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Case Report

Minimally invasive approach supported by the use of mouthguard in the treatment of sport-related root fracture: a case report

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Abstract: All sporting activities have an associated risk of orofacial injuries that can affect the oral health-related quality of life (OHRQoL). A custom-made mouthguard can be used as an adjuvant treatment for faster recovery of an athlete to resume sporting activities. This case report described a minimally invasive approach by use of mouthguard for treating sport-related root fracture and its impact on OHRQoL. In a dental trauma care program, the patient was treated by repositioning the coronary portion and the confection of a splint. It was opted to not realize the endodontic treatment and the patient was inserted in a rigorous clinical and radiographic follow-up. A custom-made mouthguard was made, which allowed for the immediate return of athletes to practicing sports. The athlete's OHRQoL was negatively impacted by dental trauma, but the treatment proposed was associated with the use of custom-made mouthguards. After 2 years, the absence of radiographical lesions and a positive response to sensibility tests were observed. The success of the minimally invasive approach was attributed to immediate conduct following dental trauma, the implementation of follow-up, and associated with the use of custom-made mouthguard.

Keywords: Dental trauma, contact sports, mouthguard, quality of life

Introduction

Orofacial injuries represent a major public health problem worldwide [1] due to their high prevalence, prolonged management, financial burden associated with these injuries [2], and psychological impact [3]. With the ever-increasing competitiveness in sports and a more diffuse practice in the general population, there is a natural trend to see an increase in sports lesions. Studies conducted in different countries have reported that sports activities increase the risk of these injuries in athletes [4, 5]. Most injuries affect the upper jaw, with the maxillary anterior teeth being the most prone to injury [6].

Horizontal radicular fracture, that generally results from horizontal impact, is a lesion that affects pulp, ligament, dentin, and cementum at the same time. This fracture is uncommon, with an incidence of 7% of all traumatic dental lesions [7]. It is diagnosed mainly by radiographic examination, requiring several conventional two-dimensional imaging projections and angulations [8, 9]. This fracture can appear in the cervical, middle, or apical third, although in most cases, the middle third is the most affected region [10].

Dental trauma has consequences not only for the traumatized individual but also for family members and society. Orofacial lesions can be agonizing events causing not only physical but also psychological trauma to the victim [11]. Therefore, evaluating the oral health-related quality of life (OHRQoL) is important for assessing an individual's perception of life, with regard to culture and the values by which he lives and his or her life goals, expectations, patterns, and

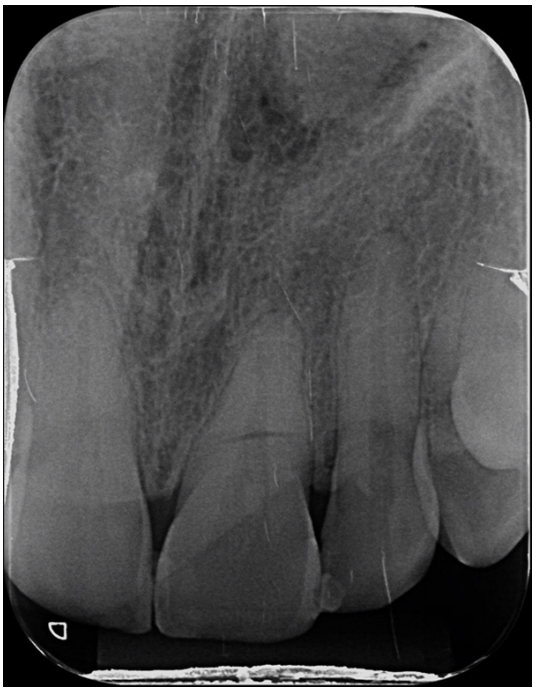

Figure 1. Initial periapical radiograph, showing horizontal radicular fracture in the cervical third.

concerns [11]. This is a subjective concept that complements clinical health and encompasses a well-rounded physical well-being, including mental and social health, and not only the absence of disease [11].

