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Biomimetic approach to extensive fracture of anterior teeth – a case report

CASE REPORT

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Abstract – The fracture of anterior teeth in children and adolescents is a common injury. When most tooth structure is compromised and the broken fragment is not recovered, its restoration can become rather complex to both dentist and dental technician. Restoration of single anterior elements is one of the most demanding challenges in fixed prosthodontics. This article describes a clinical case of a 13-year-old patient with an extensive fractured central incisor and contra lateral incisor. Endodontic treatment was performed on both teeth, and a temporary removable appliance was made for esthetics. One month later, an indirect esthetic post and core was made for each tooth, and provisionals were placed. After a 6-month period of soft tissue stabilization, two pressed all-ceramic crowns were fabricated and bonded to the preparations. The authors believe this to be a stable long-term option relative to the reminiscent tooth structure, esthetic demand, and occlusal features of the case.

Fracture of anterior teeth, especially of maxillary central incisors, is a frequent consequence of trauma in children and teenagers (1–4). Reattaching the tooth fragment with adhesive techniques is a traditional way of addressing these fractures (5, 6). When the fragment is lost, though, this process can be demanding in both esthetic and functional point of view. Composites are accepted as a first-choice material to solve many of these cases, especially when the fractures are not too large and tooth vitality is maintained (7). The literature also describes the use of composites for full crown reconstruction of anterior traumatized teeth that were endodontically treated and reinforced with an esthetic post (e.g. polyethylene and glass fibers) (8). Feldspathic porcelain has many similar properties to natural enamel, and hybrid/microhybrid composites are much alike dentin in optical and mechanical behavior (7, 9). *Magne and Belser* state that posts and core composites should only be used when the remaining tooth structure does not allow for veneer crowns (7). Nevertheless, the use of porcelain in teenagers is controversial. Authors suggest it to be unwise because of possible modifications of the spatial arrangement of teeth in the dental arch and soft tissue maturation until adulthood (7, 10). However, in spite of this belief, Slavicek also accept that the fixed and final spatial arrangement of dental occlusion is achieved when the second molars erupt and intercuspate (11). From the occlusion point of view, the Class I sagittal dental relation (or the statistical approximation to it) seems to offer better stabilization to the dental arch (11). Using these principles, when a fracture is massive enough to damage most coronal structure (compromising pulp vitality) and dental occlusion is fully developed and locked in a *quasi*-sagittal Class I relationship, a porcelain crown placed over a composite core could be an interesting choice to treat complex fractures of anterior teeth.

Single anterior crowns are one of the most esthetic challenges in fixed prosthodontics (12, 13). Proper shade mapping, choice of ceramic system, and appropriate communication with the dental technician are combined factors for success (12, 13). This clinical treatment describes the restoration of two single anterior teeth – a central incisor and a lateral incisor from the opposite quadrant – in a teenager with state-of-the-art materials and techniques.

Case description

A 12-year-old girl suffered a bumper car accident 7 days prior to her first visit. The patient had been taken to a public hospital for an emergency consult 4 h after the accident. At the hospital, a splint from the left central incisor to left canine was made with a resin composite (Fig. 1a,b,c). A pulpectomy was performed on the right central and left lateral incisors. The patient was instructed to maintain meticulous oral hygiene and remain on a soft diet and to consult a dentist. The prescribed medication by the doctor at the hospital was ibuprofen of 400 mg twice a day for 3 days.

The patient came to the office 7 (seven) days after the accident (Fig. 2) Clinical examination revealed the following:

1 absence of any apparent trauma of the soft tissues;
2 right central and left lateral incisors had sustained a complicated crown fracture:
  (i) tooth 8 – an oblique fracture with more than 2/3 of coronal tooth loss and
  (ii) tooth 10 – a horizontal fracture extending subgingivaly on the palatal side with loss of the coronal fragment;
3 the left central incisor had second-degree mobility;
4 spontaneous pain in the area for the first 2 days; and

Fig. 1. Intra oral view of the initial case.

Fig. 2. Extra oral view of the initial case.

