systemp desensitizer® [Ivoclar Vivadent AG] with regards to a direct application of GIC[9] when other de-stabilisers were used, such as OptiBond™ SoloPlus, Copal/ether varnish (Bosworth® Copaliner) or BisBlock ™ dentin desensitizer (Bisco Inc, Schaumburg, USA), no differences were observed[9, 11]

CONCLUSIONS

In summary and within the limitations of the present systematic revision we can conclude that:

6. All analysed cements generate post-cementation sensitivity in all follow-up periods.
7. Sensitivity usually flares up during the first week after cementation.
8. SARC and GIC cements presented the lowest post-operatory during the different follow-up times.
9. $ZnPO_4$ presented the highest degree of post-cementation sensitivity during the different follow-up periods.

10. The restoration design or material apparently are not determinant factors in the presence or absence of post-cementation sensitivity.

Future randomised clinical trials with standardised methodologies (measurement scales, applied thermal tests and same-data reports) could be developed in order to:

1. To provide more consistent conclusions regarding the true effect of cements on post-cementation sensitivity of restorations.
2. To determine if the use of de-stabilising agents – not analysed in the present project – could eliminate post-cementation sensitivity of indirect restorations.

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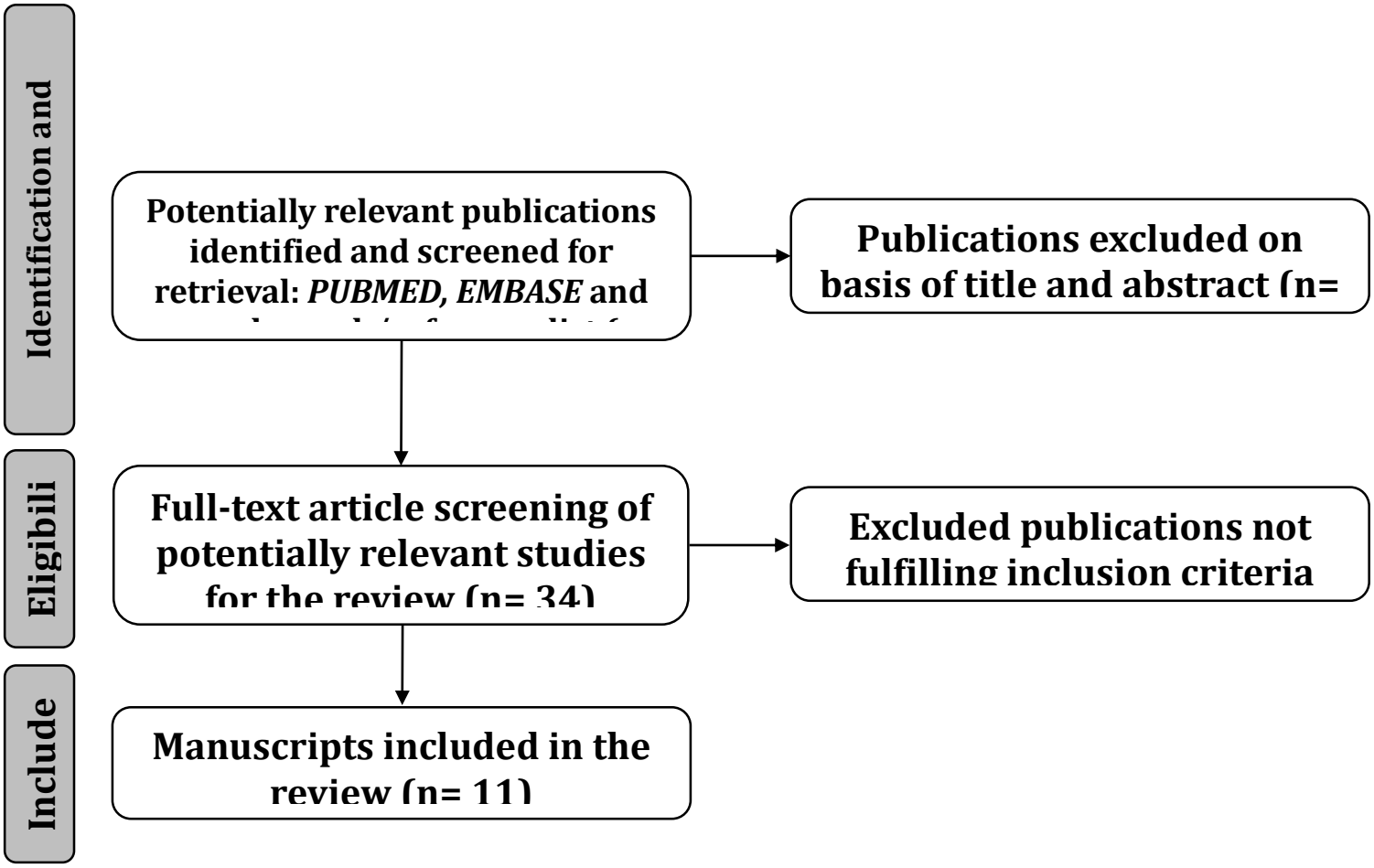
10.1.3 Figura 1.



10.1.4 Figura 2

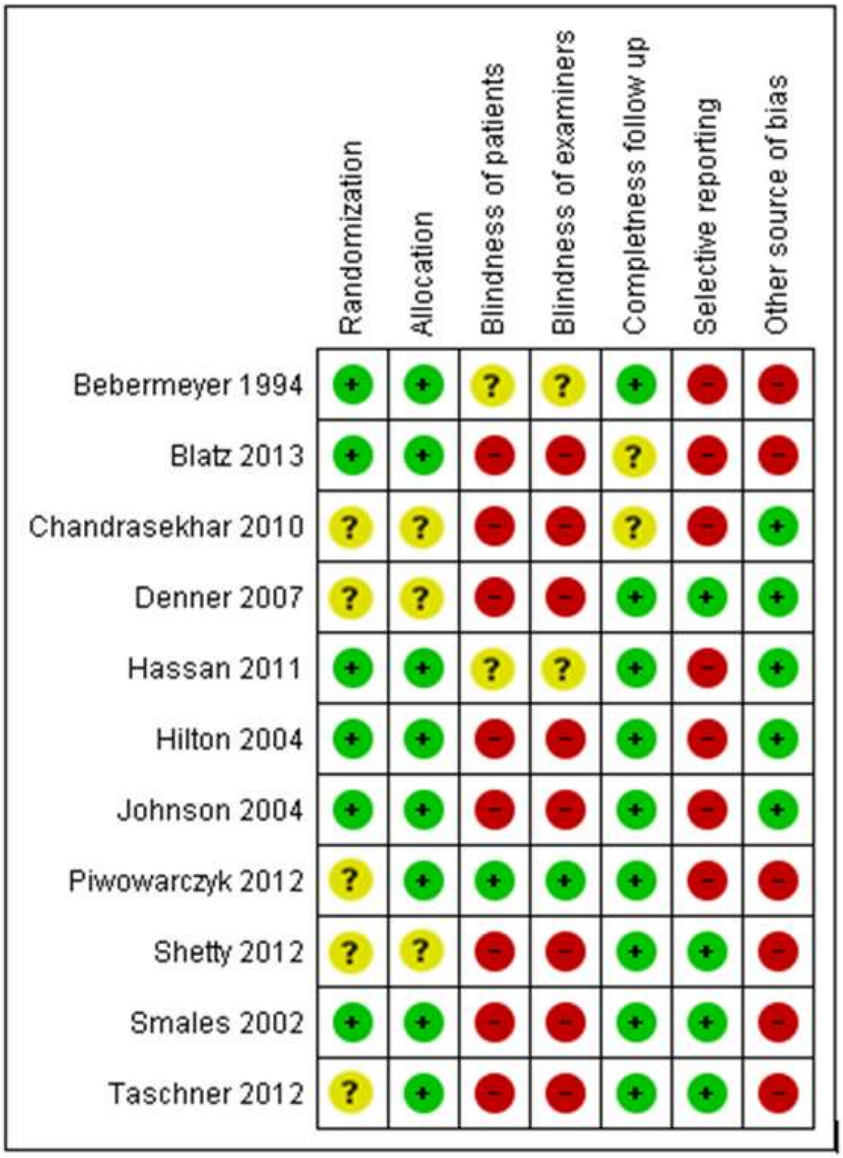


Figure 2. Risk of bias summary

10.1.5 Certificado editorial Operative Dentistry

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Manuscript title:

POST-CEMENTATION SENSITIVITY IN VITAL ABUTMENTS OF INDIRECT RESTORATIONS: A SYSTEMATIC REVIEW

Authors:

Madelline Mayo, Alfonso Cuadro, Martha Cecilia Tamayo, Juan Carlos Uribe, Cecilia Ruiz. Leandro Chambrone

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Article entitled: POST-CEMENTATION SENSITIVITY IN VITAL ABUTMENTS OF INDIRECT RESTORATIONS: A SYSTEMATIC REVIEW
Corresponding author: Prof. Tamayo-Muñoz

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Date of signature: 16-03-2018

10.1.7. Respuesta de pares revisores Operative Dentistry

May 1, 2018

Dear Author,

The referee comments regarding your manuscript "POST-CEMENTATION SENSITIVITY IN VITAL ABUTMENTS OF INDIRECT RESTORATIONS: A SYSTEMATIC REVIEW" have been received. On the basis of the reviews I regret to inform you that I cannot accept this article for publication. The referee comments are attached and are written to help our colleagues improve on content presentation and/or improve their research techniques. I urge you to accept these criticisms in the spirit in which they are offered.

At the current time, Operative Dentistry receives a large number of outstanding papers. This makes it necessary for us to be extremely conservative in our acceptance of new manuscripts. Even relatively minor errors in protocols, English language usage, reporting of the research or minor contribution to our knowledge base can prevent acceptance of a paper.

It is obvious that much time and effort was spent in creating this manuscript. We are honored that you would submit this paper for consideration by Operative Dentistry and look forward to receiving future papers from you for publication consideration

Sincerely,

Jeffrey Platt

Editor

Operative Dentistry

Editors comments (if any)-: Thank you for your submission to this journal.

Reviewer comments -

Reviewer #1 (Required Comments for the Authors):

Well structured and well set-up article with good contribution to the knowledge base.

Minor flaws: Text in lines 126-138 is somewhat reduplicated and needs to be corrected

Reviewer #2 (Required Comments for the Authors):

This manuscript is a systematic review of the literature related to the evaluation of tooth sensitivity after cementation of indirect restorations. The review involved a comprehensive search of the literature using multiple key words that relate to the issue. The authors used very stringent criteria for selection and followed several standard guidelines in conducting a systematic review. The authors identified 648 relevant articles but the review criteria were so stringent that 615 articles

were excluded on the basis of title and abstract; plus another 23 were excluded due to exclusion criteria compliance. The first problem is that the numbers do not add up; 648-615=33 and not 34, as stated in the manuscript (lines 126-129 and Figure 1). Another 23 were excluded, which leaves 10 viable articles but the authors stated 11 were accepted into the review.
With a broad category like this, using five types of cements (zinc phosphate, glass ionomer, resin modified glass ionomer, resin cement and self-adhesive resin cement), multiple restoration types (inlays, onlays, single crowns and fixed bridges) and multiple restorative materials from all metal to all ceramic restorations, the use of only 11 articles to make comparisons and draw conclusions, is not realistic. In addition, the 11 studies that were included were done in 5 different countries, all of which have widely varying educational and clinical practice standards. Of the 11 studies included, only 4 were published in the last five years, 2 between five and ten years and the remaining 5 were from 13 to 24 years old. Even in the bibliography, 18 of 42 articles (43%) used to justify the review are greater than 10 years since publication. Despite the fact that the authors followed strict criteria for a systematic review, the variations are too extensive to make valid comparisons.

To have a current application that would be useful to the journal readers, zinc phosphate and original glass ionomer are very old materials that are either no longer or very rarely used in clinical practice. If studies using those cements are excluded, there are only three studies left with relevant comparisons. This is insufficient to justify any consideration for publication in Operative Dentistry.

Several other issues are also to be considered in the manuscript:

1. Word selection is questionable in several areas

Line 26, 271: cavitary

Line 66: zinc oxide phosphate

Line 75: dichotomic

Lines 151, 153 and other places: assignation

Line 204: pots

Line 313: de-stabilizing agents

Lines 132-137 are a repeat of lines 126-130

10.2 Preparación para Brazilian Oral Research

Indicaciones Revisiónes sistemáticas y metanálisis:

Al resumir los resultados de los estudios originales, cuantitativos o cualitativos, este tipo de manuscrito debe responder a una pregunta específica, con un límite de 30,000 caracteres, incluidos espacios, y seguir el formato y estilo Cochrane (www.cochrane.org). El manuscrito debe informar, en detalle, el proceso de búsqueda y recuperación de los trabajos originales, los criterios de selección de los estudios incluidos en la revisión, y proporcionar un resumen de los resultados obtenidos en los estudios revisados (con o sin metadatos). Enfoque de análisis). No hay límite para el número de referencias o figuras. Las tablas y figuras, si se incluyen, deben presentar las características de los estudios revisados, las intervenciones comparadas y los resultados correspondientes, así como los estudios excluidos de la revisión. Otras tablas y figuras relevantes para la revisión deben presentarse tal como se describió anteriormente. El resumen puede contener un máximo de 250 palabras.

Diseño - Archivos de texto

- Archivo de la página de título (en formato DOC, DOCX o RTF).
- Archivo de texto principal (Documento principal, manuscrito), en formato DOC, DOCX o RTF.
- Tablas, en formato DOC, DOCX o RTF.
- Declaración de intereses y financiación, presentada en un documento separado y en formato PDF. (si es aplicable)
- Justificación de la participación de cada autor, proporcionada en un documento separado y en formato PDF.

