Dentists' Preference of Pulp Capping Agent for Indirect Pulp Capping in Primary and Permanent Molars - An Observational Study

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Abstract

One of the major challenges associated with indirect pulp capping is to prevent the exposure of the pulp and maintain its vitality. It is based on the rationale that pulpal mesenchymal cells induce dentin bridge formation. The common pulp capping agents used are calcium hydroxide and mineral trioxide aggregate both of which act based on their high pH. The aim of the study is to infer the most preferred pulp capping agent by dentists in a private dental college so as to achieve a good prognosis after indirect pulp capping of primary and permanent molars.A total of 297 restorative procedures were obtained after reviewing patient case sheets and were analysed using descriptive statistics on SPSS Software. Among 139 treatment procedures, the most common pulp capping agent used was calcium hydroxide (69.1%) in primary molars and mandibular permanent molars and MTA (30.9%) mostly in maxillary permanent molars. Within the limits of the study, calcium hydroxide was the preferred pulp capping agent for indirect pulp capping by dentists in a private dental college in both primary and permanent molars. However, with its clinical advantages, mineral trioxide aggregate shows a promising candidate as an indirect pulp capping agent in primary and permanent teeth.

Keywords: *Calcium hydroxide; mineral trioxide aggregate; indirect pulp capping; pulp capping agents*

Introduction

Dental caries is a pathologic process depending on several etiological factors which causes destruction of dental tissues and produces local and general complications [1]. It is one of the most widespread diseases in the civilized population with a prevalence of 40% at 7 years and 85% in seventeen year old boys [2]. Dental caries in primary dentition is greatly influenced by parental attitude towards restoration in deciduous teeth [3]. However, recent evidence has suggested a decrease in incidence of dental caries in children aged 5-17 years of about 36% and almost 50% of children were considered caries free in permanent dentition [4] due to inclusion of various prophylactic measures in their routine activities [5,6,7]. The inception of dental caries can be altered by components present in the saliva. It has come to light that such salivary molecules act as biomarkers in the detection of caries [8]. The consequence of pulp and near pulp exposure from caries due to intrinsic [9] or extrinsic factors[10] or trauma,[11] can be severe, resulting in pain and infection. The consequences of the treatment involve restorations, endodontics therapy, extraction which often involves considerable expense and multiple appointments [12–18].

An alternative procedure would be indirect pulp capping (IPC) where a medicament is placed over residual caries in an attempt to prevent an exposure

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and maintain pulp vitality and avoid the extensive treatment dictated by other options [19]. The pulp response is influenced by the thickness of the remaining dentin [20]. A remaining dentin thickness (RDT) of 2mm or 1.5 mm must be present to protect the pulp. However when caries extend deeper into dentin, this thickness can be distinctly compromised owing to pulpal inflammation. Some investigators found a minimum thickness of 0.5 mm to 1 mm to be sufficient for pulpal protection [21]. The success of pulp capping depends on the vitality of pulp. Teeth with a history of non-spontaneous pain and without any radiographic pathology can be ideal candidates. Unfortunately, the true state of pulp health cannot be determined by clinical signs, symptoms or radiologic appearance. The true "gold standard" of pulp status is histological analysis. Studies have shown a chronically inflamed state of pulp without any symptoms from the patient [22,23]. However, the ultimate rationale of pulp capping is to stimulate pulpal cells to form reparative dentin and arrest the progression of dental caries [24].

The ideal requirements of a pulp capping agent as suggested by Cohen are: the pulp capping agent must adhere to dentin, provide bacterial seal, resist forces, maintain vitality and must be radiopaque. However, the type of agent is less important to success than the placement of well- sealed restoration.

The gold standard of pulp capping agent is calcium hydroxide introduced in 1921. Its main advantages include excellent antibacterial activities [25] and its high pH of 12 is known to irritate the pulpal tissue and stimulate repair via an unknown mechanism [26]. Mineral Trioxide Aggregate (MTA) has generated great interest as a pulp capping agent in recent years. It's similar to calcium hydroxide in regards to antibacterial activity and biocompatibility [27]. Additionally, it provides some seal to the tooth structure [28].

The aim of the study is to infer the most preferred pulp capping agent by dentists in a private dental college so as to achieve a good prognosis after indirect pulp capping of primary and permanent molars.

Methodology

This observational study was conducted in the Department of Pediatric and Preventive Dentistry in a Private Dental College in Chennai during the period of June 2019 to March 2020. The ethical clearance for the study was obtained from the Institutional Ethical Committee.

