Case report

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Treatment of uncomplicated fracture of a permanent central incisor – a case report

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Abstract

Traumatic dental injuries (TDIs) are common in children and adolescents and can have significant long-term consequences for both the hard and soft tissues of the oral cavity. Uncomplicated enamel-dentin fractures are a prevalent form of dental trauma, particularly in the pediatric population. The primary treatment modalities for these injuries include direct restoration with composite resin, indirect pulp capping, and fragment reattachment. Using modern technologies, we restored the missing fragment using a 3D-printed model that copied the crown form of the adjacent incisor. Based on our results, we can conclude that even 12 months after the traumatic injuries, the tooth is vital, the root formation is finished, and the prognosis is favourable.

Keywords: traumatic injuries, 3D printed model, direct restoration

Introduction

Traumatic dental injuries (TDIs) are common in children and adolescents and can have significant long-term consequences for both hard and soft tissues of the oral cavity (1). They are a major dental health problem worldwide and present clinicians with several functional, therapeutic, and psychosocial challenges (2). Luxations are the most common injuries in the primary dentition, while crown fractures are the most common in the permanent dentition (3). The prevalence of crown fractures is very high compared to other traumatic dental injuries, accounting for 26% to 76% of cases, and the most commonly reported age of children affected by dental trauma is between 7 and 12 years (4, 5). The maxillary central incisors are both dentitions' most commonly affected teeth (6). Injuries are more common in boys, and the causes are sports injuries, traffic accidents, or falls (7). The severity of dental trauma is further increased by the possibility of a combination of different injuries in which the trauma has caused both luxation and fracture of the same tooth (8).

The treatment of this TDI often requires the application of evidence-based diagnostic and treatment practices that are optimally contextualized and individualized to the child's specific requirements (9). The goal of treatment of immature permanent teeth is to preserve and maintain the vitality of the dental pulp, as well as continued apexogenesis of the tooth root (10). The restoration of the missing hard tooth structures is of no less importance, and this is related to preserving the aesthetics and self-esteem of the young child (11, 12).

Fractures of permanent anterior teeth with incomplete root development in children present a challenge to achieve function and aesthetics conservatively. One of the most desirable treatments is reattaching the broken fragment to the damaged tooth (13). This approach allows the dentist to restore the original anatomy of the tooth and is considered very conservative, especially if the fragment is available, intact, and well-adapted to the fractured tooth (14). In cases where the missing fragment is unavailable, the most commonly

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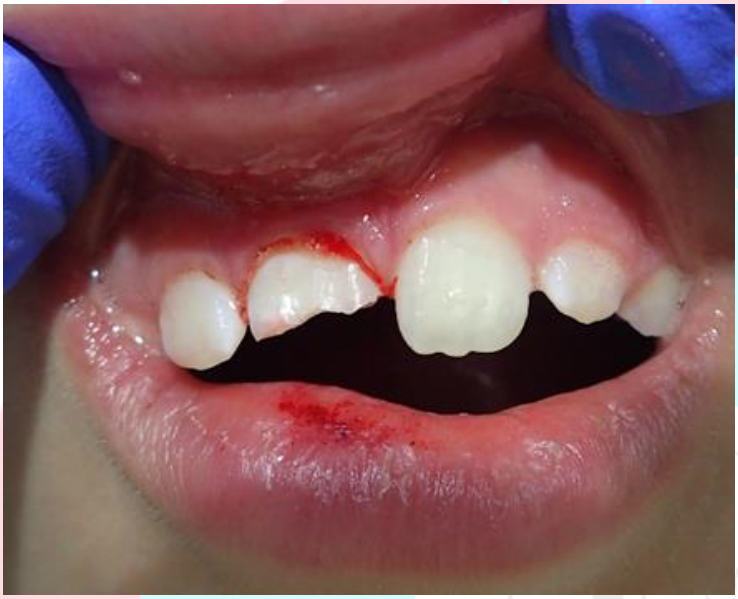
used approach in children is to restore the traumatized tooth with a composite resin restoration. This option is also valuable, as it has good aesthetic results and an acceptable retention rate (15). Restoration is recommended as soon as possible after the injury occurs. World guidelines recommend that in fractures involving enamel and dentin, provisional treatment should be performed by covering the exposed dentin with glass ionomer cement or definitive treatment with composite or other restorative material (16).

Clinical case



An eight-year-old boy was admitted to our dental clinic as an emergency after a combined trauma to the permanent maxillary central incisor (Fig. 1).

Anamnesis: The injury was caused after falling from a scooter in a park, and the incident occurred one hour before the child entered the dental office. The parents and the child denied having noticed any neurological abnormalities or problems immediately after the trauma, such as nausea, vomiting, disorientation, headache, loss of consciousness, amnesia, or difficulty in the child's speech. The parents also did not report that the child had any established allergies or general diseases. The child did not take any regular medication.

