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Dental injuries in young athletes, a five-year follow-up study

ABSTRACT

Aim *The aim of this study is to produce a clinical therapy protocol for a group of 20 athletes between the ages of 8 and 14, who all suffered traumas affecting hard dental and periodontal tissues.*

Material and methods *This study involves a group of 20 athletes (10 male and 10 female) who had suffered dental traumas of varying severity. In order to collect the data, two classification systems were used: one for hard tissue traumas and another for periodontal lesions. The athletes were subdivided into lesion groups, treated depending on the type of lesions and then followed-up over a period of 5 years. A statistical analysis was carried out to study the association between type of lesions, types of sports and the number of teeth involved.*

Results *We found that recovery time ranged from 3 to 5 days for uncomplicated fractures and up to 14 days for luxations. Only four complications were registered during the follow-up period and these were most likely due to the severity of the trauma. Out of the 20 athletes, 16 had begun and maintained the habit of using mouth protection devices when practicing their sport. The statistical analysis focused on the possible association between the risk levels of a sport and the typical lesions and complications that usually occur. Due to their high frequency, the two types of lesions taken into account in our study were complicated fractures (FP) and luxated/fractured teeth (LF). The average number of teeth involved varied according to the sport's risk level (medium or high) with averages of 1.6 teeth involved for medium-risk sports and 2.0 teeth for high-risk sports.*

Conclusions *What emerged in particular was the regular progress in the recovery time needed for the injuries sustained, with few complications or delays in rehabilitation; we also noted that the numerous athletes who habitually used mouthguards while competing during the recovery period did not suffer any recurrences of injuries or further complications. Regarding the results of our statistical analysis, no association was found between the sport's risk, the types of lesions and the occurrence of complications. In addition, analysis of the average number of teeth involved showed that there is no statistical evidence to reject the hypothesis that the ratios remain the same in the two groups.*

Keywords *Dental trauma; Mouthguard; Sports risk levels; Sports-related dental injuries.*

Introduction

The number of traumatic injuries affecting the oral cavity and dental apparatus (TDIs) as a percentage of all oral pathologies lies between 18–30% [Ranalli, 2002; Andreasen and Ravn, 1972]; a considerable number of these are the result of sports injuries and about one quarter (25%) of them involve young adolescents (8–15) because they are more physically active than adults [Flanders and Bhat, 1995]. Injuries to the dento-alveolar apparatus of permanent teeth can be classified using a number of different systems [Feliciano and de Franca Caldas, 2006].

The most commonly used classification is the WHO-Andreasen system [Andreasen et al., 2012] used to classify injuries to dental hard tissues, pulp and to the periodontium. It is divided into eight descriptive classes of hard tissue injuries (enamel, dentin, cementum and alveolar bone) and six classes to describe injuries to the periodontium; however, there are further classification systems that can be of aid in collecting documentary evidence. One such system concerning injuries to dental hard tissues is the Spinas' Classification [Spinas and Altana, 2002], which classifies various types of coronal fracture into 4 classes and 3 sub-classes. Once a dental injury occurs, it is of the utmost importance that the injured subjects receive treatment as soon as possible in order to prevent worsening over time [Re et al., 2014; D'Ercole et al., 2016]. So, it is essential to set in place a protocol of action to treat patients immediately and continue short-term monitoring (immediate follow-up) as well as organise a series of checkups in the longer term (long-term follow-up) [Diangelis et al., 2012]. There are very few studies in the existing literature that have addressed the question of the most effective therapeutic strategies to adopt in treating dental injuries sustained by young adolescents in sports competition [Inouye and McGrew,

Injuries to the dental hard tissues and pulp	Infraction
	Enamel fracture
	Enamel-dentin fracture
	Enamel-dentin-pulp fracture
	Crown-root fracture (uncomplicated)
	Crown-root fracture (complicated)
	Root fracture
	Alveolar fracture
Injuries to the periodontal tissue	Concussion (shock)
	Subluxation
	Intrusion (central luxation)
	Extrusion (peripheral luxation)
	Lateral luxation
	Total luxation (exarticulation)

TABLE 1 Andreasen-WHO dental injuries classification.