The mouthguard is a protective appliance that effectively reduces the frequency and severity of oral facial injuries in sports activities [12]. Mouthguards can also help prevent other prejudicial consequences of impact, such as brain lesions, concussions, bone fractures, and lesions in the temporomandibular articulation [13, 14]. Even so, many athletes and their trainers do not understand the importance of wearing mouthguards during sports [15, 16].

Therefore, this case report described a minimally invasive approach supported by the use of mouthguard for treating sport-related root fracture of element 21. A custom-made mouthguard was used to recover the athlete earlier to sporting activities and as a preventive measure for other injuries. Furthermore, the impact of the proposed treatment was assessed on the patient's oral health-related quality of life (OHRQoL).

Case report/clinical techniques

A 36-year old male athlete was referred to the Dental Trauma Care Program (DTCP) in a Brazilian public university due to dental trauma that occurred during a soccer match. The immediate treatment was performed in a private clinic two hours after dental trauma. The patient presented at the university clinic approximately three days after the dental trauma (**Figures 3** and **4**). Ethics approval was obtained from the local Research Ethics Committee (No. 1.233.367). A patient informed consent form was obtained. During anamnesis, the athlete reported that the maxillary left central incisor presented mobility toward the palatal region (vertical mobility). In the previous appointment in a particular clinic, the tooth was manually repositioned, and splinting with light-curing resin was performed. The patient reported that the dentist had planned to extract the tooth followed by implant placement. The initial radiograph showed an oblique horizontal radicular fracture in the cervical third (**Figure 1**). Pulp sensibility tests to hot and cold were performed, and it was positive. Based on this positive diagnosis, treatment plan was splint maintenance for three months associated with custom-made mouthguards to guarantee the athlete's safe return to sports practice.

Custom-made mouthguards were fabricated by the authors. Impressions were made by standard trays using alginate impression material and were poured with dental stone to obtain working models. Before the models were confected, the impressions were disinfected using 1% sodium hypochlorite. Mouthguard consisted of a double 3-mm and 1-mm lamination of ethyl vinyl acetate (EVA) sheet (Ultradent, Salt Lake City, UT, USA). Sheets were placed in a thermal forming machine (BioSTAR; Scheu-Dental, Iserlohn, Germany). A pressure-molding machine was used for 70 s at 220°C under 5.5 bar pressure of. The cooling phase lasted for 179 sec. The design of the mouthguards followed the criteria: (i) labially 2 mm short of the vestibular reflection with rounded borders at the buccal peripheries, (ii) approximately 4 mm from the cervical margin in the palatal limit, tapered at the edges, and (iii) enclosing the maxillary teeth to the distal surface of the first molars. Finally, the mouthguard was polished

Figure 2. One-month follow-up radiograph.

Figure 3. Initial photograph of the palatal region.

and the margin adaptation, stability, and retention were checked, while delivering.

Regular follow-up was performed at intervals of one-month (**Figure 2**), three months (**Figure 6**), one-year (**Figure 7**), and two years (**Figure 8**). Clinically, normal and healthy appearance of the left central incisor was observed. The tooth showed no sensitivity to percussion and no tenderness of the surrounding tissues on palpation. Pulp sensibility was assessed with a cold pulp test, and the tooth had a very slight reaction. The radiographic examination revealed a radiopaque area in the cervical fractured root, suggesting bone neoformation along with the results of minimally invasive treatment. No

Figure 4. Initial athlete occlusion.

Figure 5. Finalized type IV custom-made mouthguard.

post-op complication such as ankylosis or coronary discoloration was observed.

The athlete's OHRQoL was assessed upon arrival in DTCP (T1), immediately after placing the custom-made mouthguard (T2), three-month (T3), one-year (T4), and two-year (T5) follow-up. The OHRQoL index involves socio-dental factors that complement to the clinical indicators of the oral condition, detecting psychosocial aspects along with the disease status. This allows a more holistic view of how the patient is affected.