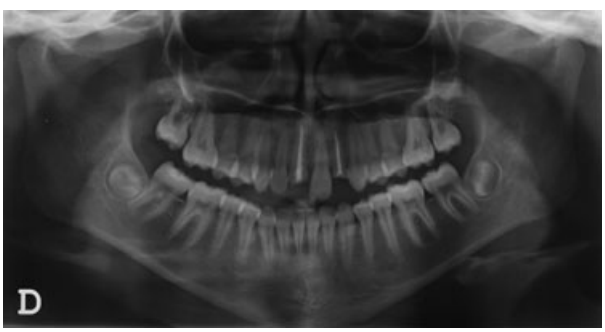

Fig. 3. Panoramic X-ray.

5 no pain whatsoever at the 7th day (first dental visit)

Periapical radiographs revealed closed apices and no root or bone fracture.

It was decided to endodontically treat teeth 8 and 10, which was made in two sessions with gutta-percha cones (Kerr Co., Romulus, MI, USA) step-back technique with lateral and vertical condensation (AH Plus ®; Dentsply De Trey, Konstanz, Germany). In between consults, the patient used a removable provisional with supraocclusal structure in acrylic covering the fractured teeth remnants. This appliance was fabricated in the first visit.

Two weeks later, another X-ray was taken to evaluate the periapical response to endodontic treatment (Fig. 3). Afterward, gutta-percha was removed with a reamer (Peso Reamer; Dentsply-Maillefer, Ballaigues, Switzerland). The post space was then enlarged with a post drill (ParaPost®; Fiber Lux, Coltène Whaledent). The post length was 9 mm for tooth number 8 and 7 mm for tooth number 10.

An impression was made with putty and light silicone base impression material (Aquasil™; Dentsply De Trey) and send to the laboratory (Fig. 4a), which fabricated two fiber reinforced indirect core resin (Adoro®, Ivoclar Vivadent, Schaan, Liechtenstein) posts (ParaPost®; Fiber Lux), via a die injection technique (Fig. 4b,c). The posts were luted with a dual-cure resin cement system (NX3®; Kerr Co.) in accordance with the manufacturer's adhesive procedures (Fig. 5).

In the same appointment, the teeth were prepared and provisional crowns (Enamel plus TEMP, Micerium SpA, Italy) were made and cemented with Temp Bond Clear (Kerr Co.,). The provisional (Fig. 6) was characterized with stains and a glazing resin (Enamel plus HFO, Micerium SpA). An impression was made with a silicone base impression (Aquasil™; Soft Dentsply De Trey) and poured in type IV dental stone (Fugirock, GC Europe, Belgium) for the dentist and technician to evaluate whether the preparations were suitable for the definitive restoration. The laboratory then made a resin index (Duralay™; Reliance Dental Mfg Co, Worth, IL, USA) to guide the appropriate reduction in the preparation height (Fig. 7). The purpose of the reduction was to

