A Conservative Treatment Approach with Laser Therapy for Complicated Crown Root Fractures of Maxillary Anterior Teeth: A Report on Three Representative Cases of Pediatric Patients

Maksiller Anterior Dişlerde Meydana Gelen Komplike Kron Kök Kırıklarında Lazer Destekli Konservatif Tedavi Yaklaşımı: Çocuk Hastalarda Üç Representatif Olgu Raporu

Ülkü ŞERMET ELBAY,[a]
Mesut ELBAY,[a]
Sinem YILDIRIM,[a]
Emine KAYA,[a]
Önjen TAK[b]

Departments of
[a]Pediatric Dentistry,
[b]Prosthodontics,
Kocaeli University Faculty of Dentistry, Kocaeli

Geliş Tarihi/*Received:* 23.10.2014
Kabul Tarihi/*Accepted:* 19.02.2015

One case was presented at 20th Turkish Pedodonty Association Congress, 7-10 November 2013, Kayseri and second case was presented as a porters at 18th World Congress on Dental Traumatology, 19-21 June 2014, İstanbul

Yazışma Adresi/*Correspondence:*
Ülkü Şermet ELBAY
Kocaeli University Faculty of Dentistry, Department of Pediatric Dentistry, Kocaeli,
TÜRKİYE/TURKEY
ulkusermet_3@msn.com

ABSTRACT If a complicated crown fracture includes subgingival fractures, accessibility to the fracture line determines how conservative the treatment needs to be. Exposure of the fracture line with traditional methods of oral surgery using scalpels or electro surgery may produce significant postoperative discomfort and a prolonged healing time. In addition, soft tissue surgical procedures are often not suitable for children as problems with cooperation means that they cannot be performed without general anesthetic. Therefore, laser supported therapy is a suitable alternative in oral surgery of traumatic injuries in pediatric dentistry as it is needle-free, causes less discomfort, and tends to be accepted by young patients; thereby reducing unnecessary psychological trauma. This paper describes the management of three cases of complicated crown-root fractures that extended subgingivally and involved pulp exposure to the permanent maxillary incisors. A dental laser was utilized in exposing the fracture line. Fiber posts were also used to reinforce the teeth structures. At 1 year follow up, clinical and and radiographic findings of the cases were satisfactory.

Key Words: Laser therapy; tooth fractures; injuries

ÖZET Komplike kron kök kırıklarında kırık hattı subgingival alana uzandığında, kırık hattının ulaşılabilirliği tedavi seçeneğinin konservatif olup olmayacağını belirler. Kırık hattını bistüri kullanarak ya da elektro cerrahi gibi geleneksel yöntemlerle açığa çıkarmak, postoperatif rahatsızlık ve iyileşme süresinin uzamasına neden olabilmektedir. Ayrıca çocuklarda, yumuşak doku cerrahi işlemleri kooperasyon problemlerinden dolayı yapılamayabilmekte, genel anestezi gerektirebilmektedir. Bu yüzden çocuk hastalarda lazer destekli tedaviler; anestezi ihtiyacını ortadan kaldırması, hasta konforunu olumlu etkilemesi ve çocuklar tarafından daha rahat kabul edilmesi gibi avantajlarından dolayı travmatik yaralanmaların tedavisinde geleneksel cerrahi yöntemlere alternatif olabilmektedir. Bu makalede maksiller anterior dişlerde meydana gelen, subgingival alana uzanan ve pulpayı içine alan komplike kron kök kırığına ait üç olgu sunulmaktadır. Bu olgularda kırık hattını açığa çıkarabilmek için dental lazerden faydalanılırken, diş yapısını desteklemek için de fiber postlar kullanıldı. Bir yıl sonraki klinik ve radyografik bulgular tedavilerin başarılı olduğunu destekler nitelikteydi.

Anahtar Kelimeler: Lazer tedavisi; diş kırıkları; yaralanmalar

Turkiye Klinikleri J Dental Sci Cases 2015;1(1):27-35

Most cases of dental trauma involve the anterior region of the mouth and mainly affect the maxillary central incisors.[1] Traumatic injuries of anterior teeth in children create a psychological effect on the parents and the child, especially if the injury affects the permanent dentition and involve the loss of extensive tooth structure. Therefore, tooth injuries due to trauma necessitate immediate treatment.[2]

doi: 10.5336/dentalcase.2014-42170

Traumatic tooth injuries cause damage that ranges from minimal enamel loss to complex fractures involving the pulp tissue and even loss of the tooth crown.[3,4] Crown-root fractures make up a significant number of tooth injuries and usually result from horizontal impact, which involves enamel, dentin, and cementum; these fractures occur below the gingival margin and may be classified as complicated or uncomplicated, depending on whether pulp involvement is present or absent. While uncomplicated enamel and dentin fracture is the most common type of fracture, probability of a complicated crown-root fracture is less likely to occur.[5,6]