For the evaluation of OHRQoL, the Brazilian version of the Oral Health Impact Profile (OHIP), measured by the 14-question instrument (OHIP-14), was applied in the form of interviews. The response categories of OHIP-14 were based on a 5-point Likert scale (0 = never, 1 = rarely, 2 = sometimes, 3 = often, and 4 = always), and the participants can select one of the five options [17]. These scores were calculated by the addition of the athletes' responses. The OHIP-14 value for each of its seven domains was also analyzed separately. This assessment method ranged from 0 to 56. High scores revealed poor OHRQoL.

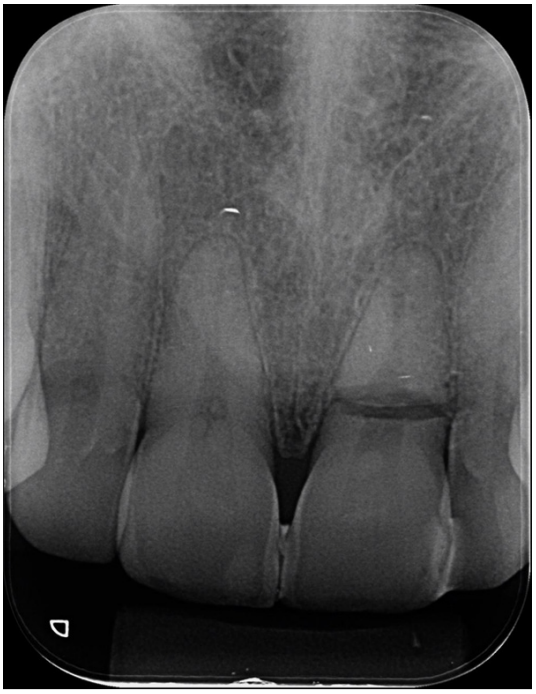

Figure 6. Three-month radiographic follow-up showing the beginning of tissue regeneration and newly formed bone.

Figure 7. One-year radiographic follow-up with bone and tissue regeneration in progress.

Table 1 shows an impact of OHRQoL in athlete. In T1, the athlete's quality of life was negatively impacted. With the use of custom-made mouthguards (Figure 5), OHRQoL was reapplied and showed a positive influence on the athlete's quality of life, as it reduced the psychosocial impact according to the scores. The differences observed between pre- and post-treatment scores confirmed the treatment's success. Even though, due to trauma, the athlete demonstrated a negative impact on the emotional well-being domain, the points were different post-treatment (T2). Therefore, this case report highlights that dental trauma can compromise the athlete's psychosocial well-being.

Figure 8. Two-year radiographic follow-up, where pulp tissue regeneration is observed as well as newly formed stabilized bone.

Furthermore, the traumatized tooth showed improvement with minimally invasive treatment. Another success factor in this case was the implementation of a custom-made mouthguard as a co-adjuvant in treatment, guaranteeing more safety in sports and reducing recovery time.

Discussion

Health is a concept that takes a multidimensional holistic view of an individual. This evaluation is important for athletes. Several case reports about horizontal root fracture [18-24] (Table 2); however, to the best of our knowl-