Children of the age 3-17 years with signs and symptoms of reversible pulpitis were included in the study. The wide age range was included to include primary as well as permanent molars. Children with pre-existing medical conditions and those with special needs were excluded from the study. The two pulp capping agents included in this study were calcium hydroxide and mineral trioxide aggregate.

The pulp capping procedures were carried out by postgraduate students belonging to the Pediatric department. After appropriate diagnosis of deep carious lesions with no spontaneous pain and radiographic assessment, the caries removal was done using No.69 carbide bur under rubber dam isolation. Complete or partial carious (dark brown and hard layer) removal was carried out. After adequate drying, calcium hydroxide (Dentsply Dycal) base and catalyst pastes are taken in equal quantities, manipulated in a paper pad and placed onto the floor of the cavity. Sufficient care was taken to impart a fluid free environment so as to prevent the dissolution of the cement. This is followed by a bilayered restoration using GIC and composite resin. Similarly, mineral trioxide aggregate (MTA Angelus) was used as a pulp capping agent. A powder liquid ratio of 3:1 of MTA was manipulated on a glass slab and placed into the cavity using a carrier. This is succeeded by placement of a bilayered restoration.

The concerned data associated with these treatment procedures was obtained after reviewing 86,000 case sheets, of which those pertaining to children aged 3-17 years were analysed and the data was extracted for the purpose of this study. The data verification, collection and analysis were carried out by two persons. Cross-verification of the included data was done through photographic verification. In order to avoid sampling bias, only those data which were accustomed to the eligibility criteria were included. The internal validity was high as it was a representative sample and the external validity was high as the study results may be generalized to the Chennai population.

The extracted data was tabulated into Excel Sheet and was imported into SPSS Software by IBM for

data analysis. A total of 139 treatment procedures were included for data analysis. Any incomplete data was included. The obtained data was analyzed using descriptive statistics on SPSS software and the results were represented graphically

Results and Discussion

A total of 139 treatment procedures were analyzed using Descriptive Statistics on SPSS Software Version 23.0 based on the most preferred pulp capping agent. The study participants included 75 males (54%) and 64 females (46%). Out of 139 molars pulp capped, 43.9% were permanent molars and 56.1% were primary molars. [Figure 1] Maxillary permanent molars were 15.1%, mandibular permanent molars were 28.8%, maxillary primary molars were 12.9% and mandibular primary molars were 43.2%. [Figure 2] The most preferred choice of pulp capping agent was calcium hydroxide (69.1%) [Figure 3] irrespective of gender [Figure 4]. It was preferred in primary molars and mandibular permanent molars. [Figure 5,6] There was an inclination towards MTA (30.9%) mostly in maxillary permanent molars. [Figure 6]

Indirect pulp capping is a procedure by which some amount of caries (affected dentin) is allowed to remain adjacent to a vital pulp rather than risk pulp exposure and is covered by a cavity liner/sealer and is restored. Partial caries removal significantly reduces the chance of pulp exposure during caries excavation [19]. Several studies show restored teeth with partial caries removal have equal success compared to restored teeth with complete caries removal [29,30]. The materials used protect the pulp from noxious agents (heat, cold, bacteria) and stimulate the cell-rich zone of the pulp to lay down a bridge of reparative dentin. Dentin formation usually starts within 30 days of the pulp capping (there can be a delay in onset of dentin formation if the odontoblasts of the pulp are injured during cavity removal) and is largely completed by 130 days [31]. Studies have evaluated the fate by re-assessment of tooth in which indirect pulp capping was done. The findings include lesion colour change from light brown to dark brown, soft to dry and hard consistency, S.*mutans* and *Lactobacilli* have been significantly reduced to a limited number or even zero viable organisms, and the radiographs show either no change or even a decrease in the radiolucent zone [32,33].

Calcium hydroxide was introduced by Hermann and is considered as the gold standard of pulp capping agents. The mechanism by which calcium hydroxide (also the hydration product of MTA) may be due to its high pH which causes pulpal irritation and stimulates repair by the release of bioactive molecules. It is known that a variety of proteins are incorporated into dentin during dentinogenesis.The main proteins are Bone Morphogenic Protein (BMP) and Transforming growth factor (TGF-B1) which when stimulated by Calcium hydroxide has the ability to repair pulp and form tertiary dentin [26,34].