Several therapeutic procedures can be used to treat teeth with complicated crown root fractures depending on the level of fracture line and the amount of remaining root. In cases where the fracture involves a maximum of half the root, and the remaining root structure is long enough to support the subsequently applied restoration, the choice of treatment is surgical extrusion.[7] On the other hand, when the fracture involves a maximum coronal one-third of the root, treatment options for a subgingival or intraosseous fracture include orthodontic extrusions, osteotomy, intentional replantation, and surgical gingivectomy.[7-10]

Dental laser is another current treatment procedure. Although still a relatively new and modern piece of technology, the laser has found widespread use because of its advantages and benefits over conventional surgery on soft tissues.[11] One particular advantage of laser treatment is that there is little or no need for local anesthesia, and administering local anesthesia and managing pain are two of the most important elements of dentistry, particularly pediatric dentistry.[11] Other advantages include the fact that hemostasis during soft tissue treatment involves a more visible cut because the laser seals off lymphatic and blood vessels; reduced operator chair time and postoperative pain and swelling, which results in faster postoperative recuperation; reduced risk of postoperative infection because the laser sterilizes the tissue as it cuts; rapid wound healing with less post-operative discomfort; lower production of necrosis of adjacent tissues; and less need for prescription antibiotics.[11-14] As a result, recent advances have shown that laser treatment can be added as an alternative or complementary treatment to conventional methods.

Dental lasers have been used for numerous clinical soft tissue procedures including crown lengthening for aesthetic reasons, in restorative procedures with the presence of subgingival caries, gingival recontouring in periodontology procedures, and exposure of unerupted teeth in pedodontics.[11-15] It has also been reported that laser treatment is suitable in gingival surgery for the treatment of a traumatic dental injury. A limited number of studies report on dental lasers[12-13] being utilized in complicated crown-root fractures for the purpose of successfully exposing the fracture line of the tooth below the gingival attachment and the alveolar bone level.

A diode laser, with wavelengths ranging from 810–980 nm in a continuous or pulsed mode, was suggested as a possible modality for soft tissue surgery in the oral cavity.[16-18] Treatment of pediatric patients requires the application of minimal effective energy and power for procedures using the laser. However, there is no consensus in the various studies related to laser usage in pediatric dentistry.[11,17,19,20] For most minor intraoral surgical procedures, the recommended average power setting is in the range of 2–4 W with diode lasers.[18]

This paper describes the treatment of three cases of complicated crown-root fractures that extended subgingivally and involved pulp exposure to the permanent maxillary incisors that required endodontic treatment. Dental laser was utilized in exposing the fracture line and recontouring the gingival tissue to obtain clinical success.

CASE REPORTS

CASE 1

A 12-year-old male patient with a dental injury applied to the Pediatric Dentistry Clinic one year after an accident. Clinical and radiological examination showed a complicated crown-root fracture and a horizontal radicular fracture located in the middle-third of the upper right central incisor (Figure1a, Figure 2a). The tooth was found to be non-vital and

FIGURE 1: Radiography of maxillary incisors **a:** before treatment, **b:** after endodontic treatment, **c:** after a 1 year follow up

