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Ich bedanke mich bei den unten aufgeführten Kolleginnen und Kollegen für ihre wertvolle Mitarbeit, die sie in den vergangenen drei Jahren geleistet haben.

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# Facial and Dental Injuries in Karate

A Survey of Fighters in Europe

#### KEYWORDS

facial trauma,  
 dental trauma,  
 karate,  
 mouthguard,  
 tooth rescue box

#### SUMMARY

Karate is a martial art that carries a high trauma risk. Trauma-related Swiss and European karate data are currently unavailable. This survey seeks to increase knowledge of the incidence of traumatic facial and dental injuries, their emergency management, awareness of tooth rescue boxes, the use of mouthguards and their modifications. Interviews were conducted with 420 karate fighters from 43 European countries using a standardized questionnaire. All the participants were semi-professionals. The data were evaluated with respect to gender, kumite level (where a karate practitioner trains against an adversary), and country. Of the 420 fighters

interviewed, 213 had experienced facial trauma and 44 had already had dental trauma. A total of 192 athletes had hurt their opponent by inflicting a facial or dental injury, and 290 knew about the possibility of tooth replantation following an avulsion. Only 50 interviewees knew about tooth rescue boxes. Nearly all the individuals interviewed wore a mouthguard ( $n = 412$ ), and 178 of them had made their own modifications to the guard. The results of the present survey suggest that more information and education in wearing protective gear are required to reduce the incidence of dental injuries in karate.

## Introduction

Sports injuries are common, especially in fast sports, and close body contact can cause facial and tooth injuries. Approximately 10–15% of all dental injuries occur during sporting activities, and the most common dental injury associated with sports is a crown fracture (PERUNSKI ET AL. 2005, STESEVIC & FILIPPI 2012). The avulsion of a permanent tooth is one of the most severe dental injuries. The prognosis after tooth replantation depends on the extraoral time and the storage conditions (KENNY ET AL. 2001, FLORES ET AL. 2007, KIRSCHNER ET AL. 2006). The tooth rescue box provides ideal conditions for the temporary extraoral, physio-

logical storage of avulsed teeth and can prolong the time between occurrence of injury and replantation without compromising the prognosis. Thus, such boxes should be available in every karate dojo (training hall) especially during tournaments. The storage medium is an important link in the rescue chain and in cases of avulsion. Placement in a suitable storage medium is the most appropriate action at the scene of the accident, resulting in a better prognosis for the avulsed teeth. Several studies have shown that this first-aid equipment is not well known to sports participants (MERZ ET AL. 2011). If worn, mouthguards can reduce or prevent most sports accidents

affecting the teeth. In many contact sports, such as karate, mouthguards are part of the protective gear. In general, the risk of a serious injury while engaged in a sport is not very high (BIRRER & HALBROOK 1988). American football, ice hockey, and rugby, however, are high-risk sports associated with facial trauma (EMSHOFF ET AL. 1997, HILL ET AL. 1998, MALADIÈRE ET AL. 2001). The available data show a prevalence of facial injury of 80% in combat sports, mostly occurring during kickboxing (SHIRANI ET AL. 2010). Nose and tooth trauma are the most common facial injuries (TELFER ET AL. 1991, BIRRER 1996, GARTLAND ET AL. 2001, ZAZRYN ET AL. 2003, MOUROUZIS & KOUMOURA 2005). Other studies report the same finding: that craniomaxillofacial injuries in sports players are very common (EMSHOFF ET AL. 1997, GARTLAND ET AL. 2001, ZAZRYN ET AL. 2003, KAZEMI ET AL. 2005, KAZEMI & PIETER 2004). ZETARUK ET AL. (2005) reported a 30% injury rate in practitioners of Shotokan karate (a particular style of karate), with 9.6% of the injuries affecting the head region (ZETARUK ET AL. 2000, 2005).