Figure 1. Intraoral photograph and x-ray after the TDI

Extraoral examination: The clinical examination of the child did not reveal any lesions of the soft tissues on the face. In the lower lip area, a bruise and a hematoma with swelling were observed without a lacerated wound. No abnormalities were observed in the occlusion and bite force, which ruled out alveolar fractures. No limitations were observed in the mouth's opening and in the movement of the lower jaw. Palpation of the facial skeleton did not reveal any fractures of the facial bones. Palpation of the temporomandibular joint revealed no swelling, clicking, or crepitus.

Intraoral examination: No soft tissue lacerations or foreign bodies were detected in the oral cavity. Examination revealed an oblique fracture of the crown of tooth 11, involving enamel and dentin, without pulp involvement (uncomplicated fracture). The tooth did not show increased mobility or displacement. Bleeding was observed in the gingival margin of the injured tooth (Fig. 1). Percussion tests revealed tenderness in the maxillary right central incisor, consistent with subluxation. No change in tooth color was observed. The child and parents reported pain and sensitivity to air, hot, and cold drinks, a consequence of the exposed dentin in the fracture. At the first visit of the child, vitality test was perform with the help of cold spray and the affected tooth responded normally.

Treatment plan: The soft tissues were cleaned with a hydrogen peroxide and chlorhexidine swab. The parents were warned about possible complications in the following months, such as swelling, staining/darkening of the crown, increased mobility, or fistula. After each meal, the child was shown and

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explained in the first two to three days to carefully clean the injured tooth and gingiva with gauze and chlorhexidine. The child was demonstrated and trained in a modified Stillman brushing technique in the next few days after the injury. The exposed dentine was sealed with a thin composite layer until the next visit. The occlusion was not restored at this stage.

Following the conservative and minimally invasive treatment principles, the missing tooth structures were restored using a pre-fabricated silicone key. An upper and lower jaw impression was taken using A-silicone (Elite HD, Zhermack SpA, Rome, Italy) and a two-stage, two-phase technique. Bite registration was also made using bite silicone (Variotime Bite, Kulzer, Hanau, Germany). A plaster model was cast in a dental laboratory and scanned using an extraoral scanner (ZirkonZahn). Using a software program (Program CAD/CAM Exocad Basic), a digital reconstruction of the fractured tooth was made as a similar copy of the adjacent incisor, after which the model of the restored tooth was 3D printed from plastic material (Figure 2).