Diseño: archivos gráficos

- Figuras: sin límite en el número de figuras en PDF

En el siguiente link se pueden revisar las indicaciones para los autores: http://www.scielo.br/revistas/bor/iinstruc.htm

10.2. 1. Pagina del titulo/ Title Page

Dental Materials

Title: POST-CEMENTATION SENSITIVITY IN VITAL ABUTMENTS OF INDIRECT RESTORATIONS: A SYSTEMATIC REVIEW

***M, C, Tamayo-Muñoz**

M, Mayo-Cordoba

A, Cuadro-Causil

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CONFLICT OF INTEREST:

The authors report no conflict of interest related to this study.

Clinical Relevance Statement: Postcementation sensitivity in vital teeth is a common clinical complication possibly due to the cements chemical properties. In this systematic review all cements reported postcementation sensitivity but cements containing resin matrix show less sensitivity to thermal tests 1 week after cementation.

10.2.2 Articulo complete/Main Text

Clinical Relevance Statement: Postcementation sensitivity in vital teeth is a common clinical complication possibly due to the cements chemical properties. In this systematic review all cements reported postcementation sensitivity but cements containing resin matrix show less sensitivity to thermal tests 1 week after cementation.

INTRODUCTION

Crowns and partially fixed prostheses are some of the most common restoration procedures in restorative dentistry. These require preparation of dental tissue involving enamel and dentin before being cemented. Hyper-sensitivity is one of the most frequent complications during vital teeth bonding.[1]

The condition is characterized by transient, acute pain of the exposed dentin as a result of tooth dehydration, osmotic changes, thermal, chemical and tactile stimuli. It presents after cementing a definitive restoration on a vital tooth and cannot be described as any other type of dental pathology.[1-3]

Various studies have suggested that post-cementing hyper-sensitivity has multiple causes such as bacterial, mechanical and chemical properties inherent to the cement. Those of bacterial origin are related to marginal microfiltration due to improper adaptation of provisional restorations or by a defective crown seal, which allows a hydrolytic degradation of the cement.[4-8] Mechanical origins are related to friction heat generated during dental preparation, air-drying, the mechanical pressure of cement on dentinal fluid of exposed tubules and occlusal discrepancies. Chemical causes are generated by the exposure of dentin to cavity disinfectants, acids, adhesives or hemostatic agents. Those inherent to the cementing agent are related to physical and biological characteristics, such as pH and biocompatibility. [4-8]

It has been observed that the post-cementing hyper-sensitivity frequency ranges from 3.1% to 32% with varying degrees of severity: light, moderate and severe.[1, 5, 8-10] Additionally, it has been reported that it is maintained between 3% and 6% of cases following a post-cementation of two and three years, respectively.[11] There are also reports of gender incidence in which females present greater hyper-sensitivity before and after dental preparation.

The analysis of randomized clinical trials showed that the determining factor in post-cementation hyper-sensitivity is the type of cement. For decades, one of the most used was zinc oxide phosphate [$ZnPO_4$], considered the gold standard due to its initial low pH and solubility, [1, 12] but it has now fallen out of use. Another widely used cement is the glass-ionomer [GIC] due to its cariostatic effect from the release of fluoride and excellent physical and mechanical properties.[13] However, the hyper-sensitivity produced can be compared to that of zinc phosphate[8] or greater.[14-15]

This can also be related to its low initial pH 1[6], which has led many dentists to avoid it.[17] The most recent option is resin cement [RC], which presents low solubility and its initial pH is higher than that of zinc phosphate and glass ionomer. It has also been reported to have post-cementation hyper-sensitivity, which may be related to the material's polymerization contraction, generating marginal seal defects of the restorations. [11, 18-19]

Post-cementation hyper-sensitivity is a multifactorial entity and one of the most evaluated factors is the type of cement. Nonetheless, in study results, there has been no consensus and no meta-analysis or systematic review about this topic that allow dentists to make informed and accurate clinical decisions based on evidence to avoid this complication. Therefore, this systematic review aimed to answer the following focused question: What type of luting agent presents greater postoperative hyper-sensitivity in indirect restorations on vital teeth?

MATERIALS AND METHODS

This review was structured in accordance with guidelines from *PRISMA,*[20] the *Cochrane Handbook of Systematic Reviews of Interventions*[21] and the *CheckReview* checklist.[22] In addition, the protocol was registered with the National Institute for Health Research PROSPERO, International Prospective Register of Systematic Reviews (http://www.crd.york.ac.uk/PROSPERO, registration number (ID=CRD42016038883).

Type of Studies and Participants (Inclusion Criteria)

The studies were considered eligible for inclusion if they met the following criteria: randomized clinical trials (RCTs) and controlled clinical trials that assessed the presence of postoperative hyper-sensitivity after cementation of indirect fixed restorations cemented with the following **luting agents:** zinc oxide phosphate cement [ZnPO4], conventional glass-ionomer cement [GIC], resin modified glass-ionomer [RMGIC], conventional resin cement [RC] and self-adhesive resin cement [SARC]. Studies were also included if the participants met the following criteria: adult patients, males and females, who required newly cemented indirect fixed restorations, such as inlays, onlays, single full coverage restorations and fixed partial dentures, with at least one week of follow-up.

Outcome Measures

The primary outcome was post-cementation sensitivity evaluated after thermal and mechanical stimulation with a visual analogue scale or dichotomic scale with at least one week of follow-up.

Search Strategy

Detailed search strategies were developed for Medical Literature Analysis and Retrieval System Online (*MEDLINE*) and Excerpta Medical Database (*EMBASE*) without language restrictions. Databases were searched up to and including July 10, 2018 using Medical Subject Headings (*MeSH*) terms, key words, other free terms and Boolean operators (OR, AND). These were combined and detailed search strategies were developed for each database following the search strategy presented for *MEDLINE*:

#1: Dentin sensitivity OR dentin hyper-sensitivity OR dentinal tubules OR dentin pain OR dentinal hyper-sensitivity OR tooth hyper-sensitivity OR root hyper-sensitivity OR vital tooth OR pulp sensitivity

#2: Cements OR dental cements OR dental adhesives OR resin cements OR crown cementation OR resin cements OR luting agents OR bonding

#3: #1 AND #2

#4: Early hyper-sensitivity OR post-cementation hyper-sensitivity OR crown cementation/ hyper-sensitivity OR cementation

#5: #3 AND #4

In addition, reference lists of studies considered potentially eligible for inclusion in this review were hand searched as well.

Assessment of Validity Data Extraction (Selection and Coding)

Two independent reviewers (AC and MM) screened the titles, abstracts and full texts of the papers and disagreements between the reviewers was mediated by discussion. In the event an agreement was not reached, a third reviewer (MCT) was consulted. When important data for the review was missing, an attempt to contact the authors was carried out to resolve the ambiguity from the trials.

The following data were collected and recorded in duplicate: citations, publication status and year of publication, location of the trial, study design, characteristics of the participants, outcome measures, methodological quality of the trials and conclusions.

Assessment of Risk of Bias and Quality Assessment in the Included Studies

For RCTs and controlled clinical trials, the methodological quality was evaluated following the Cochrane Collaboration's tool for assessing risk of bias[21] as adapted by Chambrone *et al*. (2010a): randomization and allocation methods (i.e., selection bias), completeness of the follow-up period, incomplete outcome data (i.e., attrition bias), masking of patients (i.e., performance bias) and examiners (i.e., detection bias), selective reporting (i.e., reporting bias) and other forms of bias were classified as adequate (+), inadequate (-), or unclear (?). Based on these answers, the risk of bias was categorized according to the following classifications: (1) a low risk of bias if all criteria were met (i.e., adequate methods of randomization and allocation concealment), a positive answer to all questions about completeness of follow-up questions and masking of examiners, and a negative answer to selective reporting and other sources of bias); (2) an unclear risk of bias if one or more criteria were partly met (i.e., unclear criteria were set), or (3) a high risk of bias if one or more criteria were not met.

Data synthesis

Data were filed in a table of evidence and a descriptive summary was performed to define the quantity of data by inspection for further study variations in terms of characteristics and results.

RESULTS

Search Results and Excluded Trials

The search was carried out in electronic databases such as *PUBMED* (April 2016 to July 2018) and *EMBASE* (April 2016 to July 2018) as well as manually. A total of 648 studies were found, from which 615 were discarded by title or abstract, pre-selecting 33 articles that could be included in the revision. Twenty-one were discarded afterwards[1, 3, 6, 7, 9, 11-14, 17, 18, 23-33] because they did not comply with the inclusion criteria [Fig. 1] and only 11 were finally included [table 1]. [2, 4, 8, 15, 16, 19, 34-38]

The characteristics of these studies are shown in table 1. They all had a follow-up of at least one-week post-cementation; two studies had only one week,[2,19] and the rest had longer periods of three weeks,[38] up to a month,[15, 35] up to three months,[4, 8, 34] 21 months[36] and two years [16, 37] Four studies were carried out in the United States,[2, 4, 8, 38] two in Germany,[16,37] two in India,[19,35] one in Pakistan[34] and one in Hong-Kong.[15]

Methodological Quality of Included Studies

The comparison of all studies with regard to the different methodological parameters showed that the one with the highest number of parameters with low risk of bias was Piwowarczyk *et al*., (2011). It was also observed that only the selective report and other bias sources had a high risk of such and the randomization method was not clear[Fig. 2].[36]

Most of the studies selected were adequate in the follow-up periods [2, 4, 8, 15, 16, 19, 34, 36, 37] and in the allocation processes.[2, 4, 8, 15, 34, 36-38] Six of the studies had an adequate randomization sequence. [2, 4, 8, 15, 34, 36] and, in five, it was not clear.[16, 19, 34, 37, and 38] The randomization and sample allocation were considered adequate for all included studies [Fig. 2]. Most studies did not report patient and examiner masking, [4, 8, 15-16, 19, 34-35, 38] or a selective report [Fig. 2]. [2, 4, 8, 34-37] Thus, all studies were considered to be at a high risk of bias [Fig. 2].

Effect of Interventions

Among the selected studies, there were six in which post-cementation sensitivity of the GIC had been evaluated, [2, 4, 15-16, 19, 35] four studies had assessments of the zinc oxide phosphate cement [$ZnPO_4$], [2, 4, 35-36] four had assessments of the resin cement (RC) [16,19,34,37], four evaluated the resin-modified glass ionomer (RMGIC) [15, 34-35, 38] and, in three, the self-adhesive resin cement (SARC) was evaluated.[36-38]

The GIC was evaluated with regards to the $ZnPO_4$ in three studies[2, 4, 35,] with regards to RMCIG in three, [8, 15, 35] with regards to RC in two[16, 19,] and it was not assessed with regards to SARC in any study. Upon analyzing the studies, it was observed that only three had reports of statistically significant differences. The Johnson *et al*. (1993) and Chandrasekhar *et al*., (2010) showed that the post-cementation sensitivity of $ZnPO_4$ cement was significantly greater than GIC's.

The significant differences in the study of Johnson *et al*. (1993) were present immediately after cementation ($p=0.045$) and remained during the following two weeks ($p=0.013$); in that of Chandrasekhar *et al*., (2010), the differences among cements were observed during the first follow-up week with the cold air and water tests ($p=0.01$), and they persisted for a month of follow-up ($p=0.001$). In the study of Shetty *et al*. (2012), there was a report of a statistically significant higher sensitivity of the GIC with regards to the posterior RC with the spray ice test after a week of cementation ($p<0.05$).

The RC was evaluated with regards to GIC in two studies, [16, 19] with regards to RMGIC in one, [34] with regards to SARC in one, [37] and in none with regards to $ZnPO_4$. It was observed that, in only

one of the studies[19], there was a report of statistically significant sensitivity of the GIC compared to RC after one week of cementation ($p<0.005$) and there were no significant differences with regard to the other cements.[16, 34, 37]

The RMGIC was evaluated in five studies: three with regards to GIC, [8, 15, 35] one with $ZnPO_4$, [35] one with RC [34] and one with SARC.[38] Statistically significant lower post-cementation sensitivity was reported only for the RMGIC when compared with $ZnPO_4$ with the cold air and water tests after a week of cementation ($p=0.001$), and after one month of cementation ($p=0.001$).[35]

The $ZnPO_4$ was evaluated with regards to GIC in three studies, [2, 35] with RMGIC in one,[35] and SARC in another.[35] It was not assessed in any study with regards to RC and statistically significant differences were only found in two studies, with regard to GIC[4, 35] and RMGIC.[35] The sensitivity generated by $ZnPO_4$, as observed in the studies of Johnson *et al*. (1993) and Chandrasekhar *et al.*, (2010) was greater than GIC's with the different thermal tests, such as water[4, 35] and cold air[35], immediately after cementation ($p=0.045$)[4], after one week ($p=0.01$),[35] after two weeks ($p=0.013$)[4], and after one month post-cementation.[35] In the study of Chandrasekhar *et al.,* (2010) the $ZnPO_4$ was compared to RMGIC and there were significant differences with the cold water and air tests after one week ($p=0.001$) and after one-month post-cementation ($p=0.001$) with $ZnPO_4$ showing greater sensitivity.

SARC was compared to $ZnPO_4$ in one study, [36] to RC in one, [3] and to RMGIC in another.[38] It was to be evaluated with regards to GIC in any study and statistically significant differences were reported with respect to RMGIC is the study of Blatz *et al*. (2013), in which SARC was observed to produce lower sensitivity to cold air after one week of cementation ($p=0.01$) and the ice test throughout the follow-up ($p<0.01$) of one day, one week and three weeks. All cements presented some degree of post-cementation sensitivity with one or other of the thermal or masticatory tests, except in the study of Taschner et al. (2012), in which SARC and RC did not present any type of sensitivity during the follow-up period with the spray ice test.