2015]. It is often the case that medical sports teams want the injured athlete to return to sports activity as soon as possible [McTigue, 2000], even though this should only be the case after maximum safety precautions have been taken to avoid jeopardising the healing of the injuries suffered. Although the most commonly used guidelines are those that are regularly updated by the IADT [Diangelis et al., 2012], there are no specific recommendations for the treatment of and recovery from competitive sports injuries and contributions in the existing sports medicine literature [Piccininni et al., 2017] are too generic for the purposes of our study.

The aim of this study is to create a clinical therapy protocol applied to a group of 20 athletes between the ages of 8 and 14 years, who all suffered traumas (TDIs) affecting hard dental and periodontal tissues. The athletes were monitored for a five-year period following the trauma in order to assess the healing rate of the injuries suffered, to observe any relationship between type of lesions and type of sports as well as the number of teeth involved and finally, the number of athletes that began and subsequently continued to use mouth-guards during their sports activities.

Materials and methods

Classifications

To classify TDIs, for this study both the WHO-Andreasen system (updated to 2012) [Andreasen et al., 2012] (Table 1) and the Spinas' Classification [Spinas and Altana, 2002] (Table 2) were used. For sports activities, the FDI classification was used [(FDI), 1990].

Sample characteristics

The sample of 20 athletes, aged between 8 and 14 years (average age 11 years, standard deviation 2.08), 10 males and 10 females, all engaged in competitive sports (7 subjects for basketball, 2 for soccer, 3 for handball, 3 for field hockey, 2 for cycling/mountain bike, 1 for martial arts, 1 for skating and 1 for tennis), was selected from a larger group of 60 young adolescents with TDIs to permanent teeth, who were treated during the 2010-2011 two-year period.

Class A	Simple enamel lesions involving mesial or distal coronal angle or incisal edge
Class B	Enamel-dentin lesions involving mesial or distal coronal angle and incisal edge
	Subclass b1: pulp exposition
Class C	Enamel-dentin lesion involving incisal edge at least a third of the crown
	Subclass c1: pulp exposition
Class D	Enamel-dentin lesion involving mesial or distal coronal angle and the incisal and palatal surface with root involvement
	Subclass d1: pulp exposition
Class h	Fractured tooth with silent or necrotic pulp

TABLE 2 Crown fracture classification (Spinas, 2002).

Among the initial group of 60 subjects, 30 had presented sports injuries but only 20 subjects had met the following inclusion criteria:

- The athletes must practice a competitive sport
- Presence of dental injuries caused by sports activity
- The athletes did not wear any type of MG during sport activity
- Absence of fixed orthodontic devices.

The athlets were subsequently monitored from the time of the trauma up to the year 2016, with periodic checkups at the University of Cagliari's Centre for Dentistry and sports studies. The athletes underwent the same procedure for diagnoses (following the IADT International protocol, www.iadt-dentaltrauma.org) which consisted of examinations, case history reviews and the acquisition of medical records, intraoral x-rays, photographs and pulp sensitivity tests. As planned, monitoring took place at 30, 60, and 90 days, then again after 6 months and one year, with subsequent annual checkup (providing no complications emerged) for a further five years, employing the same examination protocol used for the original assessments.

The initial examinations and subsequent checkups were conducted and coordinated by the same expert practitioner, with the support of two less experienced assistants trained for the specific task. All the athletes and/or their parents signed an informed consent form prior to beginning the treatment.

