

Treatment of uncomplicated crown fractures of permanent central incisors with the help of digital dental technology – a case report

Krasimir Hristov

Department of Pediatric Dentistry, Faculty of Dental Medicine, Medical University, Sofia, Bulgaria

Abstract

Traumatic dental injuries remain a significant concern in paediatric dentistry, particularly when involving the permanent dentition. They result often in fractured permanent teeth, which present unique challenges in terms of aesthetics, function, and long-term prognosis. In recent years, the advent of digital technologies has profoundly influenced the diagnosis, treatment planning, and restoration of fractured permanent teeth in children. These technologies enable precise, minimally invasive, and patient-friendly restoration in case of traumatic dental injuries. This clinical case demonstrates successful treatment of uncomplicated crown fractures of maxillary central incisors in eight-year-old boy, using intraoral scanning, digital planning and 3D printing to create a precise replica of the palatal surface.

Keywords: traumatic injuries, uncomplicated crown fractures, digital technologies, 3D printing

Introduction

Traumatic dental injuries remain a significant concern in paediatric dentistry, particularly when involving the permanent dentition. Children are especially susceptible to tooth injuries because of accidental falls, sports activities, or other traumatic incidents [1]. Such events often result in fractured permanent teeth, which present unique challenges in terms of aesthetics, function, and long-term prognosis. In recent years, the advent of digital technologies has profoundly influenced the diagnosis, treatment planning, and restoration of fractured permanent teeth in children, offering clinicians' powerful tools to enhance clinical outcomes and the overall patient experience [2].

Dental injuries can range from simple enamel infractions to complex crown-root fractures. In the paediatric population, central incisors are the most commonly affected teeth, mainly due to their anterior positioning and early eruption in the oral cavity [1]. Prompt and effective management is essential to preserve natural dentition, promote oral health, and maintain the child's self-esteem [3]. Reattaching the broken fragment to the tooth is often the preferred treatment option [4]. Historically, restorative procedures relied heavily on manual impressions, traditional radiographs,

and direct restorative materials, which, while effective, had limitations concerning precision, patient comfort, and long-term durability [5].

The integration of digital technologies into dental practice has revolutionised the field, offering unprecedented precision, customisation, and predictability [6]. Key developments include the introduction of intraoral scanners, computer-aided design and computer-aided manufacturing (CAD/CAM) and 3D printing.

Intraoral scanners capture high-resolution, three-dimensional images of the dental arches, eliminating the need for traditional impression materials and reducing discomfort for young patients [7, 8]. They have significantly improved the process of taking dental impressions, which is often challenging in anxious or uncooperative children [9]. These scanners generate immediate, accurate 3D representations of the affected area, allowing for better visualisation and precise communication with the dental laboratory. The digital models can be stored, duplicated, and transferred instantly, reducing the risk of data loss or distortion [7, 8].

CAD/CAM software allows for the virtual design and precise fabrication of restorations such as crowns, veneers, and onlays [2]. Digital treatment planning software enables clinicians to simulate different restorative approaches virtually. The software can reconstruct the original tooth morphology based on the mirrored image of the contralateral, uninjured tooth. This digital mock-up ensures that the final restoration will mimic the child's natural dentition in both shape and function, thereby enhancing aesthetic outcomes and patient satisfaction [10].

3D Printing provides the ability to print custom dental models, surgical guides, and even provisional restorations and this has streamlined many clinical procedures [10, 11]. Custom models of the patient's dentition can be printed to aid in diagnostic wax-up, try-ins, or as educational tools for the child and their caregivers [12]. Provisional crowns, veneers, and splints can also be 3D printed quickly, providing immediate protection and improving oral function while definitive restorations are being fabricated [13].

The initial step in restoring a fractured permanent tooth involves accurate diagnosis and assessment of the injury's extent [1]. Digital radiography and CBCT have become invaluable, providing detailed images with reduced radiation exposure compared to conventional radiographs—an important consideration in paediatric care. These images help clinicians assess the pulp, root integrity, and surrounding bone, informing decisions about the need for endodontic intervention or other preparatory procedures [14].

The purpose of this paper is to present management of uncomplicated crown fractures of 8-year-old boy with the help of digital dental technologies.

