

The use of Portland cement in direct pulp capping: a systematic review

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Abstract

This systematic review focus on the biocompatibility of Portland cement (PC), a material used in direct pulp capping of human teeth. Research was done using MEDLINE, LILACS, BBO, Cochrane Library, SciELO, PubMed and the CAPES thesis data base. A total of 12 publications were selected. Two examiners searched for randomized, non randomized clinical trials, case-control, cohort and transversal studies, focusing on human beings. In vitro studies, studies in animals, literature review, letters and editorials were excluded. Ten studies were excluded because they didn't meet the inclusion criteria. Thus, only 2 studies made up the sample. The latter showed that PC provided excellent results in direct capping and behaves similarly to Mineral Trioxide Aggregate (MTA) when used in this sort of treatment. This systematic review found that there is still little research on the biocompatibility of PC in direct capping in humans and for that reason, additional studies should be undertaken.

INTRODUCTION

Direct pulp capping is regarded as a conservative treatment, which consists of the medicamentous therapy of vital pulp and the placement of restorative material directly against accidentally or intentionally exposed pulp. This treatment allows pulp vitality to be preserved by hard tissue repair (1). To estimate the prognosis of the treatment two factors must be considered: first, the general status of the pulp tissue and secondly, the prevention of pulp contamination during operative procedures (2).

A large variety of materials have been used for direct pulp capping. Such materials should enhance the healing of the pulp through the stimulation and production of mineralized tissue, sealing the exposed area and thus controlling microleakage and bacterial penetration (3;4). The capping material should be completely reabsorbed and be harmless to the pulp tissue (5).

Several studies have demonstrated that MTA presents excellent results when used in direct pulp capping, due to its capacity to promote the deposition of hard tissue, stimulate the formation of complete dentin bridge on the pulp tissues and prevent inflammation which might jeopardize the healing process (6;7). PC, for its part, is physically, chemically and biologically similar to MTA, and therefore can be used instead of MTA, with the advantage of costing much less (8).

Up to now, PC biocompatibility has just been investigated through research carried out on animals (9;10;11). The lack of data concerning the behavior of PC in human dental pulp suggested that one such study should be undertaken.

This systematic review aims at analyzing the biocompatibility of PC for direct pulp capping, in vivo, in human teeth.

MATERIALS AND METHODS

The sources for information on the biocompatibility of PC as a material for direct pulp capping, in vivo, in human teeth were LILACS, MEDLINE, Cochrane Library, SciELO, BBO, and PubMed databases, as well as CAPES thesis database.

The words used in the search for relevant studies were: "Dental Pulp capping" and "Portland". The search in the CAPES thesis database was done in Portuguese: "Capeamento da polpa" and "Portland"

With the purpose of delimiting the subject and the field of investigation, only the studies published in English, Portuguese or Spanish from 1997 to 2007 were selected. Inclusion criteria such as randomized and non randomized clinical essays, control-case, cohort and transversal studies all with focus on humans were used. The exclusion criteria were: in vitro studies, studies carried out in animals, literature review, letters and editorials.

Two examiners analyzed all the titles, summaries and full texts selected with the aim of identifying those which met the inclusion criteria. In addition, they also examined the bibliographical references of the works selected, searching for studies which, potentially, could be included in this systematic review.

RESULTS

Research performed in LILACS, MEDLINE, Cochrane Library, SciELO, BBO, PubMed and the CAPES thesis database revealed respectively 1, 3, 0, 0, 1, 4 and 3 works that related PC with pulp capping. The search for relevant research papers in the bibliographical references of the sample selected was not successful. From a total of 12 studies selected, only the 2 found in the CAPES thesis database fully met the criteria and consequently made up the sample.

Written by Barbosa (2004) (12) and Sampaio (2006) (13), respectively, both studies assessed, through randomized clinical essays, the biocompatibility of PC in direct pulp capping in vivo in human third molars. Each author used different experimental periods of time.