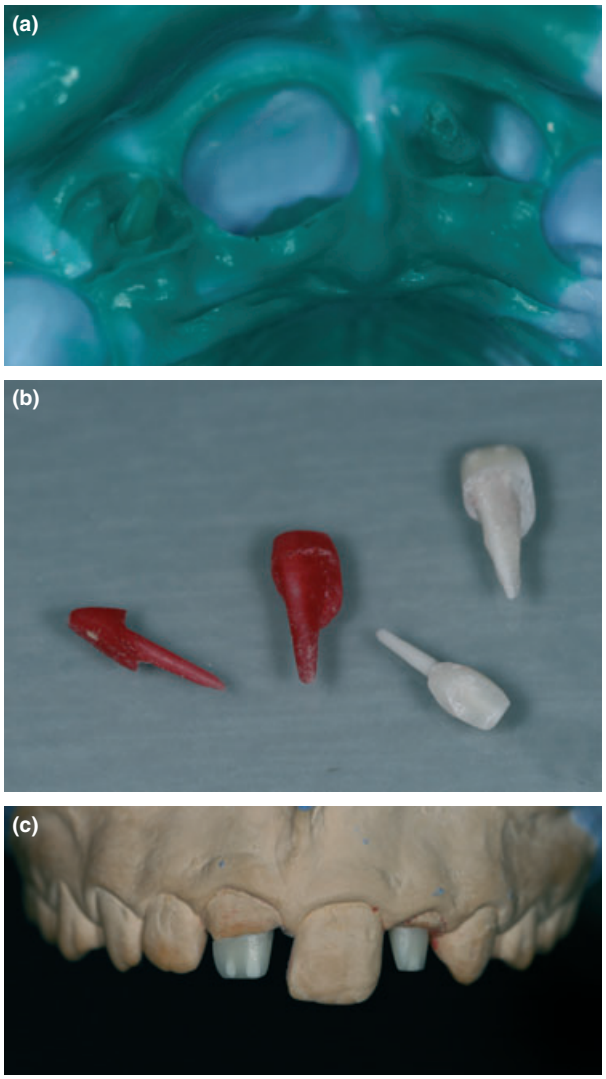

Fig. 4. (a) Polivinylsiloxane impression detail; (b) indirect aesthetic posts finished; (c) cast model with posts.

Fig. 5. Posts cemented and initial tooth reduction.

enhance optical effects of the ceramics in the incisal region.

At this time, new pulp vitality tests were performed to tooth number 9. Vitality was positive, and mobility was similar to the other teeth (physiological). It was then decided that endodontic treatment on this tooth was inappropriate.

Fig. 6. Provisionals *in situ*.

Fig. 7. Preparation reduction for optimal space for porcelain stratification.

A new impression was made 6 months after the tooth preparation with a vinyl polysiloxane material (Aquasil™; Soft Dentsply De Trey) – Soft Putty and Light in a double-mix impression. In this waiting period, we were able to account for soft tissue healing and observe stabilization of the gingival margin. Two all-ceramic crowns where then fabricated via an injection technique (IPS Empress Aesthetic; Ivoclar-Vivaden; Fig. 8a,b). After injection, the crowns were then cut back to dentin and layered for better mimic of the adjacent teeth. Mamelon building and incisal features were carefully stratified to achieve the esthetic goal of the case. The crowns were then sent to the clinic for try-in (Fig. 9). Esthetics and adaptation were evaluated, and with the patient and parents agreement, we proceeded to finishing the crown. The crowns were tested with a try-in agent (NX3; Kerr Co.)] for better esthetic outcome with three types of color: white, clear, and opaque. After choosing the best color for the cement, excess material was washed away with air–water spray.

The intaglio surface of the ceramic restorations was etched with hydrofluoric acid (10%) (Fig. 10) for 60 s (Porcelain Etch; Ultradent Product, Inc. South Jordan, UT, USA). Orthophosphoric acid (37%) (Ultradent Product, Inc) was applied to the prepared surfaces for 15 s and then air–water spray washed away. Excess water was removed with a small hydrophilic cotton ball. A thin layer of adhesive (Prime and Bond NT; Dentsply

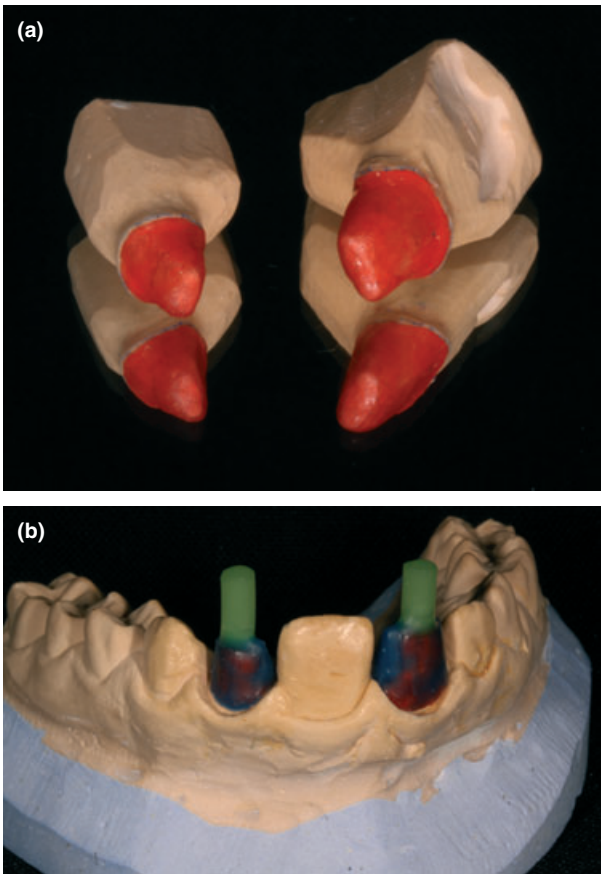

Fig. 8. (a) Copings ready for wax pattern; (b) Waxed copings ready for ceramic injection.

