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Prospective study on anterior permanent teeth with a history of trauma using bio dentine for pulpotomies

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Abstract

Introduction: The Following multicentric prospective study's objective was to assess how Biodentine (BD) pulpotomies on permanent teeth with complex crown fractures performed on clinical and radiographic examination.

Methodology: The study was conducted at Rama Dental College, Kanpur. The study included patients who injured their anterior permanent teeth and sought emergency care. At one week, two, six, twelve, and twenty-four months after therapy, clinical and radiographic evaluations of the treatment outcome were made.

Results: This study comprised 40 patients, ranging in age from 12 to 18 years old. At 1, 6, and 15 months of follow-up, four failures were detected. The teeth underwent either traditional root canal treatment or regenerative endodontic therapy. According to the results the teeth were less sensitive to cold over time, and more teeth during this trial responded normally to tests of pulp vitality. Eight teeth (17%) showed a little discolouration. 91% of cases with radiographic results had dentinal bridge creation, and all teeth that were still developing indicated as ongoing formation of root.

Conclusions: Biodentine can be used as a material for pulpotomies on anterior permanent teeth with complicated crown fractures. It may be excellent alternative to MTA pulpotomies as it does not result into significant discoloration and it allows completion of root maturation.

Keywords: VAT, MAT, Biodentine,

Introduction

8.49% to 34.48% of all traumatic dental injuries are complicated crown fractures (1). Treating cases involving pulp exposures in permanent teeth is still difficult for many practitioners. Vital pulp therapy (VPT), a conservative treatment for reversible pulpal injuries, encourages the healing of pulp tissue and induces the creation of hard tissue, which in turn maintains the vitality of pulp (2). Partial and complete

pulpotomies are included in this minimally invasive procedure. The target population for partial pulpotomies according to current recommendations is immature permanent teeth that have been traumatically exposed (3). However, new research indicates that neither the the age at which the patient underwent treatment nor the stage of root development has an impact on treatment outcomes (4).

The material of choice in the past has been Ca(OH)2 (5). However, Recent research has demonstrated that MTA causes a thicker dentinal bridge with less porosity, lowers pulpal inflammation, and has superior marginal adaption (5-8). Nevertheless, despite its many benefits, MTA has significant disadvantages, including a lengthy initial setting time, challenging handling characteristics due to a consistency that resembles wet sand, and the risk for tooth discolouration (9, 10). The latter has a significant aesthetic disadvantage, especially on anterior teeth. Recently, research focus has switched to various cements with calcium silicate as their base (CSC), like Biodentine (BD), in an effort to identify an alternative product.

When administered directly to the pulp tissue, BD is a biocompatible and bioactive substance that promotes pulp healing (11, 12). The manufacturer claims that BD has several clinical uses in dental traumatology, paediatric dentistry, endodontics, and restorative dentistry (11). Only a few case reports with BD pulpotomies on permanently traumatised teeth have so far been published (13–15). Therefore, prospective studies with long-term follow-ups are required to better understand and confirm results. The purpose of this study was to assess how BD pulpotomies treated traumatic pulp exposures in permanent teeth from both a clinical and radiological perspective.

Materials and Methods

A prospective case series was conducted for this study in Rama Dental College, Kanpur. The Institutional research ethics boards both gave their approval to the investigation. The study included patients who had been injured to their anterior permanent teeth and sought emergency care. Both the participant's verbal consent and the legal guardian's written consent were obtained. Patients with complex crown fractures in their permanent teeth and resorbable teeth without radiological or clinical evidence of necrosis of pulp or periodontally compromised teeth were the inclusion criteria.

The following were the exclusion criteria:

1. Patient with a history of medical illness
2. lack of cooperation from the patient
3. A prior history of trauma to the teeth
4. A tooth with avulsion
5. the presence of an apical lesion
6. the presence of internal or external resorption
7. uncontrolled bleeding during pulpotomy procedure.

To produce a similar success rate to CH and MTA given in the literature for VPT (4) with a power of 79.1% at an alpha level of 0.045, a sample of 40 teeth was needed. With a 95.1% confidence interval, a unilateral binomial test of non-inferiority was employed to show that the experimental success rate is not inferior to 73.1%.

Procedure

Prior to the start of the trial and on an annual basis, all operators participated in a training session to make sure that all examinations and treatments carried out adhered to a standard, in-depth operating protocol. Furthermore, all data was gathered using a systematic, unaltered form.

