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# Dental injuries in mountain biking – a survey in Switzerland, Austria, Germany and Italy

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**Abstract** –Mountain biking is considered an extreme sport, causing not only head and neck injuries, but also injuries to every part of the body. Using standardised interview, the aim of this work was to survey the frequency of dental injuries in mountain biking, as well as the behaviour of athletes after experiencing dental trauma, depending on their intensity level. Furthermore, habits of wearing helmets and mouthguards as well as knowledge about the tooth rescue kit were investigated. A total of 423 male mountain bikers from Germany, Italy, Austria and Switzerland were surveyed for this study, including 50 juniors from Switzerland. 27 athletes (5.7%) had endured tooth accidents in mountain biking. Only 246 (52%) were aware of the fact that avulsed teeth can be replanted, and only 30 individuals knew about the tooth rescue kit (6.3%). 71.9% (n = 340) were familiar with mouthguards; however, only 21 individuals (4.4%) used mouthguards while mountain biking. The results show that where mountain biking is concerned, more information about prevention is required.

Accident-caused dental injuries are found in the permanent dentition of children and adolescents in 20–35% (1–5). Sport activities such as mountain biking, inline skating, skateboarding, and aggressive contact sports increase the risk of dental trauma (6). Upper incisors are the most predisposed teeth to injuries (52–90% of all trauma cases) because of their location. Most frequently uncomplicated crown fractures are experienced (44–62.5% of all dental trauma cases) (7–11).

Accidents with mountain bikes often cause injuries as a consequence of hard fall on uneven ground. Knee and skin injuries as well as injuries to shoulders and arms are frequently occurring (12). An Austrian study surveyed tooth and jaw injuries of 502 bicyclists and 60 mountain bikers (13). Cycling injuries amounted to 10.3% of all injuries, 31.0% of all sports injuries, and 48.4% of all traffic accidents. Mountain bikers suffered from 55.0% facial bone fractures, 22.0% dentoalveolar injuries and 23.0% soft tissue injuries. More serious injuries resulted from mountain biking than from cycling. The dominant fracture site in bicyclists was the zygoma (30.8%), whereas mountain bikers obtained impressive 15.2% Le Fort I, II and III fractures. Condyle fractures were more common in bicyclists with 18.8% as opposed to 10.8% in mountain bikers (13). As of date, no data regarding tooth injuries in mountain biking have been provided.

To some extent, wearing a mouthguard is regulated in the statutes of professional sports. However, for recreation and school sport activities, such recommendations are rare. In addition, it is discussed, whether it is possible to reduce not only dental trauma, but also severe injuries such as concussion, brain bleeding and injuries of the head and neck area by wearing a mouthguard (14–26). However, among athletes there are different reasons for not wearing a mouthguard. Most of them do not recognize the necessity of wearing one (27–32). Others anticipate problems in verbal communication, poor retention, breathing difficulties and disagreeable esthetics (6, 19, 21).

Mountain biking is commonly exercised in the countryside, with dental services being less available because of the distance. Therefore, in case of an avulsion, replantation may be delayed for several hours. Thus, cell-physiological storage of avulsed teeth is essential prior to replantation. Dry storage of avulsed teeth rapidly leads to cell death in the periodontal ligament adhering to the root. This process can only be slowed down and not altogether prevented by storage in certain media, such as milk, saline, or saliva. Thus, storage under such conditions is limited to short periods of time (33–37). Only special cell culture media like Dentosafe® (Medice, Iserlohn, Germany) maintain vitality and

proliferative capacity of the cells in the periodontal ligament for extended periods (36, 38). In a clinical study, immediate replantation, the extraoral maintenance (duration of dry or wet storage) as well as the maturity of the roots significantly aided periodontal healing in a multivariate analysis (39). Thus, the tooth rescue kit has to be rapidly available, whenever avulsions take place, to improve healing after replantation (40).

The aim of this work was to investigate the frequency of dental accidents in mountain biking, wearing habits of mouthguards, and knowledge about the tooth rescue kit Dentosafe® (38).