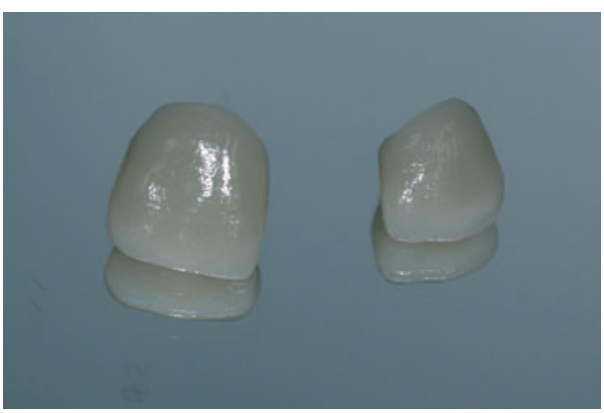

Fig. 9. Porcelain crowns ready for try in appointment (IPS Empress Aesthetic, Ivoclar Vivadent).

De Trey) was then applied to the whole surface of the preparation with a small probe, without any scrubbing. Light polymerization was then performed for 10 s. At this point, transparent glycerin jelly was then applied to the preparations and photo-activation was applied for another 10 s to polymerize the oxygen-inhibited layer of the adhesive. Excess glycerin was removed with a cotton

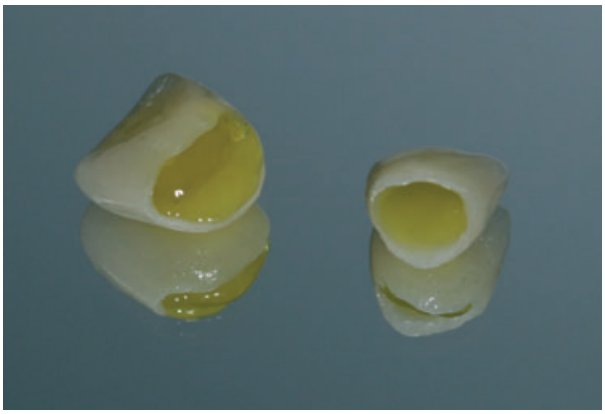

Fig. 10. Crown etching with hidrofluoridric acid 10% (60 s).

Fig. 11. Preparations after adhesive procedures.

Fig. 12. Porcelain crowns *in situ* 6 months after definitive cementation. Notice the stability of the soft tissue around the restaurations (Ceramic work made by Mr. Claudio Silva, Porto de Mós, Portugal).

ball soaped in an ethanol-based solution (Alcoól etílico 96% vol. Continente, Portugal). The preparations were then air-dried (Fig. 11).

A dual-cure resin luting agent (NX3®; Kerr Co.,) was mixed and applied to the crown restorations. The crowns were then seated, and the excess cement was removed after tack light polymerization of each surface for 3 s. Further polymerization was carried out for 60 s. The restorations have been in place for 1 year (Fig. 12). Extra-oral pictures presented in Fig. 13a,b,c show evolution of the patient esthetics from before the accident until the 1-year follow up.

Fig. 13. Extra-oral pictures presented (a) before the accident; (b) on week after the accident, beginning of the case; (c) until the 1-year follow up.

Case discussion

Crown fracture restorations localized in the superior incisor area need to be evaluated from several perspectives, including the topography, tissues involved, quality and the quantity of the remaining tooth structures, adaptation of the fragment to the dental remnant, and the patient's age (14).

When more than one tooth must be restored in growing patients, it is not advisable to link the two hemi arches by means of a fixed prosthesis to ensure the harmonic development of maxilla along the palatal suture (14).

According to the guideline on pediatric restorative dentistry of the American Academy of Pediatric Dental Council on Clinical Affairs, a complicated crown fracture can be defined as an enamel-dentin fracture with pulp exposure. This diagnosis combines clinical and radiographic findings that reveal a loss of tooth structure with pulp exposure (15). The treatment objectives are to maintain pulp vitality and restore normal esthetics and function (15). For permanent teeth, the pulpal treatment alternatives are direct pulp capping, partial pulpotomy, and pulpectomy (15). The prognosis of crown fractures appears to depend primarily upon a concomitant injury to the periodontal ligament (15). The age of the pulp exposure, extent of dentin exposed, and stage of root development at the time of injury may also affect the tooth's prognosis (15). Optimal treatment results follow timely assessment and care (15).