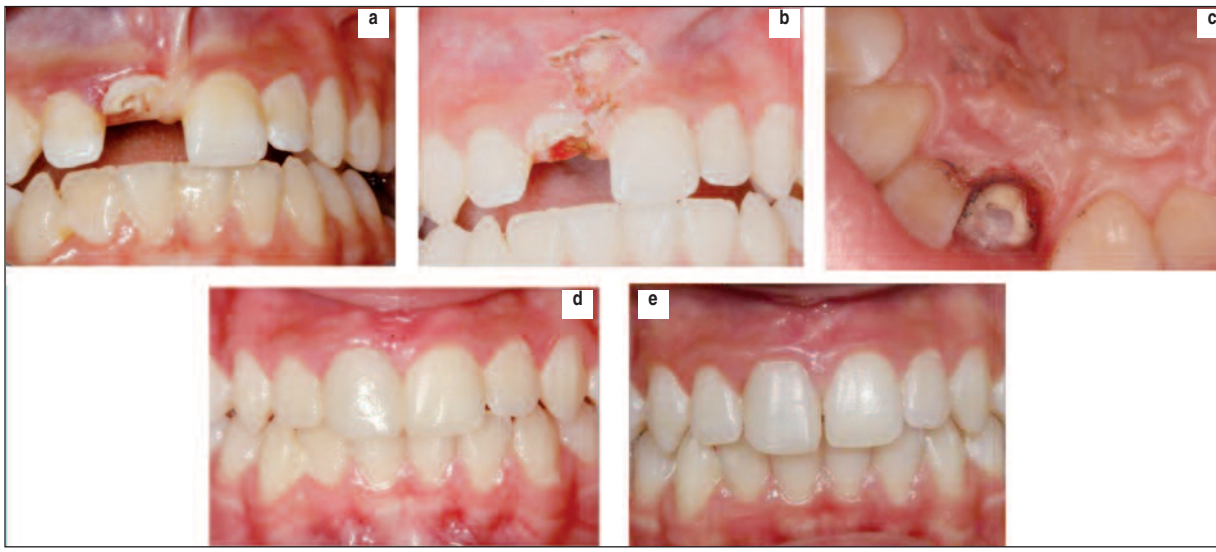

FIGURE 2: a: Intraoral view of the patient before treatment, **b, c:** After laser therapy, **d:** Restoration of the tooth with composite resin, **e:** İntraoral appearance after a 1 year follow up.

root canal treatment was planned. Written consent was obtained from the parents and patients before treatment. After accessing, instrumentation, and irrigation were correctly carried out, the root canal was dressed with calcium hydroxide paste (Metapaste, Meta Biomed, Korea) and changed once a month for six months. When the tooth became asymptomatic, the canal was filled with gutta-percha points (Figure 1b). Subsequent to endodontic treatment, aesthetic rehabilitation was started. The fracture line of the tooth was below the palatal gingival margin, which prevented the performance of a composite restoration. In order to expose the fracture line, an 810 nm AlGaAs diode laser (Cheese Laser Systems, China) with 400 micron fiber was used in contact mode at a 3-3.5 W output power with continuous and controlled movement to remove the palatal gingival margin (Figure 2b-c). Also the hypertrophic maxillary labial frenulum that invaded in to the anterior papilla was removed to prevent creating a diastema between the maxillary central incisors (Figure 2b). After the periodontal

tissue management, glass fiber post (Reforpost, Angelus, Brazil) was used to support the remaining tooth structure and the radicular fracture line in the middle-third of the tooth. Then the restoration was completed with composite resin (Majesty Esthetic, Kuraray, Japan) (Figure 2d). After a one year follow-up, the treated tooth was asymptomatic and presented satisfactory aesthetics. Periodontal parameters were stable, and no pain symptoms, color changes, mobility or per radicular pathology were observed on the restored teeth (Figures 1c, 2e).

CASE 2

An 11-year-old male patient with a dental injury applied to the Pediatric Dentistry Clinic one month after an accident. The clinical and radiographic examination indicated that the right maxillary central and lateral incisors had a complicated oblique crown-root fracture and the pulp was completely exposed (Figure 3a, Figure 4a). The crown fragments were mobile but still in place. Root canal treatment was planned for both incisors. Written consent was obtained from the parents and patient before treatment. The coronal fragments of the teeth were removed and endodontic treatments were performed with the chemical-mechanical preparation and calcium hydroxide paste (Metapaste, Meta Biomed, Korea) was placed in the root canals and changed once a month for three months. When the teeth became asymptomatic, the root canal treatment was completed (Figure 3b). Then laser assisted therapy was carried out to excise the gingival tissue overlying the gingival margins of the fracture line using gingivectomy technique with 810 nm diode laser (Cheese Laser Systems, China) (contact mode at a 3-3.5 W output power with continuous and controlled movement). The subgingival fracture lines were exposed (Figure 4b). After the soft tissue management, glass fiber post (Reforpost, Angelus, Brazil) was used to support the remaining tooth structures of the right maxillary central incisor. Then the maxillary right central and lateral incisors were restored with resin composite (Kuraray Majesty Esthetic, Japan) (Figure 4c). Oral hygiene instructions were given to the patient and his parents. Examination one year after treatment showed that the restorations were functionally acceptable and aesthetically pleasing. Periodontal tissues were healthy with no bleeding and no periodontal pocket (Figures 3c, 4d).