Case report

An eight-year-old boy visited the dental office one day after fracturing both central maxillary incisors at school. Neurological symptoms as loss of consciousness, headache, nausea, vomiting, disorientation or amnesia were not reported. The child was systemically healthy and did not take any medications. The patient reported mild discomfort with sensitivity from cold stimuli. Extraoral examination revealed a bruise with slight swelling of the upper lip. Intraorally symmetrical oblique fractures of both central maxillary incisors were observed with no increased mobility or displacement. The surrounding gingival tissues appeared healthy without signs of trauma or

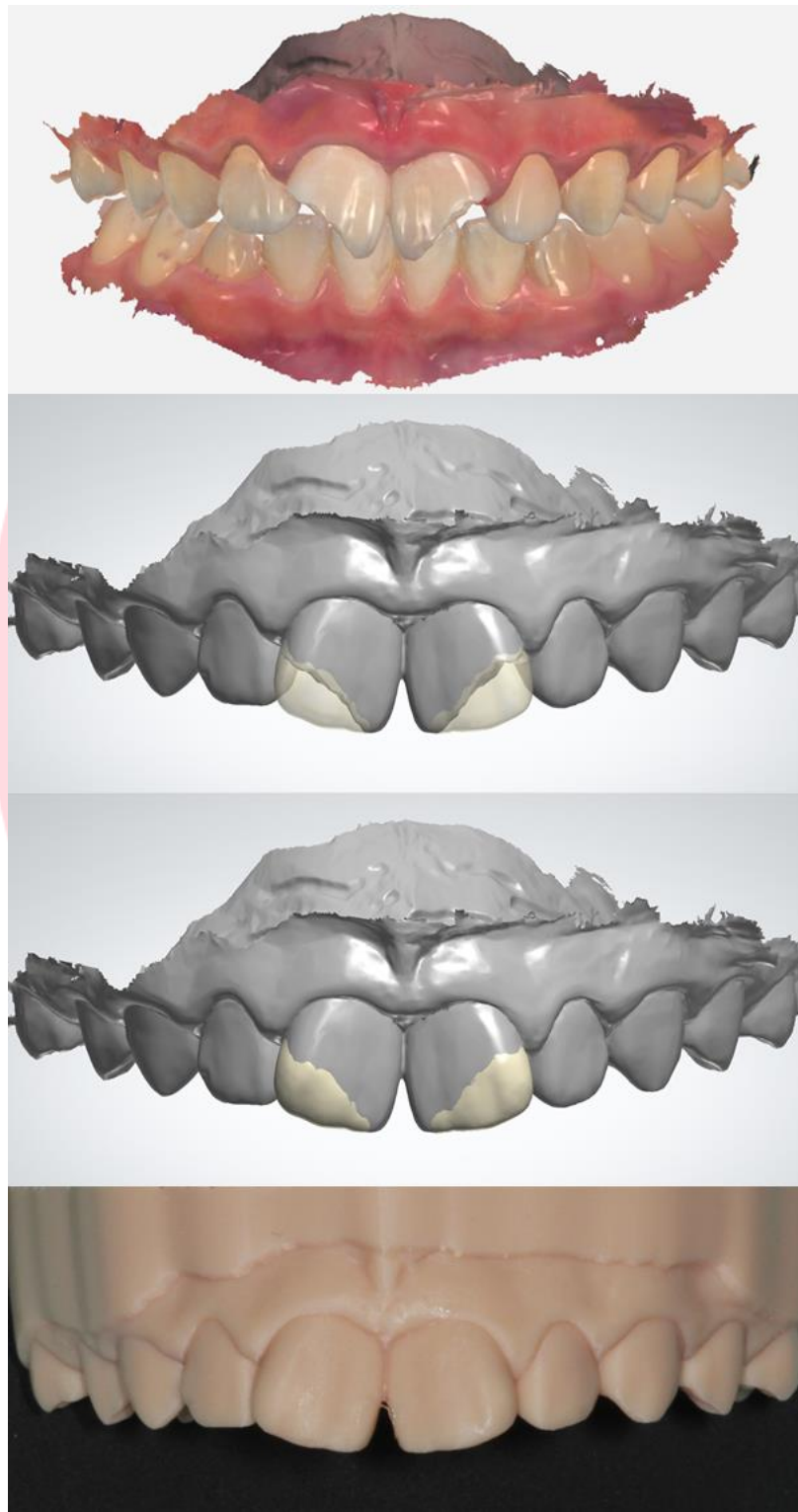


Figure 1. Initial status, reconstruction of missing tooth structures and printed 3D model.

inflammation. The teeth were tender on percussion with normal color of the crowns. No exposure of the pulp was observed and the teeth responded positively to vitality tests. Occlusion was assessed to identify any changes in bite or functional interference because of the injury.