Data on the patient's demographics and clinical traits were gathered at the baseline evaluation, including information on the colour of the pulp tissue, the length

of time since the patient was exposed to pulp (in minutes), and the amount of the exposure (in mm). It was also determined if there had been any prior trauma (concussion, subluxation, extrusive, intrusive, and/or lateral luxation). Additionally, tooth movement, tooth colour, vertical and lateral percussion sensitivity, and sensitivity to palpation were noted.

An IOPAR, using the paralleling technique, was recorded to evaluate the presence or the absence of any apical periodontal lesion or pulp pathosis (widening of periodontal ligament, periapical radiolucency or pulpal inflammatory resorption) and the root development stage. The latter was assessed according to the Demirjian developmental stages of permanent dentition (16). After informed consent was obtained, protocol for standardized vital pulpotomy technique was performed. Two percent lidocaine with 1:100,000 epinephrine (Lignospan® standard,Septodont, SaintMaur-des-Fosses, France), was administered. the tooth was isolated with a dental dam. A new sterile 330-diamond bur was used to remove the inflamed pulp.

In the next step the pulp tissue was irrigated with 3% sodium hypochlorite (NaOCl). To disinfect and achieve hemostasis, a cotton pellet saturated in sodium hypochlorite was gently applied for five minutes to the exposed pulp tissue (9). If the bleeding could not be stopped, full pulpotomy was performed instead of partial pulpotomy in order to remove deeper pulp tissue. After achieving hemostasis, BD was prepared in accordance with the manufacturer's directions and applied using an amalgam carrier. Before moving further with a temporary or permanent repair, the cement was covered with a glass ionomer cement (shofu japan) after five minutes. To establish a baseline for subsequent follow-ups, a post-operative IOPAR was acquired utilising the paralleling approach.

Follow up

Clinical Analysis

At one week, one, two, six, nine, twelve, and twenty-four months, clinical and radiographic evaluations of the treatment's success were made. The patient's symptoms (such as sudden pain or sensitivity to cold or heat), tenderness to palpation and percussion, probing depth, movement, and reaction to vitality tests (such as the cold test and electric pulp test) were all taken into consideration during the clinical evaluation. The seal of the final restoration as well as variations in tooth colour (greyish, yellowish, or other) were noted.

Radiographic Examination

Postoperative IOPAR were taken and compared with the pre-Operative radiographs at each follow-up consultation. Two times, separated by two weeks, the two examiners independently analysed 50 radiographs from pulpotomy instances. According to Demirjian's developmental stages of permanent dentition (16), the data reviewed included the stage of root maturation, open or closed apex, the presence or absence of a dentinal bridge, and pulpal or periapical pathosis. Significant interobserver and intraobserver agreement was demonstrated by Kappa Cohen statistics ($k = 0.62$ and $k = 0.76$).

In immature teeth, radiographs determined the stage of root development and weather there is completion of root formaton, as well as the presence or absence of periapical or pulpal pathosis, dentinal bridge formation, and the stage of root growth.

Outcomes

The presence of spontaneous pain, soreness to palpation or percussion, aberrant mobility of tooth, probing depth greater than 3 mm, Negative response to both vitality testing, and considerable tooth discolouration for prolonged period of time were all considered clinical

failure criteria. Periapical radiolucency, inflammatory pulp resorption, and the absence of root maturation (lack of apexogenesis) in developing teeth were all considered radiographic failure criteria. Successful teeth were those without spontaneous discomfort, without infection, and/or without radiographic evidence of pulpal or periapical pathosis. Survival was defined as keeping the tooth following treatment, and failure was described as having the tooth pulled.

Statistic evaluation

All of the variables were subjected to a descriptive analysis. The association between nominal variables (sex, root maturation, and related trauma) and the results of BD pulpotomy was evaluated using Kaplan Meier with Log-Rank (Mantel-Cox). The relationship between age, the length of pulp exposure, and the volume of pulp exposure was examined using Cox regression. The adoption of the significance threshold was p 0.05. SAS software (version 9.4 of the SAS System for Windows) was used to analyse the data.

Results

Initially, 40 patients' 51 permanent teeth were examined in this investigation. Table 1 shows the participants' demographic and clinical features. Male participants made up 54% of the group, and their average age was 15 years. Central incisors (96% of the treated teeth) made up the bulk. Subluxation was the most frequent dental trauma in half of the cases (60%) and two of the cases required stabilisation using a flexible splint. 47 percent of the teeth were still developing and had an open apex. The average follow-up time was 13 months (6-24), and six teeth were lost.