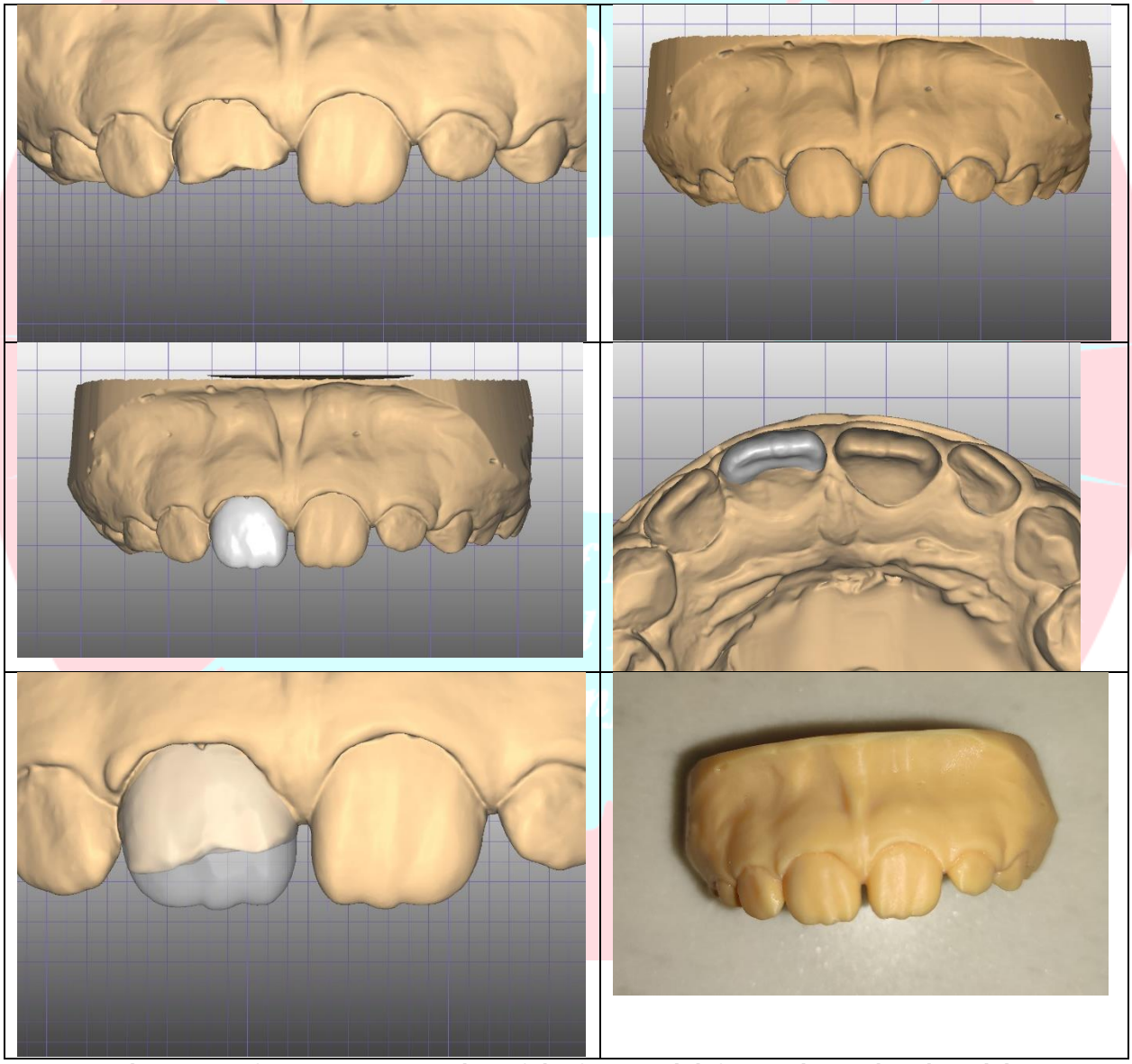

Figure 2. Software reconstruction of the fractured defect and 3D printed model.

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A silicone key was taken from the 3D printed model of the palatal surface of the restoration, including the incisal edge of the anterior teeth and the tooth to be restored. This silicone key was used as a guide for the direct restoration of the tooth with composite material (Figure 3).

