APEXIFICATION FOLLOWED BY DIRECT COMPOSITE VENEER ON ELLIS CLASS IV FRACTURE: A CASE REPORT

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ABSTRACT

Introduction: *Traumatized immature permanent teeth can cause pulp necrosis, leading to imperfect root formation, and thus resulting an open apex. The apical opening of the immature teeth is mostly large and thus may lead to difficulties in performing a root filling. In such cases, apexification is mandatory before doing root canal treatment. The aim of this case report was to inform that apexification and direct veneer was suitable to treat Ellis class IV fracture with necrotic pulp*

Case Report: *21-year-old female came to the Dental Conservation Clinic RSGM Prof. Soedomo Faculty of Dentistry UGM with chief complaint of right central incisive maxilla fracture and tooth discoloration. Radiographic examination showed an open apex of tooth 11 with a diffuse apical radiolucent area. Root canal treatment and apexification were carried out using circumferential technique and Mineral Trioxide Aggregate (MTA). Vertical warm obturation was performed, followed by intra coronal bleaching in the next visit. Final restoration was carried out using direct composite veneer. Post treatment radiographic showed a 1 mm diameter of radiolucent area at the apex in a good healing process.*

Conclusion: *Apexification using MTA can be used to treat an open apex tooth.*

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INTRODUCTION

An anterior crown fracture is a common form of traumatic dental injuries that mainly affects the maxillary incisors, especially in children and adolescents[1]. Traumatized teeth with immature apices cause a serious challenge[2]. The complications of untreated trauma to anterior teeth may include one or a combination of the following: pulp necrosis, pulp canal obliteration, tooth discoloration, apical periodontitis, ankylosis, resorption, dentoalveolar abscess, apical granuloma or cyst[3].

Apexification is a procedure aimed at inducing apical repair as a hard-tissue barrier across an open apex in an immature necrotic tooth[4]. The current gold standard in the treatment of permanent teeth with incomplete apices is to create an apical plug with setting calcium silicate materials such as Biodentine and Mineral Trioxide Aggregate (MTA). This material is biocompatible, inducing hard tissue formation on its surface[5]. The use of MTA for apexification may lessen the treatment procedure with more satisfying results and help increase a patient's comfort. In addition, this material also has a high sealing ability, excellent marginal adaptation, a high degree of biocompatibility, a suitable setting time (about 4 hour), and an antibacterial property to promote hard-tissue formation[4].

Tooth discoloration is divided into three categories: intrinsic, extrinsic, and mixture. Pulp necrosis may cause intrinsic discoloration due to

bacterial substance, mechanical or chemical irritation of the pulp, then the product can enter the dentinal tubules. Dental bleaching is a minimally invasive conservative solution to aesthetic problems, without any destruction of tooth structure[6].

Aesthetic dentistry requires minimally invasive treatments with restorations that mimic the surrounding dentition. The direct composite resin layering techniques allow greater preservation of sound tooth structure than indirect restorations[7]. The evolution of adhesives and light-cured composite resins has provided the realization of adhesive restorative procedures that are less invasive and offer excellent cosmetic results[8]. Among these bonding procedures is making direct facets in composite resin, which consists of applying and sculpting, texturing and characterization of one or more layers of this material on the labial surface of the dental element[9].

CASE REPORT

A 21-year-old female patient came to the Dental Conservation Clinic RSGM Prof. Soedomo Faculty of Dentistry UGM to repair the right incisor that had been broken for 3 days before being examined. When the patient was about 10 years old, she had an accident that caused her right incisor to hit the floor. After the accident, the patient immediately had a dentist patch her tooth. She had dental discomfort due to the traumatized tooth for several days, but the pain gradually disappeared since then. However, the patient felt that the particular tooth darkened a year ago. Thus, the patient wanted the dentist to repair the structure and the discoloration. The patient had no history of systemic disease, was not in the care of a doctor when she visited us, and did not take any drug for a long time.

Visit I *(Apexification)*

Subjective and objective examinations, intraoral photographs, radiographic photographs were performed. The patient was informed about the procedures, the costs, and the time of treatment. After the patient agreed to proceed with the treatment, the patient filled out and signed an informed consent. Tooth 11 was diagnosed as 11 pulp necrosis with asymptomatic apical periodontitis, open apex, and intrinsic discoloration.

