ECRONICON OPEN ACCESS

EC DENTAL SCIENCE
Case Report

Multidisciplinary Treatment Approach for Crown Fracture: 18 Years Follow Up

Renata Pereira[1]*, Tamires Pereira Dutra[2], Laura Nobre Ferraz[1], Débora Alves Nunes Leite Lima[1], Flávio H Baggio Aguiar[1] and Enílson A Sallum[2]

[1]Department of Restorative Dentistry, Division of Operative Dentistry, Piracicaba Dental School, University of Campinas (UNICAMP), Piracicaba, SP, Brazil

[2]Department of Prosthodontics and Periodontics, Division of Periodontics, Piracicaba Dental School, University of Campinas (UNICAMP), Piracicaba, SP, Brazil

***Corresponding Author:** Renata Pereira, Department of Restorative Dentistry, Division of Operative Dentistry, Piracicaba Dental School, University of Campinas (UNICAMP), Piracicaba, SP, Brazil.

Received: August 26, 2022; **Published:** September 26, 2022

Abstract

Rehabilitation of traumatized injured teeth is challenging for all clinicians. Several endodontic, periodontal and restorative approaches may be necessary to treat the effects of dental trauma. Regarding restorative procedures, fragment reattachment and direct composite restoration are considered the primary options of restorative treatment for crown fractures. However, they may present limited longevity. Ceramic crowns represent a long-lasting treatment option to restore these teeth, as they provide both mechanical resistance and esthetic. The purpose of this clinical report is to describe the eighteen years clinical follow up of a case showing a fractured, discolored and with pulpal exposure anterior tooth, previously submitted to periodontal flap surgery with ostectomy, endodontic treatment, fragment reattachment and composite restoration. A ceramic crown of zirconium covered by lithium disilicate was used to counteract the limited longevity of previous restorative procedures and re-establish esthetics and function, significantly influencing the patient's overall oral health, self-esteem and quality of life.

Keywords: *Tooth Fractures; Dental Esthetics; Longevity; Periodontium*

Introduction

Accidental trauma in daily life, such as street fights, contact sports and falls may lead to dental fractures, affecting mainly children and adolescents [1]. Approximately one-fourth of the population under the age of 18 years sustains traumatic injury in the form of anterior tooth fracture [2]. Of these, 80% are central incisors and 16% are lateral incisors [3]. The fractures can be classified as uncomplicated crown fracture, with no pulp exposure, or complicated crown-root fracture, with pulp involvement [4-7]. The latter one is relatively uncommon, constituting between 5% and 8% of all traumatic injuries [3,5,6].

The currently most conservative therapy of crown fractures is reattachment of the tooth fragment, which allows both the maintenance of anterior guidance, and obtainment of satisfactory esthetic results, keeping the tooth form and shade [8-10]. Also, due to the development of adhesive systems, the fragment reattachment with resin composite requests minimal or even no tooth wear, which may increase mechanical resistance, and thus masticatory function [8-12]. The treatment of a complicated crown-root fracture requires a multidisciplinary therapy due to the involvement of the crown, pulp and periodontal structures, when the fracture extension is located subgingivally. This therapy may consist in pulp capping, pulpotomy or pulpectomy, flap surgery with osteoplasty/ostectomy (when "biological width" invasion is present) procedures and reattachment of the fragment, when it is available [7,10].

Despite the fact that the treatment of a complicated crown-fracture is full of complex procedures, some case-reports have highlighted the stability of the tissues after treatment, revealing periodontal health and normal function following several months and years [13-18]. One may consider, however, that long-term clinical esthetic outcomes of fragment reattachment is questionable. Over time, the injured teeth may suffer discoloration and fragment detachment, for instance [19]. In this case, new clinical approaches should be considered to regain patient's oral health, self-esteem and quality of life.

All-ceramic restorations are considered an alternative solution to aesthetic deficiency that may arise with dental trauma, as they present characteristics, such as color stability, translucency, tooth-like optical properties, mechanical resistance, durability and compatibility with periodontal tissue. Thus, providing esthetics and longevity [20].

