ISSN- O: 2458 - 868X, ISSN–P: 2458 – 8687
Index Copernicus Value: 49. 23

International Journal of Medical Science and Innovative Research (IJMSIR)
IJMSIR : A Medical Publication Hub
Available Online at: www.ijmsir.com
Volume – 3, Issue –3, June - 2018, Page No. : 250 – 258

Clinical and radiographic evaluation of MTA Apexification, Revascularization and Regenerative Endodontics using PRF: A Comparative Study

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Type of Publication: Original Research Paper

Conflicts of Interest: Nil

Abstract

Introduction: Dental trauma has become more prevalent in the present world owing to increase in spending time outdoors and active participation in sports activities. However, trauma to teeth, especially anterior teeth which renders them non vital before their root growth is complete poses a special challenge in their treatment. Apexification is the treatment of choice because of its shorter treatment duration and high success rates. But, Apexification doesn't improve the poor crown root ratio in such cases and the tooth remains susceptible to fracture. Regenerative Endodontic procedures in the past decade have shown us that the root growth can be achieved even after the loss of tooth vitality.

Materials And Methodology: This study was done in children aged 8 to 12 years with the aim to comparatively evaluate the clinical and radiographic outcomes of the treatment of non-vital immature permanent anterior teeth by Regenerative Endodontics using PRF, Revascularization and MTA Apexification with a regular follow up of 3, 6 and 9 months.

Result: The clinical results in all the three groups came out to be successful. Radiographically, a few teeth showed increase in length and width of the root, but the result came out to be statistically insignificant. However, all the teeth which were treated survived which otherwise would have been lost.

Conclusion: Regenerative endodontic procedures should be attempted in non vital immature teeth where conventional apexification or root canal treatment is not possible.

Keywords: Trauma, non vital tooth, Regenerative endodontics

Introduction

There is an overall increase in the prevalence of traumatic dental injuries in the last 30 years. A 12 year review of the literature suggests that one third of all preschool children have experienced TDIs and approximately one fourth of all school children and one third of all adults have experienced injury to the permanent dentition. Tooth fracture constitutes 4%–5% and luxation injuries 30%–44% of all dental trauma injuries. Because of their position, the anterior teeth tend to bear the brunt of most impact injuries. In many cases, the tooth loses its vitality and further development of the tooth is stopped. Because the root development takes place for almost 2 years after the tooth has erupted into the oral cavity, an incompletely formed apex is one of the most common features seen in

traumatized teeth. The mechanical cleaning and shaping of a tooth with blunderbuss canal are difficult, if not impossible. The thin, fragile lateral dentinal walls can fracture during mechanical filing, and the large volume of necrotic debris contained in a wide root canal is difficult to disinfect completely. Apexification with Calcium Hydroxide or MTA are widely used and successful treatment options. Apexification aims at providing a barrier at the apical end but it doesn't improve the crown-root ratio of the tooth. Obturation of wide canal systems requires precise fabrication of a customized gutta-percha cone, and there is danger of fracture of the root during lateral condensation. It is reported that 30% of these teeth fracture during or after such treatment. Recently, Revascularization procedures have been recommended to treat immature permanent teeth with necrotic pulp tissue and/or apical periodontitis/abscess. Revascularization is defined as "the procedure to re-establish the vitality in a non-vital tooth to allow repair and regeneration of tissues"G. L. Feldman in 1932 showed evidence of regeneration of dental pulp under certain optimal biological conditions. This work introduced the biological-aseptic principle of tooth therapy to achieve pulp regeneration using dentine fillings as building material for stimulating pulp regeneration. Subsequent researchers further improved this work. Major breakthrough in dental history was achieved in year 2000 when Gronthos et al. identified and isolated odontogenic progenitor population in adult dental pulp.8 These cells were referred to as dental pulp stem cells (DPSCs) and are believed to play an important role in the regeneration of pulp.It should be taken into consideration that Regenerative Endodontics has certain practical limitations. There is no agreement on the methods to produce predictable clinical outcomes or optimal disinfection protocols. A range of treatment protocols have been used to treat these cases, with various irrigants, medicaments, clinical procedures and follow-up times. It is difficult to select the appropriate non-vital teeth with residual vital apical cells, which are believed to be necessary for a successful regenerative procedure.