In our study, primary molars were likely in requirement of IPC. This may be due to the structural morphology of the enamel in primary teeth. The consequence of short time for enamel development results in formation of a thin enamel with a less organized and mineralised structure [35,36]. As a consequence, acids are able to demineralize deciduous enamel in a rampant manner [37]. Due to awareness, practise of caries preventive strategies, early detection and sealant placement, the progression of caries is reduced in the permanent dentition [4].

In this study, the indirect pulp capping procedures were more likely to be done in the mandibular arch. The studies concurrent with this fact was given by Sathe et al [38] and Tiwari and Chawla [39]. Honkala et al supplement that increased caries in primary dentition of mandibular arch may manifest as the same in the complementary set [40].

According to our study results, calcium hydroxide was highly preferred as a pulp capping agent. (69.1%). Calcium hydroxide is known for its excellent antibacterial properties [25]. One study found 100% reduction in micro-organisms within 1 hour of contact with calcium hydroxide [41]. However, the self-cure formulations are highly soluble and dissolute over time [42]. But it has been noted that a dentin bridge is formed by the time calcium hydroxide is dissolved [43]. It's been noted that calcium hydroxide can cause tunnel defects in reparative dentin allowing patency to the pulp chamber sometimes with fibroblasts and capillaries present within the defect [44]. However this finding seems to be controversial due to varying evidence.

Mineral trioxide aggregate is a new material inspired from Portland cement. It primarily consists of calcium oxide and forms calcium hydroxide on hydration [45]. Hence, the advantages of MTA are similar to calcium hydroxide, including its antibacterial and biocompatible properties, high pH, radio opacity and ability to release bioactive proteins [27,46]. A significant downside to MTA is the prolonged setting time of approximately 2 hours and 45 minutes [47]. The cost and handling characteristics are the added disadvantages.

The superior performance of MTA when compared with calcium hydroxide is elicited in two studies in which zinc oxide eugenol (ZOE) was used as the temporary restoration. Owing to the high interfacial leakage associated with ZOE,[48] MTA still showed superiority which can be attributed to its sealing properties [49,50]. Even though the success of indirect pulp capping is greatly due to a well-sealed restoration, the grander enhancement provided by MTA can be utilized for a better prognosis of a pulp capped tooth.

The limitations of the study include its small sample size , restricted geographic location and the usage of commonly marketed conventional, cost effective and readily available materials for pulp capping. A questionnaire based study which focuses on various geographic areas directed towards general practitioners, endodontists and pedodontists may provide better and generalized results for an ideal pulp capping agent.

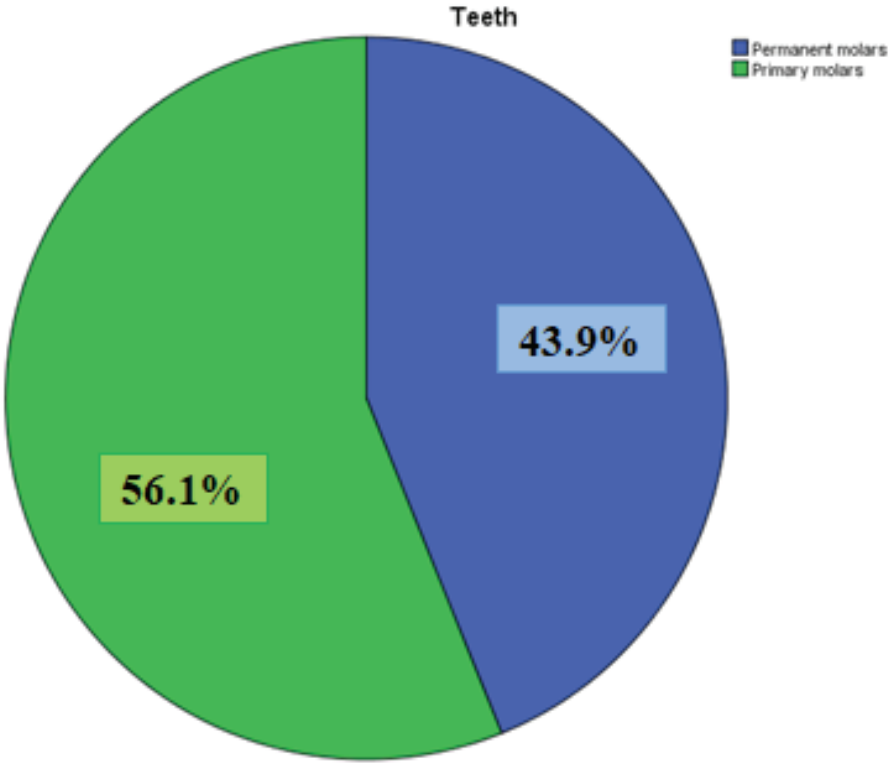

Figure 1. The pie chart represents the distribution of primary and permanent molars treated by pulp capping procedure . 43.9% were permanent molars and 56.1% were primary molars