The purpose of this clinical report is to describe the eighteen years follow up of a young patient with a fractured tooth, initially treated by flap surgery with ostectomy, endodontic treatment, reattachment of tooth fragment combined to direct restoration with resin composites and now restored by a ceramic crown.

Case Report

In 2001, an 11-year-old girl was referred to the graduate clinic of the Piracicaba Dental School - State University of Campinas, 2 months after an accident that caused a fracture of her maxillary left central incisor (Figure 1). The medical history of the patient revealed no systemic disease.

Figure 1: *Fractured maxillary left central incisor.*

Although the tooth fragment was mobile, it was still in place. Intra-oral examination revealed that the fracture was located subgingivally on the palatal aspect of the tooth, with a probing depth of 5mm on the distal palatal site and bleeding on probing. Pulpal exposure was clinically and radiographically confirmed. However, radiographic exam could not clearly show the depth of the fracture, which was only observed after the fragment removal.

The patient's parents were informed about possible treatment options and a decision was made to treat this complicated subgingivally fractured permanent central incisor by periodontal flap procedure + ostectomy, endodontic treatment and reattachment of the tooth fragment combined to direct restoration with resin composites (Z-100 - 3M Oral Care, St. Paul, MN, USA; Charisma - Kulzer, Tokyo, Japan; and Durafil Kulzer), as described in the previously published case-report [18].

The patient was incorporated in a regular supervised maintenance care for six months and intra-oral and radiographic examinations revealed a stable reattachment of the fragment, good esthetics, and periodontal health, with no bleeding on probing or periodontal pocket (Figure 2).

Figure 2: *Buccal view 6 months after first treatment.*

The maintenance care could not continue because the child's family moved to another location and the contact was lost. Eighteen years later, the patient came back to the graduate clinic of Piracicaba Dental School - UNICAMP, looking for a better esthetic solution for the tooth that was described before. When asked about the clinical history of the tooth, the patient revealed that during the time she was away, the fragment had been detached and restorations were performed and replaced a few times, because of unfavorable esthetic. In addition, orthodontic treatment was performed.

Clinical examination revealed an unsatisfactory discolored composite veneer on left maxillary central incisor. Shape and volume of composite restoration were inadequate, as well as polishing and texture in general. Moreover, the tooth was slightly brownish and distally tipped, turning the smile disharmonious (Figure 3). Overall, endodontic and periodontal condition was stable; no periapical defects, no deep probing depth and no bleeding on probing were noticed. During clinical examination, a single caries was found on cervical margin of right maxillary central incisor. The radiographic exams revealed that a glass fiber post was cemented on the root canal, probably in order to ensure higher retention and support to the restorative material (Figure 4).

Figure 3: *Buccal view (above) and aspect of smile (below) 18 years after first treatment.*

Figure 4: *Radiograph taken 18 years after first treatment.*

Treatment options were presented to the patient and potential risks and complications of each choice were discussed. Considering the high esthetic result demanded by the patient and all previous treatment already performed, the selected treatment included dental bleaching, direct composite restoration of right maxillary central incisor and ceramic crown on left maxillary central incisor.

After professional prophylaxis and provisional restoration of right maxillary central incisor with resin-modified glass ionomer (Vitremer, 3M Oral Care), maxillary and mandibular alginate impressions (Hydrogum, Zhermack, Badia Polesine, RO, Italy) were taken for construction of study cast models and fabrication of diagnostic wax-up of left maxillary central incisor. Three condensation silicone impressions (Zetaplus, Zhermack, Badia Polesine, RO, Italy) were taken from diagnostic wax-up for posterior use: the former and second, as guides for tooth preparation; and last, for confection of provisional restoration.

Cast models were used for fabrication of custom bleaching trays. The patient received appropriate guidelines and home bleaching was performed for 3 weeks with 10% carbamide peroxide (Opalescence PF, Ultradent Products, South Jordan, UT, USA).

Fifteen days after completion of home bleaching, the patient's teeth looked much lighter and the final restoration with resin composite (Filtek Z350 XT, 3M Oral Care) was performed on cervical margin of right maxillary central incisor (Figure 5).