Inclusion and exclusion criteria

Inclusion criteria

Incompletely developed permanent anterior teeth with an open apex and negative to pulp vitality testing were included for this study. (The pulp vitality tests were conducted using electric pulp vitality tester).

Exclusion criteria

Avulsed/replanted tooth, subluxated /luxated tooth because of their questionable prognosis. In subjects younger than 8 years or older than 12 years. The study population comprised of children 8 to 12 years of age. The permanent maxillary central and lateral incisors were chosen for the study because they are the most commonly injured teeth in the oral cavity. Maximum esthetic value is also associated with these teeth. The central incisors erupt by the age of 7-8 years and lateral incisors by 8-9 years of age. The root completion occurs by 9-10 years in central incisors and by 11 years in lateral incisors.16 This is also the age where trauma in teeth peaks in children. Hence, if the tooth becomes non-vital owing to trauma in this age group, there are more chances of a stunted root growth leading to an open apex. The normal variation in tooth eruption timing and various factors that affect tooth eruption were also taken into consideration before finalizing the age group to be taken into the study. Subject with a systemic disease that impairs healing andchildren with special needs like those with mental retardation, cerebral palsy or Down's syndrome were also excluded from the study.

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Methodology

The study population comprised of 39 children aged 8-12 years. The children selected for study had necrotic maxillary anterior teeth (central and lateral incisor). The vitality of teeth was confirmed with the help of a detailed case history, periapical radiographs and by using electric pulp tester. The patients selected were then divided equally into three groups A, B & C. An informed consent was taken from the parents/legal guardians of the children.

Group A: MTA Apexification

Any remaining fragments of necrosed pulp in the root canal was removed using broaches and files. The canal was then shaped. Instrumentation was be done 2 mm short of the apex. Simultaneous irrigation was done using 2.5% Sodium hypochlorite and saline. The canal was dried using sterile paper points. MTA (ProRoot, Dentsply) was mixed according to the manufacturer's instructions and carried into the canal with the help of MTA carriers. Pre-selected pluggers were used gently to condense the MTA into an apical 3 – 4 mm barrier. Multiple sequential radiographs were taken to check the apical position and condensation of MTA. After the last increment of MTA was condensed, a temporary restoration was placed and the patient recalled after 24 hours. Obturation was done using Gutta Percha if the patient was asymptomatic after 24 hours.

Group B: Revascularization

Access preparation was followed by copious and gentle irrigation with Sodium Hypochlorite in a concentration of 2.5%.Instrumentation was done slowly and minimally with endodontic files. Working length was determined by IOPA radiographs. Distilled water or saline was used along with sodium hypochlorite. Canal was dried with sterile paper points. Hoshino's triple antibiotic paste was prepared by mixing the three antibiotics, Ciprofloxacin (200mg), Metronidazole (500mg) and minocycline (100mg) in a vehicle of propylene glycol, using a glass mortar and pestle. This paste was placed in the canal with the help of pluggers and condensers below the cemento – enamel junction. The remaining canal was then sealed with 3 to 4 mm of temporary restorative material. After 3 weeks, the patient was evaluated for any signs or symptoms of persistent infection like pain, swelling or a sinus tract. If positive, additional treatment with antibiotics or an alternative antimicrobial was considered. If the patient were symptom free, the tooth was anesthetized using 2% plain lignocaine because Adrenaline, if present constricts the blood vessels in the region of administration of local anesthesia, making induction of bleeding very difficult. The tooth was then isolated with rubber dam and access opening made. The triple antibiotic paste was removed gently with copious irrigation. The canal dried with sterile paper points. Bleeding was inducted into the canal by over instrumentation to approximately 2mm beyond the working length. A blood clot was allowed to form. A 3 to 4 mm thick increment of MTA was used to seal the remaining part of the canal followed by a temporary restoration.