Type and Material of the Restorations Used

The studies reported the type and restoration material used but not the sensitivity results for the assessed cements. However, the following was found:

In two studies, only partial-coverage restorations were used.[35, 37] In another, both complete crowns and partial-coverage restorations were used.[2] In another, complete crowns as part of a

fixed partial prostheses[34] were used. Another study had individual crowns and crowns as part of fixed partial prostheses[16] and the remaining studies only had complete individual crowns.[4, 8, 15, 19,36,3]

It was also observed in seven studies that the materials used were metal and metal porcelain; however, it was not specified what type of metal or porcelain.[4, 8, 15-16, 34, 36, 38] Metallic gold were used in two studies[2, 15] and metallic nickel-chrome in another.[19]Another had gold restorations[4], another had metallic restorations in a non-specified metal[35] and in only one were ceramic restorations reported.[37]

DISCUSSION

Summary of the Main Results

The review of the results of most studies showed that almost all cements had sensitivity with thermal tests. [2, 4, 8, 15, 16, 19, 34-36, 38] The analysis of such sensitivity with regards to follow-up time yielded that RC,[19,34] GIC,[4,16,35] $ZnPO_4$,[4,15,35] RMGIC [8,15,34-35,38] and SARC[34,36,38] presented sensitivity immediately after cementation. RC,[16,19,34] GIC,[2,8,16,19,34-36] $ZnPO_4$,[4, 15, 35] SARC[36,38] RMGIC[34] and RMGIC presented sensitivity one week after cementation and RC,[16,34] GIC,[8,16,19,35] $ZnPO_4$,[35] RMGIC,[35] and SARC[34,38] showed sensitivity in a period greater than two weeks after cementation. It is interesting to note that the evaluated cements with resin matrix, such as RMGIC[8, 15, 34-35, 38] RC[16, 19, 34, 37] and SARC[36-38], had a significantly lower sensitivity to thermal tests when compared with other cements one week after cementation. In only one study, which evaluated both resin cements SARC and RC[37], there was no sensitivity present during any of the follow-up periods. The present study had patients with inlay and onlay type restorations made with ceramic and it was the only one in which metallic materials were not used. However, it has been observed in various studies that the restorative material does not influence post-cementation sensitivity. [39-42] No studies were found that evaluated the association between restoration design and sensitivity and this is consistent with the studies of Chandrasekhar et al., (2010) and Bebermeyer and Berg, (1994), in which there was post-cementation sensitivity with partial-coverage restorations.

Quality of the Evidence

None of the studies were considered to be at a low risk of bias because there were inconsistences regarding randomization [16, 19, 35-37], allocation, [16, 19, 35, 37]patient and examiner masking, [2, 4, 8, 15, 16, 19,

[34, 35, 37, 38], completeness of follow-up times [35, 38], selection reports [2, 4, 8, 34, 35, 36, 38,] and other sources of bias. [2, 15, 19, 36 -38.]

Limitations and Potential Biases in the Review Process

The studies could not be subjected to a meta-analysis due to differing scales and tests for evaluating sensitivity; additionally, the results were reported with various types of data:

Scales and Sensitivity Tests

The scales used in the selected studies varied; nine used the Visual Analogue Scale (VAS) in which six used a range from zero to ten,[4,8,19,34,36-38] one had a range from one to five,[2] one from one to three,[35] and another used four ranges, modifying the range nomenclature as: none=no response, mild=slight response, moderate=obvious, and severe=intolerable.[15] Others used scales were the ordinal perception had three ranges: normal response (NR)=sensitivity to cold without pain, severe response (SR)=increased sensitivity causing a reflex[16] and the USPHS criteria modified, which registered a dichotomy sensitivity.[37] Different types of thermal tests were also used in order to evaluate sensitivity: cold water was used in two studies,[35-36] cold air was used in five,[4, 15-16, 37,38] and three used spray ice.[34, 37] Additionally, two more evaluated sensitivity during mastication[8, 35] and, in one, the experience of sensitivity by the patient was assessed.[2]

Type of Data used for Results

Results were reported differently in most studies: three studies had sensitivity reported by the number of patients (absolute frequencies),[2, 16, 19] four used the mean and standard deviations of different values of the scales [8, 35-36, 38] and the remaining four had results with relative frequencies (percentages. [4,15,34,37] Apart from the reported biases, there were other sources as such: the ample age range of the evaluated patients,[2, 3] which determines pulpal age and dentinal tubule size, as well as the application of cavity enamel before the cements.[4] These two factors may lead to varied and heterogeneous pulpal response to cements. In the study of Bebermeyer and Berg, (1994), a lack of experience from the operators and lack of calibration of the examiners, which were undergraduates, was observed that may have affected the final results.

Agreements and Disagreements with Other Studies or Reviews

The comparison of results obtained from articles included in the present review[2, 4, 35] with another study that also compared the GIC and ZnPO4 cements, with follow-up commencing more than one

week after cementation,[14] yielded similar but contradictory results. In the studies of Kern *et al*. (1996) and Bebermeyer & Berb (1994), it was observed that both cements showed some post-cementation sensitivity, without statistically significant differences. However, the results from Kern *et al*. (1996) are not the same as those reported by Chandrasekhar *et al*., (2010) and Johnson et al. (1993), which did result in statistically significant differences, with ZnPO4 presenting the highest sensitivity. Post-cementation sensitivity of SARC was also evaluated[13, 30] and, as has been reported in the present review, it had the greatest sensitivity among the resin cements[38] or did not present any at all[37] with enamel selective etching[30].

In the present review, any studies in which a dentinal desensitizer agent was used were excluded[9, 11] because they posed a bias risk in the final results. Nonetheless, the said studies did report a significant reduction in post-cementation sensitivity when compared with the application of GC Tooth Mousse™ [GC-Asia dental Ptd] or Systemp desensitizer® [Ivoclar Vivadent AG]. With regard to a direct application of GIC[9] when other desensitizer were used, such as OptiBond™ SoloPlus, Copal/ether varnish (Bosworth® Copaliner) or BisBlock ™ dentin desensitizer (Bisco Inc, Schaumburg, USA), no differences were observed[9, 11]

CONCLUSIONS

In summary, and within the limitations of the present systematic review, we can conclude that:

3. All analyzed cements generated post-cementation sensitivity in all follow-up periods.
4. Sensitivity usually flared up during the first week after cementation.
5. SARC and GIC cements presented the lowest post-operatory sensitivity during the different follow-up times.
6. $ZnPO_4$ presented the highest degree of post-cementation sensitivity during the different follow-up periods.
7. The restoration design or material apparently are not determinant factors in the presence or absence of post-cementation sensitivity.

Future randomized clinical trials with standardized methodologies (measurement scales, applied thermal tests and same-data reports) could be developed in order to:

1. Provide more consistent conclusions regarding the true effect of cements on post-cementation sensitivity of restorations.

2. Determine if the use of desensitizers agents – not analyzed in the present project – could eliminate post-cementation sensitivity of indirect restorations.

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Table 1. Characteristics of included studies

Figure 1. Flowchart of articles screened in the review process.

Figure 2. Risk of bias summary

10.2.4. Tabla 1

Table 1. Characteristics of included studies

Study	Participants /type of restoration/ study design	Test/ control groups*	Post-operative sensitivity evaluation: Scale and parameters/Test/ Post-operative follow-up **	Outcome/ Statistical significance	*Author's main conclusions and notes*
1. Bebermeyer & Berg, 1994 [USA]	45 adult patients 45 Cast complete crowns, 3/4 or 7/8 crown or onlay per group Randomised clinical trial. Split-mouth	Test group: GIC [Ketac™ Cem 3M/ESPE, St Paul,MN, USA] Control group: $ZnPO_4$ [Fleck's Zinc Phosphate Cement Keystone Industries GmbH, Singen, Germany]	**Perception ordinal scale** 1 No sensitivity 5: Extreme sensitivity Descriptive information about aetiology of sensitivity obtained by questionnaire One week.	Sensitivity level (N° of Patients) GIC: 5(3), 1-4(39) $ZnPO_4$: 5(4), 1-4(40) There was no statistically significant difference observed between ZnPO4 and GIC when they were tested one week after cementation. P value was not reported	The results indicate that restorations cemented with glass-ionomer cement did not show any more sensitivity than those cemented with zinc phosphate cement. Mixing conditions of the glass-ionomer materials are strict, it is particularly important to adhere to each manufacturer's recommendations for use to allow maximal benefit and minimal risk of sensitivity.
2. Blatz *et a*l., 2013 [USA]	70 adult patients age range 24-65 years. Male: 16 CG/ 18 TG Female 29 CG/ 26 TG 88 full-coverage crowns: 44 per group. Randomised clinical trial – open	Test group: SARC [iCem Heraeus Kulzer GmbH, Hanau,Germany] Control group: RMGIC [GC Fuji PLUS, GC Corporation, Tokyo174, japan]	**Visual Analog Scale [VAS]** Range 0-10 0: no sensitivity 10: most severe sensitivity Sensitivity reported by patient compressed air test spray ice test After: LB, one day, one week and three weeks.	**Patient sensitivity report** [Mean (range)] **RMGIC:** LB 0.43(0-6), one day 1.30 (0-8); one week.: 0.50 (0-6); three weeks:0.43 (0-6) **SARC:** LB 0.36(0-4), one day 0.52 (0-7); one week.: 0.39 (0-7); three weeks:0.48 (0-9) **Patient sensitivity report** [Me ((IQR)] **RMGIC:** LB 0(0-0), one day 0 (0-3); one week.: 0 (0-0); three weeks: 0 (0-0) **SARC:** LB 0.0(0-0), one day 0 (0-0); one week.: 0 (0-0); three weeks: 0 (0-0) **Air sensitivity** [Mean (range)] **RMGIC:** LB 0.77(0-5); one day 0.48 (0-4); one week.: 0.43 (0-3); three weeks:0.34 (0-3) **SARC:** LB 0.55(0-4); one day 0.23 (0-5); one week.: 0.07 (0-1); three weeks:0.09 (0-1) **Air sensitivity** [Me ((IQR)] **RMGIC:** LB 0(0-1); one day 0 (0-0.75); one week.: 0 (0-1); three weeks: 0 (0-0) **SARC:** LB 0(0-1); one day 0(0-0); one week.: 0 (0-0); three weeks: 0 (0-0) **Ice sensitivity** [Mean (range)] **RMGIC:** LB 3.91(1.25-6); one day 3.11 (0-8); one week.: 2.45 (0-6); three weeks:1.98 (0-8) **SARC:** LB 3(0.25-7); one day 1.52 (0-9); one week.: 1.05 (0-8); three weeks:1.00 (0-9) **Ice sensitivity** [Me ((IQR)] **RMGIC:** LB 3.21(0-8); one day 3(1.25-4.75); one week.: 2 (1-4); three weeks:2 (0-3) **SARC:** LB 3.48(0-9); one day 1.52 (0-9); one week.: 1.05 (0-8); three weeks:1 (0-9) **Patient sensitivity report**: Post-cementation sensitivity was significantly higher for RMGIC after 1 d (p=0.02). No statistically significant difference was observed between RMGIC and SARC when they were tested at LB (p=0.78), one week. (P=0.11) and three weeks (p=0.98) after cementation.	The cementation of crowns with SARC resulted in lower post-operative sensitivity than with RMGIC in the most of intervals of time evaluated by the different tests.