Figure 5: *Buccal view after completion of home bleaching and final restoration of right maxillary central incisor.*

Preparation of left maxillary central incisor was performed initially through peripheral delimitation with #1016 spherical diamond bur (KG Sorensen, Cotia, SP, Brazil) at cervical margin, on facial and lingual surfaces. A cylinder, round-end #3146 diamond bur was then used to prepare tooth facial surface, taking into account axial inclinations - cervical, medium and incisal, reducing 2.0 mm of total facial surface. In this step, the use of previous mentioned silicone impression matrix was important to guide the amount of wear. Proximal margins were defined also with #3146 diamond bur, first protecting adjacent teeth with metal strip (TDV Dental, Pomerode, SC, Brazil) and wearing the proximal margin of left central incisor with #2200 diamond bur. The incisal edge was reduced for about 2 mm, from interoclusal distance, with round facial incisal line angles. Then, an ovoid #3168 diamond bur was used to prepare the lingual surface, considering its typical concavity. Finally, in order to obtain 6° expulsiveness, a tapered-cylinder round-end #4138 diamond bur was applied over proximal surfaces, and a #4137 diamond bur regularized the facial surface, begetting a round shoulder finishing line intrasulcular located. To finish the preparing a #0 retraction cord (Ultrapak, Ultradent Products) was inserted into gingival sulcus to expose all prepared surface area; all angles were rounded, and surfaces were finished and polished with extrafine diamond burs, aluminum oxide polishing discs (Sof-Lex contouring and polishing discs, 3M Oral Care), and abrasive silicone tips (Optimize, TDV Dental, Pomerode, SC, Brazil). Figure 6 presents the silicone matrix guide placed over the tooth, evidencing the total amount of wear, while figure 7 shows the final aspect of tooth prepared for ceramic crown. Herein, it is important to note the brownish shade of substrate, which led the wear amount of 2 mm.

Figure 6: *Silicone matrix guide placed over the tooth, evidencing the total amount of wear.*

Figure 7: *Final aspect of tooth prepared for ceramic crown.*

After preparing the tooth, provisional restoration was performed through resin composite application over acrylic resin (Refine Bright, Kota, Cotia, SP, Brazil). Silicone impression matrix obtained from diagnostic wax-up was filled with acrylic resin and positioned on the prepared tooth. After final polymerization, the outer layer of resin was removed with tungsten maxi-cut carbide burs (Edenta, Au/St. Gallen, Switzerland) and resin composite (Filtek Z350 XT, 3M Oral Care) was applied, begetting an aesthetically favorable provisional restoration. Provisional was finished and polished.

In the following session, prepared tooth was submitted to dual impression using polyvinyl siloxane material in light and heavy consistencies (Express XT, 3M Oral Care). Prior to impression, a #00 retraction cord and a #0 one were placed into gingival sulcus and were left for four minutes in order to properly retract gingival margin. The last cord was removed in the moment of inserting light consistency impression material.

Shade of ceramic crown was selected by practitioner under different light conditions. Photographs and impressions were sent to prosthetic technician for dental stone pouring, fabrication of removable dies, and manufacture of milled lithium disilicate-reinforced glass ceramic crown with IPS e.max CAD-ceramic system (Ivoclar Vivadent AG, Schaan, Liechtenstein) of LT B1 shade. The milled ceramic crown was finished through staining and glazing technique.

Once the crown was received from the technician, provisional restoration was carefully removed and teeth were cleaned with a soft rubber cup and pumice. Subsequently, teeth were relative isolated with cotton rolls, and ceramic crown was tried-in. Shape, marginal adaptation, proximal contacts, volume and shade of crown were evaluated. Although marginal adaptation, proximal contacts and volume were adequate, practitioner and patient did not approve the shade of crown, once it looked grayer than the adjacent teeth (Figure 8A). The crown was sent back to technician, who made the decision together with the practitioner to confect an yttrium-stabilized zirconium coping (IPS e.max ZirCAD, Ivoclar Vivadent AG) to better mask the discolored substrate. The zirconium coping was covered by stratified processing technique with lithium disilicate-reinforced glass ceramic (IPS e.max Ceram, Ivoclar Vivadent AG) and finished through staining and glazing technique.