## Materials and methods

The data of 473 mountain bikers from Germany, Italy, Austria and Switzerland were surveyed by standardized interview. The questionnaires were analyzed on the basis of nation and intensity level (professional, amateur, junior) (Table 1). All juniors were Swiss, and their results were part of the Swiss data also in the international comparison. The interview contained 15 questions about tooth injuries, tooth replantation, awareness of the tooth rescue kit as well as habits of wearing a helmet and a mouthguard (Table 2). This questionnaire had already been used in previous studies on sports-related dental injuries and their prevention (29–32). The interviewer was always the same person who interrogated each athlete individually. Age, nation and intensity level of each athlete were recorded at the beginning of the investigation. The interviews took place at international mountain bike competitions in Switzerland without participation of foreign juniors. Level of statistical significance was set at $P < 0.05$. Statistical analyses were performed with the Fisher's Exact Test. (SPSS/WIN 13.0, SPSS Inc., Chicago, IL, USA).

*Table 1.* Interviewees in Switzerland, Austria, Germany and Italy

| | Prof./Semi-prof. | Amateurs | Juniors | Total |
|---|---|---|---|---|
| Switzerland | 53 | 55 | 50 | 158 |
| Austria | 53 | 54 | – | 107 |
| Germany | 50 | 54 | – | 104 |
| Italy | 51 | 53 | – | 104 |
| Total | 207 | 216 | 50 | 473 |

*Table 2.* Questionnaire

1. Have you ever suffered from a serious injury in mountain biking?
2. If yes, what kind of injury? (fracture, laceration, contusion, head injury, jaw fracture)
3. Have you ever suffered from a dental injury in mountain biking?
4. If yes, what kind of dental injury? (avulsion, fracture, dislocation)
5. Have you continued competition after the injury?
6. Have you visited a dentist?
7. When did you visit the dentist? (immediately, on the same day, after a day)
8. Have you ever observed a dental injury in mountain biking?
9. Are you aware that avulsed teeth have to be retrieved?
10. Are you aware that avulsed teeth can be replanted?
11. Do you know the tooth rescue kit? (Dentosafe®)
12. What kind of helmet do you wear? (normal helmet, helmet with lower jaw protection)
13. Do you know a mouthguard?
14. Do you wear a mouthguard?
15. If not, why? (not necessary, esthetics, breathing, communication, costs)

## Results

In this study, 158 Swiss athletes (including 50 juniors), 107 Austrians, 104 Germans and 104 Italians were surveyed. The average age altogether was 30.8 years (9–66 years). Out of 473 interviewed individuals, 251 (53.1%) experienced injuries (other than tooth injuries) caused by an accident related to mountain biking. Statistically significant differences could be determined between the intensity levels ($P < 0.0001$); professionals suffered more injuries (68.1%) than juniors (50.0%) or amateurs (39.4%). Also the comparison between nations showed statistically significant differences ($P = 0.005$); most injuries were noted in Austria (66.4%), least in Switzerland (44.3%).

Most common injuries were contusions (37.0%), lacerations (29.0%) and head injuries (11.0%). Of all questioned participants, 25.4% had witnessed mountain bike accidents resulting in dental trauma before. Twenty-seven individuals (5.7%) had experienced dental trauma themselves (Fig. 1). Two of the athletes had injured two teeth ($n = 29$): each of them one dislocation and one crown fracture. Juniors experienced more injuries ($n = 5$, 10.0%) than amateurs or professionals. However, no statistically significant differences were found between intensity levels ($P = 0.137$) or nations ($P = 0.486$).

Crown fractures were the most frequent tooth injury ($n = 20$, 4.2%, 11 in professionals, five in amateurs, four in juniors). Dislocations ($n = 5$, 1.1%, one in professionals, three in amateurs, one in juniors) and avulsions ($n = 4$, 0.8%, two in professionals, two in amateurs) occurred less. After tooth injury, 10 of 14 professionals (71.4%), five of eight amateurs (62.5%) and two of five juniors (40.0%) continued mountain biking despite the accident. Thirteen of them experienced a crown fracture and four a dislocation. All athletes who dislocated a tooth stopped the exercise or competition immediately.

