ISSN (Print) : 0974-6846
ISSN (Online) : 0974-5645
Indian Journal of Science and Technology, *Vol 10(26), DOI: 10.17485/ijst/2017/v10i26/110736, July 2017*

Clinical and Radiographic Evaluation of Indirect Pulp Capping Agents in Very Deep Carious Lesions: Systematic Review with Meta-Analysis

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Abstract

Objectives: To compare the clinical performance of the different capping materials and calcium hydroxide in deep carious lesions. **Methodology**: Fourteen studies are obtained from the data base search in 4 different data base after eligibility criteria, this studies was eight of high quality, three of medium quality and two of low quality of evidence. **Finding**: Only three studies are included in the Meta analysis as they are equal in the follow up time, the comparator, intervention and outcome. The rest of the studies have different criteria with different outcome assessment. **Conclusion**: The I^2 statistic = 94% (p-value < 0.01) indicating considerable heterogeneity in the results, which means that the results are inconclusive. Therefore, it is recommended to further investigate the difference in treatment effects between glass ionomer and calcium hydroxide cements.

Keywords: Calcium Hydroxide, Deep Carious Lesions, Glass Ionomer, Indirect Pulp Capping, Systematic Review

1. Introduction

In the era of conservative dentistry we are now focusing on repair rather than replacement. Indirect pulp capping is one of the conservative alternative treatments of deep carious lesions. In this procedure the pulp is lined indirectly by biocompatible material. The aim of this treatment is to preserve the pulp vitality and to stimulate the odontoblast to lay down secondary dentine.

Calcium hydroxide is the gold standard for indirect pulp capping as its biocompatible with the pulpal tissues, alkaline, available and of low price. But have some limitations and drawbacks as high solubility, tunnel defects in the formed dentine bridge and poor sealing[1].

In the past decades, conventional Glass Ionomer (GICs) was used on a wide scale in dentistry. This material has the main advantage; its adhesive property as it chemically bonds to the tooth structure also it aids in stopping the caries progression due to its fluoride release intraorally. In addition, it has biocompatibility with the pulpal tissues but it has main disadvantage of high solu-

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bility in the oral cavity and sometimes irritation to the pulp tissues due to its initial acidity[2].

With the improvement of Resin Modified Glass Ionomer (RMGICS) in the mechanical properties over the conventional one it shows more sensitivity toward the pulpal tissues. As the addition of HEMA to the conventional cements has adverse effects on the pulpal tissues so, RMGICs have been proven to be more cytotoxic than conventional GICs[3].

A relatively new agent is MTA it used also in pulp capping whether indirect or directly it has the advantage of biocompatibility to the pulp tissues and stimulates the odontoblast for thicker secondary dentine formation without tunnel defects and formation of hydroxyapatite like material to seal the pulp tissues. Although it has slow setting time, discolor the tooth, relatively high cost compared to the gold stander calcium hydroxide[4].

"A new bioactive cement, also called as smart dentin substitute and is known nowadays as Biodentine was recently launched as a dentine substitute"[5]. Biodentine is a derivative of to the same category of MTA "this new calcium silicate-based material has chemical and physical properties very close to the properties of Portland cement derivative". It is perfectly biocompatible with the pulpal tissues as it can stimulate the pulp odontoblasts to induce the opposition of reactionary dentine through the induction of cell differentiation. Biodentine, in fact, is a true dentine substitute that can be used in restoring the coronal tooth structure (for indirect pulp capping), but can also be directly placed in contact with the pulp. Because of its fast setting time, it can be used immediately in restoring the coronal region of the tooth, or it can be directly used intraorally without fear of the material deterioration.

2. Methods

The current systematic review was conducted in accordance with the guidelines of the PRISMA Statement (Preferred Reporting Items for Systematic reviews and Meta-Analyses)[6]. The PICO question (Problem, Intervention, Comparator and Outcome) was formulated to compare the clinical performance of the different capping materials (Biodentine/MTA/GICs/RMGIs) and calcium hydroxide in deep carious lesions. So we can solve the problem of choice of the indirect pulp capping material in the dental practice.

2.1 Systematic Searches

The result of this review has been searched into three databases (PubMed, Cochrane library, Lilacs) Date: 17/6/2016.the author combined intervention (I) , comparator (C) and Population (P) and the result from I&C&P is combined .