The second crown was then tried-in, and shade, adaptation and size in general were evaluated. The evaluation showed that shade was not adequate again (Figure 8B). One more time, the crown was sent back to the prosthetic technician, who maintained the zirconium coping covered by lithium disilicate glass ceramic and changed the staining technique. For the third time, the ceramic crown was tried-in, but now the practitioner and patient approved it. Shape, marginal adaptation, proximal contacts, volume and shade were adequate (Figure 8C).

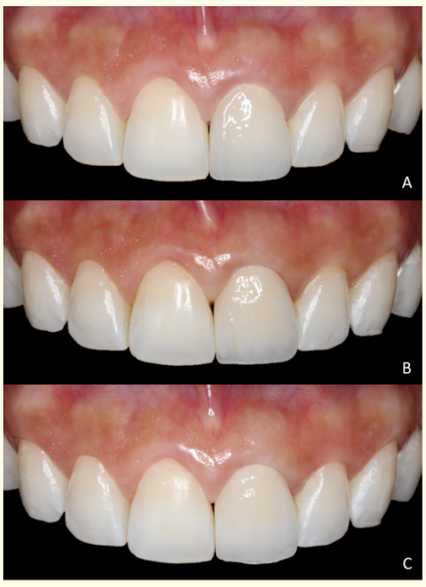

Figure 8: *Successive ceramic crowns try-in. A: milled lithium disilicate glass ceramic crown. B: zirconium coping covered by stratified processing technique with lithium disilicate glass ceramic. C: zirconium coping covered by stratified processing technique with lithium disilicate glass ceramic.*

Prior to luting procedure, every necessary proximal and occlusal adjustments were made. Operatory field was relative isolated with aid of a rubber lip and cheek retractor. Adjacent teeth were protected with polytetrafluorethylene-based tape (Isotape, TDV Dental), and a #00 retraction cord was placed into gingival sulcus of prepared tooth. Ceramic crown internal surface was previously sandblasted with aluminum oxide, rinsed with water spray, and air-dried. Subsequently, an acid primer-based adhesive (Single Bond Universal, 3M Oral Care) was applied for 20 seconds. Prepared tooth surface, in turn, was etched for 20 seconds with 35% phosphoric acid (Ultra-etch, Ultradent Products), rinsed and air-dried, keeping the dentin moist. Additionally, a layer of primer, followed by a layer of adhesive bonding agent (Adper Scotchbond Multi-Purpose, 3M Oral Care) was applied for 10 seconds uniformly, creating a thin coating. Both layers were gentle air-dried to allow solvent evaporation. Adhesive layer was light-cured by polywave light emitting diode curing unit (VALO, Ultradent Products) in Standard mode: 1000 mW/cm^2, for 10 seconds.

Ceramic crown was cemented using A1 shade of RelyX Ultimate dual cure adhesive resin cement (3M Oral Care) following manufacturer's instructions. Cement excesses were firstly light-cured for 5 seconds and were gently removed. Then, further 40 seconds of light-curing was performed on facial, lingual, incisal, mesial, and distal segments. The retraction cord was taken off from gingival sulcus and removal of cement excesses from proximal and cervical surfaces was performed using metal strip and scalpel blade. Rubber retractor was removed and restoration margins were polished with abrasive silicone tips (8090D Finishing and Polishing Kit, KG Sorensen).

After a week, the patient returned for clinical evaluation. Intra-oral and radiographic evaluation revealed satisfactory function and periodontal health (Figure 9 and 10). She was pleased with the result of cemented ceramic crown (Figure 11) and new smile obtained (Figure 12).

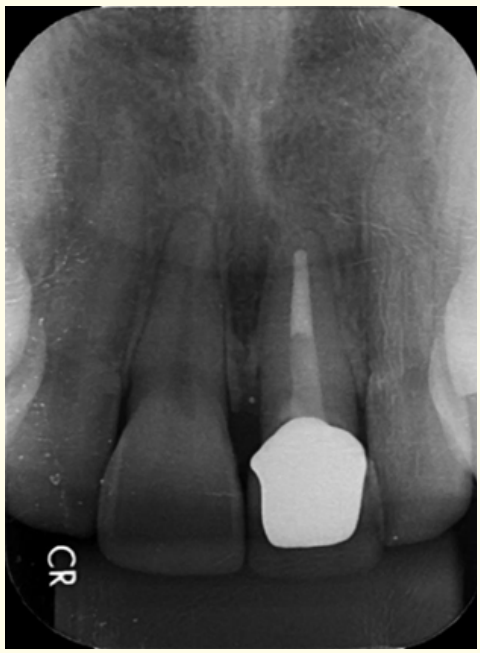

Figure 9: *Final radiograph.*

Figure 10: *Periodontal health, evidenced by periodontal probing.*

Figure 11: *Final buccal view (above) and lateral view (below).*

Figure 12: *Final aspect of smile.*

The list of materials used in this case report is presented in table 1.