To the question 'Are you aware that avulsed teeth can be replanted?' 246 individuals (52.0%) answered yes. Only minor differences were found: amateurs were informed slightly better (118/216, 54.6%) than juniors (26/50, 52.0%) or professionals (102/207, 49.3%). Only 30 bikers (6.3%) were aware of the tooth rescue kit, whereas 443 individuals (93.7%) were not. German athletes were better informed than the others with 10.6% being aware of the kit in comparison to 8.4% of the Austrians, 4.4% of the Swiss and 2.9% of the Italians.

Not all athletes visited a dentist after their dental accident (Fig. 2). No statistical differences were noted considering intensity levels and nations ($P = 1$, $P = 0.185$). Only two professionals (14.3%), four amateurs (50.0%) and two juniors (40.0%) immediately went to see a dentist. All other injured athletes consulted a dentist with a 1-day delay at the most. Type of tooth injury proved important where the immediate consulta-

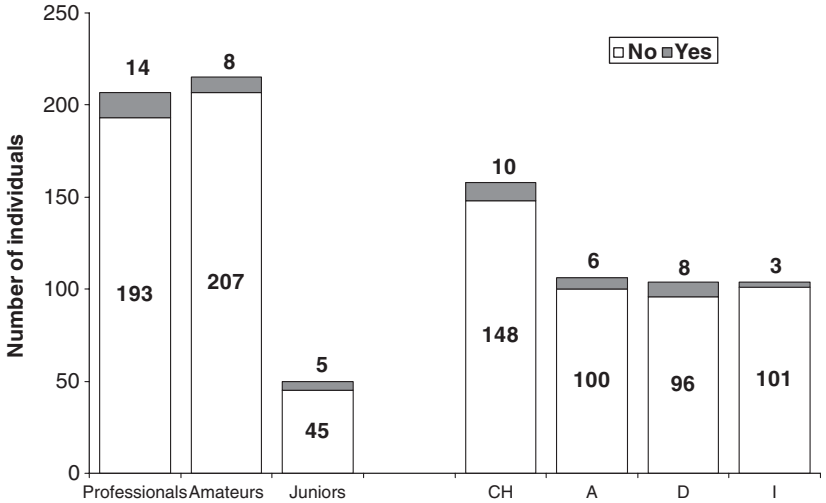


*Fig. 1.* Comparison of suffered tooth injuries according to intensity level and nation.

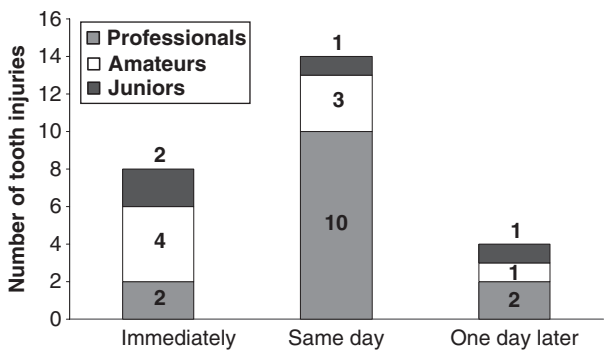


*Fig. 2.* Time that elapsed after accident when visiting a dental emergency unit depending on intensity level.

tion of a dentist was concerned: three of four athletes with an avulsed tooth immediately went to see a dentist. In comparison, only five of 20 crown fractures were shown to a dentist immediately after the accident, and none of the five athletes with dislocation (one in professionals, three in amateurs, and one in juniors) consulted a dentist.