Statistical analysis

The aim of the statistical analysis is to assess the relationship between sports risk (medium or high), complications, the number of teeth involved, and type

Group of lesions	Age	Sport	Risk factor (sport)	Sex	Type of lesion	No. of teeth involved	Treatment (IADT guidelines)	Complications	Time and precautions
F	9	Tennis	Medium	F	B/A	INC C/INC L	Conservative treatment	No	3-5 days; use of mouthguard
	12	Field Hockey	High	M	B/A/C°	2 INC C/INCL		No	
FP	9	Basketball	Medium	M	b1/b1	INC C/INC L	Pulpotomy (age < 14) and conservative treatment	No	7 days; use of mouthguard
	12	Skating	High	F	b1°/c1°	2 INC C		No	
LF	8	Basketball	Medium	M	AL e	INC C	Orthodontic splint and conservative treatment; in complicated fractures also pulpotomy or pulpectomy	No	7-14 days; use of mouthguard
	9	Basketball	Medium	F	c1L e	INC C		No	
	10	Soccer	Medium	M	b1L e	INC L		No	
	14	Mountain biking	High	F	d1L i	INC C			
L	10	Soccer	Medium	M	TL	INC C	LT: delayed replanting L: orthodontic splint	Yes	7 days for luxations, 14 days for the total luxation; use of mouthguard
	14	Cycling	High	M	TL	INC L		Yes	
	14	Basketball	Medium	F	L e	INC C		No	
LF/F	12	Handball	Medium	M	B°/BL s	INC C/INC L	Orthodontic splint and conservative treatment; conservative treatment for fractured teeth	No	7-14 days; use of mouthguard
	13	Field Hockey	High	F	C /BL s	INC L/INC C		No	
	14	Field Hockey	High	M	B/C°/AL s	2 INC L/INC C		Yes	
	14	Handball	Medium	M	CL i /A	INC C/ inc c		Yes	
	14	Martial Arts	High	F	C°/AL s	INC L/INC C		No	
FP/F	9	Basketball	Medium	M	B/c1°	INC C/INC L	Pulpotomy or pulpectomy (age > 14) and conservative treatment; Fracture d1 needed the position of a glass fibre post	No	5-7 days; use of mouthguard
	11	Handball	Medium	F	A /d1	INC C/INC L		No	
	12	Basketball	Medium	F	A /c1	inc c /INC C		No	
		Basketball	Medium	F	c1° /A	INC C/inc c		No	

Legend: A-B-C-b1-c1-d1 refer to the Spinas Classification; F= only uncomplicated crown fracture; FP= only complicated fracture; L = luxation (T= total; i =intrusive luxation; e =extrusive; s = subluxation); LF= Luxation and Fracture (same tooth); LF/F= luxation and uncomplicated fracture in different teeth; F/FP= uncomplicated fracture and complicated fracture.
Teeth: INC= upper incisor incisive (C: central – L: lateral); inc = lower incisor (c: central – l: lateral); ° = fragment reattachment

TABLE 3 Cases of teeth crown fracture (Spinas classif.) and luxation (WHO classif.).

of lesions sustained. Due to the limited sample size, we looked for any association by adapting the Fisher's exact test using the software SAS (©SAS Institute Inc., Cary, NC 27513). The significance level was set at $P < 0.05$.

Results

Table 3 indicates the type of oral injury suffered by each individual subject (using the WHO's as well as the Spinas classification), the number and type of teeth affected, treatment, results, recovery time and precautions used to ensure a safe return to sports activity. All the various sports were divided into the two categories used according to the FDI Classification: high risk and medium risk [FDI, 1990]. Among the injuries suffered in the group of young athletes, 8 affected the hard dental tissue (tooth fracture), 9 were injuries affecting both the hard tissue (fracture) and the support tissues (luxation), while 3 injuries affected only the support tissues (luxation); two of these were cases of dental avulsion.

Overall, 35 traumatised teeth were included (14 of which had hard tissue fractures and 12 involved the periodontal tissue; there were 9 cases of teeth affected by both hard and periodontal tissue lesions). The most affected teeth were the upper central incisors (20 cases in total), upper lateral incisors (12 cases) and lower central incisors (3 cases).

All information was essential in deciding the prognosis, treatment and the right time for a return to sport activities. For the sake of simplicity, groups were created according to the type of injury and were given a reference code: uncomplicated crown fractures group

(F), complicated crown fractures and pulp involvement group (FP), luxation and crown fractures group (LF), and only luxation group (L).