				Air Sensitivity: Post-cementation sensitivity was significantly higher for RMGIC at one week after (p=0.01). No statistically significant difference was observed between RMGIC and SARC when they were tested at LB (p=0.38), one day and three weeks after cementation (p >0.05). **Ice sensitivity:** Post-cementation sensitivity was significantly higher for RMGIC at one day (p <.001), one week (p <.001), and three weeks. (p <.001).No statistically significant difference was observed between RMGIC and SARC when they were tested at LB (p =0.36).	
3.Chandrasekhar, 2010 [India]	60 adult patients Age range 15-50 years	Test group: GIC [Glass Inomer Cement CX-Plus SHOFU Dental corporation, Tokyo, Japan]	**Scale 0-3** Grade 0 – No sensitivity Grade 1 – Mild sensitivity Grade 2 – Moderate sensitivity Grade 3 – Severe sensitivity	**Biting pressure mean ± SD** **1 mm** $ZnPO_4$ 0.35±0.59; GIC 0.25±0.44; RMGIC 0.15±0.37 **One week.** $ZnPO_4$ 0.20±0.52; GIC 0.15±0.49; RMGIC 0.00±0.00 **one month** $ZnPO_4$ 0.10±0.30; GIC 0.50±0.2; RMGIC 0.00±0.00 **Compressed air mean ± SD** **1 mm** $ZnPO_4$ 1.10±0.8; GIC 0.95±0.82; RMGIC 0.95±0.83 **One week.** $ZnPO_4$ 1.30±1.033; GIC 0.40±0.60; RMGIC 0.05±0.22 **one month** $ZnPO_4$ 1.35±1.04; GIC 0.00±0.00; RMGIC 0.05±0.22 **Cold water mean ± SD** **1 mm** $ZnPO_4$ 1.55±1.00; GIC 1.55±1.05; RMGIC 1.55±1.05 **One week.** $ZnPO_4$ 1.85±0.99; GIC 0.80±0.95; RMGIC 0.30±0.47 **one month** $ZnPO_4$ 1.60±0.99;GIC 0.40±0.82; RMGIC 0.15±0.37	The patients with restorations cemented with resin-modified glass ionomer demonstrated the least postoperative sensitivity when compared to glass ionomer and zinc phosphate cement at all intervals of time evaluated by different tests.
	60 inlay cast restorations, 20 per group	Test group: RMGIC [VITREMER®, 3M/ESPE, St Paul,MN, USA]	Cold water test Compressed air test Biting pressure test Sensitivity reported by patient		
	Randomised clinical trial The teeth were randomly divided into three groups of 20 each. Group-I: 20 inlay cast restorations cemented with glass ionomer luting cement. Group-ii: 20 inlay cast restorations cemented with zinc phosphate cement. Group iii: 20 inlay cast restorations cemented with resin-modified glass ionomer cement	Control group: $ZnPO_4$ [Harvard Cement Harvard Dental Company GmbH.Berlín-Alemania]	After 1mm, one week and one month.	There were no significant differences (P>0.05) between the three cements at different intervals of time for **biting pressure test**. There were no significant differences (P> 0.05) among the three cements immediately after cementation, both with cold water test and compressed air test. After one week there was a significant difference between the three cements with the **cold water test** ZnPO4 Vs. GIC: (P=0.01); ZnPO4 Vs. RMGIC: (P=0.001); GIC Vs. RMGIC: (P=0.05). After one month with the same test there were significant differences between ZnPO4 and GIC: (P=0.001) and between ZnPO4 and RMGIC: (P=0.001), but there was not a significant difference between GIC and RMGIC: (P>0.05). After one week. There was a significant difference between the three cements with the **compressed air test:** ZnPO4 Vs. GIC: (P=0.01); ZnPO4 Vs. RMGIC: (P=0.001); GIC Vs. RMGIC: (P=0.02). After one month with the same test there were significant differences between ZnPO4 and GIC: (P=0.001) and between ZnPO4 and RMGIC: (P=0.001), but there was no significant difference between GIC and RMGIC: (P>0.05). The ZnPO4 group reported the highest level of sensitivity values and the RMGIC group reported the least level at these two intervals of time with both tests: cold water and compressed air.	
4. Denner *et al*., 2007 [Germany]	60 adult patients Age range 22-65 years Mean age: 44. 4 years Male: 38 Female:22	Test group: RC [Chemiace II® Sun Medical Company, Ltd Moriyama, Japan]	**Perception ordinal scale.** **No Response [N]** **Normal response [NR]:** sensation of cold but no pain **Severe response [SR]:** increased sensitivity causing a patient reflex.	**RC: Time- Point- Scale [N° of patients]** **One week.** NR [45], SR [6], N [0]; **six months** NR [46], SR [3], N [2]; **12 months** NR [44], SR [1], N [0]; **24 months** NR [46], SR [0], N [0]. **GIC: Time- Point- Scale [N° of patients]** **One week.** NR [48], SR [3], N [0]; **six months** NR [48], SR [3], N [0]; **12 months** NR [44], SR [3], N [0]; **24 months** NR [48], SR [0], N [0].	The incidence of post-operative hyper-sensitivity after cementation of full-crown restorations with a conventional glass-ionomer cement and a new adhesive resin cement was similar. In the patients observed 24 months after cementation, no cases of hyper-sensitivity were reported for either group. The percentage of hyper-sensitivity decreased notably during the follow-up period. There was a significant decrease of hyper-sensitivity with age. Women showed a significantly higher rate of hyper-sensitivity than men.
	120 full-coverage crowns independent or in FPD: 60 per group.	Control group: GIC [Ketac-Cem®, 3M/ESPE, St Paul, MN, USA).	Ice spray Test		
	Randomised clinical trial – Split-mouth double blind		After: one week., six months., 12 months and 24 months	**There was no statistically significant difference between cements at any interval of evaluated time** (P>0.05)	
5. Hassan *et al*., 2001 [Pakistan]	208 adult patients Age range: 20 – 30 years Mean age: 26.16 ± 3.15	Test group: RC [Panavia® F2	**Visual Analog Scale** Range 0-10 1-4: mild sensitivity	The sensitivity results showed that 98% of the patients exhibited only mild to moderate sensitivity irrespective of the type of cement used, at all follow-up appointments.	Majority of the patients exhibited either mild or moderate sensitivity on cold sensitivity tests, with a very small

		Kuraray Noritake Dental Inc., Japan]	5-7: moderate sensitivity 8-10: severe sensitivity		percentage experiencing severe sensitivity. The sensitivity responses reduced with time with both the luting cements. There was no significant difference (p>0.05) between the resin-based luting cement and glass- ionomer luting cement in terms of post cementation sensitivity in vital teeth with fixed restorations.
	208 full-coverage crowns in FPD: 108 per group.	Control group: RMGIC [Fuji® GC-II Glass Ionomer Cement, GC Corporation, Tokyo 174, Japan	Cold sensitivity test.		
	Randomised clinical trial- single blind		After: One week. One month Three months	There was no statistically significant difference between the two cements in terms of post-cementation sensitivity. (P>0.05)	
6. Hilton *et al.*,2004 [USA]	209 adult patients Male: 102 Female: 107	Test group: RMGIC [GC Fuji® I Enhanced, Self-Cured Luting Cement, GC Corporation, Tokyo 174, Japan	**Visual Analog Scale** Range 0-10 0 = no pain 10 = worst imaginable pain	**GI** *Means (SD) Heat [H], Cold [C] and Biting [B] Sensitivity* **N° (absent/present) for sensitivity at any time:** H: 73/30; C: 52/51; B: 77/26 **RMGI** *Means (SD) Heat [H], Cold [C] and Biting [B] Sensitivity* **N° (absent/present) for sensitivity at any time:** H: 84/22; C: 64/42; B: 85/21	**The intervention was carried out by private dentists with an extensive experience in fixed prosthodontics in their private practice. Patients were part of the dentists' clinical practice. The follow-up was done by the same dentists and the examiners filed the information via telephone.**
	209 independent full-coverage crowns; 106 [RC] and 103 [GIC]		Descriptive information about aetiology of sensitivity obtained by questionnaire: hot, cold and biting		
	Randomised clinical trial	Control group GIC [Rely X luting cement, 3M/ESPE, St Paul, MN, USA]	After: One hour, one week, one month and three months	There was no statistically significant difference between the two cements in hot, cold or biting sensitivity at any time. (P>0.05)	
7. Johnson *et al.*,1993 [USA]	86 adult patients	Test group: GIC [Ketac™ Cem. ESPE Premier, 3M/ESPE, St Paul, MN, USA).	**Visual Analog Scale [VAS]** Range 0-10 0 = no pain 10 = severe pain	**Immediate sensitivity** **ZnPO4:** 32% **GIC:** 19% **Air sensitivity:** **ZnPO4:** two weeks 0%; three months0% **GIC:** two weeks 0%; three months: 0% **Biting sensitivity** **ZnPO4:** two weeks 0%; three months: 0% **GIC:** two weeks 0%; three months: 0% **Cold sensitivity:** **ZnPO4:** two weeks 34%; three months: 0% **GIC:** two weeks 19%; three months: 0%	**Clinicians were standardised in bridge and crown preparations. There was stump reconstruction with amalgam and glass ionomer when the clinician considered it. Cavity varnish was applied on vital stumps for teeth cemented with ZnPO4 and the smear layer was not removed for those cemented with GIC.**
	214 independent full-coverage crowns; 101 [ZnPO4] and 113 [GIC]		Descriptive information about aetiology of sensitivity obtained by questionnaire. Immediate sensitivity by cemented procedure Direct testing: air cold, biting		
		Control group: $ZnPO_4$. [FLECK'S®Mizzy Cement, Keystone Industries GmbH, Singen, Germany]		There was a statistically significant difference between the two cements in immediate sensitivity (p=0.045), being higher the sensitivity reported for $ZnPO_4$ There was no statistically significant difference between the two cements for air sensitivity and biting sensitivity – at any time. (P>0.05). There were significant differences between base line at two weeks for cold sensitivity with ZnPO4, which were higher than GIC. (p=0.013)	**The authors report in materials and methods that follow-up would commence after the first week. However, results are reported after the second week.**
	Randomised clinical trial		After: 1mm, one to two weeks and three months		
8. Piwowarczyk *et al.*, 2012. [Germany]	20 adult patients Mean age: 53 years	Test group: SARC [RelyX Unicem Self-Etch Resin Cement 3M/ESPE, St Paul, MN, USA].	**Visual Analog Scale [VAS]** 0= no sensitivity 10= Extremely **Dichotomous scale** Yes or no	**VAS: Mean ± SD** **ZnPO4:** 3-10 d. 1.3±2.1; four weeks. 0.6 ±1.5; six months 0.2 ±0.8; one year 0.04±0.3; two years 0.1±0.4; 3 Yr. 0.1±0.2 **SARC**: 3-10 ds.1.0±1.9; 4 Weeks. 0.5±1.1; six months: 0.1±0.4; one year 0.1±0.3; two years 0.3±0.7; three years0.1±0.2	The clinical performance of both luting agents (SARC and ZnPO4) barely differed with regard to the investigated parameters including post-operative hyper-sensitivity. The scores obtained from the Visual Analog Scale differed significantly within both groups over the observation period (p<0.0001), they were noted at follow-up examinations compared to the baseline: ZnPO4: at the framework try-in and one year following cementation SARC at the framework try-in.
	40 independent full-coverage crowns; 20[ZnPO4] and 60 [SARC]	Control group: ZnPO4 [Hoffmann's Cement normalhärtend, Hoffmann Dental Manofaktur GmbH, Berlin, Germany]	**VAS:** descriptive information about aetiology of sensitivity obtained by questionnaire (chewing, air streams, cold or hot temperatures and electronic pulp tester). **Dichotomous scale** (Yes or no) for: cold water test and air/ compressed blast test	No difference between the luting agents was noted concerning the risk of developing hyper-sensitivity (OR=1.31, p>0.05) No significant differences were observed with respect to questions surveyed by a Visual Analog Scale between the two cement types (p>0.05).	
	Randomised clinical trial split-mouth		After: three to ten days, four weeks, six months, one, two and three years.		
	50 adult patients	Test group:	**Visual Analog Scale**	**GIC : Level VAS (N° Patients)**	

9. Shetty. *Et al.,* 2012 [India]	Mean age: 33.8 years 100 full-coverage crowns; 50 GIC] and 50 [RC] Randomised clinical trial single – blind	RC [SmartCem® 2 Self-Adhesive Cement, Densply Cirona USA] Control group: GIC [GC Gold Label ®Lutinng and Lining Cemet, GC Corporation, Tokio 174, Japan	Range 0-10 0 = no pain 10 = worst imaginable pain Ice spray test After: 1 mm, 24 h and 7 ds.	LB(n=25): 1(9); 2(5); 3(7); 4(4) 24h(n=25): 0(2); 1(11); 2(8); 4(4) 7d(n=25): 0(6); 1(12); 2(7) **RC : Level VAS (N° Patients)** LB(n=25): 1(11); 2(9); 4(1); 5(4) 24h(n=25): 0(9); 1(10); 2(2); 3(3); 5(1) 7d(n=25): 0(16); 1(5); 2(4) No statistically significant difference was observed between RC and GIC when sensitivity was tested immediately and 24 hours after cementation. Post-cementation sensitivity was significantly higher with GIC when compared with RC after seven days. ($p<0.05$).	None of the patients with either of the cements reported severe response. With RC most patients reported no response after seven days. With GIC the average response was 1.04 which is not clinically significant.
10. Smales *et al*., 2002. [Hong Kong]	50 adult patients Mean age: 43.5 years Male: 24 Female:26 88 full-coverage crowns; 30[RMGIC], 30[RMGIC] and 28[GIC] Randomised clinical trial	Test group 1: RMGIC [Fuji DUET, GC Corporation, Tokyo 174, Japan Test group 2: RMGIC [Vitremer® Luting Cement-3M/ESPE, St Paul, MN, USA). Control group: GIC [GC Fuji I Enhanced, Self-Cured Luting Cement, GC Corporation, Tokyo, Japan	**Perception ordinal scale. 4 levels** NONE [NR]: no response MILD: slight response MODERATE: obvious response SEVERE: not tolerable Compressed blast test After: one to four weeks	**Cement-LEVEL: N° patients (%)** **GIC:** NR 23 (82.1%), MILD 5 (17.9%) MODERATE 0 (0%) **RMGIC [FUJI DUET]:** NR 25 (83.4%), MILD 3 (10%), MODERATE 2 (6.6%) **RMGIC [VITREMER LC]:** NR 24 (80%), MILD 4 (13.4%), MODERATE 2 (6.6%) No teeth were recorded as having severe sensitivity any time. There were no statistically significant differences between the three luting cements when post cementation sensitivity was evaluated ($p=0.64$).	Using a conventional glass-ionomer cement or two resin-modified glass-ionomer cements for cementation of gold or ceramic-metal crowns on vital teeth resulted in less post-cementation sensitivity to air blasts within a one-to-four week recall period than was present pre-operatively. Most teeth showed no post-cementation sensitivity, and there were no statistically significant differences found among the three luting cements.
11. Taschner *et al.,* 2012 [Germany]	30 adult patients Age Range 23-64 years Mean age: 39 years Male: 11 Female:19 93 inlay and onlay restorations; 43[SARC] and 40[RC] Randomised clinical trial	Test group: SARC [Breeze™ Self-Adhesive Resin Cement. Pentron Clinical. CA, USA] Control group: RC [RelyX ARC 3M/ESPE, St Paul, MN, USA]	**Modified USPHS [Criteria #8: Changes in sensitivity]** Alpha1: Excellent Alpha2: Good Bravo: Sufficient Charlie: Insufficient Delta: Poor Ice spray test After: one week., six months and one year	**2week (83%): SARC (100%):** Alpha1 RC (100%): Alpha1 **six months (83%): SARC (100%):** Alpha1 RC (100%): Alpha1 **1Yr (82%): SARC (100%):** Alpha1 RC (100%): Alpha1 **2Yr (82%): SARC (100%):** Alpha1 RC (100%): Alpha1 No statistical analysis was performed for changes in sensitivity because there was no post-operative hyper-sensitivity reported by any patient, any time	No post-operative hyper-sensitivity was reported by any patient at any time

* Glass-ionomer luting cement [GIC], zinc oxide phosphate cement [$ZnPO_4$], resin cement[RC], resin-modified glass ionomer [RMGIC] , self-adhesive resin cement [SARC]
** Immediately after (1mm) Hour (hr), Day (d), Week (Week.), Month (Mo.), Year (Yr.)