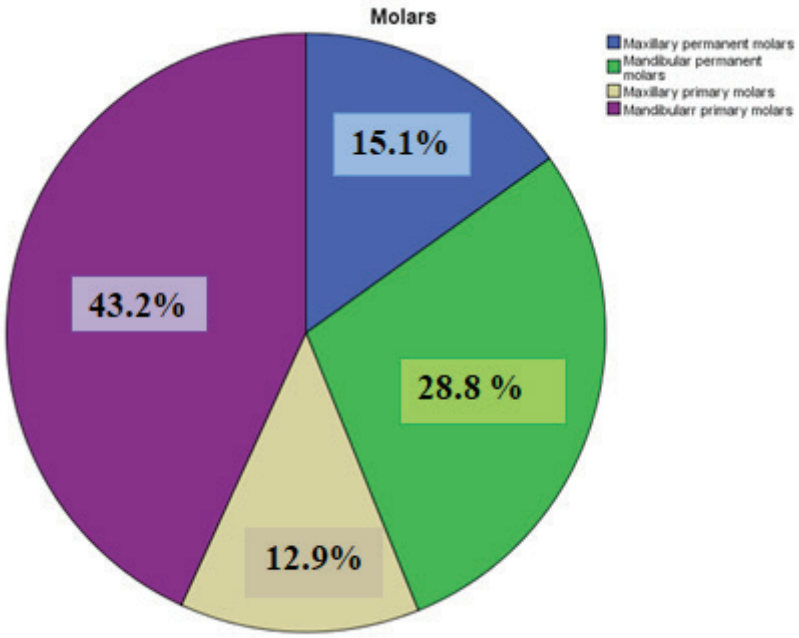

Figure 2. The pie chart represents the distribution of maxillary and mandibular primary and permanent molar teeth treated by pulp capping procedures. 15.1% were maxillary permanent molars , 28.8% were mandibular permanent molars, 12.9% were maxillary primary molars and 43.2% were mandibular primary molars.

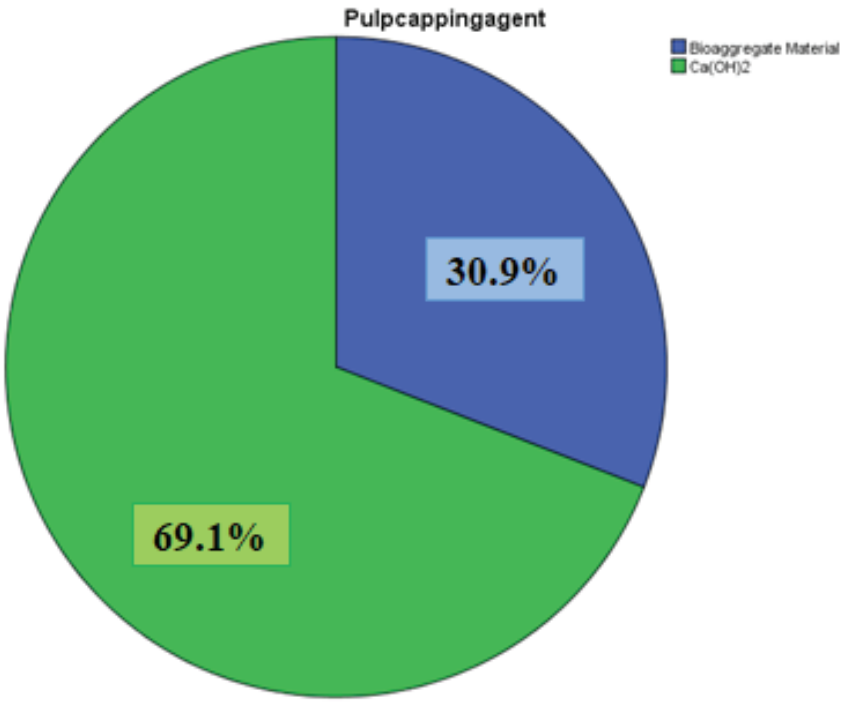

Figure 3. The pie chart represents the distribution of pulp capping procedures done according to pulp capping agents used. 30.9% used Bio aggregate material and 69.1% used Calcium hydroxide.