Product	Material brand name (manufacturer)
Composite resin	Z100 (3M Oral Care, St. Paul, MN, USA)
Composite resin	Charisma (Kulzer, Tokyo, Japan)
Composite resin	Durafil (Kulzer, Tokyo, Japan)
Resin-modified glass ionomer	Vitremer (3M Oral Care, St. Paul, MN, USA)
Alginate	Hydrogum (Zhermack, Badia Polesine, RO, Italy)
Condensation silicone	Zetaplus (Zhermack, Badia Polesine, RO, Italy)
10% carbamide peroxide gel	Opalescence PF (Ultradent Products, South Jordan, UT, USA)
Composite resin	Filtek Z350 XT (3M Oral Care, St. Paul, MN, USA)
#1016, #3146, #2200, #3168, #4138, #4137 diamond burs	FG Diamond burs (KG Sorensen, Cotia, SP, Brazil)
0,05 mm x 7 mm metal strip	Metal matrix strip (TDV Dental, Pomerode, SC, Brazil)
Retraction cord	Ultrapak (Ultradent Products, South Jordan, UT, USA)
Aluminum oxide discs	Sof-Lex contouring and polishing discs (3M Oral Care, St. Paul, MN, USA)
Abrasive silicone tips	Optimize (TDV Dental, Pomerode, SC, Brazil)
Acrylic resin	Refine Bright (Kota, Cotia, SP, Brazil)
Maxi-cut burs	Tungsten carbide burs (Edenta, Au/St. Gallen, Switzerland)
Polyvinyl siloxane material	Express XT (3M Oral Care, St. Paul, MN, USA)
Ceramic system	Lithium disilicate-reinforced glass ceramic system - IPS e.max CAD - LT B1 shade (Ivoclar Vivadent AG, Schaan, Liechtenstein)
Zirconium coping	Yttrium-stabilized zirconium coping (IPS e.max ZirCAD, Ivoclar Vivadent AG, Schaan, Liechtenstein)
Ceramic system	Lithium disilicate-reinforced glass ceramic system - IPS e.max Ceram (Ivoclar Vivadent AG, Schaan, Liechtenstein)
Polytetrafluorethylene-based tape	IsoTape (TDV Dental, Pomerode, SC, Brazil)
Acid primer-based adhesive	Single Bond Universal (3M Oral Care, St. Paul, MN, USA)
35% phosphoric acid	Ultra-etch (Ultradent Products, South Jordan, UT, USA)
Adhesive system	Primer and Adhesive bonding agent Adper Scotchbond Multi-Purpose (3M Oral Care, St. Paul, MN, USA)
Polywave light emitting diode curing unit	Valo (Ultradent Products, South Jordan, UT, USA)
Dual-cure adhesive resin cement	RelyX Ultimate - A1 shade (3M Oral Care, St. Paul, MN, USA)
Abrasive silicone tips	8090D Finishing and Polishing Kit (KG Sorensen, Cotia, SP, Brazil)

Table 1: *Materials used and respective manufacturers.*

Discussion

Dental trauma may dramatically affect anterior teeth aesthetics and, therefore, the smile, which is important when considering appearance and attractiveness [21]. The present case report describes the eighteen-year clinical follow up of a complicated crown fracture