10.2.5. Figura 1 y Figura 2 (archivos independientes)

Figure 1. Flowchart of articles screened in the review process.

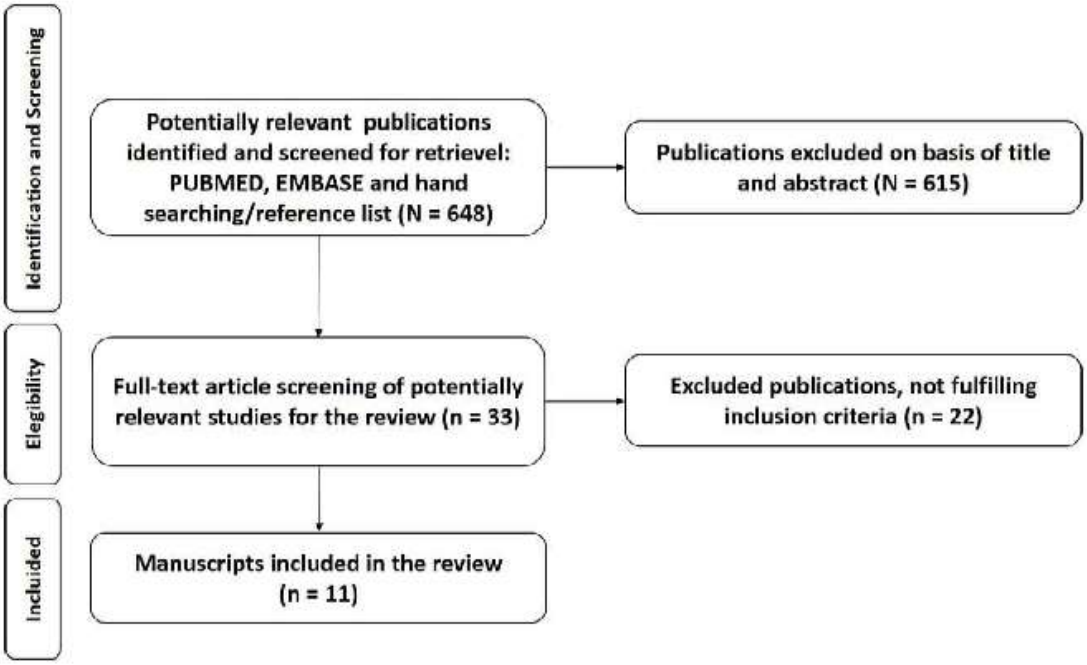
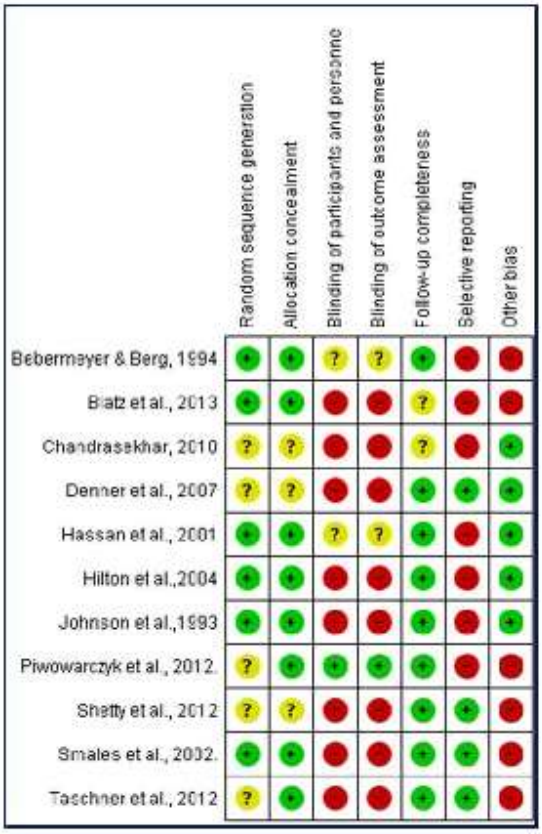


Figure 2. Risk of bias summary



10.2.8. Certificado editorial – ingles

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POST-CEMENTATION SENSITIVITY IN VITAL ABUTMENTS OF INDIRECT RESTORATIONS: A SYSTEMATIC REVIEW

Authors:

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10.3. Preparación para Brazilia dental Journal

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1. Carta de presentación
2. Página de título.
3. Archivo de manuscrito (texto, tablas, leyendas de las figuras).
4. En el manuscrito, observe:
    - Identificación de autores solo en la página de el título.
    - Texto escrito en letra Times New Román 12, con espaciado de 1.5, márgenes de 2.5 cm en cada lado. NO USE letras en negrita, marcas de agua u otros recursos para que el texto sea visualmente atractivo.
    - Las páginas deben numerarse consecutivamente, comenzando con el resumen.
    - Tablas, leyendas de las figuras y figuras al final de el manuscrito.

5. Archivos digitales de figuras, en blanco y Negro, guardados en formato TIFF con una resolución mínima de 300 ppp

En este link se pueden consultar las inficaciones generales para los autores:
http://www.scielo.br/revistas/bdj/iinstruc.htm

10.3.1. Carta de presentación disponible en linea

10.3.2. Pagina del titulo/ Title page

Title: POST-CEMENTATION SENSITIVITY IN VITAL ABUTMENTS OF INDIRECT RESTORATIONS: A SYSTEMATIC REVIEW

Short running title: Post-cementation Sensitivity of Indirect Restorations.

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10.3.3 Archivo delManuscrito/ Manuscript

POST-CEMENTATION SENSITIVITY IN VITAL ABUTMENTS OF INDIRECT RESTORATIONS: A SYSTEMATIC REVIEW

ABSTRACT

The aim of this systematic review was to evaluate the type of luting agent that has more post-cementation hyper-sensitivity in vital abutments of indirect restorations. *MEDLINE* and *EMBASE* were searched up to, and including, May 2018 without language restrictions. Randomized clinical trials and controlled clinical trials of at least one-week duration, that evaluated post-cementation hyper-sensitivity of zinc oxide phosphate cement [ZnPO4], conventional glass-ionomer cement [GIC], resin modified glass-ionomer [RMGIC], conventional resin cement [RC] and self-adhesive resin cement [SARC] in vital abutments of indirect restorations were included. Of the 648 potentially eligible articles, 11 were included in this study. In general, all cements reported sensitivity to thermal tests at different follow-up times; and they had immediate post-cementation sensitivity. The RC, $ZnPO_4$, SARC and RMGIC cements showed sensitivity during the post-cementation week; and RC, GIC, $ZnPO_4$, RMGIC and SARC cements had sensitivity over a period greater than two weeks after cementation. All evaluated cements containing a resin matrix, such as RMGIC, RC and SARC had significantly lower sensitivity to thermal tests when compared to other cements during the post-cementation week. In conclusion the ZnPO4 cement showed the highest degree of post-cementation sensitivity during different follow-up times. The design of the restoration or the material are apparently not determining factors of the presence or absence of post-cementation sensitivity.

Key words: dentin sensitivity, hyper-sensitivity, dental cements, post-cementation, controlled clinical trial

10.2.4. Cuerpo del manuscrito/

INTRODUCTION

Crowns and partially fixed prostheses are some of the most common restoration procedures in restorative dentistry. These require preparation of dental tissue involving enamel and dentin before being cemented. Hyper-sensitivity is one of the most frequent complications during vital teeth bonding (1).

The condition is characterized by transient, acute pain of the exposed dentin as a result of tooth dehydration, osmotic changes, thermal, chemical and tactile stimuli. It presents after cementing a definitive restoration on a vital tooth and cannot be described as any other type of dental pathology (1-3).

Various studies have suggested that post-cementing hyper-sensitivity has multiple causes such as bacterial, mechanical and chemical properties inherent to the cement. Those of bacterial origin are related to marginal microfiltration due to improper adaptation of provisional restorations or by a defective crown seal, which allows a hydrolytic degradation of the cement (4-8). Mechanical origins are related to friction heat generated during dental preparation, air-drying, the mechanical pressure of cement on dentinal fluid of exposed tubules and occlusal discrepancies. Chemical causes are generated by the exposure of dentin to cavity disinfectants, acids, adhesives or hemostatic agents. Those inherent to the cementing agent are related to physical and biological characteristics, such as pH and biocompatibility (4-8).

It has been observed that the post-cementing hyper-sensitivity frequency ranges from 3.1% to 32% with varying degrees of severity: light, moderate and severe (1, 5, 8-10). Additionally, it has been reported that it is maintained between 3% and 6% of cases following a post-cementation of two and three years, respectively (11). There are also reports of gender incidence in which females present greater hyper-sensitivity before and after dental preparation.

The analysis of randomized clinical trials showed that the determining factor in post-cementation hyper-sensitivity is the type of cement. For decades, one of the most used was zinc oxide phosphate [$ZnPO_4$], considered the gold standard due to its initial low pH and solubility (1, 12), but it has now fallen out of use. Another widely used cement is the glass-ionomer [GIC] due to its cariostatic effect from the release of fluoride and excellent physical and mechanical properties (13). However, the hyper-sensitivity produced can be compared to that of zinc phosphate (8) or greater (14-15).

This can also be related to its low initial pH (16), which has led many dentists to avoid it (17). The most recent option is resin cement [RC], which presents low solubility and its initial pH is higher than that of zinc phosphate and glass ionomer. It has also been reported to have post-cementation hyper-sensitivity, which may be related to the material's polymerization contraction, generating marginal seal defects of the restorations (11, 18-19).

Post-cementation hyper-sensitivity is a multifactorial entity and one of the most evaluated factors is the type of cement. Nonetheless, in study results, there has been no consensus and no meta-analysis or systematic review about this topic that allow dentists to make informed and accurate clinical decisions based on evidence to avoid this complication. Therefore, this systematic review

aimed to answer the following focused question: What type of luting agent presents greater postoperative hyper-sensitivity in indirect restorations on vital teeth?

MATERIALS AND METHODS

This review was structured in accordance with guidelines from PRISMA (20), the Cochrane Handbook of Systematic Reviews of Interventions (21) and the CheckReview checklist (22). In addition, the protocol was registered with the National Institute for Health Research PROSPERO, International Prospective Register of Systematic Reviews (http://www.crd.york.ac.uk/PROSPERO, registration number (ID=CRD42016038883).

Type of Studies and Participants (Inclusion Criteria)

The studies were considered eligible for inclusion if they met the following criteria: randomized clinical trials (RCTs) and controlled clinical trials that assessed the presence of postoperative hyper-sensitivity after cementation of indirect fixed restorations cemented with the following luting agents: zinc oxide phosphate cement [ZnPO4], conventional glass-ionomer cement [GIC], resin modified glass-ionomer [RMGIC], conventional resin cement [RC] and self-adhesive resin cement [SARC]. Studies were also included if the participants met the following criteria: adult patients, males and females, who required newly cemented indirect fixed restorations, such as inlays, onlays, single full coverage restorations and fixed partial dentures, with at least one week of follow-up.

Outcome Measures

The primary outcome was post-cementation sensitivity evaluated after thermal and mechanical stimulation with a visual analogue scale or dichotomic scale with at least one week of follow-up.

Search Strategy

Detailed search strategies were developed for Medical Literature Analysis and Retrieval System Online (MEDLINE) and Excerpta Medical Database (EMBASE) without language restrictions. Databases were searched up to and including July 10, 2018 using Medical Subject Headings (MeSH) terms, key words, other free terms and Boolean operators (OR, AND). These were combined and detailed search strategies were developed for each database following the search strategy presented for MEDLINE:

#1: Dentin sensitivity OR dentin hyper-sensitivity OR dentinal tubules OR dentin pain OR dentinal hyper-sensitivity OR tooth hyper-sensitivity OR root hyper-sensitivity OR vital tooth OR pulp sensitivity

#2: Cements OR dental cements OR dental adhesives OR resin cements OR crown cementation OR resin cements OR luting agents OR bonding

#3: #1 AND #2

#4: Early hyper-sensitivity OR post-cementation hyper-sensitivity OR crown cementation/ hyper-sensitivity OR cementation

#5: #3 AND #4

In addition, reference lists of studies considered potentially eligible for inclusion in this review were hand searched as well.

Assessment of Validity Data Extraction (Selection and Coding)

Two independent reviewers (AC and MM) screened the titles, abstracts and full texts of the papers and disagreements between the reviewers was mediated by discussion. In the event an agreement was not reached, a third reviewer (MCT) was consulted. When important data for the review was missing, an attempt to contact the authors was carried out to resolve the ambiguity from the trials.

The following data were collected and recorded in duplicate: citations, publication status and year of publication, location of the trial, study design, characteristics of the participants, outcome measures, methodological quality of the trials and conclusions.

Assessment of Risk of Bias and Quality Assessment in the Included Studies

For RCTs and controlled clinical trials, the methodological quality was evaluated following the Cochrane Collaboration's tool for assessing risk of bias (21) as adapted by Chambrone et al. (2010a): randomization and allocation methods (i.e., selection bias), completeness of the follow-up period, incomplete outcome data (i.e., attrition bias), masking of patients (i.e., performance bias) and examiners (i.e., detection bias), selective reporting (i.e., reporting bias) and other forms of bias were classified as adequate (+), inadequate (-), or unclear (?). Based on these answers, the risk of bias was categorized according to the following classifications: (1) a low risk of bias if all criteria were met (i.e., adequate methods of randomization and allocation concealment), a positive answer to all questions about completeness of follow-up questions and masking of examiners, and a negative answer to selective reporting and other sources of bias); (2) an unclear risk of bias if one

or more criteria were partly met (i.e., unclear criteria were set), or (3) a high risk of bias if one or more criteria were not met.