The World Karate Federation modified the rules for karate competitions in 2000, with the intention of decreasing the injury rate (WFK 2013). MACAN ET AL. (2006) compared the injury rates before and after the rules were modified. They found a similar incidence before 2000, but the relative risk of injuries was significantly higher in 1997 (under the old rules). They also observed that the incidence of head injuries was significantly higher under the old regulations (MACAN ET AL. 2006). This result shows that the new rules for kumite fights play an essential role in preventing head injuries. The present survey was intended to increase knowledge of the incidence of traumatic facial and dental injuries, their emergency management, awareness of tooth rescue boxes, and use of mouthguards and their modifications among kumite karate fighters.

## Materials and Methods

### Data

Karate fighters (kumite) from 43 European countries were interviewed (at the 2nd Swiss Karate League in Liestal, Switzerland, from 16–17/4/2011, and the 46th Karate European Championship, held in Zürich, Switzerland, from 6–8/5/2011). Participants in the two largest tournaments in Switzerland were selected, and the individuals were chosen by availability. Each interviewee was questioned separately using a standardized questionnaire (Tab. I) in one of three languages (English, French, or German). The same interviewer conducted the study at both tournaments. The interview contained 17 questions (Tab. I). Similar questionnaires have been used in previous surveys (LANG ET AL. 2002, PERUNSKI ET AL. 2005, PERSIC ET AL. 2006, FASCIGLIONE ET AL. 2007, MÜLLER ET AL. 2008, MAXÉN ET AL. 2011, HERSBERGER ET AL. 2012). Discussions in a group were excluded, and an identical study design was created. This type of survey results in a mixture of quantitative and qualitative data.

### Statistical analysis

The statistical evaluation differentiated between gender (male/female), kumite level (low = 1–2 kumite training sessions/week; medium = 3–4 kumite training sessions/week; high = more than 4 kumite training sessions/week), and origin (Swiss/European countries).

To compare categorical variables, the values in the cross-tabulations are reported as counts and percentages, and p values were calculated by either the chi-square test or Fisher's exact test (for small counts). The level of significance was set at

**Tab. I** Questions in the questionnaire

1.	Sex
2.	Age
3.	Country
4.	How many times per week do you perform kumite (1–2×, 3–4×, or more)?
5.	How many fights do you have (per week, month, and year)?
6.	Since when have you been participating in this sport?
7.	Since when have you been participating in competitions?
8.	Have you ever experienced a facial injury?
9.	If yes, what type of facial injury (e.g., nose, orbital, or cheek-bone fractures and lip injuries)?
10.	Have you ever experienced a dental injury?
11.	If yes, what type of dental injury (e.g., avulsion, crown fracture, or dislocation)?
12.	Have you inflicted a facial or tooth injury to your rival?
13.	If yes, what type of injury?
14.	Imagine your tooth being knocked out. Do you know that replanting an avulsed tooth is possible?
15.	Do you know about tooth rescue boxes (e.g., Dentosafe®)?
16.	What type of mouthguard do you wear (e.g., stock, mouth-formed, or dentist-made)?
17.	Have you ever manipulated your mouthguard (e.g., cut the mouthguard with scissors)?

$p < 0.05$ . Because of the descriptive nature of the study, adjustment for multiple comparisons was omitted. All the analyses were performed using R version 2.15.1 (R DEVELOPMENT CORE TEAM 2011, VIENNA, AUSTRIA).

## Results

The survey included data collected from 420 karate fighters from 43 European countries. The average age of the participants was 19.5 years. All the competitors were in the same division and were semi-professionals.