The results on helmet design showed that helmets without jaw protection were used more commonly than helmets with jaw protection at all intensity levels (86.5%) ($P = 0.029$). A total of 340 athletes (71.9%) knew about mouthguards (Fig. 3). Depending on the intensity level, clear statistical differences were shown ($P < 0.0001$): 80.7% professionals, 66.2% amateurs and only 60% juniors were familiar with it. Only 21 of 473 individuals (4.4%) wore a mouthguard while mountain biking (Fig. 4). Most of them were professionals (7.2%), followed by juniors and amateurs. Furthermore, the comparison of the nations also showed statistically significant differences ($P = 0.006$): Germans used mouthguards most commonly (7.7%), whereas none of the Italians had. Most athletes were of the impression that a mouthguard is unnecessary during mountain biking (46.2%), and many believed that it would create breathing difficulties (38.3%) (Fig. 5). Disagreeable esthetics was seldom mentioned (6.8%).

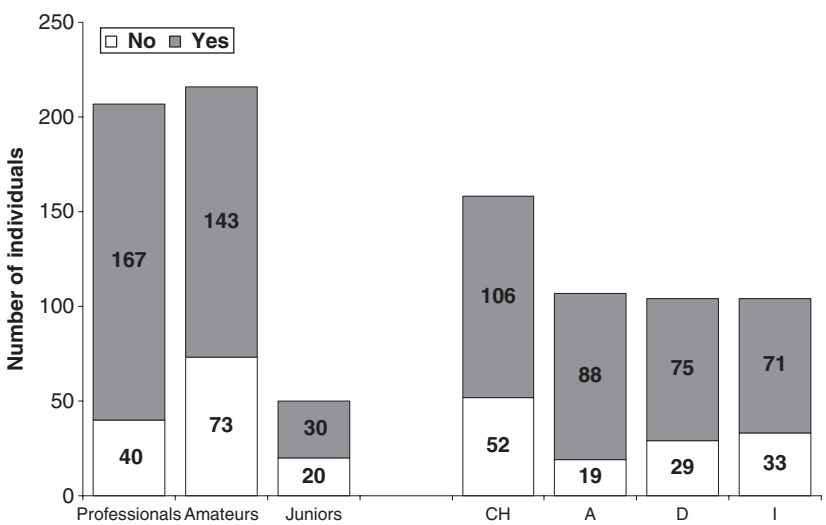


*Fig. 3.* Awareness of mouthguards according to intensity level and nation.

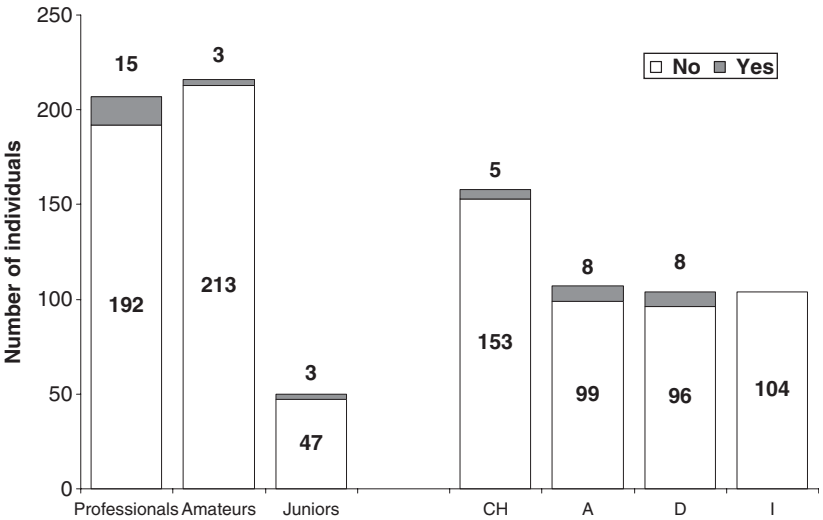


*Fig. 4*. Wearing habits of mouthguards according to intensity level and nation.