Data synthesis

Data were filed in a table of evidence and a descriptive summary was performed to define the quantity of data by inspection for further study variations in terms of characteristics and results.

RESULTS

Search Results and Excluded Trials

The search was carried out in electronic databases such as PUBMED (April 2016 to July 2018) and EMBASE (April 2016 to July 2018) as well as manually. A total of 648 studies were found, from which 615 were discarded by title or abstract, pre-selecting 33 articles that could be included in the revision. Twenty-one were discarded afterwards (1, 3, 6, 7, 9, 11-14, 17, 18, 23-33) because they did not comply with the inclusion criteria [Fig. 1] and only 11 were finally included [table 1] (2, 4, 8, 15, 16, 19, 34-38).

The characteristics of these studies are shown in table 1. They all had a follow-up of at least one-week post-cementation; two studies had only one week (2,19), and the rest had longer periods of three weeks (38), up to a month (15, 35), up to three months (4, 8, 34), 21 months (36) and two years (16, 37) Four studies were carried out in the United States (2, 4, 8, 38), two in Germany (16,37), two in India (19,35), one in Pakistan (34) and one in Hong-Kong (15).

Methodological Quality of Included Studies

The comparison of all studies with regard to the different methodological parameters showed that the one with the highest number of parameters with low risk of bias was Piwowarczyk et al., (2011). It was also observed that only the selective report and other bias sources had a high risk of such and the randomization method was not clear[Fig. 2] (36).

Most of the studies selected were adequate in the follow-up periods (2, 4, 8, 15, 16, 19, 34, 36,37) and in the allocation processes (2, 4, 8, 15, 34, 36-38). Six of the studies had an adequate randomization sequence (2, 4, 8, 15, 34, 36) and in five, it was not clear.(16, 19, 34, 37,38), The randomization and sample allocation were considered adequate for all included studies [Fig. 2]. Most studies did not report patient and examiner masking (4, 8, 15-16, 19, 34-35, 38), or a selective

report [Fig. 2] (2, 4, 8, 34-37). Thus, all studies were considered to be at a high risk of bias [Fig. 2].

Effect of Interventions

Among the selected studies, there were six in which post-cementation sensitivity of the GIC had been evaluated (2, 4, 15-16, 19, 35), four studies had assessments of the zinc oxide phosphate cement [$ZnPO_4$] (2, 4, 35-36), four had assessments of the resin cement (RC) (16,19,34,37), four evaluated the resin-modified glass ionomer (RMGIC) (15, 34-35, 38) and, in three, the self-adhesive resin cement (SARC) was evaluated (36-38).

The GIC was evaluated with regards to the $ZnPO_4$ in three studies (2, 4, 35), with regards to RMCIG in three (8, 15, 35), with regards to RC in two (16, 19), and it was not assessed with regards to SARC in any study. Upon analyzing the studies, it was observed that only three had reports of statistically significant differences. The Johnson et al. (1993) and Chandrasekhar et al., (2010) showed that the post-cementation sensitivity of $ZnPO_4$ cement was significantly greater than GIC's.

The significant differences in the study of Johnson et al. (1993) were present immediately after cementation ($p=0.045$) and remained during the following two weeks ($p=0.013$); in that of Chandrasekhar et al., (2010), the differences among cements were observed during the first follow-up week with the cold air and water tests ($p=0.01$), and they persisted for a month of follow-up ($p=0.001$). In the study of Shetty et al. (2012), there was a report of a statistically significant higher sensitivity of the GIC with regards to the posterior RC with the spray ice test after a week of cementation ($p<0.05$).

The RC was evaluated with regards to GIC in two studies (16, 19), with regards to RMGIC in one (34), with regards to SARC in one (37), and in none with regards to $ZnPO_4$. It was observed that, in only one of the studies (19), there was a report of statistically significant sensitivity of the GIC compared to RC after one week of cementation ($p<0.005$) and there were no significant differences with regard to the other cements (16, 34, 37)

The RMGIC was evaluated in five studies: three with regards to GIC (8, 15, 35), one with $ZnPO_4$ (35), one with RC (34) and one with SARC (38). Statistically significant lower post-cementation sensitivity was reported only for the RMGIC when compared with $ZnPO_4$ with the cold air and

water tests after a week of cementation (p=0.001), and after one month of cementation (p=0.001) (35).

The $ZnPO_4$ was evaluated with regards to GIC in three studies (2, 35), with RMGIC in one (35), and SARC in another (35). It was not assessed in any study with regards to RC and statistically significant differences were only found in two studies, with regard to GIC (4, 35) and RMGIC (35). The sensitivity generated by $ZnPO_4$, as observed in the studies of Johnson et al. (1993) and Chandrasekhar et al., (2010) was greater than GIC's with the different thermal tests, such as water (4, 35) and cold air (35), immediately after cementation (p=0.045) (4), after one week (p=0.01) (35), after two weeks (p=0.013) (4), and after one month post-cementation (35). In the study of Chandrasekhar et al., (2010) the $ZnPO_4$ was compared to RMGIC and there were significant differences with the cold water and air tests after one week (p=0.001) and after one-month post-cementation (p=0.001) with $ZnPO_4$ showing greater sensitivity.

SARC was compared to $ZnPO_4$ in one study (36), to RC in one (3), and to RMGIC in another (38). It was to be evaluated with regards to GIC in any study and statistically significant differences were reported with respect to RMGIC is the study of Blatz et al. (2013), in which SARC was observed to produce lower sensitivity to cold air after one week of cementation (p=0.01) and the ice test throughout the follow-up ($p<0.01$) of one day, one week and three weeks. All cements presented some degree of post-cementation sensitivity with one or other of the thermal or masticatory tests, except in the study of Taschner et al. (2012), in which SARC and RC did not present any type of sensitivity during the follow-up period with the spray ice test.

Type and Material of the Restorations Used

The studies reported the type and restoration material used but not the sensitivity results for the assessed cements. However, the following was found:

In two studies, only partial-coverage restorations were used (35, 37). In another, both complete crowns and partial-coverage restorations were used (2). In another, complete crowns as part of a fixed partial prostheses (34) were used. Another study had individual crowns and crowns as part of fixed partial prostheses (16) and the remaining studies only had complete individual crowns (4, 8, 15, 19,36,3).

It was also observed in seven studies that the materials used were metal and metal porcelain; however, it was not specified what type of metal or porcelain (4, 8, 15-16, 34, 36, 38). Metallic

gold were used in two studies (2, 15) and metallic nickel-chrome in another (19). Another had gold restorations (4), another had metallic restorations in a non-specified metal (35) and in only one were ceramic restorations reported (37).

DISCUSSION

Summary of the Main Results

The review of the results of most studies showed that almost all cements had sensitivity with thermal tests (2, 4, 8, 15, 16, 19, 34-36, 38). The analysis of such sensitivity with regards to follow-up time yielded that RC (19,34), GIC (4,16,35), $ZnPO_4$ (4,15,35), RMGIC (8,15,34-35,38) and SARC (34,36,38) presented sensitivity immediately after cementation. RC (16,19,34), GIC (2,8,16,19,34-36), $ZnPO_4$ (4, 15, 35), SARC (36,38), RMGIC (34) and RMGIC presented sensitivity one week after cementation and RC (16,34), GIC (8,16,19,35), $ZnPO_4$ (35), RMGIC (35) and SARC (34,38) showed sensitivity in a period greater than two weeks after cementation. It is interesting to note that the evaluated cements with resin matrix, such as RMGIC (8, 15, 34-35, 38), RC (16, 19, 34, 37) and SARC (36-38), had a significantly lower sensitivity to thermal tests when compared with other cements one week after cementation. In only one study, which evaluated both resin cements SARC and RC (37), there was no sensitivity present during any of the follow-up periods. The present study had patients with inlay and onlay type restorations made with ceramic and it was the only one in which metallic materials were not used. However, it has been observed in various studies that the restorative material does not influence post-cementation sensitivity (39-42). No studies were found that evaluated the association between restoration design and sensitivity and this is consistent with the studies of Chandrasekhar et al., (2010) and Bebermeyer and Berg, (1994), in which there was post-cementation sensitivity with partial-coverage restorations.

Quality of the Evidence

None of the studies were considered to be at a low risk of bias because there were inconsistences regarding randomization (16, 19, 35-37), allocation (16, 19, 35, 37), patient and examiner masking (2, 4, 8, 15, 16, 19, 34, 35, 37, 38), completeness of follow-up times (35, 38), selection reports (2, 4, 8, 34, 35, 36, 38), and other sources of bias (2, 15, 19, 36 -38).

Limitations and Potential Biases in the Review Process

The studies could not be subjected to a meta-analysis due to differing scales and tests for evaluating

sensitivity; additionally, the results were reported with various types of data:

Scales and Sensitivity Tests

The scales used in the selected studies varied; nine used the Visual Analogue Scale (VAS) in which six used a range from zero to ten (4, 8, 19, 34, 36-38) one had a range from one to five (2) one from one to three (35), and another used four ranges, modifying the range nomenclature as: none=no response, mild=slight response, moderate=obvious, and severe=intolerable (15). Others used scales were the ordinal perception had three ranges: normal response (NR) =sensitivity to cold without pain, severe response (SR) =increased sensitivity causing a reflex (16) and the USPHS criteria modified, which registered a dichotomy sensitivity (37). Different types of thermal tests were also used in order to evaluate sensitivity: cold water was used in two studies (35-36), cold air was used in five (4, 15-16, 37, 38). and three used spray ice (34, 37). Additionally, two more evaluated sensitivity during mastication (8, 35) and, in one, the experience of sensitivity by the patient was assessed (2).

Type of Data used for Results

Results were reported differently in most studies: three studies had sensitivity reported by the number of patients (absolute frequencies) (2, 16, 19), four used the mean and standard deviations of different values of the scales (8, 35-36, 38) and the remaining four had results with relative frequencies percentages (4, 15, 34, 37). Apart from the reported biases, there were other sources as such: the ample age range of the evaluated patients (2, 3), which determines pulpal age and dentinal tubule size, as well as the application of cavity enamel before the cements (4). These two factors may lead to varied and heterogeneous pulpal response to cements. In the study of Bebermeyer and Berg, (1994), a lack of experience from the operators and lack of calibration of the examiners, which were undergraduates, was observed that may have affected the final results.

Agreements and Disagreements with Other Studies or Reviews

The comparison of results obtained from articles included in the present review (2, 4, 35) with another study that also compared the GIC and ZnPO4 cements, with follow-up commencing more than one week after cementation (14), yielded similar but contradictory results. In the studies of Kern et al. (1996) and Bebermeyer & Berb (1994), it was observed that both cements showed some post-cementation sensitivity, without statistically significant differences. However, the results from Kern et al. (1996) are not the same as those reported by Chandrasekhar et al., (2010) and Johnson

et al. (1993), which did result in statistically significant differences, with ZnPO4 presenting the highest sensitivity. Post-cementation sensitivity of SARC was also evaluated (13, 30) and, as has been reported in the present review, it had the greatest sensitivity among the resin cements38 or did not present any at all37 with enamel selective etching (30).

In the present review, any studies in which a dentinal desensitizer agent was used were excluded (9, 11) because they posed a bias risk in the final results. Nonetheless, the said studies did report a significant reduction in post-cementation sensitivity when compared with the application of GC Tooth Mousse™ [GC-Asia dental Ptd] or Systemp desensitizer® [Ivoclar Vivadent AG]. With regard to a direct application of GIC (9) when other desensitizer were used, such as OptiBond™ SoloPlus, Copal/ether varnish (Bosworth® Copaliner) or BisBlock ™ dentin desensitizer (Bisco Inc, Schaumburg, USA), no differences were observed (9, 11).

ABSTRACT PORTUGUÉS

O objetivo desta revisão sistemática foi avaliar o tipo de agente de cimentação que possui maior hipersensibilidade pós-cimentação em abutments vitais de restaurações indiretas. O MEDLINE e o EMBASE foram pesquisados até maio de 2018, sem restrições de idioma. Ensaios clínicos randomizados e ensaios clínicos controlados com pelo menos uma semana de duração, que avaliaram a hipernsensibilidade pós-cimentação de cimento de fosfato de óxido de zinco [ZnPO4], cimento de ionômero de vidro convencional [GIC], ionômero de vidro modificado por resina [RMGIC], cimento resinoso convencional [RC] e cimento resinoso auto-adesivo [SARC] em pilares vitais de restaurações indiretas foram incluídos. Dos 648 artigos potencialmente elegíveis, 11 foram incluídos neste estudo. Em geral, todos os cimentos relataram sensibilidade a testes térmicos em diferentes tempos de acompanhamento; e eles tiveram sensibilidade pós-cimentação imediata. Os cimentos RC, ZnPO4, SARC e RMGIC apresentaram sensibilidade durante a semana pós-cimentação; e os cimentos RC, GIC, ZnPO4, RMGIC e SARC tiveram sensibilidade ao longo de um período superior a duas semanas após a cimentação. Todos os cimentos avaliados contendo matriz de resina, como RMGIC, RC e SARC apresentaram sensibilidade significativamente menor aos testes térmicos quando comparados a outros cimentos na semana pós-cimentação. Em conclusão, o cimento ZnPO4 apresentou o maior grau de sensibilidade pós-cimentação em diferentes tempos de acompanhamento. O design da restauração ou do material aparentemente não são fatores determinantes da presença ou ausência de sensibilidade pós-cimentação.

CONCLUSIONS

In summary, and within the limitations of the present systematic review, we can conclude that:

1. All analyzed cements generated post-cementation sensitivity in all follow-up periods.
2. Sensitivity usually flared up during the first week after cementation.
3. SARC and GIC cements presented the lowest post-operatory sensitivity during the different follow-up times.
4. $ZnPO_4$ presented the highest degree of post-cementation sensitivity during the different follow-up periods.
5. The restoration design or material apparently are not determinant factors in the presence or absence of post-cementation sensitivity.