2.2 Study Selection

All the studies from different databases were pooled in Endnote X1 software (Thomson Reuters, Philadelphia, PA, USA) to remove duplicates. Then screened to first filtration then the eligibility criteria (inclusion, exclusion)

2.2.1 Inclusion criteria

- No date restrictions.
- English language.
- No publication restrictions.
- Randomized controlled trials.
- Clinical evaluation.
- Radiographical evaluation.

Table 1. Methodological data extraction

Studies	study design	patient information							Random-ization	inclusion/ exclusion criteria	blinding	follow up time	drop out
		total no of PT	sex		age/ years								
			M	F	rang	mean	M	F					
[12]	RCT	24	14	10	14-24	-	-	-	-	yes	N	12	0
[13]	RCT	116	-	-	6-16y	-	-	-	-	yes	-	8-24w	-
[14]	RCT	299	110	189	-	16.6	-	-	YES	yes	YES	1,2 years	119,177
[15]	RCT	299	-	-	6-53y	-	-	-	YES	yes	-	24 M	86
[16]	RCT	267	131	145	6-11y	7.8	-	-	YES	yes	YES	12M	10
[17]	RCT	299	86	130	≥17	-	-	-	yes	yes	single blined	1,3 y	86

Table 1 Continued

[18]	RCT	44	-	-	11-35 y	17.62	-	-	yes	yes	Doubleblined	3-4 m	3
[19]	RCT	60	34	26	16-36 y	23.37	23.78-25.06	22.75-23.43	yes	yes	Single blind	3 m , 6 m	0
[20]	RCT	53	21	32	18-76 y	28	-	-	yes	yes	Single blind	1,6,12	21
[21]	RCT	123	64	59	4-15Y	8.7	-	-	yes	inclusion	-	1 y	0
[22]	RCT	156-153	63-69	-	18-49	29	-	-	yes	yes	Single blind	1 y	29
[23]	RCT	26	-	-	16-40	-	-	-	yes	inclusion only	-	3, 6, 12 m	0
[24]	RCT	223	110	189	6-53Y	-	-	-	yes	yes	Single blinding	18 m	86
[25]	RCT	86	51%	49%	17-30	17.2	-	-	yes	inclusion only	-	6 m	16

2.2.2 *Exclusion criteria*

- Other languages.
- In vitro studies, animal studies, case reports, case series, case control and observational studies.
- Direct pulp exposure.
- Other methods for evaluation (histological, microbiological).

2.3 Data Extraction

The articles that met the inclusion and exclusion criteria (14 articles) is extracted and enter the computer data base on excel sheets. The extracted data is in Table 1. The extracted data include the name of the first author, year of publication, patient's information (age, sex and number), study design, randomization, blinding, inclusion and exclusion criteria, follow up time and drop out.

2.4 Quality Assessment

The quality of the included articles were double assessed by the authors according to the Cochrane Handbook for Systematic Reviews of Interventions chapter 8 into eight studies of low risk of bias, three unclear and two high risk of bias[7].

2.5 Measure of Effect Size

Treatment success was measured on an ordinal scale or a binary outcome. Odds ratio was calculated as a measure of effect size when comparing between glass ionomer and calcium hydroxide cements.

2.6 Assessment of Heterogeneity

Heterogeneity was assessed by checking the graphical display of the estimated treatment effects from each study in the forest plots and their 95% confidence intervals. Also tests of homogeneity analysis were performed to estimate the I^2 statistic. The I^2 statistic is classified according to the Cochrane Handbook for Systematic Reviews of Interventions where 0% to 40% might not be important, 30% to 60% may represent moderate heterogeneity, and 50% to 90% may represent substantial heterogeneity and 75% to 100% considerable heterogeneity.

2.7 Data Synthesis (Qualitative and Quantitative)

The meta-analyses were conducted as inverse variance weighted averages. Both random and fixed effects models were performed to calculate pooled estimate of effect. Statistical package used for this study: R statistical package, version 2.15.2 (26-10-2012) was used for analyzing the data. Copyright (C) 2012 - The R Foundation for Statistical Computing.

3. Result

3.1 Search Strategy

The detailed search strategy is included in PRISMA flow chart 2009 in Figure 1.