CASE 3

An 11-year-old male applied to the Pediatric Dentistry Clinic two hours after the trauma occurred. A

FIGURE 3: Radiography of maxillary incisors, **a:** Before endodontic treatment, **b:** After endodontic treatment, **c:** After a 1 year follow up.

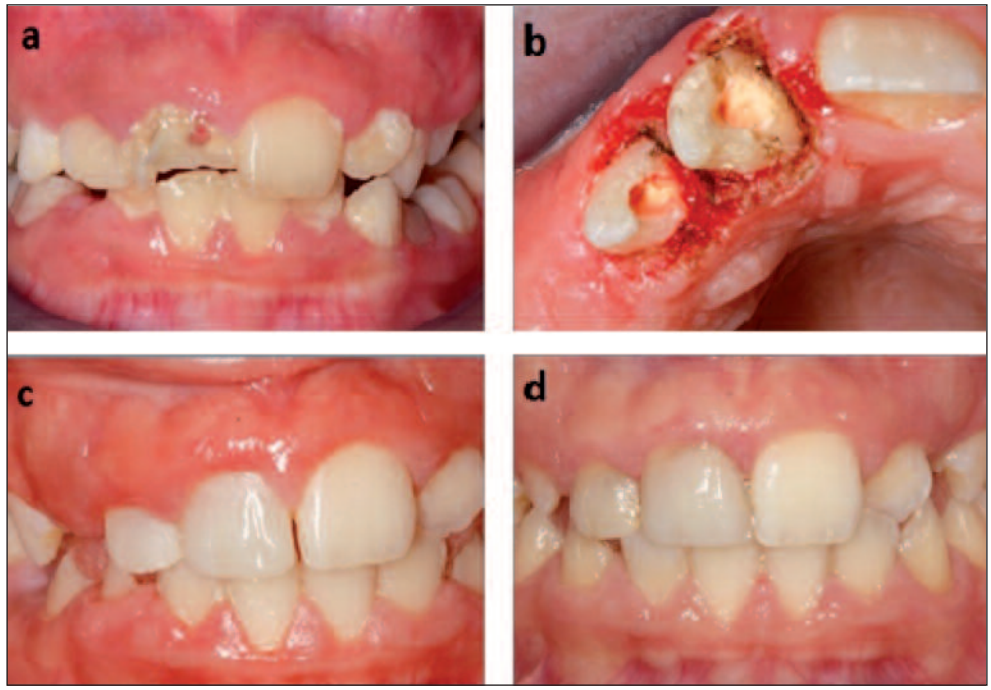

FIGURE 4: a: Intraoral view of the patient before treatment, **b:** After laser therapy, **c:** İntraoral view after composite restorations, **d:** İntraoral appearance after a 1 year follow up.

radiologic and clinical examination revealed a complicated crown-root fracture of the maxillary right central incisor and a complicated crown fracture of the left central incisor due to a previous trauma (Figures 5a, Figure 6a). The initial treatment plan comprised endodontic treatment. After written consent was obtained from the parents and patient, accessing, instrumentation, and irrigation were correctly carried out. Calcium hydroxide paste was applied (Metapaste, Meta Biomed, Korea) and was changed once a month for four months. At the end of this period, root canal therapy was completed (Figure 5b). To perform aesthetic rehabilitation with composite resin restoration, the palatal gingi-