The following observations were made:

- 2 athletes (5 teeth in total) had sustained only enamel or enamel-dentin fractures (group F) not affecting the pulp (class A, B, C of the Spinas classification);
- 2 subjects (4 teeth in total) had complicated crown fractures (FP group, classes b1, c1, and d1 of the Spinas classification); 1 subject (1 tooth affected) had dental luxation injuries and concomitant uncomplicated crown fractures;
- 3 subjects (3 teeth) had luxation and classes c1 and d1 complicated fractures (all belonging to the LF group);
- 3 subjects (3 teeth) had luxation injuries only (group L); two of these had suffered complete dental avulsion.

The remaining 9 subjects had multiple and mixed dental injuries:

- 5 subjects manifested uncomplicated crown fractures (6 teeth) together with dental luxation injuries (5 teeth), making a total of 11 teeth that were placed into the mixed LF/F group;
- 4 subjects had complicated crown fractures (4 teeth) and concomitant uncomplicated crown fractures (4 teeth, classes A, B, C according with he Spinas classification), making a total of 8 teeth that were placed into the mixed FP/F group (Table 3).

Treatment

All the athletes in the study who manifested uncomplicated crown fractures (in one or more teeth) belonged to group F or to the mixed group F/FP (15 teeth) were treated using the same procedures.

Depending on the extent of the fracture, the crown injuries were treated in the same session, using direct composite resin restoration, or in cases where the original tooth fragment could be recovered and/or in cases of soft tissue (gums, lips) lesions, conservative treatment was carried out over two or three sessions, but always ensuring that treatment was terminated within three weeks from the traumatic event [Spinas, 2004].

As for returning to sports activity, the subjects were able to do so rapidly, at most within 3 days from the time of trauma. In all cases, the athletes were advised to use mouth protection devices (class C and B crown fractures with reattachment of fragments), using new generation (n.g.). Boil and Bite (B&B) mouth guards (MG). This type of self-adapted MG [Spinas and Savasta, 2007] is simple to use (the athletes can do it themselves), since they have rigid lateral-front inserts that maintain the correct interocclusal distance and are removed once the customisation phase is complete. This phase of the study was undertaken under the strict control of an expert, using products made by either QUATTROTI DENTECH, Srl (Cislago,Va, Italy), Powerguard (Enso, Australia), or Opro Shields (Herts,UK). By the end of the five-year period, no patient in this group had experienced any complications. Taking into account the maturity of the endodontic system, a similar protocol was followed for the FP group (the group with complicated crown fractures, 2 subjects and 4 teeth) and the mixed F/FP group with uncomplicated and complicated crown fractures affecting four athletes (4 complicated crown fractures). All the necessary actions were taken to maintain pulp vitality, undertaking pulpotomy therapy when necessary [Murray and Garcia-Godoy, 2006]. This treatment required more frequent examinations during the first 90 days (five/six appointments total).

The treatment resulted in the successful crown reconstruction of all the teeth subjected to pulpotomies, within one year from the trauma [Spinas, 2003]. During the five-year follow-up period, none of the teeth in this group had complications such as pulp or tooth necrosis.

Follow-ups continued after six months, one year and then at yearly intervals for the subsequent 4 years, applying standard check-up procedures. There were no cases of complications affecting the periodontium (radicular resorption, fistulation). In all these cases, the athletes were able to resume sports competition within 7 days and in one case only (class d1 fracture) after 14 days (i.e. after the rehabilitation phase). In all cases, subjects were advised to use readily available B&B n.g. mouth guard protection when resuming their respective sports activities. Three out of four subjects (4 teeth affected) in the LF group (the group with luxation and crown fractures), had complicated fractures. A further group of five subjects (in Groups LF/F) was composed by athletes with fractures and luxation (5 teeth) as well as other teeth with crown fractures (6 teeth). In the diagnostic phase for this group, the type of dental luxation was first identified and categorised in order to decide on the immediate treatment [Robertson et al., 2000].

Out of the 9 teeth (4 in the LF group and 5 in the LF/F group) affected by both luxation and crown fractures:

- 4 were also affected by subluxation (1 of these developing pulp necrosis over time) with moderate tooth mobility (1st/2nd grade);
- 3 had extrusive luxation (2 teeth subsequently suffered pulp canal obliteration) as well as vestibular and lingual movement (2 teeth);
- 2 teeth had intrusive movement, which subsequently led to pulp necrosis [Stewart et al., 2009].