This study revealed a 100% survival rate and a 91% success rate (41/40). At 1, 6, and 15 months of follow-up, four failures were reported; three patients had periapical lesions and one had spontaneous discomfort. With the exception of one tooth, which needed a regenerative endodontic procedure, all of these teeth had traditional root canal therapy. Only the related luxation injury (p 0.04) was an independent variable that had a meaningful relationship with the result of treatment (Table 2).

Clinical Results

Dental sensitivity to cold was the predominant symptom that individuals at follow-up visits reported. As 39% of participants reported tooth sensitivity after one month and 3% after 12 months, this symptom subsided over time. At one week after surgery, none of the patients mentioned taking painkillers. In addition, more teeth showed signs of vitality during vitality tests (cold and electric pulp tests), however this difference was not statistically significant. In fact, 94% of the teeth passed the cold and electric pulp tests at the one-month follow-up and 97% at the 12-month follow-up.

Every restoration was suitable. Eight treated teeth (17%) had minor crown darkening; three had a yellowish discoloration and five had a greyish one (Fig. 1).

Figure 1: Intra-oral photographs of two cases of tooth discoloration. A: Yellow discoloration of the apical segment of the traumatized tooth (#11). B: Gray discoloration of the apical segment of the traumatized tooth (#11).

No more therapy was necessary because none of the patients were aesthetically bothered by this discolouration.

Radiological Results

The radiography results are shown in Table 3. After one month, the bulk of the dentinal bridges were visible in 91% of the teeth. In all immature teeth, root maturation could be seen (Fig. 2). a single tooth that is joined to an extrusive luxation, showed pulp canal obliteration at six months, although the follow-up radiographs showed root maturation and increased root thickness.

Fig 2 Case Follow up Radiographs A: preoprative periapical radiographs showing complicated crown fractures if teeth 11 and 21 B: 3 months follow Radiograph dentinal bridge formation, in both teeth under the BD whihe has the same radioopacity of dentine C: Nine month follow up Radiograph Symentrical increase in root length and thickness in both teeth D: 18 month follow up radiograph full apical closure in both teeth.

Discussion

This is the first and largest cohort, to our knowledge, to study the efficacy of BD pulpotomies on permanent teeth with complex crown fractures. The only case reports that have looked at traumatic pulp exposure's effects on mature and immature permanent teeth thus far have shown encouraging clinical outcomes (13, 15). According to this study, BD VPT had a 91.3% success rate. Our results were consistent with the success rate of CH partial pulpotomies on permanent incisors with complex fractures (2, 17–19). MTA is a commonly used pulp capping agent, although there aren't many clinical research on its usage for VPT in traumatic exposures. Nonetheless, a review by Aguilar et al reported similar types of success rate of CH and MTA VPT on carious pulp exposure (72.9-92.4%) (4). Age, gender, duration and size of pulp exposure and stage of tooth maturation did not influence the treatment outcome in this pediatric population. These findings are in agreement with several other reports (2-4, 9, 20). The amount of coronal pulp removed was determined by the exposure size, but the outcome was unaffected.

Our findings demonstrated that difficult crown fracture treatment outcomes were greatly impacted by the existence of an additional trauma; all failures occurred in teeth with an extra luxation damage. Pulpal necrosis may be more likely in teeth that have been fractured and have concurrent luxation injuries (21). In fact, pulpal survival may be more affected by periodontal ligament damage than by pulp exposure alone because it may affect the pulpal blood flow (22). This should be taken into account when assessing the study's failures because they can be attributable to the concurrent acute injury rather than the actual treatment. We advise a closer follow-up for traumatic pulp exposures when a concurrent luxation injury is evident based on these findings. Eight teeth had discoloured tooth crowns that were visible. On the other hand, a number of in vitro and in vivo experiments evaluating the staining capacity of BD revealed colour stability (10, 23, 24). This difference could be explained by the fact that none of the aforementioned studies included traumatized teeth. Additionally, the pulp capping agent's location in the tooth's coronal region may have had an impact on its translucency. Patients were content with their aesthetics and no additional treatment was necessary despite the small change in tooth colour seen in our study. This discovery gives BD a significant advantage over MTA, which discolours tooth structure as a result of the interaction between collagen and its radiopacifier, bismuth oxide (24, 26).

All immature teeth showed continuing root development on radiographs. This is an advantage of VPT because, in the event that failure arises later, these teeth could still be managed with conventional root canal therapy, which has a more predictable result than regenerative endodontics. 42 teeth (91%) also showed formation of a dentinal bridge. These results are in line with earlier studies on the exposure to carious pulp after CH partial pulpotomies (2, 27). Since a dentinal bridge can be linked to a slowly progressing necrosis (27, 28), its existence alone does not necessarily indicate success.