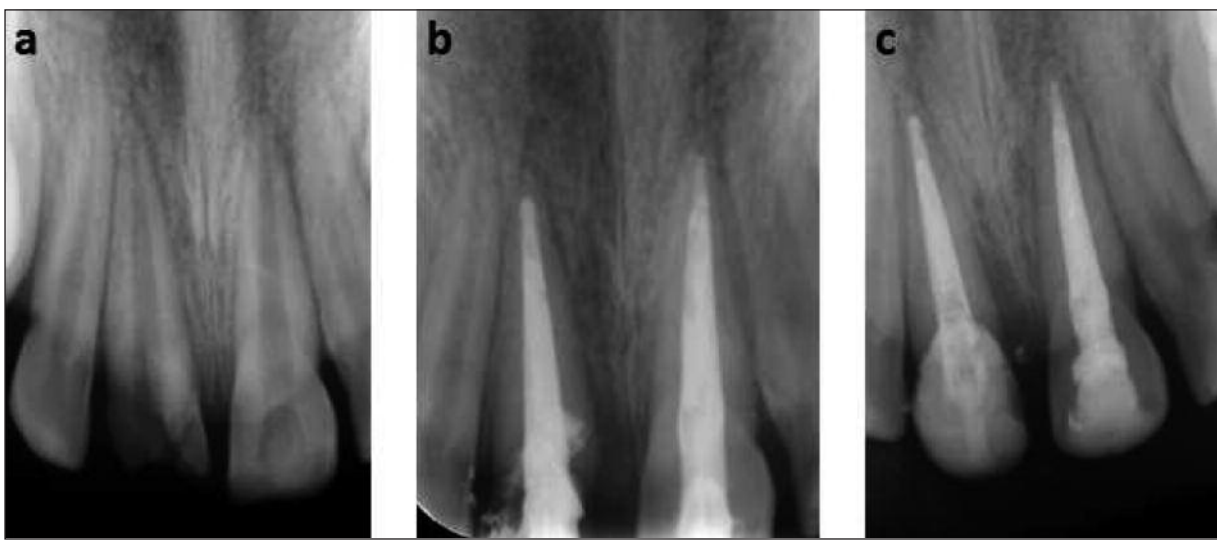

FIGURE 5: Radiography of maxillary incisors **a:** before treatment, **b:** after endodontic treatment, **c:** after a 1 year follow up.

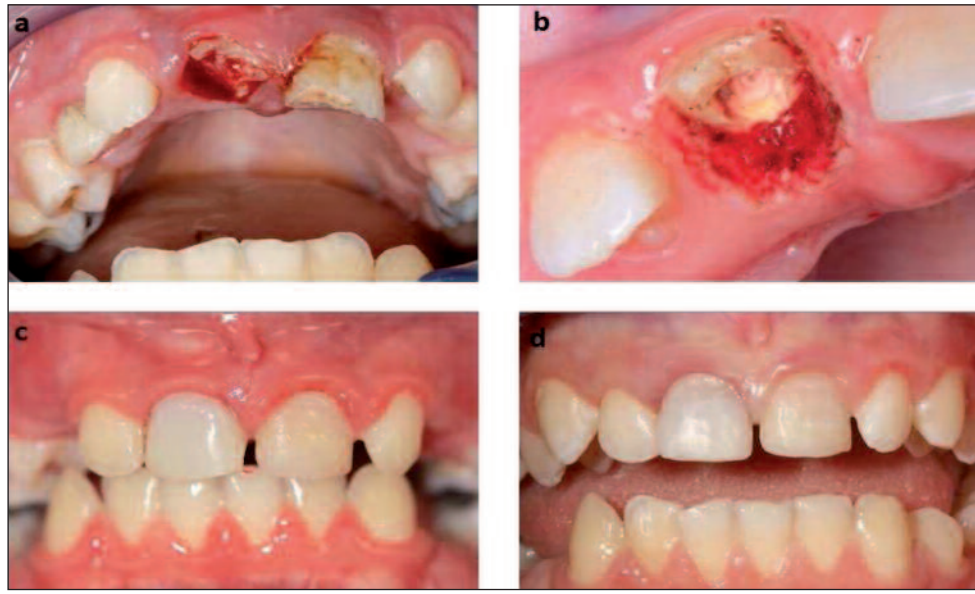

FIGURE 6: **a:** Intraoral view of the patient before treatment, **b:** After laser therapy **c:** İntraoral view after composite restorations, **d:** İntraoral appearance after a 1 year follow up.

val margin of the right maxillary incisor was recontoured with 810 nm diode laser (Cheese Laser Systems, China) (contact mode at a 3-3.5 W output power with continuous and controlled movement) and the fracture line was exposed (Figure 6b). During the same visit, the glass fiber post (Reforpost, Angelus, Brazil) was used to support the fractured tooth. Then the restoration was completed with composite resin (Figure 6c). In the one-year follow-up visit, all periodontal parameters were stable and the tooth was aesthetically and functionally successful (Figures 5c, 6d).

DISCUSSION

There are several treatment strategies for aesthetic and functional rehabilitation in the case of complicated crown-root fracture.[8-10] The treatment strategies are complex and depend on the fracture line's position and the amount of remaining root structure.[21]