Figure 1. Clinical picture of initial condition. There was a composite filling in the half incisal of tooth 11 and internal discoloration.

Cavity access was made using endo access burs and was expanded using non-cutting ended fissure burs. The treatment started with the measurement of the estimated working length with the help of periapical radiographs (25mm) with a 1 mm reduction (compensation for radiographic distortion) to obtain an estimated working length of 24 mm. Exploration was done using smooth broach. Root canals were irrigated with 2.5% NaOCl and saline solution. The working length was measured using K-file # 50.

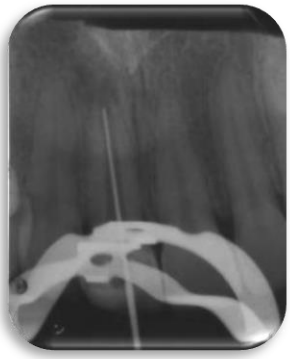

Figure 2. Radiograph measurment of working length. Confirmation with periapical radiograph showed that the working length of tooth 11 was 24 mm.

Biomechanical preparation of root canals was performed with K-file # 50 with filing movements by scraping the root canal walls circumferentially and irrigating them repeatedly with sodium hypochlorite (NaOCl) 2.5%. Preparation through the apex was not recommended because it could damage the tissue for the barrier formation. Upon the completion of the root canal preparation, the root canals were irrigated with 2.5ml 2.5% NaOCl solution and inundated for about 1 minutes with 17% EDTA solution (Smear Clear, SybronEndo) for 1 minute then disinfected with chlorhexidine digluconate 2% (Cavity Cleanser, Bisco) for 30 seconds. A saline solution was used as an intermediate irrigation solution. Afterwards, the root canal was dried using a sterile paper point and dressed with calcium hydroxide and glycerin. The cavity was covered with cotton and temporary dental lift, then the rubber dam was removed.

Visit II *(MTA Application)*

There were no complaints from the patient (there was no pain during the visits). The objective examination showed that the temporary filling was still in a good condition, with neither leakage nor fistula. The percussion, palpation, and mobility demonstrated negative results. Thus, a rubber dam isolator was installed. The temporary filling was dismantled using a round diamond bur and excavator, then the calcium hydroxide dressing material was removed using 2.5% NaOCl irrigation. The root canals were cleaned again with K-file # 80 according to the working length and irrigated with 17% EDTA solution (Smear Clear, Ivoclar), also 2% chlorhexidine digluconate (Cavity Cleanser, Bisco), then dried with sterile paper points.

Afterwards, mineral Trioxide Aggregate (ProRoot MTA, Dentsply) was prepared. Mineral Trioxide Aggregate powder was mixed with sterile distilled water in a mixing pad using a spatula. Once it reached a sand-like consistency, it was put into the root canal using a hand plugger. The Mineral Trioxide Aggregate was applied along one third of the root canal (4 mm) from the apex. The Mineral Trioxide Aggregate was inserted into the root canal and was compacted with a hand plugger that had been marked with a rubber to mark the expected height (4 mm from the apex). The remnants of the MTA attached to the root canal wall were cleaned with cotton pellets moistened with sterile distilled water. The cotton pellets that have been moistened with the sterile distilled water were squeezed and then put into the root canal. The cavity was closed with a temporary lift (Caviton, GC), then the rubber dam was removed. Retrieval of periapical radiographs to ensure MTA applications followed the expected height.

Figure 3. Periapical radiographs for MTA filling. It appears that the MTA has been filled with 4 mm long filling from the apex of tooth 11

Visit III *(Obturation of root canals)*

The subjective examination revealed no complaints (no pain between visits). The objective examination showed that a temporary filling was still in a good condition with neither leakage nor fistula. The percussion, palpation, and mobility indicated negative (-) results. A rubber dam insulator was installed, and temporary lifts were dismantled using

round diamond burs and excavators. Subsequently, the calcium hydroxide dressing material was removed by irrigation using 2.5% NaOCl. The root canals were irrigated with sterile distilled water, followed by 17% EDTA and it was disinfected with 2% chlorhexidine digluconate for 30 seconds. A sterile distilled water was used as an intermediate irrigation solution. Furthermore, the root canals were dried with sterile paper points.