For the 4 teeth affected by subluxation, stabilising treatment was immediately initiated using fixed orthodontic appliances (NIT 014/016 wires and brackets) for 14 days. For the teeth affected by extrusive luxation (3 teeth) and intrusive luxation (2 teeth), orthodontic repositioning treatment was immediately initiated (within 24 hours of the trauma), depending on the degree of tooth eruption in each subject, generally extending to 6/8 teeth contiguous to the luxated tooth, though none of the intruded teeth underwent repositioning surgery. Following standard procedure, treatment required for crown fractures was also undertaken; three of these

luxated teeth displayed pulp exposure (classes b1,c1 and d1) which somewhat complicated the prognosis of these injuries [Hamilton and Gutmann, 1999].

Repositioning therapy is generally carried out over 30/45 days and requires a further 15 days of close monitoring of the obtained results. Proper hygiene should be strictly adhered to in this phase. By the time the orthodontic splint is applied or immediately after that, all other restorative treatments will have been carried out (three original teeth fragments were re-attached) in order to ensure that the crown injuries do not impede morphofunctional efficiency.

Luxation injuries require regular monitoring over time. This is because, regardless of simultaneous crown injuries (fractures and pulp exposures), the affected teeth may lose vitality and develop necrosis even at a later time [Andreasen et al., 2002].

In our cases, 3 teeth (1 with subluxation and 2 with intrusive luxation) needed subsequent endodontic therapy, but at the present time (5 years after the trauma) there are no indications of further negative consequences such as root resorption (R.R.) or root fractures [Tsilingaridis et al., 2012].

The return to sports activity of subjects affected by both luxation injuries and hard tissue traumas had to be gradual and never occurred before 7/14 days after the trauma. For all cases it was essential for the athletes to use self-adapted n.g. B&B mouthguards, which ensure a gradual adaptation to the movement and repositioning of teeth resulting from the fixed orthodontic treatment [Spinas, 2003].

The last group of athletes with only luxation injuries (group L) consisted of 3 subjects with 3 affected teeth, one of which had manifested extrusive luxation with slight migration towards the palate (this tooth subsequently manifested pulp canal obliteration) [Malhotra and Mala, 2013], and 2 teeth had been affected by avulsion. The tooth with extrusive luxation was repositioned with a fixed orthodontic splint and carefully monitored over 14 days. This athlete was able to return to sports activity with the aid of B&B. n.g. mouthguard.

At the end of the five-year period, none of these teeth had suffered any permanent effects of the trauma. The therapy undertaken for two young male athletes (aged 10 and 14) who had suffered avulsion of the two upper incisors (one central and one lateral) was more complicated due to the replanting of the avulsed teeth, which is the chosen treatment in such cases, given the age of the patients [Andersson et al., 2012, Giannetti et al., 2007]. In these two cases, replanting was carried out a few hours after the trauma and it was classified as delayed replanting [Barrett and Kenny, 1997], with all the predictable complications associated with this procedure (ankylosis, infraocclusion and R.R) [Andersson et al., 1989]. After five years, the youngest athlete (aged 10 at the time of the trauma) had a 3 mm infraocclusion of the central incisor, which could benefit from a tooth decoronation therapy [Malmgren, 2013, Spinas et al., 2015] followed by a dental implant placement after the age of 18/20 [Schwartz-Arad and Levin, 2004].

The second athlete (14 years old) manifested a slight root resorption, ankylosis and infraocclusion and can be given a prosthetic replacement at the age of 20 using the standard procedure (full crown), without any bone regeneration treatment [de Jesus Soares et al., 2012].

Having received dental replanting treatment, both these athletes made a gradual return to sports activity 14 days after the trauma, but with the prescribed use of self-adapted B&B n.g. mouthguards, given their young age. Follow-up was then planned at 30, 60, and 90 days with further checkups and x-rays repeated every 90 days for the first two years for any occurrence of R.R.