A total of 240 male and 180 female participants completed the interview. Participants in the two largest tournaments in Switzerland were selected, and the individuals were chosen by availability. When asked “Have you ever experienced a facial injury yourself during karate?”, 213 of the 420 respondents answered “yes”, and 207 answered “no”. Of the 213 reported injuries, 57 were lesions of the nose, 17 were orbital injuries, 3 were cheekbone lesions, 63 were lip wounds, and 3 were mouth injuries (Tab. II). There were no statistically significant differences between male and female athletes, but the comparison of the three kumite levels showed that athletes competing at a higher kumite level suffered from more nose and lip injuries than the rest of the athletes ( $p = 0.001$  for nose injuries,  $p = 0.036$  for lip injuries). To the question “Have you ever experienced a dental injury yourself during kumite?”, 44 fighters replied “yes”, and 376 replied “no”. Of these 44 injuries, 4 were avulsions, 26 crown fractures, and 14 con-

**Tab. II** Classification of facial and dental trauma

Experienced facial injuries: n = 213	Experienced dental injuries: n = 44	Injuries to rivals (facial and dental): n = 192
<b>Type of injury:</b> 3 mouth 3 cheekbone 17 orbit 57 nose 63 lip	<b>Type of injury:</b> 4 avulsions 14 concussions 26 crown fractures	<b>Type of injury:</b> 1 brain concussion 2 cheekbone 4 mouth 14 orbit 44 lip 73 nose

**Tab. III** Type of mouthguard according to citizenship (CH: Switzerland, EU: European countries, 8 kumite fighters wore no mouthguard, n = 8 [1.9%])

Mouthguard	Stock n = 61	Mouth-formed n = 287	Dentist-made n = 64
	52.5% CH	57.8% CH	40.6% CH
	47.5% EU	42.2% EU	59.4% EU

cussions (Tab. II). Overall, 192 of the athletes interviewed admitted that they had hurt their opponent (inflicting a facial or tooth injury) during a karate fight. The reported injuries to an opponent were: 1 concussion, 2 cheekbone injuries, 4 mouth injuries, 14 orbital injuries, 44 lip wounds, and 73 nose injuries (Tab. II). Statistically relevant injuries were orbital injuries ( $p = 0.015$ ), which occurred more often in men than women. Mouth injuries occurred most frequently among fighters at the high kumite level ( $p = 0.04$ ).

Additionally, 69% of all participants knew that an avulsed tooth could be replanted, but only 12% of the participants were aware of the tooth rescue box. A mouthguard was nearly always worn (98.1%). Nevertheless, eight participants (1.9%) indicated that they did not wear a mouthguard. The most frequently worn mouthguards were mouth-formed (69.7%), followed by dentist-made (15.5%) and stock (14.8%) mouthguards (Tab. III). There was a difference in type of mouthguard worn between athletes from Switzerland and those from the EU ( $p = 0.042$ ). The Swiss athletes wore more stock and custom-made and fewer dentist-made mouthguards than their foreign colleagues. Another statistically significant difference ( $p = 0.046$ ) was related to the kumite levels of the athletes; specifically, more of the the middle-level athletes wore mouthguards (all types). In response to the last question "Have you ever manipulated your mouthguard?", 42.4% of the karate fighters admitted freely adjusting their mouthguard, for example by cutting the posterior part so that just the anterior segment of the jaw is covered. Swiss participants reported statistically significantly more modifications than the EU fighters ( $p \leq 0.001$ ).

## Discussion

The present survey shows that half of the karate fighters interviewed had suffered a facial injury (incidence 50.7%) during their sports career. The incidence was 0.02% per year of low- and medium-intensity training, in the high-intensity training group it was 0.03% per year (R DEVELOPMENT CORE TEAM 2013, VIENNA, AUSTRIA). Karate carries a high risk of facial injury. Data from other surveys have shown a similarly high prevalence of facial injuries in combat sports and martial arts (BIRNER 1996, GARTLAND ET AL. 2001, KAZEMI ET AL. 2005). Of all facial injuries,