In cases where the fracture line extends along the long axis of the root, extraction of the tooth is indicated. If the fracture involves the coronal third of the root, and the remaining root structure is long enough to support the subsequently applied restoration, only the fractured portion is extracted and root canal therapy is performed for aesthetic restorations.[22] In cases of subgingival fracture, surgical or orthodontic extrusion of the root is chosen to convert the subgingival fracture to a supragingival one, to allow for the restoration of the fracture with aesthetic rehabilitations.[23] Shin et al. reported on the use of orthodontic extrusion as the first treatment modality in their cases.[24] However, they found a non-response to orthodontic forces for six weeks as well as changes in the percussion sound in the aftermath of the treatment and this led to a clinical diagnosis of ankylosed. Therefore, in their case, satisfactory results were not achieved by orthodontic extrusion and a change in modality was imperative. Besides these complications, a major limitation of orthodontic extrusion is that the procedure requires multiple visits and excellent cooperation of the patient as it is expensive and involves a longer stabilization period. Kirzioglu and Karayılmaz reported on the use of surgical extrusion of the crown-root fractured immature permanent incisor in their cases.[25] Surgical extrusion only involves one step and is a less time consuming procedure than orthodontic extrusion. Nevertheless, there is a 12% risk of external root resorption.[4,26] Furthermore, bleeding during surgery, the necessity for anesthesia, and splinting the tooth present diffi-

culties in this treatment option, especially if the operation is being performed on a child.

Today dental lasers are used as an alternative method to those outlined above.[14] In the past, soft tissue surgical procedures were often rejected in children as problems with cooperation meant that they could not be performed without general anesthetic. Laser supported therapy is very useful in oral surgery in pediatric dentistry as it involves less discomfort and is well-accepted by young patients, it reduces psychological trauma and the laser produces a hemostatic effect that enhances the visibility of the surgical area, which is an advantage in children's small mouths.[15] Moreover, less anesthesia and analgesia is needed. Reduced chair time is another important advantage for pediatric dentistry. These are the most important factors when treating children. For these reasons, the diode laser was used in the three cases presented to expose the fracture line of the teeth below the gingival attachment and alveolar bone level. As there was no report of the treatment of complicated crown root fractures conducted with laser therapy, comparing the long-term results was not possible. While the soft tissue laser provides many advantages for the treatment of complicated crown root fractures, a major limitation of the application is that, when the fracture line extends intraosseously, it may be insufficient to expose the fracture line, and osteotomy may be required; for this purpose, hard tissue lasers or conventional surgery can be used.[27,28] In cases where the fracture line extends subgingivally, treatment can be completed only with a soft tissue laser, without any additional procedure.

Three types of lasers are particularly useful in the area of pediatric dentistry: diode and Nd:YAG lasers, and erbium lasers.[27] The hemostatic nature of the diode laser coupled with its ability to seal blood vessels is beneficial when hemostasis is one objective of the treatment.[28] In the presented cases, the main objective was to expose the fracture margin to a supragingival level so that composite restoration procedures could be carried out without contamination with blood. Therefore, the diode laser was used to expose the fracture line and obtain hemostasis.

As mentioned above, the recommended average power setting is in the range of 2–4 W for surgical procedures with diode lasers, though there is no consensus on power and energy in pediatric dentistry.[18] Given the wide range of variables involved, it is difficult to compare the laser parameters of previous studies and reports. Power density is only one aspect of the energy delivered to the target tissue. Wavelength, pulse duration, fiber diameter, type of tissue, pigmentation, blood circulation, applied dose, treatment time, and the experience of the operator are the other parameters that affect the results of the laser-tissue interaction.[16-20] On the other hand, it was reported that, while the power exceeds 4 W in cw–mode in diode lasers, it leads very quickly to carbonization, thermal damage, and necrosis of the tissue.[29,30] Decreasing the power may reduce these negative effects, but this can cause insufficient cutting ability of the laser, so doses (of 3-3.5 W) within the recommended range (of 2-4 W) were used, and the practitioner shortened the treatment time by acting as quickly as possible in order to reduce the total energy given to the target tissue. There were no side effects or postoperative discomfort reported by the patients.

The exposure of the pulp in a crown root fracture makes the treatment more difficult. Bacterial contamination of the pulp precludes the healing unless the exposure can be protected from further contaminations.[31,32] In the cases presented above, although all the teeth had suffered trauma with pulp exposure, the patients did not apply for treatment immediately after trauma (Case 1 and Case 2). In the treatment process, non-setting calcium hydroxide paste was used and appropriately replaced in the canals until the root canal infection was controlled, prior to obturation. The prolongation in the control of infection (six months in Case 1 and three months in Case 2) may be the result of late requests for treatment by the patients. Also, in Case 3, during the treatment process, although the temporary coronal restorative material was broken, the patient did not communicate with us;

this led to a prolonged treatment period (of four months).