Treatment plan: The soft tissues were cleaned with a sterile gauze, soaked in hydrogen peroxide. Digital intraoral scanning was performed, capturing detailed 3D representations of the fractured teeth and adjacent structures. The exposed dentin on each central incisor was covered with flowable composite (G-aenial Universal Flow, GC Corporation, Tokyo, Japan) after etching and bonding of the surface. The contacts with the opposing teeth were not restored at this stage. Digital impression was used to create a reconstruction of the missing tooth structures (Figure 1). It was later printed from resin material with a 3D printer. This model was used to create a silicone key corresponding to the palatal surface and incisal edge of the fractured teeth. This key served as a matrix for reconstructing the palatal surface of the damaged teeth. Restoration was performed three weeks following the traumatic event and involved standard adhesive and restorative protocol (Figure 2).



Figure 2. Covering the exposed dentin with composite in the first visit and final restoration after three weeks.

Discussion

The current paper presents treatment planning and management of uncomplicated crown fracture in maxillary central incisors using digital technologies. The implementation of digital tools in dentistry facilitates precise tooth preparation, preserving as much healthy structure as possible. This enables the procedures to be carried out in accordance with the principles of minimally invasive dentistry. Additionally, the elimination of traditional impression materials and reduction in chair time increase patient comfort and cooperation, thus enhancing the patient's experience [15]. This facilitates the management of anxiety and behaviour in young children, which is a significant factor in treatment of pediatric patients [16]. The accurate treatment planning and execution minimizes the risk of errors and makes providing predictable outcome and improved aesthetics [17]. These benefits of dental digital technologies were comprehensively applied in the presented clinical case.

Timely and appropriate treatment of traumatic injuries in pediatric patients is of utmost importance [18, 19]. The successful application of digital technologies in restoring fractured permanent teeth in children has been reported before [10, 20]. Nevertheless, there is lack of studies investigating the use of digital workflows and digital technologies in the diagnosis, treatment or management of dental conditions in paediatric dentistry [21]. Advances in artificial intelligence and machine learning are expected to further refine diagnostic accuracy and automate elements of the

restorative process [22]. The use of these technologies enables precise reconstruction of missing dental structures, even in cases where original tooth fragments are no longer available.

Despite the numerous benefits, certain challenges persist in the adoption of digital technologies for paediatric dental trauma management. This treatment approach is still not cost effective. The initial investment in digital equipment can be substantial, potentially limiting access in some clinical settings [23]. Additionally, the dental team must receive adequate training to maximize the benefits of digital workflows and avoid technical errors. While digital tools can enhance the experience, managing anxiety and behavior in young children remains a crucial clinical skill that can not be substituted by any technology [24].

Conclusion

Digital technologies are transforming the landscape of paediatric restorative dentistry, particularly in the management of fractured permanent teeth. By enhancing diagnostic capabilities, streamlining workflow, and improving the precision and aesthetics of restorations, these innovations are delivering measurable benefits for both clinicians and young patients. The results indicate that using digital dental technologies to restore uncomplicated fractures of permanent central maxillary incisors is a straightforward and reliable procedure with excellent clinical and aesthetic outcomes.