Barbosa (2004) (12) worked with a sample of 20 human third molars. The sample met the following inclusion criteria: healthy erupted teeth, with entire root formation, no periodontal alterations, root or cervical reabsorption. The patients, both males and females, were in the 19-31 age group, and presented with no systemic alterations. All the third molars had their pulps exposed and lined with PC. The sample was divided into 4 groups and the third molars were then extracted to be clinically and histologically evaluated using Hematoxine-Eosin (H/E) and Brown Hopps (BH) stains in experimental periods of 1,7,14, and 21 days, respectively after the direct pulp capping.

Barbosa's clinical results (2004) (12) demonstrated the absence of postoperative painful symptomatology and locoregional clinical aspects within normality patterns. The evaluation criteria used for histological analysis comprised pulp inflammation, organization of soft tissue, formation of dentin bridge and presence of bacteria. Each evaluation criteria received scores which varied from 1 to 3 and from 1 to 4. The lower the score, the more favorable the result concerning PC biocompatibility. The slides were scrutinized under a conventional light microscope by 2 pathologists in a double-blind study.

Concerning the inflammatory cellular response, all the

samples scored 1, showing none or few dispersed inflammatory cells in the pulp, below the exposure site. All the samples also scored 1 for BH stain, demonstrating absence of bacteria. In relation to the organization of the soft tissue, the scores were between 1 and 2. The groups with shorter experimental periods of time, which were 1 and 7 days, showed the best results. No evidence of dentin bridge formation was found in most of the samples.

The second study, conducted by Sampaio (2006) (13), used a sample of 18 human third molars separated in 3 groups, and the same inclusion criteria as Barbosa's (2004) (12).

Occlusal cavities were prepared until pulp exposure, on which occasion PC was applied. Samples for each time interval comprised 6 teeth, up to a total of 18 teeth. In each group formed, five teeth were pulp-capped with PC and one, with MTA as a control. After direct pulp capping, the teeth were extracted at intervals of 30, 60, and 90 days, and then clinically and histologically (H/E and BH) examined.

Of the 18 teeth in the sample, only 2 showed painful symptomatology after pulp capping. According to the patients, the pain was transitory and perceived soon after the effect of the anesthesia subsided. The patients were medicated with paracetamol (São Paulo, Brazil, Tylenol/Janssen-Cilag) and about 30 minutes afterwards, they reported they were painless.

The morphological examination (H/E and BH) was analyzed using the same evaluation criteria and the same subdivision of scores used by Barbosa (2004) (12). In the three observational periods, results revealed pulps with preservation of the tissue architecture, pulp repair with the presence of a dentin bridge and an absence of bacteria.

DISCUSSION

The data obtained through this systematic review, however limited, suggested that PC is a biocompatible material when used in direct pulp capping, being able to replace MTA in these clinical situations as a less onerous option.

Barbosa (2004) (12) and Sampaio (2006) (13) conducted studies in human third molars. They worked in real clinical conditions, taking into account a large number of variables, included the following: the patient's immunological conditions; the control of the hemorrhage during the placement of the capping agent; probable projection of dentin debris inside the pulp; inflammation due to trauma of pulp exposure in combination with injurious effects of capping materials and bacterial contamination (14). The real

human organic response was, therefore, well represented in this study, since it showed no major limitations as studies using animals do (15;16).

The choice of patients within the age group ranging from the 2nd to the 4th decades of life, in both studies, aimed at a greater standardization of the study, since the alterations in the dentin/pulp complex take place along with the aging process (17;18).

In a 14-day period, necrosis by chemical cauterization of the pulp conjunctive tissue submitted to capping with calcium hydroxide can be observed. This “mummified” zone stimulates inducers of the pulp response. However, induction on its own does not guarantee repair. Consequently, studies conducted using reduced intervals to investigate the biocompatibility of materials yield important conclusions. Data thus obtained, however, cannot be overstepped (16). For example, Barbosa (2004) (12) tested PC at intervals of 1, 7, 14 and 21 days, obtaining results indicative of healthy pulp. Nevertheless, such a result applies only to these periods, guaranteeing neither repair or necrosis of the tissue in the subsequent periods.