Table 1. Oral health-related quality of life questionnaire-OHIP-14

	Domain	Post trauma (T1)	Just after mouthguard placement (T2)	Three-month follow-up (T3)	One-year follow-up (T4)	Two-year follow-up (T5)
1-Did you have trouble saying any words?	Oral symptom	0	0	0	0	0
2-Did the taste of your food get worse?	Oral symptom	0	0	0	0	0
3-Did you feel mouth or tooth ache?	Oral symptom	2	0	0	0	0
4-Did you feel uncomfortable eating any foods?	Oral symptom	3	0	0	0	0
5-Were you concerned?	Emotional well-being	4	0	0	0	0
6-Were you stressed?	Emotional well-being	2	0	0	0	0
7-Was your eating impaired?	Functional limitation	0	0	0	0	0
8-Did you have to stop eating your meals?	Functional limitation	3	0	0	0	0
9-Did you find it hard to relax?	Emotional well-being	0	0	0	0	0
10-Have you ever felt embarrassed?	Emotional well-being	0	0	0	0	0
11-Were you irritable towards other people?	Emotional well-being	1	0	0	0	0
12-Did you have difficulty performing daily activities?	Functional limitation	0	0	0	0	0
13-Did you feel life in general got worse?	Emotional well-being	0	0	0	0	0
14-Were you totally unable to perform your daily activities?	Functional limitation	0	0	0	0	0
A) Comparing yourself to people your age, how do you see your oral health?	Social well-being	1	1	1	0	0
B) Comparing yourself to people your age, how do you see your general health?	Social well-being	1	1	1	0	0
C) In the last 3 months, due to problems with your teeth, mouth, bones in your mouth or treatments, how much was your well-being (life) affected by these events?	Social well-being	3	1	1	0	0

Footnote: T1: post trauma; T2: just after mouthguard placement; T3: three-month follow-up; T4: one-year follow-up; T5: two-year follow-up.

Table 2. Characteristics of the clinical cases inserted in the main text

Authors	Tooth	Fracture location	Splint	Splint time	Type healing	Follow up
Poi et al. [18]	Upper left-central incisor	Between the middle- and apical-third of a followed-up for over	0.7-mm stainless steel wire and photopolymerized composite	3 months	Fibrous connective tissue	3 years
Artvinli and Dural [19]	Maxillary right central incisor	Coronal third of the root	Spontaneously healed	-	Separated by bone with normal trabecular pattern	6 years
Cobankara and Ungör [20]	Maxillary first premolar	Middle-third of the root	Spontaneously healed	-	Fibrous tissue develops between the fractured segments	14 years
Cantore et al. [21]	Upper left-central incisors	Middle- and apical-third of the root	Orthodontic stainless steel	1 year	-	Over 4 years
Davis [22]	Maxillary right central incisor	-	Spontaneously healed	-	Bone repair	8 years
Soares Ditzel et al. [23]	Left maxillary lateral incisor	Middle third of the root	Rigid splint	3 months	Mineralized tissue between the fragments	8 years
Tobiska and Krastl [24]	Both maxillary central incisors	Cervical root	Titanium ring split	3 ½ months	Interposition of calcified tissue, not ocurr	12 years

edge, there are no studies reporting a minimally invasive approach by the use of mouthguard for treating sport-related root fracture and its influence on OHRQoL. Therefore, this clinical case report revealed that a custom-made mouthguard can be used as the treatment for sport-related root fracture decreasing the athlete's recovery time and can be a preventive measure for other injuries.

The prognosis of root fractures depends on the extent of the fracture line, the pulp tissue involvement, occlusion, dislocation of fragments, and the general health of the patient. The mobility of the coronary segment can occur to a greater or lesser extent according to the extent of line of fracture. In this clinical case, there was severe mobility and coronal segment displacement, due to the severe impact leading to the cervical third fracture. The immediate treatment consisted of repositioning the coronary portion and splinting. In DTCP, the authors chose to maintain this type of splint for a three-month period, due to the athlete's aesthetic needs and the possibility of making a custom-made mouthguard without the interference of an apparatus by the vestibular teeth (orthodontic wire or nylon). Immobilization for at least three months is important to stabilize the newly formed calcified material [25].