. In fact, early follow-ups on three of our four failures revealed dentinal bridge formation.

However, the development of a dentinal bridge and the results of positive pulp vitality tests support the existence of a functionally healthy pulp that is generating a physiological dentin apposition (27). When comparing the quality of the dentinal bridge, CSC, like Mineral trioxide aggregate and Biodentine, produce a thicker and higher quality of hard tissue barrier; in contrast, the one induced by CH reveals porosities and flaws, allowing direct access of germs to the pulp. Additionally, CSC have enhanced marginal adaptability and a positive pulpal response with less toxicity, necrosis, and inflammation (6, 7, 29). At the six-month follow-up, only one immature tooth, which had a complex crown fracture linked to an extrusion, displayed pulpal calcification. This is consistent with earlier research that showed pulp canal obliteration (calcific metamorphosis) happens more frequently in developing teeth when severe luxation injuries are present (22). Additionally, numerous observations on BD and MTA VPT noted the presence of calcific metamorphosis (30-32). Future research should analyse these calcifications further since they might make root canal therapy more difficult if they are discovered in the future.

There are several methodological restrictions with our study that must be taken into account. First, there was a brief follow-up period, and some patients did not comply with returning for recalls at the planned intervals. Therefore, it is important to evaluate the clinical and radiological results carefully. Although there is little consensus regarding the optimum follow-up time for VPT (20, 33), one study found that a follow-up of 21 months was sufficient to assess treatment outcomes. Our average follow-up time was 13 months, but to date, no study on BD pulpotomies and traumatic exposure has been longer. Second, because the study was carried out in two hospital departments, different operators carried out the process. However, to increase the validity of our data, all operators adhered to the same standardised process and received training. Due to the small number of cases, there was no control group. Despite these drawbacks, the current study adds to our knowledge of the clinical and radiographic success rates of pulpotomies performed utilising BD on complex crown fractures of anterior permanent teeth.

Conclusion

A high success rate was seen overall for BD pulpotomies. This material may work well for pulpotomies on traumatised anterior permanent teeth with intricate crown fractures and may be a decent substitute for MTA and CH. Furthermore, the stage of root maturity had no bearing on the results of the treatment. In order to determine the long-term success of VPT in teeth with intricate crown fractures, additional research with bigger sample sizes and longer follow-up times are still required. Despite these drawbacks, the current study adds to our knowledge of the clinical and radiographic success rates of BD pulpotomies on complex crown fractures of anterior permanent teeth.

Table 1:Patient demographic Information

Variables	N= 51
GENDER	
Female	24(45.9%)
Male	27.8(54%)
AGE	
Time of Exposure of teeth	250 min
Size of exposure	1.7 ± 1.3 mm
Trauma History	28.2 (55%)
Concussion	(N=28) 8 (28.1%)
Lateral Luxation	(N=28) 2 (7.2%)
Subluxation	(N=28) 17(7%)
Extrusive Luxation	N=28) 1 (3%)

TOOTH TYPE

Maxillary Central Incisor	45 (95.8%)
Mandibular lateral Incisor	2 (2.2%)
Maxillary Canine	1(2%)

Stages of root development †

Immature	27 (57%)
Stage F (N= 29)	5 (17%)
Stage G (N=29)	24 (83%)
Mature	
Stage H	24(43%)

Categorical variables are presented as number (n) and percentage (%).

Continuous variables are presented as mean ± standard deviation.

† According to Demirjian's developmental stages of permanent dentition.

*Some patients had multiple teeth included in the study. In that case Each tooth was treated as an individual case for analysis.

Table 2: Cox regression (a) and Kaplan Meier (b) of independent variables associated with treatment outcome

Variables	P value
Pulp exposure Size	0.078 (a)
Pulp exposure Time	0.134 (a)
Gender	0.485 (b)
Age	0.356 (a)
Root development	0.787 (b)
Trauma History*	0.049 (b)

* P< 0.06 (statistically significant).

Table 3: Radiographic findings after pulpotomy

Variables	BD pulpotomies N=40
Dentinal bridge formation	43 (91.1%)
1 Month post op	30(73.9%)
3 Month post op	9(22%)
6 Month post op	2(4%)
Continued Root Formation in Immature tooth	(N=26)* 26 (100%)

Categorical variables presented as number (n) and percentage (%). *Only 26 teeth were immature in this study.

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