Sampaio (2006) (13) chose longer intervals (30, 60 and 90 days), in order to assess the histological characteristics of the pulp, so that the absence or presence of acute or chronic inflammatory processes could be more reliably detected. That perhaps would not be possible to accomplish in less than 30 days, since a chronic inflammatory response may appear within 60 days or more, and an acute inflammatory response may take longer than 30 days to emerge. Sampaio's results (2006) (13) revealed that following a period of 30, 60 and also 90 days, the specimens presented an absence of neutrophilic and/or lymphoplasmocytic infiltration, as well as absence of degenerative processes, since they did not exhibit hydropic, fatty, calcium and hyaline degeneration in pulp conjunctive tissue.

A number of factors may affect pulp repair events, such as the force application and placement of the capping material inside the pulp (16) as well as the size of the exposed pulp area (18). The non-observance of such items may influence the rate of success of vital pulp treatment (19). Barbosa (2004) (12) and Sampaio (2006) (13) minimized these variables through the standardization of the exposed pulp, placement of paste without applying pressure to the exposure site, preparation and exhibition of the pulp with minimum damage to pulp tissue besides attaining homeostasis prior to capping procedures. The impossibility of an absolute control

of those variables may be the explanation for the hydropic degeneration of the odontoblastic layer in the areas close to the exposure site, visualized only in one case in group 4 with 21 days of Barbosa's study (2004) (12).

No tubular dentin was detected in Barbosa's study (2004) (12) over the period of 21 days following pulp capping. As some studies have demonstrated (20;21;22), tubular dentin can be seen in the most advanced stages of the dentin barrier formation. It is possible to speculate that had the intervals been longer, such an event would probably have been observed, as occurred in Sampaio's study (2006) (13).

Observation of the morphologic aspects and immunohistochemical profile, suggested that dentin bridge formation would be modulated by two types of stimulus: the primary stimulus, the starter, unleashed on the external surface of the pulp tissue, which is in direct contact with the capping material and the secondary stimulus, provoked by the deposition of the first layers of the dentin matrix (23).

Evidence of the degree of influence, caused by the presence or absence of the capping material as primary stimulus was investigated and it was found that it characterized Teflon, an inert capping material. The formation of the dentin barrier followed the same stages as those followed at the time when calcium hydroxide was used as a capping material. These stages included the final differentiation and odontoblastic reposition. It was observed, however, that the formation of the barrier was slower when the inert material was used (24). On the other hand, the application of PC in Barbosa's (2004) (12) and Sampaio's (2006) (13) studies produced faster tissue reactions, with an earlier formation of the mineralized barrier. The success of PC utilization may be explained by the strong initial stimulus, able to cause an immediate response of osteodentin formation in an attempt to isolate the remainders of the pulp from the action of the material (15).

This systematic review made it possible to understand the morphologic alterations in human dental pulp, unchained by direct contact with PC during the acute phase of the process of induced repair. Barbosa's (2004) (12) and Sampaio's (2006) (13) studies are in agreement in that PC is biocompatible and inducer of the reparative pulp tissue response in the periods of time tested in the sample studied. Sampaio (2006) (13) also demonstrated the similarity between PC and MTA, which was used as a control in the experiment, in this sort of treatment. Both materials can be indicated for use in the same clinical situations. Portland cement has the advantage of costing less, which is of great

importance owing to some countries' socioeconomic situation.

Still, something important needs to be registered. The favorable results of PC in relation to its biocompatibility when used in the direct protection of the dental pulp are related to capping performed on healthy pulps, that is, pulp without inflammation or infection. It remains to be seen whether, in the presence of a pulp previously exposed to the oral environment, this material would behave in similar fashion. Further research is needed to meet this requirement.

Despite the favorable results of the utilization of PC reported in this systematic review, the fact that only 2 studies, which presented relatively few samples and short observational intervals, made up the sample, suggest that additional research in humans with larger samples and longer experimental periods should be undertaken, so that the use of PC can be extended to the dental clinic.

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