Group C: Regenerative Endodontics using PRF

The first appointment in Group C was similar to that of revascularization. The patient was evaluated for any signs or symptoms of persistent infection like pain swelling or a sinus tract after 3 weeks. If positive, additional treatment with antibiotics or an alternative antimicrobial was considered. If the patient was symptom free, the tooth was anesthetized using 2% lignocaine with vasoconstrictor adrenaline in a ratio of 1:200000.The tooth was then be isolated with rubber dam and access opening made. The triple antibiotic paste was removed gently with copious irrigation with saline or distilled water. The canal was dried with sterile paper points. Around 5 ml of whole

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venous blood was collected from the patients in each of the two sterile vacutainer tubes of 6 ml capacity without anticoagulant. The blood was withdrawn from the median cubital vein as this vein is situated between the muscles and is easy to identify. The vacutainer tubes were then placed in a centrifugal machine at 3000 revolutions per minute (rpm) for 10 minutes. The PRF is situated in between the layers of straw coloured plasma above and red blood cells below. The PRF layer was separated using tweezers and put on a gauze piece before using it.After drying the canal, the Platelet Rich Fibrin membrane was pushed into the canal using hand pluggers, 1mm beyond the confines of the working length. The remaining canal space was sealed with MTA directly over the PRF membrane and a temporary restoration was placed. The patient was recalled after 48 hours. (figure 1)

In all the groups, a permanent composite restoration was placed 48 hours after the procedure. The patients were recalled after 3, 6 and 9 months. Radiographic evaluation was done using a positioning device so as to obtain a standard image to compare the radiographs in subsequent follow ups.

Results

The teeth with increase in root length and decrease in apical with were counted in each group. The data were analysed statistically by Fisher's exact test and P = 0.05 was considered statistically significant. Upon clinical examination, none of the patients reported any tenderness upon percussion or any other relevant symptom in any of the follow ups.

3 Months follow Up

At the stage of 3 months follow up, there was no change in the root length and apical width in any patient of Group A, B or C, hence no difference was present in terms of radiographic outcome of the treatment at this stage. Hence there was no difference amongst the three groups at this stage of treatment. (Table 1)

6 Months follow Up

At the end of 6 months, there is only one patient in Group C with an increase in root length and one in Group B and one in Group C respectively with a decrease in apical width.The difference between the three groups is not statistically significant as $p>0.05$. (Table 1)

9 Months Follow Up

At the end of 9 month's follow up, there were 2 patients in group B, 3 patients in group C with an increase in root length, and 2 patients in group B and 4 patients in group C with an increase in apical width. There was no change in root length or apical width in the patients of Group A. (Table 1)The difference is not statistically significant as $p>0.05$.But, as we proceed from a follow up of 3 to 9 months, the P value decreases from 0.419 to 0.081. It is still statistically insignificant, the decrease shows that with time, the result shows a tendency towards significance.

Discussion

The goal of tissue regeneration (e.g., formation of new tissue reproducing both the anatomy and function of the original tissue) is distinct from tissue repair which is focused over development of a replacement tissue, such as scar tissue, without restoration of function.In recent years, there has been an increase in scientific research on tissue engineering which has shown the ways to harness the potential of stem cells and growth factors present in the blood itself. Before Regenerative Endodontics captured the attention of clinicians worldwide, Apexification first with Calcium Hydroxide, then MTA was the standard line of treatment for non-vital immature permanent teeth.The most critical drawback of Calcium Hydroxide Apexifiation is the reduction in root strength due to the use of Calcium Hydroxide, and this increases the possibility of root fracture. The superior sealing ability of