extending subgingivally on the palatal aspect of the tooth. At the time of the fracture, the patient was only eleven years old, contributing to the difficulty of the case. After discussing all possible treatments with the parents, a procedure of crown lengthening and fragment reattachment combined to composite restoration was performed. The limits of the fracture were exposed after raising a mucoperiosteal flap. It was observed that the fracture extended up to the bone crest. A conservative bone removal was performed on the palatal aspect to allow proper field isolation for endodontic treatment, fragment reattachment and direct restoration with resin composites [18]. The adhesive reattachment of the coronal fragment, besides representing a conservative restorative treatment, favored the reestablishing of function and esthetics [24]. The favorable periodontal results of the present case must not be interpreted as justification to underestimate the importance of respecting the "biological width". It is known that restoration margins within the zone of supracrestal tissue attachment may impair the periodontal health of restored teeth [25], increase epithelial apical migration and cause more bone resorption [26]. A systematic review discussed the observation that there is a significant intra- and inter-individual variability in the dimensions of the biologic width [22]. Therefore, a "fixed" biologic width dimension may not be defined for all sites, since the junctional epithelium and the supracrestal connective tissue attachment dimensions may vary considerably [23]. Moreover, in the present clinical case and previous studies, other factors like the level of plaque control, individual host response and the quality of the marginal adaptation of restoration could have contributed for a favorable periodontal response [22,23].

The longevity of the initial restorative procedure was limited, since the fragment had been detached and restorations were performed and replaced during the following years. It is known that a long and dry storage of fragment may impair the bond strength, as well as the esthetic outcomes of fragment reattachment procedures [24]. In the present clinical case, the tooth fragment was kept in place (i.e. moist), but the fracture had occurred 2 months before the restorative procedure. One may suggest that the extended period of fragment maintenance compromised the longevity of restorative treatment. Another point is that the durability of resin composites restorations may be questionable. Despite the fact that direct composite restorations allow a minimally invasive approach in restorative dentistry, this treatment modality may not be considered the most appropriate option in cases of great loss of tooth structure [27-29]. Restoration may not support the masticatory efforts, once bonding area is probably insufficient [30]. Additionally, resin composites remain susceptible to discoloration, wear and marginal fractures, thereby reducing their longevity [20,28,31].

All-ceramic restorations with their longevity, high survival rates and promising esthetic results represent a suitable alternative to direct composite restorations [24]. In the present clinical case, the great loss of tooth structure added to the presence of a glass fiber post in the root canal indicated the rehabilitation with a full crown. Albeit the literature is somehow controversial regarding the need of full coverage over endodontically treated teeth restored with fiber posts, previous studies suggested that the presence of full crowns is related to a higher durability of the restorative treatment [32]. Therefore, eighteen years after the patient's dental trauma, a zirconium coping covered by stratified processing technique with lithium disilicate-reinforced glass ceramic crown was confectioned. Among dental ceramics, zirconium presents superior performance, showing high biocompatibility, more than 1000 MPa of strength level and superior fracture toughness [33,34]. Additionally, one may consider that such ceramic is suitable to restore dark substrates, which was an interesting possibility in the present case [35]. However, one of zirconium's disadvantages is related to its lower translucency, which turns the final restoration into a gray-whitish shade [36]. Therefore, either zirconium should be colored through different techniques, such as dip coating, or a veneering layer of a compatible ceramic should cover it to achieve a more favorable esthetic result [33] as it was done in present clinical case. Here the zirconium coping was covered by stratified processing technique with lithium disilicate-reinforced glass ceramic. Nevertheless, the fact that such ceramic was used as a layer over the zirconium coping may represent an inconvenience. Previous studies reported that multilayered crowns may be less resistant than the monolithic ones [33]. Chipping and delamination of the veneering ceramic have been frequently reported. In the traditional stratified processing technique, once multiple layers of powder and liquid are applied to reestablish the dental anatomy, porosities, voids and other intrinsic defects may be incorporated, favoring the ceramic fracture [33,38]. It is worth noting, however, that several factors, such as type and thickness of ceramic veneer, as well as occlusion, may influence

the failures occurrence [39]. Thus, multilayered ceramic crowns are not simply doomed to failure. In fact, it was already observed a 100% survival rate of zirconium prostheses with layered or pressed veneering ceramics in three years [40].

In the present clinical case, the ceramic full crown of zirconium covered by lithium disilicate generated an extremely satisfactory esthetic result. Considering the patient's current issue, one may state that the treatment was in short-term well succeed. Herein, it is important to emphasize that long-term treatment follow-up is critical to early detection of any possible ceramic failures, as well as periodontal breakdown.