The obturation was performed with vertical warm obturation by inserting a resin sealer using a lentulo. The gradual obturation was performed at 2-3 mm stage thickness with the gutta-percha extruder until it reached 2 mm below the orifice. Afterwards, the vertical condensation was done with a hand plugger every 2-3 mm gutta-percha insertion. The gutta-percha was filled in the root canal up to less than 2 mm from the cervix towards the apical limit of the gingival margin. The depth of the reduction in the gutta-percha was checked using a probe. The pulp chamber was cleaned, and the dentin of the labial part of the pulp chamber was also cleaned at a low-speed bur, rinsed with distilled water, and dried. The dental conditioner was applied in the pulp chamber for 10 seconds. The pulp chamber was then washed and dried gently. The cervical barrier was made using a resin-modified glass ionomer cement of 2 mm thick above the gutta-percha, then irradiated for 20 seconds. Afterwards, periapical radiographs were taken to ascertain the thickness and location of the cervical barrier base. An examination of the root canal filling was performed by taking radiographs, and the result showed a hermetic filling.

Figure 4. Radiographic appearance of tooth 11 after obturation and gutta-percha cutting, showing hermetic obturation

Visit IV *(Intracoronal Bleaching)*

The subjective examination indicated no complaints (no pain between visits), and the patient wanted to continue her dental treatment according to the treatment plan as described earlier. The objective examination demonstrated that a temporary lift was still in a good condition with neither leakage nor fistula. The percussion, palpitation, and mobility showed negative (-) results. The examination of the teeth color with a 3D fit found that the initial color of tooth 11 was 4L2.

Figure 5. Clinical Picture Examination of the teeth color with 3D fit revealed that the initial color of tooth 11 was 4L2.

A rubber sheet was installed. The temporary lift was dismantled using a round diamond bur. The pulp chamber was rinsed with distilled water and dried. An intracoronal bleaching material containing 35% hydrogen peroxide was placed in the pulp chamber, pressed against the

labial wall, and then covered with cotton, temporary lifts, and resin-modified glass ionomer cement. The patient was instructed to have a medical control 5 days later or she could return to RSGM Prof. Soedomo immediately when the color of tooth 11 had turned into the same color as the other teeth.

Visit V *(7 days after intracoronal bleaching)*

The subjective examination indicated no complaints but the color of the tooth partially changed to that of the other teeth. The objective examination demonstrated that the temporary lift was still in a good condition with neither leakage nor fistula. The percussion, palpation, and mobility indicated negative (-) results. The re-checking of the teeth color with a 3D fit found that the color of the cervical part of the teeth had not changed much compared to the tooth next to it by using a shade guide. This result required a re-application of the bleaching material and the patient was asked to have a dental control 7 days later or if the color of the particular tooth had turned the same as that of the tooth next to it.

Figure 6. Clinical features of tooth 11 after application of bleaching material for 7 days showed that the discoloration of teeth was still slightly different compared to the color of the shade guide of the adjacent normal tooth.

Control II ***(****second 7 days after intracoronal bleaching****)***

The subjective examination revealed no complaints but it indicated that the discolored tooth partially turned to the expected color. The objective examination demonstrated that the temporary lift was still in a good condition with neither leakage nor fistula. The percussion, palpitation, and mobility indicated negative (-) results. The re-checking of the teeth color with a 3D fit showed that the color of the cervical teeth had changed to 2L2.5.

Figure 7. Clinical features of tooth 11 after application of bleaching material for the second 7 days resulted in A2 color in the cervical section with 3D fit

The temporary filling was dismantled and the bleaching material was removed. The cavity was washed with warm water. Then, a calcium hydroxide paste was given to balance the pH. The cavity was closed to the temporary lift. The working model of the mock-up was created by printing. Therefore, a palatal guide was printed using elastomeric printing material filled with a blue cast stone. The patient was asked to come seven days later for the restoration.

Figure 8. Clinical features of dental mock up 11.

Visit VI *(Veneer Direct Restoration)*

The subjective examination indicated no complaints, and the discoloration had been repaired. The objective examination revealed no fistula. The percussion, palpitation, and mobility revealed negative (-) results. Cheek and tongue retractors, also occlusal bites were installed.