References

1. Tewari N, Bansal K, Mathur VP. Dental Trauma in Children: A Quick Overview on Management. *Indian J Pediatr* 2019;86(11):1043–1047.
2. Watanabe H, Fellows C, An H. Digital Technologies for Restorative Dentistry. *Dent Clin North Am* 2022;66(4):567–590.
3. Khan L. Dental Care and Trauma Management in Children and Adolescents. *Pediatr Ann* 2019;48(1):e3–e8.
4. Bogovska-Gigova R. Management of a Complicated Crown Fracture in a 16-Year-Old Patient: A Case Report. *Reports* 2025;8(3):132.
5. Beech N, Tan-Gore E, Bohreh K, et al. Management of dental trauma by general practitioners. *Aust Fam Physician* 2015;44(12):915–918.
6. van Noort R. The future of dental devices is digital. *Dent Mater* 2012;28(1):3–12.
7. Alkadi L. A Comprehensive Review of Factors That Influence the Accuracy of Intraoral Scanners. *Diagnostics (Basel)* 2023;13(21).
8. Schierz O, Hirsch C, Krey KF, et al. Digital dentistry and its impact on oral health-related quality of life. *J Evid Based Dent Pract* 2024;24(1s):101946.
9. Serrano-Velasco D, Martín-Vacas A, Paz-Cortés MM, et al. Intraoral scanners in children: evaluation of the patient perception, reliability and reproducibility, and chairside time-A systematic review. *Front Pediatr* 2023;11:1213072.
10. Bogovska-Gigova R. Treatment of uncomplicated fracture of a permanent central incisor – a case report. *Journal of Medical and Dental Practice* 2025;12(1):2028–2034.

11. Tian Y, Chen C, Xu X, et al. A Review of 3D Printing in Dentistry: Technologies, Affecting Factors, and Applications. *Scanning* 2021;2021:9950131.
12. Aktaş N, Ciftci V. Current applications of three-dimensional (3D) printing in pediatric dentistry: a literature review. *J Clin Pediatr Dent* 2024;48(5):4–13.
13. Balhaddad AA, Garcia IM, Mokeem L, et al. Three-dimensional (3D) printing in dental practice: Applications, areas of interest, and level of evidence. *Clin Oral Investig* 2023;27(6):2465–2481.
14. Patel S, Puri T, Mannocci F, et al. Diagnosis and Management of Traumatic Dental Injuries Using Intraoral Radiography and Cone-beam Computed Tomography: An In Vivo Investigation. *J Endod* 2021;47(6):914–923.
15. Khan MK. Modern Digital Pediatric Dentistry with the Advent of Intraoral Sensors, Computer-Aided Design/Computer-Aided Manufacturing, and Three-Dimensional Printing Technologies: A Comprehensive Review. *Journal of Dental Research and Review* 2022;9(3).
16. Christopoulou I, Kaklamanos EG, Makrygiannakis MA, et al. Patient-reported experiences and preferences with intraoral scanners: a systematic review. *Eur J Orthod* 2022;44(1):56–65.
17. Kihara H, Hatakeyama W, Komine F, et al. Accuracy and practicality of intraoral scanner in dentistry: A literature review. *J Prosthodont Res* 2020;64(2):109–113.
18. Bogovska-Gigova R. Conservative Management of Traumatic Intrusion and Crown Fracture in an Immature Permanent Incisor: A Pediatric Case Report. *International Journal of Science and Research (IJSR)* 2025;14(7):1695–1699.
19. Levin L, Day PF, Hicks L, et al. International Association of Dental Traumatology guidelines for the management of traumatic dental injuries: General introduction. *Dent Traumatol* 2020;36(4):309–313.
20. Yang B, Li X, Li Y, et al. Application of virtual technology to maximize esthetics and function in the restoration of anterior traumatic dental injuries. *J Prosthet Dent* 2023.
21. Garcovich D, Lipani E, Aiuto R, et al. Application of digital workflow and technologies in clinical paediatric dentistry: a scoping review. *Eur Arch Paediatr Dent* 2024;25(5):731–766.
22. Bonny T, Al Nassan W, Obaideen K, et al. Contemporary Role and Applications of Artificial Intelligence in Dentistry. *F1000Res* 2023;12:1179.
23. Suese K. Progress in digital dentistry: The practical use of intraoral scanners. *Dent Mater J* 2020;39(1):52–56.
24. Gizani S, Seremidi K, Katsouli K, et al. Basic behavioral management techniques in pediatric dentistry: A systematic review and meta-analysis. *J Dent* 2022;126:104303.

Corresponding author:

Krasimir Hristov
Medical University – Sofia, Faculty of Dental Medicine
Department of Pediatric Dentistry,
St. George Sofiyski Str., 1431 Sofia.
E-mail: k.christov@fdm.mu-sofia.bg

Hristov Kr, Treatment of uncomplicated crown fractures of permanent central incisors with the help of digital dental technology – a case report, *J. Med. Dent. Pract*, 2025; 12(3):2176-2181.