3.2 Descriptive Analyses

In the 14 included studies Table 2 nine studies compared between the calcium hydroxide and glass ionomer with different follow up times three months, six months, 12, 18, 24 months and three years. One study compared the calcium hydroxide with MTA at 3 months and one study compared them at 6 months. One compared between the calcium hydroxide with MTA and Portland cement at 12 months. One study compared between the glass ionomer and biodentine at 12 months. One study compared between the calcium hydroxide and calcium hydroxide suspension at 12 months. One study evaluated the thickness of tertiary dentin formed after indirect pulp capping. One study evaluated the periapical radiolucency radiographically after pulp capping procedure. One study evaluated clinically the remaining dentin after pulp capping procedure in (bacterial loading, color, consistency and ultastruterally).

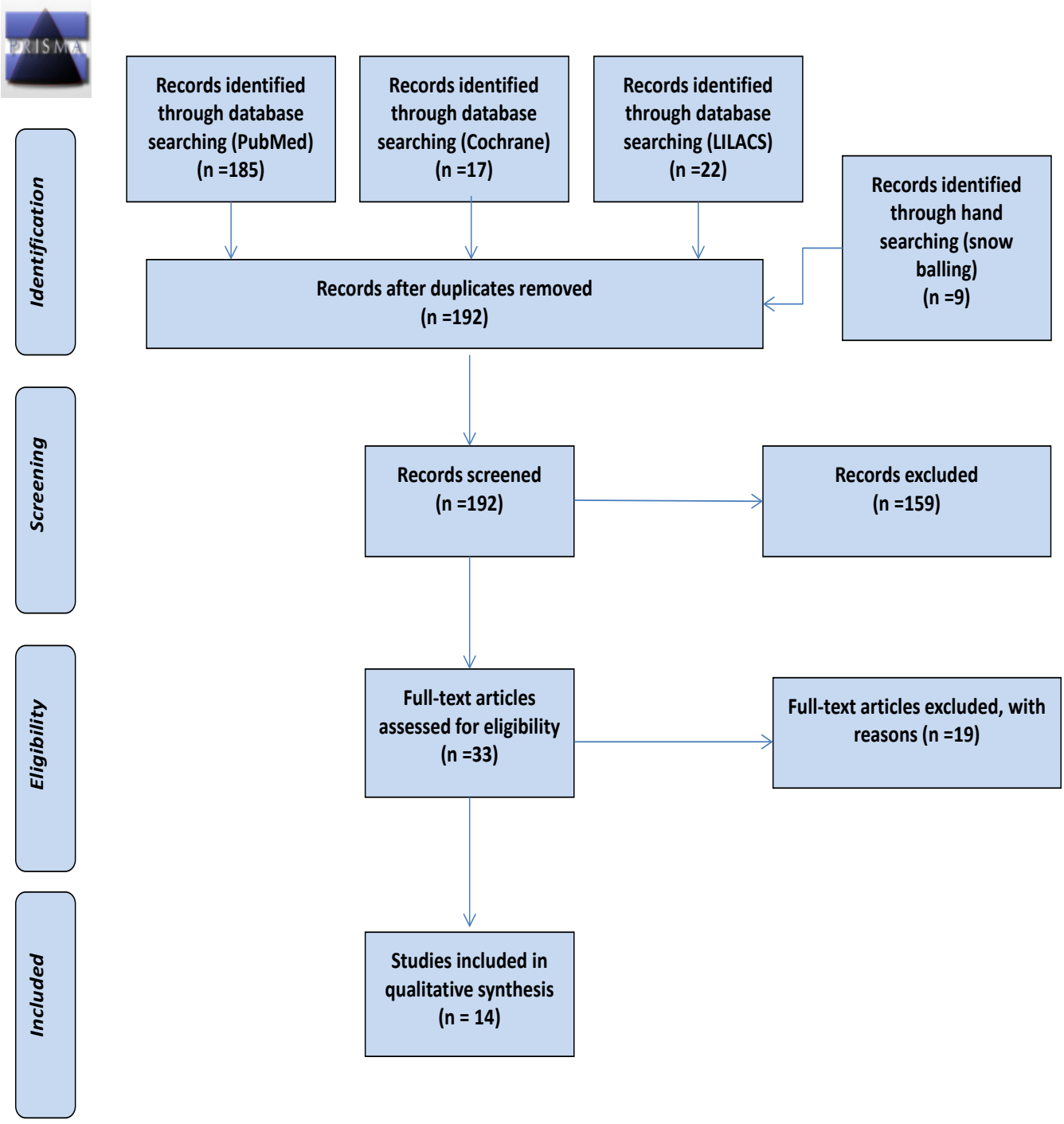

Figure 1. PRISMA "2009" Flow chart

Table 2. Included studies data

Title	Source	Study design	intervention	Comparator	Outcome
Indirect pulp-capping of carious teeth with periapical lesions	PubMed	RCT	Glass ionomer	Calcium hydroxide -Glass ionomer	Success rate %
Pulp exposure after stepwise versus direct complete excavation of deep carious lesions in young posterior permanent teeth	PubMed	RCT	Glass ionomer	Calcium hydroxide	Success rate %
Partial removal of carious dentine in deep caries lesionin the permanent dentition	Lilacs	RCT	Glass ionomer	Calcium hydroxide	Success rate %
Partial Caries Removal in Deep Lesions: 19-30 months follow-up study	Lilacs	RCT	Glass ionomer	Calcium hydroxide	Success rate %
Clinical evaluation of three caries removal approaches in primary teeth: A randomised controlled trial	PubMed	RCT	Glass ionomer	-	Success rate %

Table 2 Continued

Randomized Trial of Partial vs. Stepwise Caries Removal: 3-year Follow-up	PubMed	RCT	Glass ionomer	Calcium hydroxide	Success rate %
Clinical and ultrastructural effects of different liners/ restorative materials on deep carious dentin: a randomized clinical trial.	PubMed, Cochrane library	RCT	Glass ionomer and Calcium hydroxide	Wax	Clinical assessment of remaining dentine
Evaluation of mineral trioxide aggregate (MTA) versus calcium hydroxide cement (Dycal??) in the formation of a dentine bridge: A randomised controlled trial.	PubMed, Cochrane library	RCT	MTA	Calcium hydroxide	Success rate %, radiographically and thickness of tertiary dentin