Five-millimetre gutta-percha below CEJ (cementoenamel junction) was taken using Pesso reamer. The result was confirmed using K-files of which a stopper was installed. Cavities in the occlusal and buccal parts were prepared by the design of class I cavity preparation. The cavity was prepared by making a short bevel at cavosurface margin using micro preparation flame-shaped bur formed at an angle of 450 towards the cavity. A little preparation/roughing was done on the inner walls of the cavity and the cervicobuccal surface to obtain fresh cutting enamel using a fissure diamond bur. The teeth were isolated with a cotton roll. Cavitation with 37% phosphoric acid was carried out on the prepared cavity, and it was settled for 15 seconds in the enamel and 10 seconds in the prepared dentin, then rinsed with syringe water and the cavity surface was moistened with the cotton pellets and sterile distilled water to absorb water in the cavity.

The prepared tooth cavity surface was then smeared with a thin cure activator (G-Premio Bond DCA, GC Europe) and generation V bonding (Stae, SDI) using a micro brush. The micro brush was placed on the bottom of the cavity and then brought to the entire cavity. It was allowed to stand for 20 seconds and aerated for 2 seconds. A gust of wind should not directly enter the cavity, but only concentrated on the upper part of the cavity. Afterwards, the tooth cavity was irradiated with a light cure unit for 10 seconds and it was applied with bulk-fill composite resin (SDR, Dentsply) approximately 2 mm at the bottom of the cavity. Short-fiber reinforced flowable composite (Ever-x GC Europe) was applied at a thickness of approximately 2 mm into the cavity and it was pressed gently and then irradiated for 20 seconds. The packable composite resin (P60, 3M) was applied on its upper part to the thickness of the dentin, then irradiated for 20 seconds using a light-curing unit to activate the polymerization.

Labial veneer preparation on tooth 11 began with a deep cutting bur as a marker of the depth of the veneer. The surface was flattened using a fissure-shaped guide pin bur to facilitate the preparation of the cervical area. On the distal side of teeth 11 and 21, an extension for a functional aesthetic of 0.3 mm was performed to compensate for the shape of the veneer. On the mesial side, a fresh cut was prepared. The incisal side was prepared by making a bevel using a torpedo bur. The etching application used 37% phosphoric acid on the part that had been prepared for 15 seconds. Then, it was rinsed with water and the surface of the cavity was moistened and dried with a moistened and squeezed cotton pellet. The etched surface was then given a 5th generation bonding material. It was smeared thinly using a micro brush, left for 10 seconds then slowly aerated for 2 seconds. Subsequently, it was exposed to light for 10 seconds.

The bulk fill flow composite resin (SDR, Dentsply) was applied for the intracoronal parts and irradiated with a light-curing unit for 20 seconds. The palatal guide was installed to restore the palatal area, after determining the restoration limit on the palatal section to allow no excessive application of the composite resin material on the palatal part. The palatal guide was marked by sharp instruments like a sonde.

Figure 9. Palatal guide installation

A nanofiller composite resin was applied using the layering technique by firstly forming the palatal wall section using A2 color email composite and irradiating it by a light-curing unit for 20 seconds, after which the palatal guide was removed. The greater curve matrix was modified by cutting on its labial side, and it was mounted on the cervical area of the tooth for the application and formation of the composite in the cervical teeth area.