Future randomized clinical trials with standardized methodologies (measurement scales, applied thermal tests and same-data reports) could be developed in order to:

1. Provide more consistent conclusions regarding the true effect of cements on post-cementation sensitivity of restorations.
2. Determine if the use of desensitizers agents – not analyzed in the present project – could eliminate post-cementation sensitivity of indirect restorations.

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41. Murgueitio R, Bernal G. Three-year clinical follow-up of posterior teeth restored with leucite-reinforced ips empress onlays and partial veneer crowns. J Prosthodont. 2012; 21:340-345

42. Wagner J, Hiller KA, Schmalz G. Long-term clinical performance and longevity of gold alloy vs ceramic partial crowns. Clin Oral Investig 2003; 7:80-85.

Table 1. Characteristics of included studies

Figure 1. Flowchart of articles screened in the review process.

Figure 2. Risk of bias summary

10.3.4. Tabla 1.

Table 1. Characteristics of included studies

Study	Participants /type of restoration/ study design	Test/ control groups*	Post-operative sensitivity evaluation: Scale and parameters/Test/ Post-operative follow-up **	Outcome/ Statistical significance	*Author's main conclusions and notes*
1. Bebermeyer & Berg, 1994 [USA]	45 adult patients 45 Cast complete crowns, 3/4 or 7/8 crown or onlay per group Randomised clinical trial. Split-mouth	Test group: GIC [Ketac™ Cem 3M/ESPE, St Paul,MN, USA] Control group: $ZnPO_4$ ¡Fleck's Zinc Phosphate Cement Keystone Industries GmbH, Singen, Germany]	**Perception ordinal scale** 1 No sensitivity 5: Extreme sensitivity Descriptive information about aetiology of sensitivity obtained by questionnaire One week.	Sensitivity level (N° of Patients) GIC: 5(3), 1-4(39) $ZnPO_4$: 5(4), 1-4(40) There was no statistically significant difference observed between ZnPO4 and GIC when they were tested one week after cementation. P value was not reported	The results indicate that restorations cemented with glass-ionomer cement did not show any more sensitivity than those cemented with zinc phosphate cement. Mixing conditions of the glass-ionomer materials are strict, it is particularly important to adhere to each manufacturer's recommendations for use to allow maximal benefit and minimal risk of sensitivity.
2. Blatz *et al*., 2013 [USA]	70 adult patients age range 24-65 years. Male: 16 CG/ 18 TG Female 29 CG/ 26 TG 88 full-coverage crowns: 44 per group. Randomised clinical trial – open	Test group: SARC [iCem Heraeus Kulzer GmbH, Hanau,Germany] Control group: RMGIC [GC Fuji PLUS, GC Corporation, Tokyo174, japan]	**Visual Analog Scale [VAS]** Range 0-10 0: no sensitivity 10: most severe sensitivity Sensitivity reported by patient compressed air test spray ice test After: LB, one day, one week and three weeks.	**Patient sensitivity report** [Mean (range)] **RMGIC:** LB 0.43(0-6), one day 1.30 (0-8); one week.: 0.50 (0-6); three weeks:0.43 (0-6) **SARC:** LB 0.36(0-4), one day 0.52 (0-7); one week.: 0.39 (0-7); three weeks:0.48 (0-9) **Patient sensitivity report** [Me ((IQR)] **RMGIC:** LB 0(0-0), one day 0 (0-3); one week.: 0 (0-0); three weeks: 0 (0-0) **SARC:** LB 0.0(0-0), one day 0 (0-0); one week.: 0 (0-0); three weeks: 0 (0-0) **Air sensitivity** [Mean (range)] **RMGIC:** LB 0.77(0-5); one day 0.48 (0-4); one week.: 0.43 (0-3); three weeks:0.34 (0-3) **SARC:** LB 0.55(0-4); one day 0.23 (0-5); one week.: 0.07 (0-1); three weeks:0.09 (0-1) **Air sensitivity** [Me ((IQR)] **RMGIC:** LB 0(0-1); one day 0 (0-0.75); one week.: 0 (0-1); three weeks: 0 (0-0) **SARC:** LB 0(0-1); one day 0(0-0); one week.: 0 (0-0); three weeks: 0 (0-0) **Ice sensitivity** [Mean (range)] **RMGIC:** LB 3.91(1.25-6); one day 3.11 (0-8); one week.: 2.45 (0-6); three weeks:1.98 (0-8) **SARC:** LB 3(0.25-7); one day 1.52 (0-9); one week.: 1.05 (0-8); three weeks:1.00 (0-9) **Ice sensitivity** [Me ((IQR)] **RMGIC:** LB 3.21(0-8); one day 3(1.25-4.75); one week.: 2 (1-4); three weeks:2 (0-3) **SARC:** LB 3.48(0-9); one day 1.52 (0-9); one week.: 1.05 (0-8); three weeks:1 (0-9) **Patient sensitivity report**: Post-cementation sensitivity was significantly higher for RMGIC after 1 d (p=0.02). No statistically significant	The cementation of crowns with SARC resulted in lower post-operative sensitivity than with RMGIC in the most of intervals of time evaluated by the different tests.

				difference was observed between RMGIC and SARC when they were tested at LB (p=0.78), one week. (P=0.11) and three weeks (p=0.98) after cementation. **Air Sensitivity**: Post-cementation sensitivity was significantly higher for RMGIC at one week after (p=0.01). No statistically significant difference was observed between RMGIC and SARC when they were tested at LB (p=0.38), one day and three weeks after cementation (p >0.05). **Ice sensitivity:** Post-cementation sensitivity was significantly higher for RMGIC at one day (p <.001), one week (p <.001), and three weeks. (p <.001).No statistically significant difference was observed between RMGIC and SARC when they were tested at LB (p =0.36).	
3.Chandrasekhar, 2010 [India]	60 adult patients Age range 15-50 years	Test group: GIC [Glass Inomer Cement CX-Plus SHOFU Dental corporation, Tokyo, Japan]	**Scale 0-3** Grade 0 - No sensitivity Grade 1 – Mild sensitivity Grade 2 – Moderate sensitivity Grade 3 – Severe sensitivity	**Biting pressure mean ± SD** **1 mm** $ZnPO_4$ 0.35±0.59; GIC 0.25±0.44; RMGIC 0.15±0.37 **One week.** $ZnPO_4$ 0.20±0.52; GIC 0.15±0.49; RMGIC 0.00±0.00 **one month** $ZnPO_4$ 0.10±0.30; GIC 0.50±0.2; RMGIC 0.00±0.00 **Compressed air mean ± SD** **1 mm** $ZnPO_4$ 1.10±0.8; GIC 0.95±0.82; RMGIC 0.95±0.83 **One week.** $ZnPO_4$ 1.30±1.033; GIC 0.40±0.60; RMGIC 0.05±0.22 **one month** $ZnPO_4$ 1.35±1.04; GIC 0.00±0.00; RMGIC 0.05±0.22 **Cold water mean ± SD** **1 mm** $ZnPO_4$ 1.55±1.00; GIC 1.55±1.05; RMGIC 1.55±1.05 **One week.** $ZnPO_4$ 1.85±0.99; GIC 0.80±0.95; RMGIC 0.30±0.47 **one month** $ZnPO_4$ 1.60±0.99;GIC 0.40±0.82; RMGIC 0.15±0.37	The patients with restorations cemented with resin-modified glass ionomer demonstrated the least postoperative sensitivity when compared to glass ionomer and zinc phosphate cement at all intervals of time evaluated by different tests.
	60 inlay cast restorations, 20 per group	Test group: RMGIC [VITREMER®, 3M/ESPE, St Paul,MN, USA]	Cold water test Compressed air test Biting pressure test Sensitivity reported by patient		
	Randomised clinical trial The teeth were randomly divided into three groups of 20 each. Group-I: 20 inlay cast restorations cemented with glass ionomer luting cement. Group-ii: 20 inlay cast restorations cemented with zinc phosphate cement. Group iii: 20 inlay cast restorations cemented with resin-modified glass ionomer cement	Control group: $ZnPO_4$ [Harvard Cement Harvard Dental Company GmbH.Berlín-Alemania]	After 1mm, one week and one month.	There were no significant differences (P>0.05) between the three cements at different intervals of time for **biting pressure test**. There were no significant differences (P> 0.05) among the three cements immediately after cementation, both with cold water test and compressed air test. After one week there was a significant difference between the three cements with the **cold water test** ZnPO4 Vs. GIC: (P=0.01); ZnPO4 Vs. RMGIC: (P=0.001); GIC Vs. RMGIC: (P=0.05). After one month with the same test there were significant differences between ZnPO4 and GIC: (P=0.001) and between ZnPO4 and RMGIC: (P=0.001), but there was not a significant difference between GIC and RMGIC: (P>0.05). After one week. There was a significant difference between the three cements with the **compressed air test:** ZnPO4 Vs. GIC: (P=0.01); ZnPO4 Vs. RMGIC: (P=0.001); GIC Vs. RMGIC: (P=0.02). After one month with the same test there were significant differences between ZnPO4 and GIC: (P=0.001) and between ZnPO4 and RMGIC: (P=0.001), but there was no significant difference between GIC and RMGIC: (P>0.05). The ZnPO4 group reported the highest level of sensitivity values and the RMGIC group reported the least level at these two intervals of time with both tests: cold water and compressed air.	
4. Denner *et al*., 2007 [Germany]	60 adult patients Age range 22-65 years Mean age: 44. 4 years Male: 38 Female:22	Test group: RC [Chemiace II® Sun Medical Company, Ltd Moriyama, Japan]	**Perception ordinal scale.** **No Response [N]** **Normal response [NR]:** sensation of cold but no pain **Severe response [SR]:** increased sensitivity causing a patient reflex.	**RC: Time- Point- Scale [N° of patients]** **One week.** NR [45], SR [6], N [0]; **six months** NR [46], SR [3], N [2]; **12 months** NR [44], SR [1], N [0]; **24 months** NR [46], SR [0], N [0]. **GIC: Time- Point- Scale [N° of patients]** **One week.** NR [48], SR [3], N [0]; **six months** NR [48], SR [3], N [0]; **12 months** NR [44], SR [3], N [0]; **24 months** NR [48], SR [0], N [0].	The incidence of post-operative hyper-sensitivity after cementation of full-crown restorations with a conventional glass-ionomer cement and a new adhesive resin cement was similar. In the patients observed 24 months after cementation, no cases of hyper-sensitivity were reported for either group. The percentage of hyper-sensitivity decreased notably during the follow-up period. There was a significant decrease of hyper-sensitivity with age. Women showed a significantly higher rate of hyper-sensitivity than men.
	120 full-coverage crowns independent or in FPD: 60 per group.	Control group: GIC [Ketac-Cem®, 3M/ESPE, St Paul, MN, USA).	Ice spray Test	**There was no statistically significant difference between cements at any interval of evaluated time** (P>0.05)	
	Randomised clinical trial - Split-mouth double blind		After: one week., six months., 12 months and 24 months		