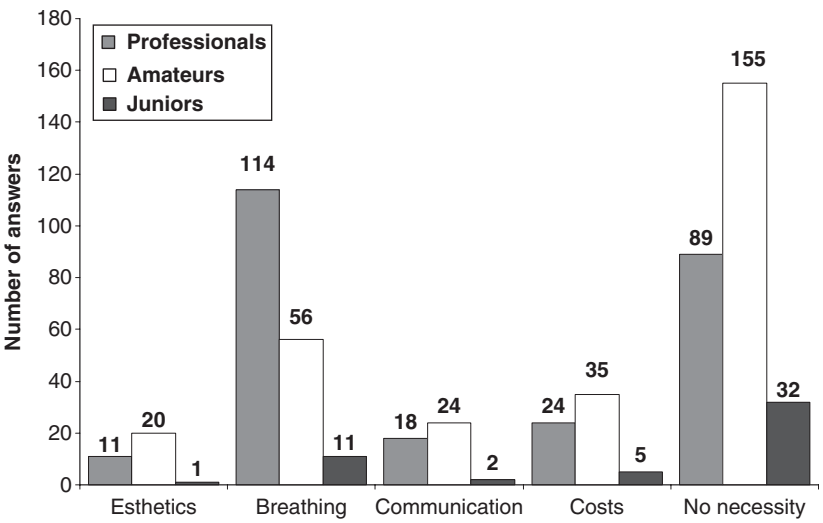


*Fig. 5*. Reasons for not wearing mouthguards at the different intensity levels.

## Discussion

This study focused on the frequency of mountain biking-associated orofacial injuries, as well as on the knowledge about and the use of mouthguards and tooth rescue kits. Although a fourth (25.4%) of the questioned individuals had already witnessed someone else experiencing dental trauma, and 27 individuals (5.7%) had already experienced tooth injuries themselves, only a minority (4.4%) used mouthguards. The most frequent reason given for not wearing a mouthguard was that the athletes had not yet acquired one (46.2%). Similar results were reported for other sports as well (29–32). Studies on sports showed that the attitude towards mouthguards changed after having experienced a dental accident (27, 28). However, this study could not confirm this among mountain bikers. Juniors experienced most tooth injuries (5/50, 10%) and were not as well informed about mouthguards as amateurs or professionals. Yet, preventive measures are especially necessary at this level. An astonishing finding was that juniors had experienced more dental trauma than professionals – the interviewed professionals were once young, and surely had been active for much longer periods of time than the juniors who participated. Nevertheless, this may be explained by the athletes forgetting tooth injuries they had experienced when they were young, or by them developing a more aggressive racing style in recent years (6). Additionally, the professionals had more frequently worn mouthguards, which may further explain these results.

Most of the professional athletes continued to participate in mountain bike competitions even after having experienced tooth injuries (71.4%). Only few athletes experienced avulsions (4/473, 0.8%), and those who did, stopped competing; three went to see a dentist immediately, one with some delay, but still on the same day. The necessity of treatment was obviously known. Regarding knowledge about replantation after avulsion, 246 athletes (52%) were aware of the fact that avulsed teeth can be replanted, 48% however were not. Amateurs were best informed (54.6%). Even juniors were better informed than professionals. To improve prevention and treatment outcomes of dental injuries, it would be of a great importance to fill these gaps of

information among athletes and coaching staff. Furthermore, the results of this study are even more disturbing when considering the existence of the tooth rescue kit ($n$ = 30/473, 6.3%). The best results came from Germany (10.6%) because of the fact that the tooth rescue kit was available there earlier than in Austria (8.4%) and in Switzerland (4.4%). On the other hand, because of its availability in every Austrian primary school, the Austrians were better aware of Dentosafe® than the Swiss participants. The tooth rescue kit is not yet available in Italy (awareness 2.9%). By supporting the preservation of cementoblasts, the tooth rescue kit plays the most important role in the tooth rescue chain and the success rate of replantation increases significantly (40). Mountain biking commonly takes place some distance away from dental services, which makes immediate consultation of a dentist impossible. The consequence of not knowing what to do with avulsed teeth is that they are likely to be transported in an unphysiological way leading to cell death and loss of a tooth. Sometimes teeth are even left behind at the place of injury (33–39).