Statistical results

This study specifically aimed at assessing the relationship between a sport's risk category (medium or high) and complicated fractures; a sport's risk level and luxated/fractured teeth; type of risk and onset of complications; type of risk and the number of teeth involved. Due to their high rate of recurrence in the study, two types of lesions were taken into account, complicated fracture (FP) and luxated/fractured teeth (LF). All the data collected are described in Table 4.

Discussion

This study has shown how TDIs progressed over time in a group of 20 young athletes aged between 8 and 14. Recovery time, as well as rest time after an injury is a much-debated subject in the relevant literature [Gould et al., 2016], but there is an evident lack of studies on the recovery time needed after traumas affecting mouth and teeth and consequently a lack of protocols and procedures to follow in such cases [Piccininni et al., 2017].

Our observational study looked at the progression and recovery of commonly occurring TDIs over a period of five years when standard therapy protocols are applied [Emerich and Gazda, 2010].

In such situations, the team hopes and expects that the athlete will return soon to sports activity. Clearly, this should only occur when there is no risk of worsening or delaying recovery from the injury [Bucher et al., 2013].

Classification of Traumas

Our study of patients affected by various forms of injury were divided into 6 groups, according to the severity of the dental and alveolar injury sustained (Pure Groups F, FP, LF,L and Mixed groups LF/F, F/FP) as well as the number of affected teeth. This was done in order to establish a protocol to ensure the correct treatment and monitoring over time of each sustained injury. It also ensured that the athletes only returned to sports activity after the recovery time and the required

Complicated fractures and sports risk				Luxated/fractured teeth and sports risk			Complications and sports risk		
Recovery time	Complicated fractures			Luxated/fractured teeth			Complications		
	FP	Others	Total	LF	Others	Total	Yes	No	Total
Medium risk	8	5	13	8	5	13	2	11	13
High risk	6	1	7	4	3	7	3	4	7
Total	14	6	20	12	8	20	5	15	20
P	0.3544			0.6424			0.2898		

TABLE 4 Data studied with Fisher's exact test.

treatments, considering the physical demands of the various sports in question. It was found that for the 2 subjects (a total of 5 teeth) belonging to Group F (simple and/or uncomplicated crown fractures according to the WHO's classification, or types A, B, C, under the Spinas' classification), a return to sports activity (training and competition) is immediately feasible in cases of type A and B fracture, but should be delayed by 3 days in cases of type C crown fractures.

Rehabilitation therapy can be carried out without further interruption of sports commitments. Over the 5-year follow-up period, the 2 subjects in this group (5 affected teeth) did not manifest complications nor recurrences of injuries that could be attributed to the post-trauma treatment protocol.

The return to training and competition of the 2 athletes (4 teeth in total) belonging to the FP group (complicated crown fractures type b1, c1, and d1, according to the Spinas classification) was possible on average after 7 days (in one case after 14 days) and subsequent intermediate therapy meant brief periods of non-participation in sport (1 day on average), which never, though, interfered with the athletes presence in competition events.

It should be pointed out that in a study of Piccininni (2017), athletes with these types of injuries were expected to continue immediately, i.e. during a game involving professional athletes engaged in high-level competition. In our case, the subjects were engaged in juvenile sports and when traumas occurred, were not examined during the game but always immediately after (within 24 hrs). On their subsequent return to sport, the use of n.g. B& B MGs was recommended to all subjects, during both training and matches, until the more urgent treatment had been carried out (pulpotomy in two cases of reattachment of the original crown fragment). All the athletes used the recommended protection and continue to do so (1 athlete uses a laminated MG).

In the group of 4 athletes who had sustained mixed dental injuries (F/FP 8 teeth affected) the treatment was very similar to that of the previous group, given that the crown and pulp injuries (in 4 teeth) were similar and the concurrent crown injuries in the other affected teeth did not warrant placing them in the serious injuries categories (3 A class and 1 B class of Spinas' Classification). As the 4 subjects were also all adolescents, recovery time was on average within 7 days, after which they began to use B&B MGs. All athletes used protective mouthguards for the period advised and continue to use them.