5. Hassan *et al*., 2001 [Pakistan]	208 adult patients Age range: 20 – 30 years Mean age: 26.16 ± 3.15 208 full-coverage crowns in FPD: 108 per group. Randomised clinical trial-single blind	Test group: RC [Panavia® F2 Kuraray Noritake Dental Inc., Japan] Control group: RMGIC [Fuji® GC-II Glass Ionomer Cement, GC Corporation, Tokyo 174, Japan	**Visual Analog Scale** Range 0-10 1-4: mild sensitivity 5-7: moderate sensitivity 8-10: severe sensitivity Cold sensitivity test. After: One week. One month Three months	The sensitivity results showed that 98% of the patients exhibited only mild to moderate sensitivity irrespective of the type of cement used, at all follow-up appointments. There was no statistically significant difference between the two cements in terms of post-cementation sensitivity. (P>0.05)	Majority of the patients exhibited either mild or moderate sensitivity on cold sensitivity tests, with a very small percentage experiencing severe sensitivity. The sensitivity responses reduced with time with both the luting cements. There was no significant difference (p>0.05) between the resin-based luting cement and glass- ionomer luting cement in terms of post cementation sensitivity in vital teeth with fixed restorations.
6. Hilton *et al*.,2004 [USA]	209 adult patients Male: 102 Female: 107 209 independent full-coverage crowns; 106 [RC] and 103 [GIC] Randomised clinical trial	Test group: RMGIC [GC Fuji® I Enhanced, Self-Cured Luting Cement, GC Corporation, Tokyo 174, Japan Control group GIC [Rely X luting cement, 3M/ESPE, St Paul, MN, USA]	**Visual Analog Scale** Range 0-10 0 = no pain 10 = worst imaginable pain Descriptive information about aetiology of sensitivity obtained by questionnaire: hot, cold and biting After: One hour, one week, one month and three months	**GI** *Means (SD) Heat [H], Cold [C] and Biting [B] Sensitivity* **N° (absent/present) for sensitivity at any time:** H: 73/30; C: 52/51; B: 77/26 **RMGI** *Means (SD) Heat [H], Cold [C] and Biting [B] Sensitivity* **N° (absent/present) for sensitivity at any time:** H: 84/22; C: 64/42; B: 85/21 There was no statistically significant difference between the two cements in hot, cold or biting sensitivity at any time. (P>0.05)	**The intervention was carried out by private dentists with an extensive experience in fixed prosthodontics in their private practice. Patients were part of the dentists' clinical practice. The follow-up was done by the same dentists and the examiners filed the information via telephone.**
7. Johnson *et al.,*1993 [USA]	86 adult patients 214 independent full-coverage crowns; 101 [ZnPO4] and 113 [GIC] Randomised clinical trial	Test group: GIC [Ketac™ Cem. ESPE Premier, 3M/ESPE, St Paul, MN, USA). Control group: $ZnPO_4$. [FLECK'S®Mizzy Cement, Keystone Industries GmbH, Singen, Germany]	**Visual Analog Scale [VAS]** Range 0-10 0 = no pain 10 = severe pain Descriptive information about aetiology of sensitivity obtained by questionnaire. Immediate sensitivity by cemented procedure Direct testing: air cold, biting After: 1mm, one to two weeks and three months	**Immediate sensitivity** **ZnPO4:** 32% **GIC:** 19% **Air sensitivity:** **ZnPO4:** two weeks 0%; three months0% **GIC:** two weeks 0%; three months: 0% **Biting sensitivity** **ZnPO4:** two weeks 0%; three months: 0% **GIC:** two weeks 0%; three months: 0% **Cold sensitivity:** **ZnPO4:** two weeks 34%; three months: 0% **GIC:** two weeks 19%; three months: 0% There was a statistically significant difference between the two cements in immediate sensitivity (p=0.045), being higher the sensitivity reported for $ZnPO_4$ There was no statistically significant difference between the two cements for air sensitivity and biting sensitivity - at any time. (P>0.05). There were significant differences between base line at two weeks for cold sensitivity with ZnPO4, which were higher than GIC. (p=0.013)	**Clinicians were standardised in bridge and crown preparations. There was stump reconstruction with amalgam and glass ionomer when the clinician considered it. Cavity varnish was applied on vital stumps for teeth cemented with ZnPO4 and the smear layer was not removed for those cemented with GIC.** **The authors report in materials and methods that follow-up would commence after the first week. However, results are reported after the second week.**
8. Piwowarczyk *et al*., 2012. [Germany]	20 adult patients Mean age: 53 years 40 independent full-coverage crowns; 20[ZnPO4] and 60 [SARC]	Test group: SARC [RelyX Unicem Self-Etch Resin Cement 3M/ESPE, St Paul, MN, USA]. Control group: ZnPO4 [Hoffmann's Cement normalhärtend, Hoffmann	**Visual Analog Scale [VAS]** 0= no sensitivity 10= Extremely **Dichotomous scale** Yes or no **VAS:** descriptive information about aetiology of sensitivity obtained by questionnaire (chewing, air streams, cold or hot temperatures and electronic pulp tester). **Dichotomous scale** (Yes or no) for: cold water test and air/ compressed blast test	**VAS: Mean ± SD** **ZnPO4:** 3-10 d. 1.3±2.1; four weeks. 0.6 ±1.5; six months 0.2 ±0.8; one year 0.04±0.3; two years 0.1±0.4; 3 Yr. 0.1±0.2 **SARC**: 3-10 ds.1.0±1.9; 4 Weeks. 0.5±1.1; six months: 0.1±0.4; one year 0.1±0.3; two years 0.3±0.7; three years0.1±0.2 No difference between the luting agents was noted concerning the risk of developing hyper-sensitivity (OR=1.31, p>0.05)	The clinical performance of both luting agents (SARC and ZnPO4) barely differed with regard to the investigated parameters including post-operative hyper-sensitivity. The scores obtained from the Visual Analog Scale differed significantly within both groups over the observation period (p<0.0001), they were noted at follow-up examinations compared to the baseline: ZnPO4: at the framework try-in and one year following cementation SARC at the framework try-in.

	Randomised clinical trial split-mouth	Dental Manofaktur GmbH, Berlin, Germany]	After: three to ten days, four weeks, six months, one, two and three years.	No significant differences were observed with respect to questions surveyed by a Visual Analog Scale between the two cement types (p>0.05).	
9. Shetty. *et al.,* 2012 [India]	50 adult patients Mean age: 33.8 years 100 full-coverage crowns; 50 GIC] and 50 [RC] Randomised clinical trial single – blind	Test group: RC [SmartCem® 2 Self-Adhesive Cement, Densply Cirona USA] Control group: GIC [GC Gold Label ®Lutinng and Lining Cemet, GC Corporation, Tokio 174, Japan	**Visual Analog Scale** Range 0-10 0 = no pain 10 = worst imaginable pain Ice spray test After: 1 mm, 24 h and 7 ds.	**GIC : Level VAS (N° Patients)** LB(n=25): 1(9); 2(5); 3(7); 4(4) 24h(n=25): 0(2); 1(11); 2(8); 4(4) 7d(n=25): 0(6); 1(12); 2(7) **RC : Level VAS (N° Patients)** LB(n=25): 1(11); 2(9); 4(1); 5(4) 24h(n=25): 0(9); 1(10); 2(2); 3(3); 5(1) 7d(n=25): 0(16); 1(5); 2(4) No statistically significant difference was observed between RC and GIC when sensitivity was tested immediately and 24 hours after cementation. Post-cementation sensitivity was significantly higher with GIC when compared with RC after seven days. (p<0.05).	None of the patients with either of the cements reported severe response. With RC most patients reported no response after seven days. With GIC the average response was 1.04 which is not clinically significant.
10. Smales *et al*., 2002. [Hong Kong]	50 adult patients Mean age: 43.5 years Male: 24 Female:26 88 full-coverage crowns; 30[RMGIC], 30[RMGIC] and 28[GIC] Randomised clinical trial	Test group 1: RMGIC [Fuji DUET, GC Corporation, Tokyo 174, Japan Test group 2: RMGIC [Vitremer® Luting Cement-3M/ESPE, St Paul, MN, USA). Control group: GIC [GC Fuji I Enhanced, Self-Cured Luting Cement, GC Corporation, Tokyo, Japan	**Perception ordinal scale. 4 levels** NONE [NR]: no response MILD: slight response MODERATE: obvious response SEVERE: not tolerable Compressed blast test After: one to four weeks	**Cement-LEVEL: N° patients (%)** **GIC:** NR 23 (82.1%), MILD 5 (17.9%) MODERATE 0 (0%) **RMGIC [FUJI DUET]:** NR 25 (83.4%), MILD 3 (10%), MODERATE 2 (6.6%) **RMGIC [VITREMER LC]:** NR 24 (80%), MILD 4 (13.4%), MODERATE 2 (6.6%) No teeth were recorded as having severe sensitivity any time. There were no statistically significant differences between the three luting cements when post cementation sensitivity was evaluated (p=0.64).	Using a conventional glass-ionomer cement or two resin-modified glass-ionomer cements for cementation of gold or ceramic-metal crowns on vital teeth resulted in less post-cementation sensitivity to air blasts within a one-to-four week recall period than was present pre-operatively. Most teeth showed no post-cementation sensitivity, and there were no statistically significant differences found among the three luting cements.
11. Taschner *et al.,* 2012 [Germany]	30 adult patients Age Range 23-64 years Mean age: 39 years Male: 11 Female:19 93 inlay and onlay restorations; 43[SARC] and 40[RC] Randomised clinical trial	Test group: SARC [Breeze™ Self-Adhesive Resin Cement. Pentron Clinical. CA, USA] Control group: RC [RelyX ARC 3M/ESPE, St Paul, MN, USA]	**Modified USPHS [Criteria #8: Changes in sensitivity]** Alpha1: Excellent Alpha2: Good Bravo: Sufficient Charlie: Insufficient Delta: Poor Ice spray test After: one week., six months and one year	**2week (83%): SARC (100%):** Alpha1 RC (100%): Alpha1 **six months (83%): SARC (100%):** Alpha1 RC (100%): Alpha1 **1Yr (82%): SARC (100%):** Alpha1 RC (100%): Alpha1 **2Yr (82%): SARC (100%):** Alpha1 RC (100%): Alpha1 No statistical analysis was performed for changes in sensitivity because there was no post-operative hyper-sensitivity reported by any patient, any time	No post-operative hyper-sensitivity was reported by any patient at any time

* Glass-ionomer luting cement [GIC], zinc oxide phosphate cement [$ZnPO_4$], resin cement[RC], resin-modified glass ionomer [RMGIC] , self-adhesive resin cement [SARC]
** Immediately after (1mm) Hour (hr), Day (d), Week (Week.), Month (Mo.), Year (Yr.)

Table 1. Characteristics of included studies

10.3.5. **Figuras 1 y 2** (como archivos independientes al manunscrito)

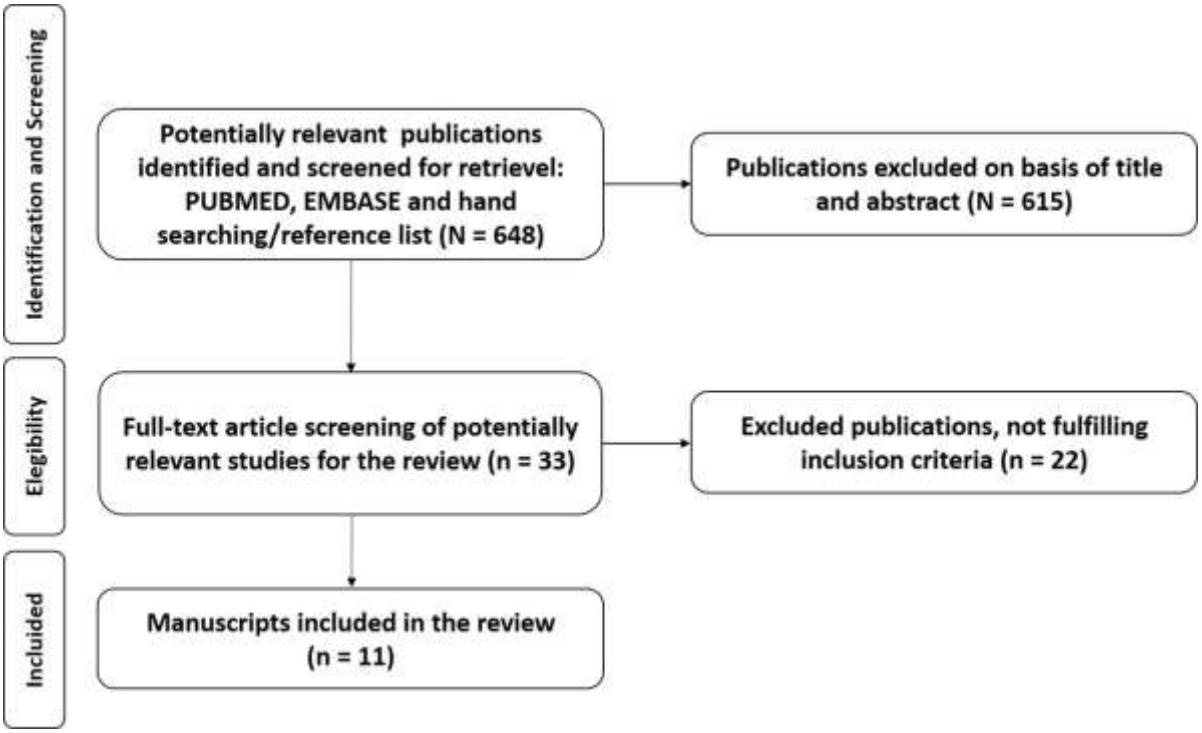

Figure 1. Flowchart of articles screened in the review process.

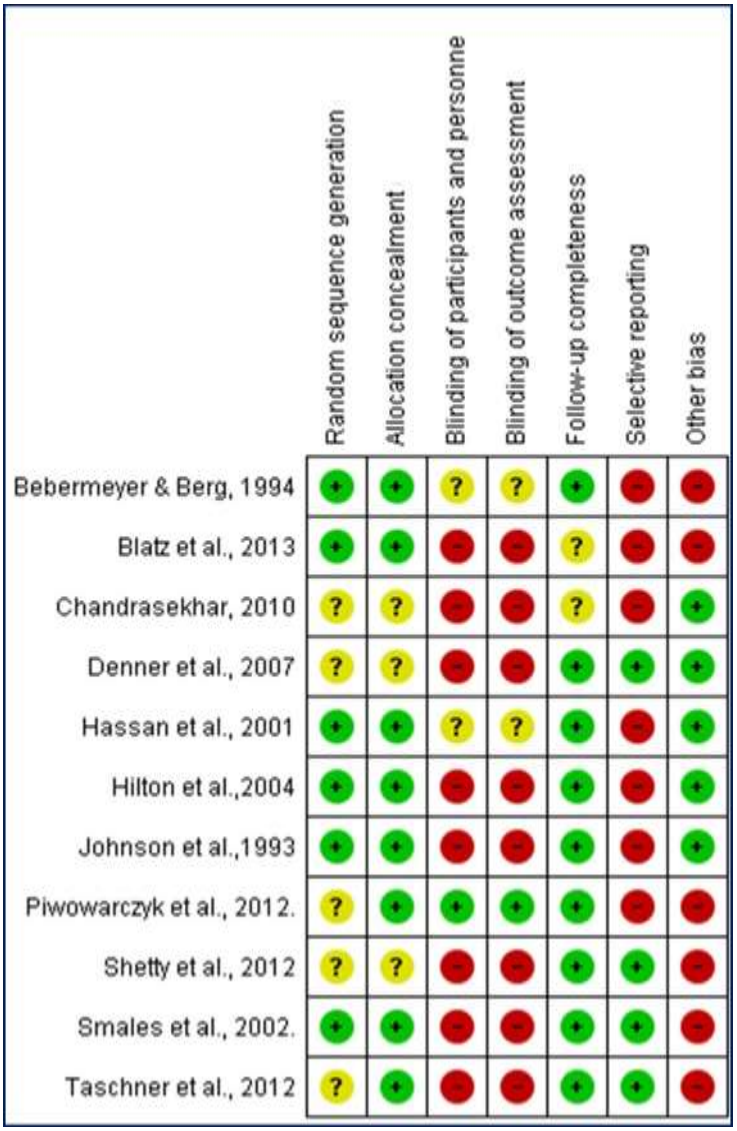

Figure 2. Risk of bias summary

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