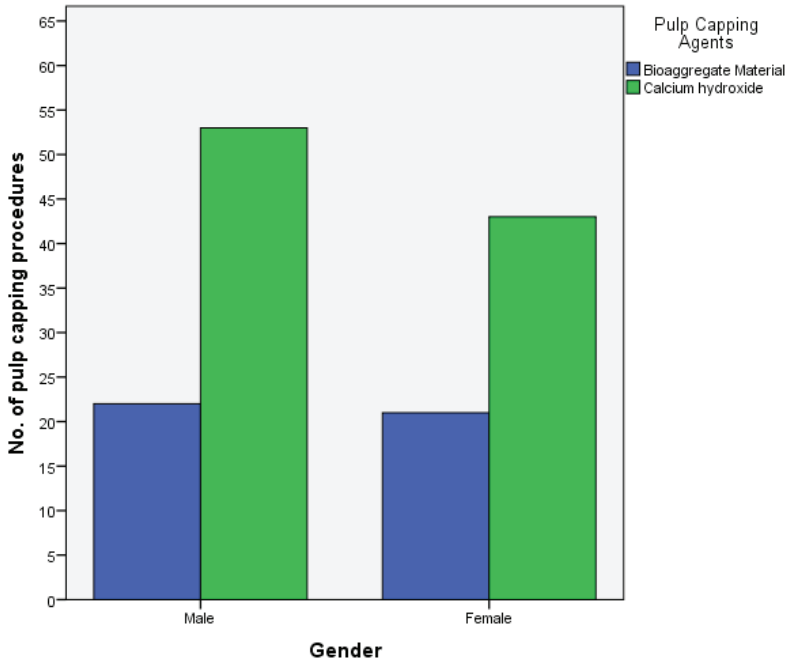

Figure 4. The graph represents the association between gender and pulp capping agents used in primary and permanent molars. X axis represents gender. Y axis represents the total number of pulp capping procedures done using calcium hydroxide denoted by green and bio aggregate denoted by blue on a scale of 0-60. Chi square test was performed. □ value = 0.65. The association was not statistically significant showing that calcium hydroxide and bioaggregate material were used irrespective of gender.

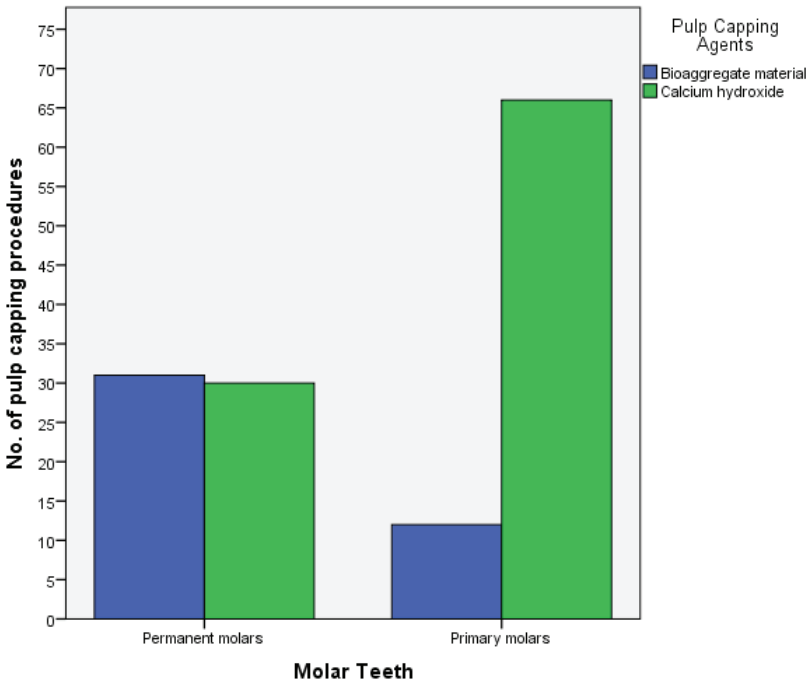

Figure 5. The graph represents the association between primary and permanent molars and pulp capping agents used to treat them . X axis represents primary and permanent molars. Y axis represents the total number of pulp capping procedures done using calcium hydroxide denoted by green and bio aggregate denoted by blue on a scale of 0-60. Chi square test was performed. □ = 0.03. The association was found to be statistically significant showing that calcium hydroxide is the pulp capping agent of choice in primary molars compared to permanent molars.