In cases of complicated crown-root fractures, when endodontic therapy is performed, an intracanal post is advocated for supporting the aesthetic restoration.[33] An intracanal post increases the retention and distributes the stress along the root. Metallic and nonmetallic posts are available with different properties. Although cast or prefabricated metallic posts have long been widely used, some disadvantages and drawbacks have been identified and fiber posts have become increasingly popular.[34,35] Fiber posts have superior specialties including aesthetic appearance, the similar modulus of elasticity between fiber posts, dentin and resin cements, high tensile strength, good transparency, resistance to corrosion, and they can be removed easily.[36] In the above cases, fiber posts were used and preferred to metal posts.

For restoration of the coronal part, alternative treatment modalities of crown-root fractures are fragment reattachment, composite resin restoration, and full crown coverage, which is performed after a fracture line of the tooth is exposed.[3,37] Although fragment reattachment is a simple and fast method, this technique cannot be considered a durable procedure for the management of extensive fractures. In addition, the color of the fragment, if extracted, may change due to dehydration, leading to aesthetic problems. A further limitation of this procedure is that in some cases the fracture fragments may be lost during the trauma. On the other hand, the reconstruction of a fractured tooth with composite resin is a good alternative for young patients,[38] having the advantage of preserving the remaining root portion and providing an immediate resolution to the case, which is particularly important for patients that cannot afford prosthetic rehabilitation. Composite resin restorations were preferred to provide aesthetics in the above cases. In two of the cases the coronal fracture fragments were not present (Cases 1 and 3), and one of them had a coronal fracture fragment (Case 2) but because of the delayed application of the patient for treatment, the fracture line had changed and the loss of structure extended. Furthermore, the patient had poor oral hygiene so it was difficult to obtain a good prognosis for the teeth that the fracture fragments joined with resin cement.

In the cases outlined here, composite resin restorations with fiber posts after dental laser applications of subgingivally fractured teeth were found to be clinically and radiographically successful 12 months after treatment. There have been only limited reports on dental laser use in trauma cases to date, so further reports and long-term follow up studies are necessary before any concrete conclusions can be drawn.

REFERENCES

1. Glendor U, Marcenes W, Andreasen JO. Classification, epidemiology and etiology. In: Andreasen JO, Andreasen FM, Andersson L, eds. Textbook and Color Atlas of Traumatic Injuries to the Teeth. 4th ed. Oxford: Blackwell; 2007. p.217-54.
2. Elbay ÜŞ, Baysal A, Elbay M, Sarıdağ S. Multidisciplinary approach to delayed treatment of traumatic teeth injuires involving extrusive luxation, avulsion and crown fracture. Oper Dent 2014;39(6):566-71.
3. Kaya S, Ganidağlı Ayaz S, Uysal İ, Adıgüzel Ö. [Treatment of complex crown-root fracture and evaluation with cone beam computed tomography: two case reports]. Turkiye Klinikleri J Dental Sci 2013;19(1):65-70.
4. Caliskan MK, Türkün M, Gomel M. Surgical extrusion of crown-root-fractured teeth: a clinical review. Int Endod J 1999;32(2):146-51.
5. Turgut MD, Gönül N, Altay N. Multiple complicated crown-root fracture of a permanent incisor. Dent Traumatol 2004;20(5):288-92.
6. Fariniuk LF, Sousa MH, Westphalen VP, Carneiro E, Silva Neto UX, Roskamp L, et al. Evaluation of care of dentoalveolar trauma. J Appl Oral Sci 2010;18(4):343-5.
7. Alaçam A. [Traumatic Teeth Injuries and Their Treatments]. Alaçam T, editör. Endodonti. 2. Baskı. Ankara: Mimtaş Yayıncılık; 2012. p.1011-27.
8. Canoglu H, Gungor HC, Cehreli ZC. Management of cervical root fracture using orthodontic extrusion and crown reattachment: a case report. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2007;104(3):e46-9.
9. Eden E, Yanar SC, Sönmez S. Reattachment of subgingivally fractured central incisor with an open apex. Dent Traumatol 2007;23(3): 184-9.
10. Poi WR, Cardoso Lde C, de Castro JC, Cintra LT, Gulinelli JL, de Lazari JA. Multidisciplinary treatment approach for crown fracture and crown-root fracture – a case report. Dent Traumatol 2007;23(1):51-5.
11. American Academy of Pediatric Dentistry. Policy on the Use of Lasers for Pediatric Dental Patients. Oral Health Policies 2013;36(6):13-4.