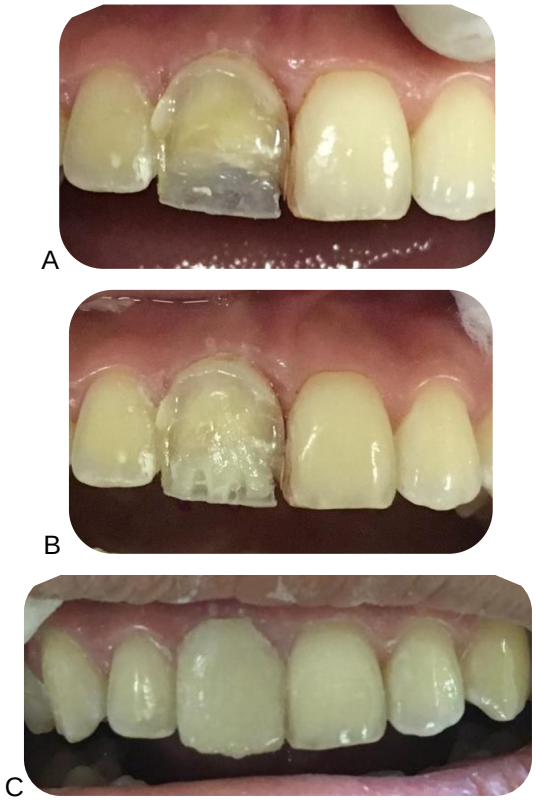

Figure 10. A) The filling of the restorative material in the cervical part 11 with the help of a greater curve matrix B) The provision of dentin color and the formation of mamelon C) The filling of the restorative material of the tooth 11.

The dentin A2 color composite resin was applied to the palatal wall. Afterwards, the dentin mamelon was irradiated with a light-curing unit for 20 seconds. The space between the dentin mamelon was filled with translucent color composite resins and irradiated with light-curing units for 20 seconds. The outermost layer next to the labial was blocked using A2 enamel color composite resin, then irradiated with a light-curing unit for 20 seconds. Celluloid strips were used to assist the application of the composite resins of the mesial proximal parts by the slip-through technique. An instrument was used for levelling the composite resin in the labial contouring.

Occlusion was checked with an articulating paper. The traumatic part next to the palatal was reduced by the peer shaped finishing of the yellow ribbon bur. Furthermore, the packable composite resin (Premisa, Kerr) A2 color enamel was used. The developmental groove in the labial section was formed by tapered fissure finishing with a long bur. Afterwards, the finishing was done using aluminium oxide-coated rotary abrasive disc (Soflex, 3M) starting from a coarse and medium roughness level with a slow rotation, then a fine and superfine level with a tight rotation. The composite resin was polished using a diamond-impregnated polishing disk (Eve computed) of superfine roughness.

Figure 11. Restoration of tooth 11 after finishing and polishing

After the treatment, the patient was educated to do the followings:

1. Having a weekly control.
2. Maintaining oral hygiene by brushing the teeth at least twice a day (morning after eating and at night before bed). Use dental floss is also recommended.
3. Having a regular dental check to a dentist every 6 months.

Visit VII Control (7 Days after)

The subjective examination showed no complaints, while the objective examination indicated neither loose nor broken spills, no fistula, no gingival inflammation around the restoration, and no food impaction. The percussion, palpitation, and mobility revealed negative (-) results. The post-treatment radiography examination appeared to have a radiolucent area in the apical area with a diameter of approximately 1 mm, and the edge of the lift was in a good condition.

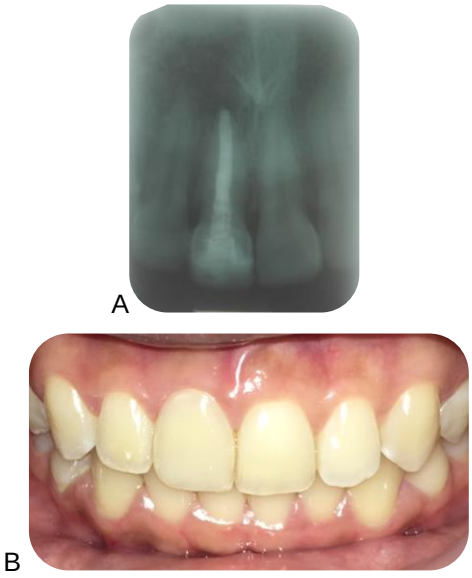

Figure 12. A) Radiographic appearance of the tooth indicates a radiolucent area in the apical section with a diameter of approximately 1 mm. The edge of the lift is in good condition. B) Clinical features of the lift 11 during the control session indicated absence of gingival inflammation at the edge of the restoration.