Conclusion

The multidisciplinary treatment approach combined with good plaque control by the patient allowed the restoration of the tooth with a ceramic crown under periodontal healthy conditions, 18 years after the initial treatment. Considering the patient's demand, the current treatment promoted highly satisfactory esthetic result with improved mechanical resistance, yielding the possibility of a long-lasting restoration and promoting quality of life.

Acknowledgments

Sincere thanks are due to Getúlio da Rocha Nogueira Filho, Luciana Machion Shaddox, Fabrício Batista Teixeira and Luiz André F. Pimentel, the authors of the first article, who provided a successful multidisciplinary treatment to this patient eighteen years ago.

Funding Support

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Conflict of Interest

The authors declares that there are no conflicts of interest regarding the publication of this paper.

Regulatory Statement

This study was conducted in accordance with all the provisions of the local human subjects' oversight committee guidelines and policies of the Research Ethics Committee of Piracicaba Dental School/UNICAMP.

Bibliography

1. Ellis E., *et al*. "Ten years of mandibular fractures: an analysis of 2137 cases". *Oral Surgery, Oral Medicine, and Oral Pathology* 59.2 (1985): 120-129.
2. Murchison DF., *et al*. "Incisal edge reattachment: indications for use and clinical technique". *British Dental Journal* 186.12 (1999): 614-619.
3. Andreasen JO and Ravn JJ. "Epidemiology of traumatic dental injury to primary and permanent teeth in a Danish population sample". *International Journal of Oral Surgery* 1.5 (1972): 235-239.
4. Andreasen JO and Andreasen FM. "Textbook and Color atlas of traumatic injuries to the teeth Blackwell Munksgaard Publisher". Copenhagen (1994).

5. Andreasen JO. "Traumatic injures of the teeth Saunders Publisher". Philadelphia (1981).

6. Wood EB and Freer TJ. "A survey of dental and oral trauma in south-east Queensland during 1998". *Australian Dental Journal* 47.7 (2002): 142-146.

7. Flores MT., *et al*. "Guidelines for the management of traumatic dental injuries. I. Fractures and luxations of permanent teeth". *Dental Traumatology* 23.2 (2007): 66-71.

8. Reis A., *et al*. "Reattachment of fractured teeth: a review of literature regarding techniques and materials". *Operative Dentistry* 29.2 (2004): 226-233.

9. Baratieri LN., *et al*. "Tooth fragment reattachment: an alternative for restoration of fractured anterior teeth". *Practical Periodontics and Aesthetic Dentistry* 10.1 (1998): 115-125.

10. Reis A and Loguercio AD. "Tooth fragment reattachment: current treatment concepts". *Practical Procedures and Aesthetic Dentistry* 16.10 (2004): 739-740.

11. Baratieri LN., *et al*. "Tooth fracture reattachment: case reports". *Quintessence International* 21.4 (1990): 261-270.

12. Baratieri LN., *et al*. "The ''sandwich'' technique as a base for reattachment of dental fragments". *Quintessence International* 22.2 (1991): 81-85.

13. Rajput A., *et al*. "Uncomplicated crown fracture, complicated crown-root fracture, and horizontal root fracture simultaneously treated in a patient during emergency visit: a case report". *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontics* 107.2 (2009): e48-e52.

14. Demarco FF., *et al*. "Reattachment using a fragment from an extracted tooth to treat complicated coronal fracture". *Dental Traumatology* 24.2 (2008): 257-261.

15. Eden E., *et al*. "Reattachment of subgingivally fractured central incisor with an open apex". *Dental Traumatology* 23.3 (2007): 184-189.

16. Ertugrul F., *et al*. "Multidiciplinary treatment of complicated subgingivally fractured permanent central incisors: two case reports". *Dental Traumatology* 24.6 (2008): e61-66.

17. Enshaei Z and Ghasemi M. "Multidisciplinary Management of Complicated Crown-Root Fracture: A Case Report". *Journal of Dentistry* 15.3 (2018): 193-196.

18. Nogueira Filho Gda R., *et al*. "Reattachment of an autogenous tooth fragment in a fracture with biologic width violation: a case report". *Quintessence International* 33.3 (2002): 181-184.