12. Martens LC. Laser physics and a review of laser applications in dentistry for children. Eur Arch Paediatr Dent 2011;12(2):61-7.
13. Caprioglio C, Olivi G, Genovese MD. Lasers in dental traumatology and low level laser therapy. Eur Arch Paediatr Dent 2011;12(2):79-84.
14. Kotlow L. Lasers in pediatric dentistry. Dent Clin North Am 2004;48(4):889-922.
15. Boj JR, Poirier C, Hernandez M, Espasa E, Espanya A. Case series: laser treatments for soft tissue problems in children. Eur Arch Paediatr Dent 2011;12(2):113-7.
16. Azma E, Safavi N. Diode laser application in soft tissue oral surgery. J Lasers Med Sci 2013;4(4):206-11.
17. Olivi G, Genovese MD, Caprioglio C. Evidence-based dentistry on laser paediatric dentistry: review and outlook. Eur J Paediatr Dent 2009;10(1):29-40.
18. Pirnat S. Versatility of an 810 nm Diode Laser in Dentistry: An Overview. J Laser Health Academy 2007;4:1-9.
19. Şimşek M, Yıldız E. [Lasers in pediatric dentistry]. Gaziantep Med J 2014;20(2):113-9.
20. Boj JR, Poirier C, Hernandez M, Espassa E, Espanya A. Review: laser soft tissue treatments for paediatric dental patients. Eur Arch Paediatr Dent 2011;12(2):100-5.
21. Naudi AB, Fung DE. Tooth fragment reattachment in multiple complicated permanent incisor crown-root fractures: a report of two cases. Dent Traumatol 2008;24(2):248-52.
22. Fermandes AS, Dessai GS. Factors affecting the fracture resistance of post-core reconstructed teeth: a review. Int J Prosthodont 2001;14(4):355-63.
23. Krastl G, Filippi A, Zitzmann NU, Walter C, Weiger R. Current aspects of restoring traumatically fractured teeth. Eur J Esthet Dent 2011;6(2):124-41.
24. Shin JH, Kim JE, Kim RJ. Multidisciplinary approach in the management of a complicated crown root fracture. Eur Jo Paediatr Dent 2013;14(2):150-2.
25. Kirzioğlu Z, Karayilmaz H. Surgical extrusion of a crown-root fractured immature permanent incisor: 36 month follow-up. Dent Traumatol 2007;23(6):380-5.
26. Tegsjo U, Valerius-Olsson H, Frykholm A, Olgart K. Clinical evaluation of the intra-alveolar transplantation of teeth with cervical root fractures. Swed Dent J 1987;11(6):235-50.
27. Kotlow L. Lasers and pediatric dental care. Gen Dent 2008;56(7):618-27.
28. Kotlow L. Lasers and soft tissue treatments for the pediatric dental patient. Alpha Omegan 2008;101(3):140-51.
29. van Hillegersberg R. Fundamentals of laser surgery. Eur J Surg Jan 1997;163(1):3-12.
30. Reinisch L. Laser physics and tissue interaction. Otolaryngol Clin North Am 1996;29(6): 893-914.
31. Bakland LK. Endodontic considerations in dental trauma. In: Ingle JI, Bakland LK (eds). Endodontics. 5th ed. England: BC Decker Inc; 2002. p.795-844.
32. Bakland LK, Andreasen JO. Dental traumatology: essential diagnosis and treatment planning. Endod Topics 2004;7:14-34.
33. Pandurie V, Gabric D, Negovetie-Mandic V. Immediate post-traumatic upper incisor receonstruction using composite resin materials. Dent Traumatol 2008;24(1):108-11.
34. Piovesan EM, Demarco FF, Cenci MS, Pereira-Cenci T. Survival rates of endodontically treated teeth restored with fiber-reinforced custom posts and cores: a 97-month study. Int J Prosthodont 2007;20(6):633-9.
35. Fredriksson M, Astbäck J, Pamenius M, Arvidson K. A Retrospective study of 236 patients with teeth restored by carbon fiber-reinforced epoxy resin posts. J Prosth Dent 1998;80(2): 151-7.
36. Hou QQ, Gao YM, Sun L. Influence of fiber posts on the fracture resistance of endodontically treated premolars with different dental defects. Int J Oral Sci 2013;5(3):167-71.
37. Wang J, Li M. Multidisciplinary treatment of a complicated crown-root fracture. Pediatric dentistry 2010;32(3): 250-4.
38. Roeters J, Bressers JP. The combination of a surgical and adhesive restorative approach to treat a deep crown-root fracture: a case report. Quintessence Int 2002;33(3):174-9.