Follow-ups are fundamental after traumatic injuries. Each follow-up should include, evaluation of any signs or symptoms, clinical and radiographic examinations, pulp sensibility testing, and photographic documentation [9]. Immediately after dental trauma, diagnostic of pulp necrosis (coronal discoloration, loss of pulpal sensibility, and periapical radiolucency) could not to discriminate between infected pulp and pulp where healing might occur (ischemic pulps under revascularization) [8]. A precipitated untimely endodontic intervention can be one of the factors associated with unsuccessful repair in radicular fractures. In the case of pulp vitality post-lesion, healing patterns can be observed by hard tissue union of fragments, connective tissue union of fragments, or nonunion due to the interposition of granulation tissue between fragments resulting from pulp necrosis of the coronal fragment [8]. A factor that significantly influences the healing process in cases of horizontal fractures is the presence or absence of a communication of the fracture line with the oral environment. If the fracture line is in communication with the oral cavity, immobilization is difficult and microbial contamination of the pulp with subsequent pulpal necrosis is inevitable [26]. In this case, the fracture occurred below the alveolar crest. Thus, there was no communication between the sulcular bacteria and the oral environment. In our clinical case, healing was due to the interposition of hard tissue between the fragments (fragments are little separated by the growth of hard tissue).

Long-term follow-up of patients with injuries is important, as pathological changes can occur several years after injury. A retrospective study of 400 root-fractured permanent incisors developed by Andreasen et al. [25] observed that the follow-up period for healed fractures ranged from 1 to 13 years (3.6 years ± 3.0). Long-term success will be identified by positive responses to sensitivity tests in cases where there is pulp vitality and absence of radiographic pathological peri-radicular alterations [18-22]. Once evidence of pulp necrosis is observed through the fistula, bone resorption in the fracture line or negative pulp sensibility test, endodontic treatment must be implemented.

There is consensus in the literature that the use of OHRQoL instruments to measure the impact of dental trauma is paramount important since these instruments help us evaluate prevention and therapeutic options and aim to improve an individual's [27] health. This questionnaire was used to complement clinical indicators, detailing functional disadvantages and psychosocial aspects of these lesions, providing a more complete image of the individual's health status [28]. In this case report, all these principles were observed and there was a negative impact on the athlete's concern, which impacted his psychosocial well-being. Throughout treatment, this was reversed, improving the OHRQoL of the athlete. The differences in scores pre- and post-treatment confirmed treatment success. The immediate association with custom-made mouthguards allowed the athlete to safely return to sports. Therefore, indicators of OHRQoL should be implemented in the dentist's clinical routine to promote health strategies encompassing psychosocial well-being and not just clinical treatment, with a broader holistic view of the patient [27].

The practice of sports activities soon after orofacial injury can represent a risk for the treatment proposed and can slow down the player's performance, causing fear for the athlete and even for his or her opponents [29, 30]. The use of protective equipment as a coadjuvant treatment provides the athlete with the possibility of getting back to sports activities faster after orofacial injuries [31]. In this case report, the use of a custom-made mouthguard allowed the athlete to return to sports activities offering more safety against possible new facial injuries and to allow the root fracture to heal during sports activities.

Regarding the use of custom-made mouthguards, athletes and their coaches have misinformation regarding their relevance in sports [17, 18]. Despite its clear role in lesion prevention, many athletes believe that mouthguards are uncomfortable and cause speech and breathing problems, which can, in turn, compromise their performance [32-34]. A systematic review developed by Ferreira et al. [35] showed that custom-made mouthguards do not cause changes in athletes performance in contrast to other kinds of mouthguards. Therefore, the use of the correct mouthguard should be reinforced, with increased athlete and sports team awareness [15].

Conclusions

Dental trauma negatively affects the psychosocial aspects of the patient's OHRQoL. Conservative treatment of root fracture associated with the use of a custom-made mouthguard provided a favorable prognosis. The athlete could return rapidly to sports and prevent future trauma, thus increasing OHRQoL. The use of a custom-made mouthguard is an efficient co-adjuvant treatment method for athletes who suffer root fractures because it reduces the period of convalescence, allowing the athlete to resume practice after a short duration, assuring comfort, safety, and protection.

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Disclosure of conflict of interest

None.

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