not only those incurred during sports, dental injuries are the most common (PETERSSON ET AL. 1997). Furthermore, 1–16% of all dental injuries are avulsions (GLENDO ET AL. 1996). In this study, dental injuries were less frequent than facial injuries (10.5%). Karate is associated with a medium risk of dental injuries. Crown fractures were the predominant type of dental injury (60%); avulsions (9%) and dislocations (31%) occurred less frequently. However, injuries causing severe damage to the periodontal ligament lead to an increased risk of tooth loss due to root resorption (FILIPPI ET AL. 2000) or ankylosis as dental post-traumatic sequelae. The fact that the mouthguard is part of the protective gear certainly reduces the incidence of dental injury. Nevertheless, eight respondents indicated that they did not wear a mouthguard. Many studies have found mouthguards to be quite unpopular (STESEVIC & FILIPPI 2012) owing to the resulting difficulty in communicating during sports, breathing problems (FRANCIS & BRASHER 1991), and the fact that they are not aesthetically appealing (LANG ET AL. 2002). However, if there are rules regarding mouthguard usage, everybody should follow them, which was not the case in the present survey. It is possible that the estimated proportion of athletes who do not wear mouthguards is much higher than 1.9%. Another finding that gives cause for concern is the incidence of mouthguard modifications made by the respondents: although this is not recommended, 42.4% of respondents admitted to modifying their mouthguard. A factor that this survey did not investigate was the type of modifications made to mouthguards, which would have been interesting to assess. The respondents stated that they feel more comfortable if the mouthguard covers just the front of the jaw, which is a modification that a referee would deem acceptable. Many participants did not believe that a mouthguard properly protected the teeth and jaw, and they thought that only the anterior teeth were at risk. Swiss fighters adjusted their mouthguards twice as often as the other European competitors. This adjustment may considerably diminish the protective effect of mouthguards (LANG & FILIPPI 2003). Additionally, the coaches and all the Swiss karate fighters should receive proper information regarding the correct use of mouthguards. The information received by our foreign colleagues appears to be better, and dentist-made mouthguards predomi-

nated in this group. One of the reasons for this finding could be the lower cost of dentist-made mouthguards. Multilayer mouthguards, which are made by dentists, protect the teeth and jaw the best and address all the previously reported problems, thus improving speech, breathing, and aesthetics.

The awareness of the tooth rescue box was a poor 12% (n = 50), although 69% (n = 290) of the respondents knew that an avulsed tooth could be replanted. The avulsion of a permanent tooth is a serious dental trauma. Replantation is the treatment of choice in most cases, but cannot always be performed immediately. If the avulsed tooth is correctly stored in a rescue box, the periodontal ligament (PDL) cells on the root surface may survive, thus allowing more time to contact a specialist. The tooth rescue box is a cell nutrient medium without antibiotics. Such boxes are available in most pharmacies without a prescription and have a shelf life of up to three years at room temperature (POHL ET AL. 1999, FILIPPI ET AL. 2008, MERZ ET AL. 2011). In the present survey, the questionnaire asked only about the tooth rescue box, because this box is the best way to store a tooth (the initial box allows storage for 25–30 h, with the possibility of using a second box for storage up to 2–3 days). Another possibility is to store the tooth in cold milk for a couple of hours (2 h). Saline solution, saliva, and tap water are not recommended because the survival of the PDL cells on the tooth surface in these media is not assured.

Compulsory protective equipment, as mandated by the World Karate Federation, includes mitts (one contestant wearing red and the other wearing blue), mouthguards, chest protectors for women, shin pads, and foot protection. Groin guards are not mandatory. The use of protective devices has been found to be highly beneficial: in sports in which their use is mandatory, a marked decrease in injuries has been reported (KERR 1986, FLANDERS 1995, YAMADA ET AL. 1998, WOODMANSAY 1997).

The limitations of the present survey are that, as in other studies, the data were collected using questionnaires and self-reported answers can be quite unreliable. The results should therefore be interpreted with caution. Furthermore, the potential value of the study is limited by the low frequency of injuries, especially avulsions (n = 4).