DISCUSSION

Anterior tooth fractures are the most common dental traumatic injuries affecting children and adolescents. The incidence of trauma to maxillary anteriors is 37% as they have the most anterior position in the arch and protrusive eruptive pattern[10], followed by maxillary laterals (16%) and mandibular central incisors[11]. Trauma to anterior teeth is often neglected when not associated with pain, shocking sensation, discolouration, and abscess. Traumatic dental injuries are often due to collision with people or inanimate objects, traffic accidents, sports, or violence[12]. If left untreated, these injuries may cause pain and psychological/ aesthetic problem[13], pulpal necrosis, dental abscess, and periapical pathosis, that could affect the quality of life of the affected individuals[14,15].

The term apexification is defined as the treatment method aimed at inducing apical repair as a hard-tissue barrier across an open apex. Apexification with calcium hydroxide is considered as the gold standard. However, this technique is associated with certain difficulties such as a very long treatment period, possibility of tooth fracture, and incomplete calcification of bridge[16]. Mineral Trioxide Aggregate as an alternative to calcium hydroxide is used as an apical obstruction for teeth with not fully formed apices, repair of root perforations, root-end closure, pulp capping, and pulpotomy procedures. Mineral Trioxide Aggregate has numerous good characteristics including biocompatibility, antimicrobial activity, preclusion of bacterial leakage, no cytotoxicity, and ability to encourage cytokine release from bone cells to prop up hard tissue formation[17].

Mineral Trioxide Aggregate is composed of tricalcium silicate, dicalcium silicate, tricalcium aluminate, and bismuth oxide. It may also contain

traces of free crystalline silica and trace constituents such as calcium oxide, free magnesium oxide, potassium, and sodium sulfate compounds. Commercial MTA exists in both gray and white forms. After setting, it has a pH of 12.5 which is similar to that of calcium hydroxide. It is a hydrophilic material and requires moisture to set. Mineral Trioxide Aggregate has been used in both nonsurgical and surgical application for root-end filling, direct pulp caps, perforation repairs of roots or perforations, and apexogenesis. Mineral Trioxide Aggregate demonstrates the cementoconductive property and total closure of the apex with cementum[18]. It is recommended that a 3–5 mm thick plug of MTA should be placed at the apex for apexification procedures. Several authors successfully treated open apex cases by placing MTA with a thickness of 2–5 mm at the apical end as a stop[19].

The whitening agent used in this case was hydrogen peroxide (H_2O_2). It is a thermally unstable free radical with a low molecular weight, which by diffusion, penetrates the enamel and dentin. Hydrogen peroxide influences both organic as well as inorganic part of the dentin. Destruction of organic components is mainly due to the oxidizing nature of hydrogen peroxide, whereas the inorganic portion is damaged due to acidity. Complex molecules of the organic pigments in the tissues are broken down into simpler hydrophilic molecules through an oxidation reduction reaction by the action of per hydroxyl ions resulting from the degradation of H_2O_2. When in contact with water, these simpler compounds are readily separated from the dental tissue, which can have a whitening effect[20, 21, 22,23].

In the case of endodontically treated teeth with a moderate loss of tooth structure (<50%), the dilemma of whether to perform direct composite or full coverage restoration depends on the occlusal loading condition and location of the tooth[24]. Composite restorations offer a cost-effective treatment alternative where aesthetics is a major concern. The survival rates of these anterior composites were reported to be extremely satisfactory even in patients with worn dentition. With improvements in the bonding chemistry and introduction of nano-composites, it is speculated that the success rate of composites will improve even further[6]. For large Class IV lesions or fractures, a preoperative impression may be taken to be used as a template for developing the restoration contours[25].

With the selection of color, we used a dentin resin to simulate the effects of dentin. It is known that resins are monochrome while the teeth are polychrome. The use of an enamel resin in the first and last layer is because this has a higher surface smoothness after finishing and polishing, which gives the largest aesthetic restoration, preventing both the build-up of plaque in the cervical region and trauma to the periodontium. Studies have demonstrated that light-cured composite resins are more wear-resistant and more color-stable than self-cured composite resins[26].

A direct restorative procedure was presented as an effective and safe alternative for oral rehabilitation. Many factors, such as planning stage, knowledge, and mastery of technique, finishing and polishing materials, determine the success of the restorations. Meanwhile, monitoring and maintenance ensure the treatment longevity[7].

CONCLUSION

This case showed successful apexification using MTA. The patient was satisfied with the final restoration. It was a safe and cost-effective technique for this case.

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