19. Mendes L., *et al*. "Ten-Year Follow-Up of a Fragment Reattachment to an Anterior Tooth: A Conservative Approach". *Case Reports in Dentistry* 1 (2017): 1-6.

20. Magne P. "Adhesion, biomaterials, and CAD/CAM International Dentistry". *African Edition* 8.6 (2019): 6-18.

21. Davis LG., *et al*. "Psychological effects of aesthetic dental treatment". *Journal of Dentistry* 26.7 (1998): 547-554.

22. Schmidt JC., *et al*. "Biologic width dimensions - a systematic review". *Journal of Clinical Periodontology* 40.5 (2013): 493-504.

23. Ercoli C and Caton JG. "Dental prostheses and tooth-related factors". *Journal of Periodontology* 89.S1 (2018): S223-S236.

24. Krastl G., *et al*. "Current aspects of restoring traumatically fractured teeth". *The European Journal of Esthetic Dentistry* 6.2 (2011): 124-141.

25. Gunay H., *et al*. "Placement of the preparation line and periodontal health-a prospective 2-year clinical study". *The International Journal of Periodontics and Restorative Dentistry* 20.2 (2000): 171-181.

26. Santamaria MP., *et al*. "Healing patterns after subgingival placement of a resin-modified glass-ionomer restoration: a histometric study in dogs". *The International Journal of Periodontics and Restorative Dentistry* 33.5 (2013): 679-687.

27. Lempel E., *et al*. "Direct resin composite restorations for fractured maxillary teeth and diastema closure: A 7 years retrospective evaluation of survival and influencing factors". *Dental Materials* 33.4 (2017): 467-476.

28. Rotoli B., *et al*. "Porcelain veneers as an alternative for esthetic treatment: Clinical report". *Operative Dentistry* 38.5 (2013): 459-466.

29. Spinas E. "Longevity of composite restorations of traumatically injured teeth". *American Journal of Dentistry* 17.6 (2004): 407-411.

30. Anchieta RB., *et al*. "Recovering the function and esthetics of fractured teeth using several restorative cosmetic approaches Three clinical cases". *Dental Traumatology* 28.2 (2012): 166-172.

31. Demarco FF., *et al*. "Should my composite restorations last forever? Why are they failing?" *Brazilian Oral Research* 31.1 (2017): 92-99.

32. Sorrentino R., *et al*. "Complications of endodontically treated teeth restored with fiber posts and single crowns or fixed dental prostheses-a systematic review". *Clinical Oral Investigations* 20.7 (2016): 1449-1457.

33. Silva LHD., *et al*. "Dental ceramics: a review of new materials and processing methods". *Brazilian Oral Research* 31.1 (2017): 133-146.

34. Zarone F., *et al*. "From porcelain-fused-to-metal to zirconia: clinical and experimental considerations". *Dental Materials* 27.1 (2011): 83-96.

35. Al Hamad KQ., *et al*. "The Effect of Ceramic Type and Background Color on Shade Reproducibility of All-Ceramic Restorations". *Journal of Prosthodontics* 27.9 (2018): 1-7.

36. Shahmiri R., *et al*. "Optical properties of zirconia ceramics for esthetic dental restorations: A systematic review". *The Journal of Prosthetic Dentistry* 119.1 (2018): 36-46.

37. Ivoclar Vivadent IPS e.max Lithium Disilicate (2019).

38. Sailer I., *et al*. "A systematic review of the survival and complication rates of all ceramic and metal-ceramic reconstructions after an observation period of at least 3 years. Part II: Fixed dental prostheses". *Clinical Oral Implants Research* 18.3 (2007): 86-96.

39. Silva Junior W., *et al*. "Multilayered and monolithic ceramic restorations: a literature review". *RFO UPF* 23.3 (2018): 353-360.

40. Naenni N., *et al*. "A randomized controlled clinical trial of 3-unit posterior zirconia-ceramic fixed dental prostheses (FDP) with layered or pressed veneering ceramics: 3-year results". *Journal of Dentistry* 43.11 (2015): 1365-1370.

Volume 21 Issue 10 October 2022