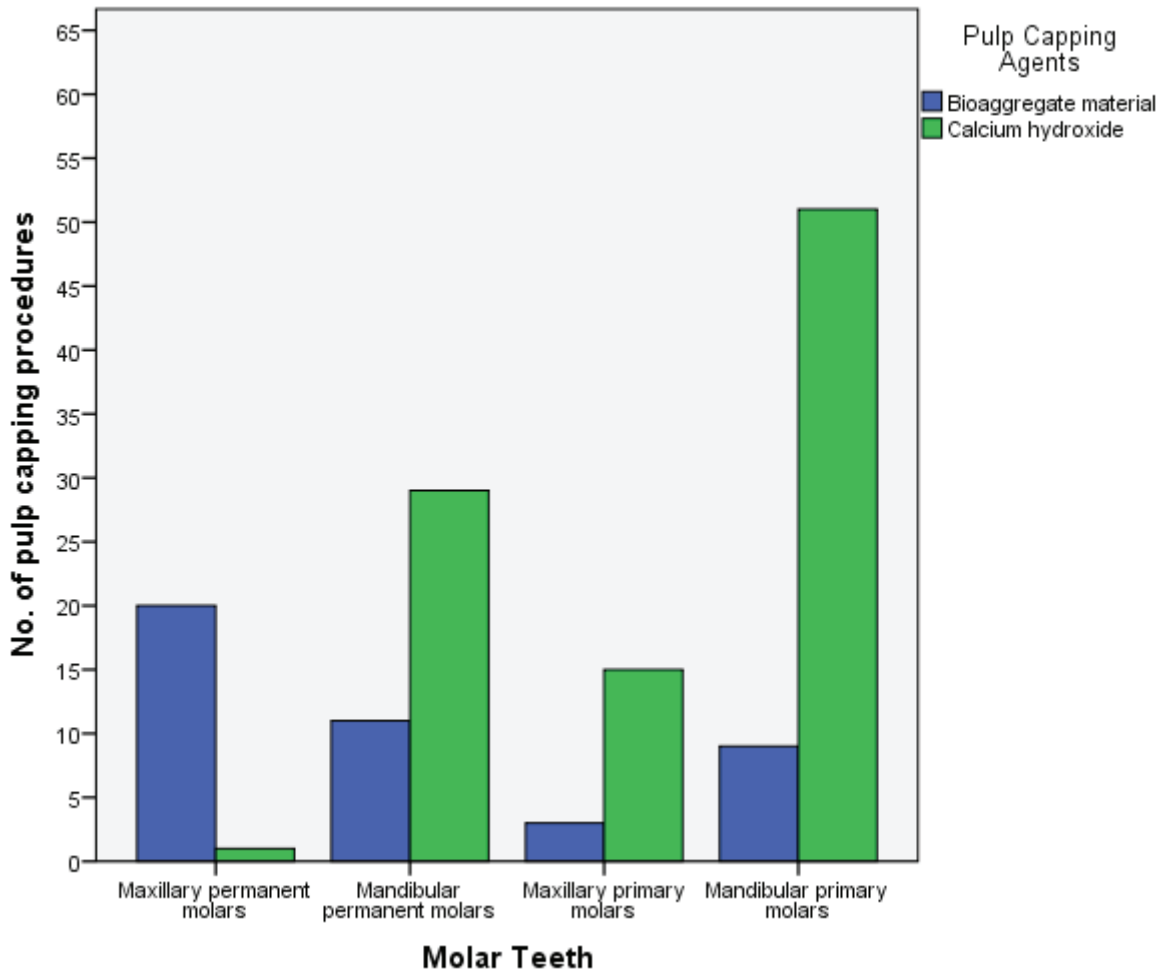

Figure 6. The graph represents the association between the maxillary and mandibular primary and permanent molar teeth and pulp capping agents used to treat them. X axis represents the maxillary and mandibular primary and permanent molars. Y axis represents the total number of pulp capping procedures done using calcium hydroxide denoted by green and bioaggregate denoted by blue on a scale of 0-60. Chi square test was performed. □ = 0.05. The association was found to be statistically significant showing that calcium hydroxide is the pulp capping agent of choice in mandibular primary and permanent molar pulp capping compared to maxillary molars.

Conclusion

Within the limits of the study, calcium hydroxide was the preferred pulp capping agent for indirect pulp capping by dentists in a private dental college in both primary and permanent molars. However, with its clinical advantages, mineral trioxide aggregate shows a promising candidate as an indirect pulp capping agent in primary and permanent teeth.

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