Treatment of deep caries lesions in adults: randomized clinical trials comparing stepwise vs. direct complete excavation, and direct pulp capping vs. partial pulpotomy.	PubMed	RCT	Glass ionomer	Calcium hydroxide	Success rate %

Table 2 Continued

Pulp exposure occurrence and outcomes after 1- or 2-visit indirect pulp therapy vs. complete caries removal in primary and permanent molars.	PubMed,Cochrane library	RCT	Calcium hydroxide	Calcium hydroxide	Success rate %
Clinical and radiographic assessment of the efficacy of calcium silicate indirect pulp capping: a randomized controlled clinical trial	PubMed	RCT	Biodentine	Glass ionomer	Success rate %
Indirect pulp capping using different calcium hydroxide products: A clinical study	PubMed	RCT	Calcium hydroxide	Calcium hydroxide suspension	Success rate %
Partial removal of carious dentine: a multicenter randomized controlled trial and 18-month follow-up results	PubMed, Cochrane library	RCT	Glass ionomer	Calcium hydroxide	Success rate %
A randomized clinical trial on the use of medical Portland cement, MTA and calcium hydroxide in indirect pulp treatment	PubMed	RCT	MTA- Portland cement	Calcium hydroxide	Success rate %

3.3 Meta-Analysis

The data from 804 patients were included in the pooled meta-analyses for comparison between treatment success of glass ionomer and calcium hydroxide cement; where 407 patients received glass ionomer cement and 397 received calcium hydroxide cement.

3.4 Treatment Success

The treatment success of each study groups was compared. The pooled estimate represents the Odds Ratio. It is equal to odds of success of the intervention group; i.e. glass ionomer cement divided by that of the control group; i.e. calcium hydroxide cement.

As shown in Figure 2 , the meta-analysis of 3 studies showed that the glass ionomer cement was 1.55 times more successful than the calcium hydroxide cement (95% CI = 1.06 - 2.25; p-value = 0.0233) for the fixed effects model. Meanwhile, there was no significant difference between the two cements using the random effects model (OR = 3.27; 95% (CI) = 0.29 - 36.75; p-value = 0.3376).

The I^2 statistic = 94% (p-value < 0.01) indicating considerable heterogeneity in the results, which means that the results are inconclusive. Therefore, it is recommended to further investigate the difference in treatment effects between glass ionomer and calcium hydroxide cements.