When the periodontal ligament is severely injured, the protective mechanism will no longer function and bone in-growth to the dental tissues may occur (16). Once the first bone bridge has been established, the dental root surface will be further invaded by cells from the bone side of the socket creating an ankylosis (16). As a consequence of this, the teeth will be remodeled in a similar way to bone remodeling (16).

It was with a surprise that the left central incisor maintain vitality. It is an uncommon event that a trauma to the central right incisor and left lateral incisor causes no apparent problem to the left central incisor. It can be speculated that the tooth suffered a subluxation as a result of the abnormal mobility that the tooth had. It is likely to develop tooth necrosis but at this time, there is no evidence of that.

According to Flores in young patients with immature, developing teeth, it is advantageous to preserve pulp vitality by pulp capping or partial pulpotomy (17). This treatment is also the choice in young patients with completely formed teeth (17).

In older patients, root canal treatment can be the treatment of choice, although pulp capping or partial pulpotomy may also be selected (17).

Metal–ceramic crowns have been widely used for restoring anterior teeth, and they have demonstrated excellent clinical results over time (18). However, the metal framework may become visible with time and can possibly produce unesthetic results, above all in young patients whose periodontal maturity has not yet been achieved (19).

Metal-free prosthetic materials are considered an alternative solution to the esthetic problems that may arise with metal–ceramic restorations. All-ceramic veneers guarantee color and translucency close to those of the natural tooth as well as fulfilling the need for adequate retention, while preserving maximum remaining tooth structure (20–24).

Restoring teeth with no remaining coronal structure can be costly, and the risk of failure is reportedly high (25, 26). It should be consider improving the success of these restorations. Sorensen and Engelman reported the importance of maintaining 'parallel walls of dentin coronal to the shoulder of the preparation' to increase the tooth's strength (27). They suggested that the 'ferrule effect' can be defined by a 360°- metal crown collar surrounding parallel walls of dentin and extending coronal to the shoulder of the preparation (27). Using this definition, Libman and Nicholls reported the need for a crown ferrule of at least 1.5 mm on maxillary central incisors to successfully endure the cyclic loading they used to simulate chewing (28, 29).

The purpose of the ferrule is to improve the structural integrity of the pulpless tooth by counteracting the functional lever forces, the wedging effect of tapered dowels, and the lateral forces exerted during insertion of the dowel (27, 30, 31).

It is Gegauff's opinion that there is a perception among fellow clinicians that placement of a ferrule unequivocally produces a stronger restorative result even when crown lengthening is required (28). Unfortunately, if the dentist prescribes crown lengthening, a number of significant disadvantages ensue (28). From the patient's perspective, these include treatment delay (especially for wound healing or orthodontic extrusion), discomfort, and the considerable added cost to an already expensive sequence of procedures (28). Biomechanically, the disadvantages include an increased crown/root ratio and loss of tooth structure that results from apical relocation of the preparation finish line (28). To counterbalance these disadvantages, crown lengthening for the sole purpose of providing a ferrule must offer a marked improvement in the treatment outcome (28).

According to the Guidelines on Pediatric Restorative Dentistry, full-cast metal crowns or porcelain-fused-to-metal crown restorations may be utilized in permanent teeth that are fully erupted, and the gingival margin is at the adult position for:

1 teeth having developmental defects, extensive carious or traumatic loss of structure, or endodontic treatment
2 as an abutment for fixed prostheses
3 for restoration of single-tooth implants (32)

The ability to biomimetically reproduce the union between synthetic dental materials and natural anatomic tooth structures is within the hand of clinicians and dental technicians (33). Re-creating the anatomical form and optical features of the intact tooth remains an arduous, challenging, and at times elusive task, both within the clinical and technical dental realms (34).

After 1 year of initial treatment, no endodontic complications were noted. Furthermore, the gingival margin was stable during the whole treatment time and the first 6 months. The parents were instructed to monitor the patient oral hygiene. Follow-up appointments are scheduled each 6 months. The patient and parents were satisfied with both esthetic result and stability of the restorations.

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