For the group of four subjects (4 teeth in total) belonging to the LF group (combination of luxation and crown fractures) as well as in the LF/F group of five subjects (11 teeth involving combinations of luxation with crown fractures and crown fractures only in other teeth), the following was noticed: due to the application of orthodontic splints in all cases of extrusive and intrusive luxation, return to sports activity was always between seven and 14 days after the trauma.

In all cases, subjects used a self-adapted B&B. n.g mouthguards. MGs are also advised for subjects with mature dento-alveolar growth in order to allow them to be modified and re-adapted [Spinas and Savasta, 2007], in cases of movement induced by fixed orthodontic appliances.

All athletes used these protective devices and continued to do so for the period recommended.

The last group consisting of three subjects and three teeth in total (Group L, teeth manifesting luxation or avulsion) required between 7 and 14 days of recovery time, with the exception of 2 cases (2 teeth) that required replanting, where 14 days were needed. The continuous use of self-adapted B&B MGs was recommended in all these cases.

Replacements of a injured tooth with an implant should not take place before the age of 18-20, when the skeleton and alveolar bone will have reached full maturity [Barrett and Kenny, 1997].

By the end of the five-year follow-up period, 16 of the 20 of the athletes in the study had begun and maintained the habit of using a MG when practicing their sport. This is a highly significant piece of data and confirms the results of previous studies [Spinas et al., 2014] which showed that a high percentage of subjects who have suffered TDIs use mouthguards regularly, as do those who are constantly reminded to do so and who may cease to use them if not given motivational reinforcement.

Out of the 16 MGs utilised (2 subjects continue to use a B&B MGs), 14 were the custom-made produced using the signature technique (DREVE Dentamid- Unna-Germany) [Dorney B, 1994] and Play safe (Glidewell, Canada, and Erkodent, Germany, Erich Kopp GmbH, Pfalzgrafenweiler, Germany) [Dorney, 1994].

The number of complications or recurrences at the end of the 5 year follow-up period in the group who had sustained traumas, specifically 5 cases of necrosis that occurred in subluxated teeth, two teeth with acute intrusion and two avulsed teeth, were no different in percentage to those normally expected in a group of injured subjects of the same age and sex affected by the same type of traumatic injuries that were not the result of sports [Lam, 2016].

It should be pointed out that the 3 teeth which three years after the trauma started to show signs of pulp canal obliteration could not be considered as complications (the initial trauma had caused extrusive luxation of the three teeth), as there were no pulp pathologies or functional anomalies [Oginni et al., 2009].

Statistical discussion

Statistical analysis showed that none of the variables listed in Table 4 are associated with the sport's risk factor, possibly due to the limited sample size. Another point taken into account was the association between the number of teeth involved and the sport's level of risk. In this case, we calculated the average number of teeth involved: 1.6 teeth for athletes who practiced medium-risk sports and 2.0 teeth for athletes who practiced high-risk sports. Due to the sample size, the comparison of the average number of teeth involved in the two groups was carried out using a non-parametric test (Wilcoxon test). The result (data not shown) indicated that there is no statistical evidence to reject the hypothesis that the ratios remain the same in the two groups.

Conclusion

The study examines treatment options for a group of young athletes who had all sustained a TDI while engaged in a sports activity. The long follow-up period showed that an accurate classification of the injuries and their immediate treatment in respect of standard protocols (IADT) ensured that the subjects could return to sports activities rapidly without affecting the athletes' performance levels.

What emerges from the study is the normal progress in the recovery time for the sustained injuries, with few complications or delays in rehabilitation. There were no discernible differences in recovery time between males and females.

It can be noticed that the athletes who regularly used mouthguards while competing during the recovery period did not suffer any recurrences of injuries or further complication. The use of MG continued after the treatment period.

It will certainly be useful in the future to undertake a new study using a larger sample in order to confirm the obtained results, and to encourage the use of MGs as an indispensable preventive measure to avoid the risk of traumatic dental injuries, especially in adolescents.

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