## Conclusion

The purpose of the present survey was to increase knowledge of the incidence of traumatic facial and dental injuries and their emergency management, assess awareness of tooth rescue boxes, and the use of mouthguards and their modifications in kumite karate fighters. Facial injuries were found to occur frequently, whereas dental trauma occurred less often. Although nearly all the individuals interviewed wore a mouthguard while fighting, many of them reported having made their own modifications, which reduced protective efficacy. The awareness of tooth rescue boxes was unsatisfactory; however, the appropriate actions that should be taken after avulsion were correctly reported by most of the respondents. Karate (kumite) carries a high risk of facial trauma and a medium risk of dental trauma.

The results of the present survey suggest that more information and education about wearing protective gear are required to reduce the incidence of dental injuries while practising karate.

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## Conflict of interest

The authors declare no conflicts of interest.

## Résumé

Le karaté est un art martial qui comporte un haut risque dans le domaine des traumatismes dentaires. Des données statistiques suisses et européennes pour le karaté ne sont malheureusement pas disponibles à ce jour. Cette enquête vise à analyser la fréquence des traumatismes cranio-dentaires dans ce sport. En même temps, les connaissances des traumatismes dentaires, leur gestion en urgence, l'utilisation des boîtes de secours dentaires ainsi que l'utilité des protège-dents et leurs modifications ont été évaluées. 420 karatékas de 43 pays européens ont été questionnées au moyen d'un questionnaire standardisé. Tous les participants sont des semi-professionnels. Les données ont été analysées en relation du sexe, du niveau de kumite et du pays d'origine. Des 420 combattants questionnés, 213 avaient subi un traumatisme facial et 44 ont déjà eu un traumatisme dentaire. Un total de 192 athlètes avait blessé leurs adversaires au visage ou aux dents. 290 connaissaient la possibilité de la réimplantation dentaire après avulsion. Seulement 50 personnes étaient au courant des boîtes de secours dentaires. Presque toutes les personnes interrogées portent un protège-dents (n = 412), dont 178 avaient fait leurs propres modifications. Les résultats de la présente étude suggèrent que plus d'informations et d'éducation sont nécessaires pour réduire les blessures dentaires liées au karaté.

## Zusammenfassung

Karate ist eine Kampfsportart, die ein hohes Traumarisiko birgt. Derzeit existieren keine schweizerischen und europäischen Daten über Unfälle beim Karate. Die vorliegende Arbeit hat zum Ziel, die Häufigkeit von unfallbedingten Gesichts- und Zahnverletzungen zu evaluieren. Ebenso wurden das Notfallmanagement, die Kenntnisse über die Zahnrettungsbox, die Verwendung von Zahnschutz und dessen Anpassungen untersucht.

Mithilfe eines standardisierten Fragebogens wurden 420 Karatekämpfer aus 43 europäischen Ländern befragt. Alle Teilnehmer waren semiprofessionelle Kämpfer. Die Daten wurden in Bezug auf das Geschlecht, Kumite-Level und die Herkunft ausgewertet. Von allen 420 befragten Kämpfern hatten sich 213 eine Gesichtsverletzung zugezogen, 44 Teilnehmer eine Zahnverletzung. Insgesamt haben 192 Athleten angegeben, ihren Gegnern eine Verletzung zugefügt zu haben, sei es dental oder fazial. 290 Befragte wussten um die Möglichkeit einer Replantation nach Avulsion. Nur 50 Personen kannten die Zahnrettungsbox. Fast alle befragten Personen haben einen Zahnschutz getragen (n = 412), 178 gaben offen zu, ihren zusätzlich selbst angepasst zu haben. Die Ergebnisse der vorliegenden Studie zeigen, dass mehr Information und Aufklärung über das Tragen der persönlichen Schutzausrüstung erforderlich sind, um das Auftreten von Zahnverletzungen im Karate zu reduzieren.

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