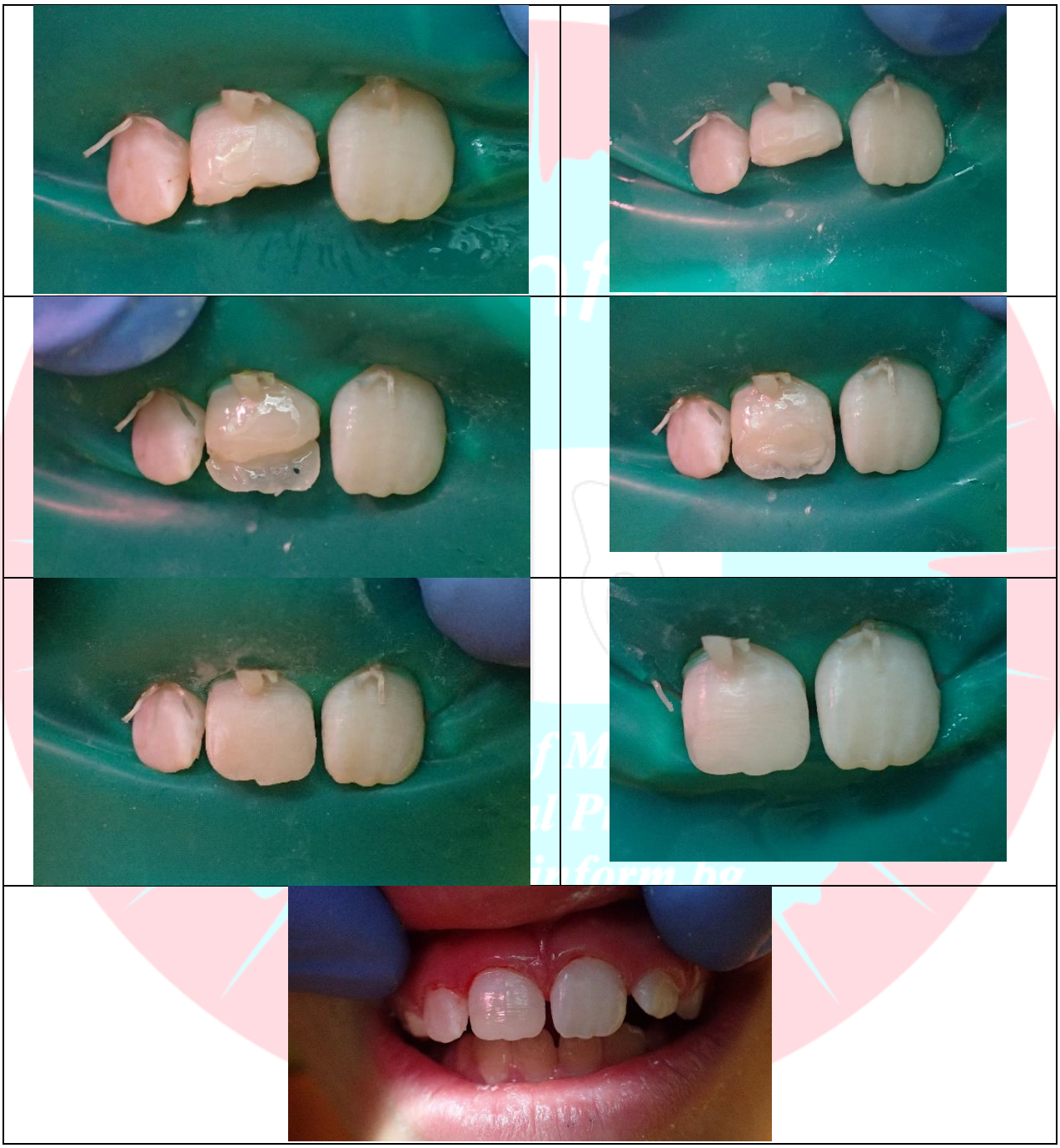

Figure 3. Restoration of the fractured fragment with enamel and dentin resin using a silicone key

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The restoration was done two weeks after the trauma, preceded by a re-evaluation of the vitality with cold spray. The response to the cold stimulation was again positive.
The treatment protocol was as follows:
- Isolation with rubber dam;
- Floss ligatures were placed to provide extra retraction;
- Removal of the resin material that was placed on the first appointment;
- The tooth was thoroughly cleaned; all edges were rounded; beveling of the walls was performed;
- Adhesive protocol – etching with orthophosphoric acid gel and bonding with single-bottle universal adhesive;
- Placement of the silicon key and building of a palatal shell with enamel composite;
- Dentin mass was applied to reproduce the mamelons;
- Enamel composite for restoring the buccal surface;
- Creation of a surface texture with a diamond bur;
- Finishing and polishing;
- Removal of the rubber dam and final check of the occlusion.

Discussion

With the advancement of adhesive materials, the possibility of restoring both function and aesthetics has become easier, more predictable, and more practical. This is especially true for restorations in the frontal areas. Our results show that fracture repair, even in childhood, can be done easily, quickly, and with predictable results and high aesthetics. Modern technologies for 3D printing models have been successfully applied in various areas of dentistry, including dental restorations and maxillofacial trauma (17, 18). It seems that the usage of this technology is an excellent choice for restoration of dental fractures if the missing fragment is lost.
Fractures involving dentin expose countless dentinal tubules – from 15,000 to 45,000, depending on the location of the fracture (19). Due to its tubular structure, bacteria can easily invade dentin into the pulp-dentin complex, leading to pulp diseases. In vivo studies have shown that invasion of the tubules by bacteria in the oral cavity can occur within a week after their exposure. This is also the reason why we chose to cover the dentinal tubules with composite material at the first visit until the 3 printed models were prepared to guide the final restoration. Correct and good sealing of the dentinal tubules is a major factor in preventing complications and in the final restoration of uncomplicated crown fractures involving enamel and dentin. The size of the fracture is decisive in assessing the pulpal prognosis in the future (7). Fractures similar to ours, which extend from the medial to the distal surface of the tooth, are less favorable and risky for pulp necrosis than oblique fractures (20). Our results show that even 12 months after the restoration, the fracture line is well sealed, with no evidence of pulpal complication or loss or fracture of the restoration.
Enamel and enamel-dentine fractures have been successfully treated with dentin adhesives and resin-based composites. Some clinicians choose to restore fractured teeth in children with crowns made of zirconia or other materials (9). However, their fabrication requires removing a larger amount of tooth structures and subgingival preparation margins of 1–2 mm (21). These requirements can often lead to pulp exposure due to the larger pulp chamber size and highly exposed pulp horns in recently erupted children's teeth (21).
Maintaining pulp vitality in a traumatized tooth with an immature root is critical in a young patient. This allows for continued root development (22). The risk of complications is generally increased if the crown fracture is associated with a luxating injury (23). Ravn's study found that pulp necrosis occurred in only 3.2% of teeth, and enamel and dentin fractures were the only damage (24). Higher risk exists in combined injuries (23).

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Based on our results, the esthetic concern was also reported to be acceptable to the patient. Fragment retention seems good if the patient does not face a second trauma or nonphysiological fragment use (4).

Conclusion

Correct diagnosis, treatment planning, and regular follow-ups are important to ensure a favorable outcome for fracture cases. Our results showed that repairing an uncomplicated fracture of a permanent central incisor with incomplete root development using a silicone key is an easy, predictable procedure with very high clinical and aesthetic results. Modern technologies and 3D-printed models that replicate the shape of the adjacent intact incisor provide convenient methods for creating beautiful and aesthetic restorations following fractures. This approach can be adopted by all clinicians involved in the management of dento-maxillofacial traumatic injuries.

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