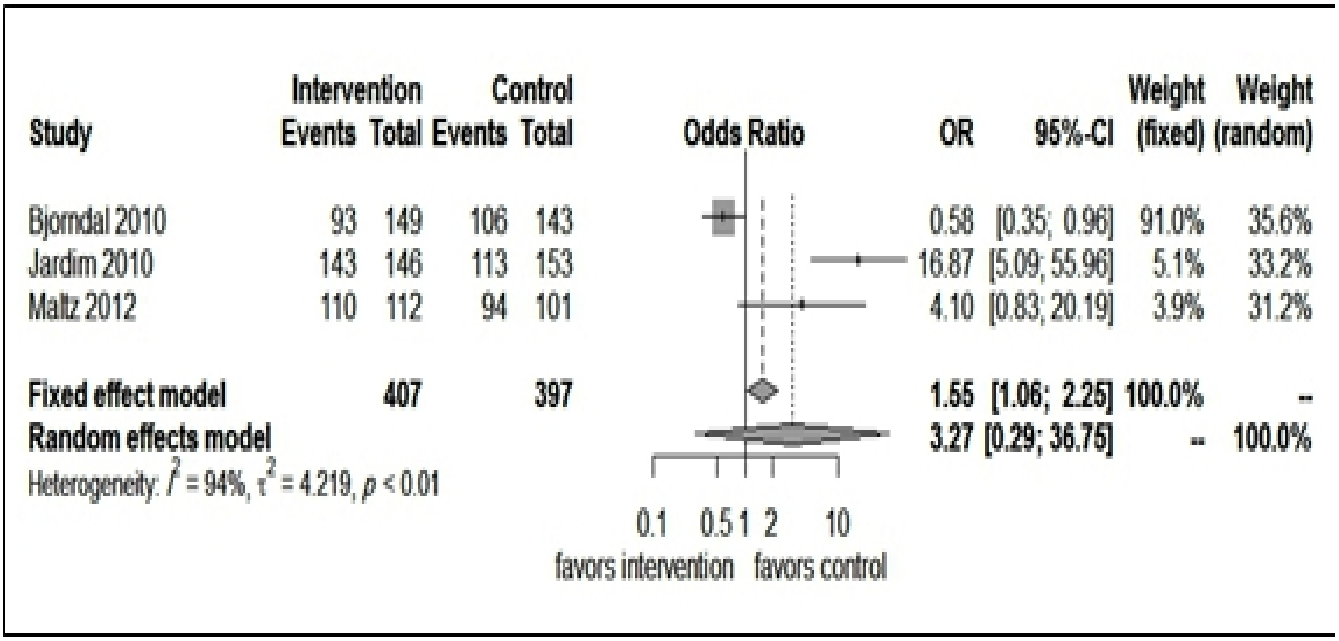

Figure 2. Comparison between glass ionomer cement (intervention group) and calcium hydroxide cement (control group) regarding treatment success – forest plot.

4. Discussion

This review is to compare the clinical performance of the different capping materials (Biodentine/MTA/GICs/RMGIs) and calcium hydroxide in deep carious lesions. So we can solve the problem of choice of the indirect pulp capping material in the dental practice. From the 14 included studies nine studies compared between the glass ionomer and calcium hydroxide with variable follow up times maximum follow up was 3 months[8]. The other capping materials are compared only in three studies[9–11]. We found different results with the different studies. Only three studies is common in the intervention and comparator and follow up time so we include them in the meta-analysis and from this meta-analysis the glass ionomer cement was 1.55 times more successful than the calcium hydroxide cement (95% CI = 1.06 - 2.25; p-value = 0.0233) for the fixed effects model. Meanwhile, there was no significant difference between the two cements using the random effects model (OR = 3.27; 95% (CI) = 0.29 - 36.75; p-value = 0.3376).

More than 60 % of the studies are of high quality of evidence only two is of low quality.

The number of studies needs to be more to get more result but till now no data is available in this topic.

This systematic review is the first to put all this data together and get the meta- analysis unless high heterogeneity of data but this is the first step to resolve the conflict in this area of conservative dentistry.

The limitation of our work is the low data available and not all the studies of high quality, not the same materials to compare, even not the follow up periods and the risk of bias. We recommend more studies in this topic with the same follow up periods.

5. Conclusion

In the light of this systematic review and meta- analysis all the data was in-conclusive and more studies are recommended in the indirect pulp capping materials concerning the success rate of the materials clinically and radiographically.

6. Funding

This research was not funded by any university or research institute.

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