The use of mouthguards should be enforced in all sport types facing a higher risk of orofacial injuries, such as mountain biking. National sport associations, dentists, and sport functionaries should commit to the challenging task of informing athletes about the necessity of tooth protection. Awareness of mouthguards and their frequent use can effectively reduce dental accidents or improve their treatment outcomes in mountain biking and possibly in other sports as well.

## References


1. Andreasen JO, Andreasen FM. Dental traumatology. Quo vadis. Endod Dent Traumatol 1990;6:78–80.
2. Kaste LM, Gift HC, Baht M, Swango PA. Prevalence of incisor trauma in persons 6–50 years of age: United States, 1988–1991. J Dent Res 1996;75:696–705.
3. Petti S, Tarsitani G. Traumatic injuries to anterior teeth in Italian schoolchildren: prevalence and risk factors. Endod Dent Traumatol 1996;12:294–7.
4. Borssen E, Holm AK. Traumatic dental injuries in a cohort of 16-year-olds in northern Sweden. Endod Dent Traumatol 1997;13:276–80.
5. Hamilton FA, Hill FJ, Holloway PJ. An investigation of dentoalveolar trauma and its treatment in an adolescent population. Part 1: the prevalence and incidence of injuries and the extent and adequacy of treatment received. Br Dent J 1997;182:91–5.
6. Bemelmanns P, Pfeiffer P. Häufigkeit von Zahn- Mund- und Kieferverletzungen und Bewährung von Mundschutzen bei Spitzensportlern. Sportverletz Sportschaden 2000;14:139–43.
7. Zerman N, Cavalieri G. Traumatic injuries to permanent incisors. Endod Dent Traumatol 1993;9:61–4.
8. Bastone EB, Freer TJ, Mc Namara JR. Epidemiology of dental trauma: a review of the literature. Aust Dent J 2000;45:2–9.
9. Rajab LD. Traumatic dental injuries in children presenting for treatment at the Department of Pediatric Dentistry, Faculty of Dentistry, University of Jordan, 1997–2000. Dent Traumatol 2003;19:6–11.
10. Tapias MA, Jimenez-Garcia R, Lamas F, Gil AA. Prevalence of traumatic crown fractures to permanent incisors in a childhood population: Mostoles, Spain. Dent Traumatol 2003;19:119–22.
11. Tovo MF, Dos Santos PR, Kramer PF, Feldens CA, SariI GT. Prevalence of crown fractures in 8–10 years old schoolchildren in Canoas, Brazil. Dent Traumatol 2004;20:251–4.
12. Kronisch R, Rubin A. Traumatic injuries in off-road-bicycling. Clin J Sport Med 1994;4:240–4.
13. Gassner R, Tuli T, Emshoff R, Waldhart E. Mountainbiking – a dangerous sport: comparison with bicycling on oral and maxillofacial trauma. Int J Oral Maxillofac Surg 1999;28:188–91.
14. Stenger JM, Lawson EA, Wright JM, Ricketts J. Mouthguards: protection against shock to head, neck and teeth. J Am Dent Assoc 1964;69:273–81.
15. Chapman PJ. The prevalence of orofacial injuries and use of mouthguards in Rugby Union. Aust Dent J 1985;30: 364–7.
16. Garon MW, Merkle A, Wright JT. Mouthprotectors and oral trauma: a study of adolescent football players. J Am Dent Assoc 1986;112:663–5.
17. Kerr IL. Mouthguards for prevention of injuries in contact sports. Sports Med 1986;3:415–27.
18. Mc Nutt T, Shannon SW, Wright JT, Feinstein RA. Oral trauma in adolescent athletes: a study of mouth protectors. J Pediatr Dent 1989;11:209–13.
19. Johnsen DC, Winters JE. Prevention of intraoral trauma in sports. Dent Clin North Am 1991;35:657–66.
20. Scheer B. Prevention of dental and oral injuries. In: Andreasen JO, Andreasen FM, editors. Textbook and color atlas of traumatic injuries to the teeth. Copenhagen: Munksgaard; 1994. p. 719–35.
21. Scott J, Burke FJ, Watts DC. A review of dental injuries and the use of mouthguards in contact team sports. Br Dent J 1994;176:310–4.
22. Flanders RA, Baht M. The incidence of orofacial injuries in sports: a pilot study in Illinois. J Am Dent Assoc 1995;126: 491–6.
23. Diab N, Mourino AP. Parental attitudes toward mouthguards. Pediatr Dent 1997;19:455–60.
24. Mischkowski RA, Zöller JE. Mundschutz zur Vorbeugung von sportbedingten Zahn-, Mund- und Kieferverletzungen. Sportverletz Sportschaden 1998;12:152–61.
25. McCrory P. Do mouthguards prevent concussion? Br J Sports Med 2001;35:81–2.
26. Labella CR, Smith BW, Sigurdsson A. Effect of mouthguards on dental injuries and concussions in college basketball. Med Sci Sports Exerc 2002;34:41–4.
27. Bolhuis JH, Baarda DB, Leurs JM, Flögel GE. Dental and facial injuries in international field hockey. Br J Sports Med 1987;21:174–7.
28. Yamada T, Sawaki Y, Tomida S, Tohnai I, Ueda M. Oral injury and mouthguard usage by athletes in Japan. Endod Dent Traumatol 1998;14:84–7.
29. Lang B, Pohl Y, Filippi A. Knowledge and prevention of dental trauma in team handball in Switzerland and Germany. Dent Traumatol 2002;18:329–34.
30. Perunski S, Lang B, Pohl Y, Filippi A. Level of information concerning dental injuries and their prevention in Swiss basketball – a survey among players and coaches. Dent Traumatol 2005;21:195–200.
31. Persic R, Pohl Y, Filippi A. Dental squash injuries – a survey among players and coaches in Switzerland, Germany and France. Dent Traumatol 2006;22:231–6.
32. Fasciglione D, Persic R, Pohl Y, Filippi A. Dental injuries in inline skating – level of information and prevention. Dent Traumatol 2007;23:143–8.
33. Blomlöf L, Otteskog P. Viability of human periodontal ligament cells after storage of monkey teeth in milk or saliva. Scand J Dent Res 1980;88:436–40.
34. Doyle DL, Dumsha TC, Sydiskis RJ. Effect of soaking in Hank's balanced salt solution or milk on PDL cell viability of