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MTA is thought to be due to the setting expansion it undergoes in moist environment. These properties make MTA an ideal choice for single step Apexification procedure compared to Apexification using Calcium Hydroxide which requires multiple visits and prolonged recalls. Apexification, as stated by a study done in 2005, gives a success rate of 74-100%. In spite of this advantage, Apexification with MTA neither strengthens the root nor induces further root development. As a result, the roots remain thin and fragile, and hence another treatment approach is needed. It has been recently suggested that regenerative endodontic treatment can be alternative approach of Apexification. Regenerative endodontic treatment has the advantages of further root development and reinforcement of dentinal walls by deposition of hard tissue, thus strengthening the root against fracture.Revascularization by formation of a blood clot is the most commonly applied technique in regenerative endodontics. The formation of blood clot yields a matrix (e.g. fibrin) that traps cells capable of initiating new tissue formation. But, it is not clear whether the new tissue is pulp or not but case reports published till date do mention continued root development and restoration of the response to pulp testing methods. One possibility is that few vital pulp cells remain in the apical portion of root canal even though most of the pulp is non-vital and infected. This is the reason minimal instrumentation is recommended while attempting for regeneration, to avoid any inadvertent harm to the vital cells (if any) at the apex. Cells must have an available supply of oxygen to survive, which is why, perhaps cells in the coronal portion of the root canal system would not survive under hypoxic conditions. Regenerative potential of platelets was introduced in 1970s and its clinical applications began in the field of medicine in 1980's. , Platelet rich plasma was the first generation of platelet concentrates. There is an increasing concern that PRP causes coagulopathies due to addition of bovine thrombin and adverse reactions such as systemic lupus erythematosus like syndrome and the usage of PRP was considerably reduced. This has led to evolution of "second generation PRP" coined as PRF which is purely an autologous human thrombin.Second generation Platelet concentrate also known as Choukroun's Platelet Rich Fibrin (PRF) is totally autologous in nature. PRF was developed in France by Choukroun et al, in 2001.This technique is very simple and inexpensive. PRF contains platelets, growth factors, and cytokines that enhances the healing potential of both soft and hard tissues. Platelet rich fibrin has a unique property of sustained release of important growth factors like platelet derived growth factor (PDGF) and transforming growth factor β (TGF β) along with cytokines for a period of over 28 days. This ensures a very strong and discrete reparative, regenerative and augmentative process sets in a refined qualitative manner. Literature survey reveals that there is an absence of documentation regarding the application of PRF in the field of regenerative endodontics. The purpose of this study was also to discover the potential of PRF in a long term.

Conclusion

In the present study, MTA Apexification, Revascularization and Regenerative Endodontics using PRF showed clinical and radiographic success. There was no statistically significant difference when the three procedures were evaluated clinically and radiographically.Regenerative Endodontic Procedures in the present study increased the structural integrity of a tooth by increasing the root length and decreasing the apical width. However, the follow up duration of the present study was 9 months. It is suggested that more studies with longer follow up be carried out in order to

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establish a standard protocol for the management of an immature non-vital permanent tooth.

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List of Table and Figure

	MTA Apexification	**Revascularization**	**Regenerative Endodontics using PRF**
Total* (3 month recall)	12	12	13
Increase in root length	0	0	0
Decrease in apical width	0	0	0
Total* (6 month recall)	12	10	13
Increase in root length	0	0	1 (7.7%)
Decrease in apical width	0	1 (10%)	1(7.7%)
Total* (9 month recall)	12	10	13
Increase in root length	0	2 (20%)	3 (23.1%)
Decrease in apical width	0	2 (20%)	4(30.8%)

Table 1: Total number of patients returned for recall and percentage of patients with increase in root length and/or decrease in apical width of the root canal

Total*: Number of patients who reported for recall

Figure 1:

Figure 2:

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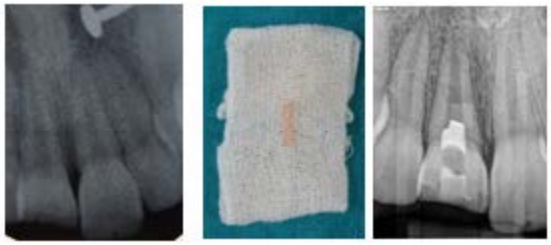

Figure 3:

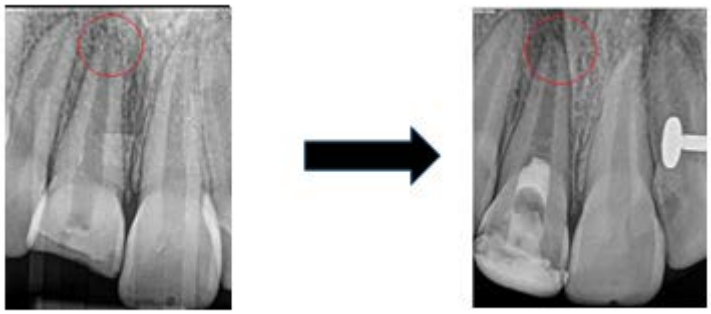

Figure 4: 9 month follow up of a case treated by Regenerative Endodontics using PRF with completed root apex

Figure 5: 9 month follow up of a case treated by Revascularization with increased dentinal thickness

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