dry stored human teeth. Endod Dent Traumatol 1998;14:221–44.
35. Huang SC, Remeikis NA, Daniel JC. Effects of long-term exposure of human periodontal ligament cells to milk and other solutions. J Endod 1996;22:30–3.
36. Trope M, Friedman S. Periodontal healing of replanted dog teeth stored in Viaspan, milk and Hank's balanced salt solution. Endod Dent Traumatol 1992;8:183–8.
37. Pettiette M, Hupp J, Mesaros S, Trope M. Periodontal healing of extracted dogs' teeth air-dried for extended periods and soaked in various media. Endod Dent Traumatol 1997;13:113–8.
38. Pohl Y, Tekin U, Boll M, Filippi A, Kirschner H. Investigations on a cell culture medium for storage and transportation of avulsed teeth. Aust Endod J 1999;25:70–5.
39. Andreasen JO, Borum MK, Jacobsen HL, Andreasen FM. Replantation of 400 avulsed permanent incisors. 4. Factors related to periodontal ligament healing. Endod Dent Traumatol 1995;11:76–89.
40. Pohl Y, Filippi A, Kirschner H. Results after replantation of avulsed permanent teeth. II. Periodontal healing and the role of physiologic storage and antiresorptive-regenerative therapy (ART). Dent Traumatol 2005;21:93–101.