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An investigation on the radiological findings of dental and bone diseases related to jaw trauma in combat sports

Musa CON[1], Mehmet Yalcin TASMEKTEPLIGIL[1], Taner TUNC[2], Yesim DENIZ[3]

[1] *Ondokuz Mayis University Yasar Dogu Faculty of Sports Sciences, Samsun, Turkey.*
[2] *Ondokuz Mayis University Faculty of Art and Science, Department of Statistics, Samsun, Turkey.*
[3] *Ondokuz Mayis University Faculty of Dentistry Department of Oral and Maxillofacial Radiology, Samsun, Turkey.*
Address correspondence to M. Con, e- mail; musacon@omu.edu.tr

Abstract

This study was designed to examine the prevalence of previously experienced maxillofacial injuries in athletes engaging in combat sports and to investigate any possible radiologic findings of dental and bone pathology that can be caused by repetitive head (jaw) impacts. Thirty-two boxers and thirty-two taekwondo athletes and sex- and age-matched non-athletes control group participated in the study. A special questionnaire was used with questions on previously experienced maxillofacial trauma and mouthguard use. Temporomandibular dysfunctions were also examined. Panoramic radiographs of the athletes and control group were examined by two radiologists. Both athlete groups experienced significantly more dental ($p < 0.059$), temporomandibular joint (TMJ) ($p<0.05$) and nasal ($p<0.05$)injury than non-athletes. In addition, boxers experienced more TMJ ($p<0.05$)and nasal injury ($p<0.05$) than taekwondo players. Although most of the athletes (96.9%) wore mouthguards in sports competitions, few of them (9.4%) used the guards while training. Temporomandibular dysfunction (TMD) was mostly examined in combat sport athletes ($p<0.05$; $X^2=10.494$).There was no statistically significant difference between the athletes and the control group for the possible radiologic findings of dental and bone pathology that could be caused by the repetitive head (jaw) impacts on panoramic radiographs ($p>0.05$). Athletes engaging in combat sports, especially boxers, have significantly more maxillofacial injuries. Therefore, they should be educated to use more safety and protective guards not only in competitions but also in training to prevent maxillofacial injury. This is the first report of panoramic findings on dental and bone pathology that could be caused by repetitive head (jaw) impacts.

Keywords: Combat sports, maxillofacial injury, panoramic imaging, temporomandibular dysfunction, mouth guards.

INTRODUCTION

Widespread participation in sports around the world has produced an increase of sports-related injuries. In addition, athletes who take part in combat sports are more at risk than other types of athletes for experiencing trauma to the teeth, mandible, zygoma, and temporomandibular joint (TMJ)(5). In boxing, trauma is an integral component of the sport; therefore, it is accepted to be a high-risk sport for maxillofacial injuries. Taekwondo is a modern fighting sport. To contrast the two, boxing primarily involves head-oriented strikes, whereas taekwondo awards point for body shots(9).

A laboratory study (10) on the effects of taekwondo kicks on head injury measures recorded comparable head accelerations from the turning kick (72.8 ± 25.3 g) to head impacts in boxing (71.2 g) (32). Furthermore, subsequent research found that average impacts (130 g) of the turning kick far surpassed those reported in other sports (11). These head injury measures support earlier claims (25,26) of the dangers of head kicks in taekwondo and provide a reason to further investigate injury prevention interventions to ensure the safety of the athletes.

Due to the high rotational accelerations and resultant shear strain on the brain imparted to the head of boxers, it has been suggested that these athletes are at a higher predisposition to the long-term effects (i.e. chronic traumatic encephalopathy) of repeated head impacts (35). Recent medical reports (21,22) indicate that multiple heads blow in other sports may result in chronic traumatic encephalopathy, a pathology originally suggested to be exclusively present in boxing (35). Therefore, we aimed to examine if there were any long-term effects of repetitive blows to the maxillofacial structures,

such as dental/bone (jaw) changes and TMD, according to the number of years they had spent in boxing and taekwondo.

Panoramic radiography is a useful technique to show tooth anomalies/pathologies and soft tissue calcifications that can be attributed to previously experienced maxillofacial trauma (22). Some of these pathologies are stylohyoid ligament calcification (21), external/internal resorption (4), root dilaceration (23), hypercementosis (23), tooth/mandible fracture (36), and traumatic bone cyst (23).

Various studies have investigated different types of trauma to the oral and maxillofacial region sustained during sports, and a comparison of data from these different sports and organizations may vary (3,10,18,19,34). This study differs from the others in that it examines the long-term effects of the head (jaw) impacts to the maxillofacial structures.

To sum up, the aims of this study were to examine the prevalence of previously experienced maxillofacial injuries, mouth guard usage, and TMD in boxers and taekwondo athletes. Additionally, this study set out to investigate any possible radiologic findings of dental and bone pathology that could be caused by repetitive head(jaw) impacts experienced by athletes on panoramic radiographs and to compare the results with the control group of non-athletes.

MATERIAL & METHODS

Thirty-two boxers and 32 taekwondo athletes (who had trained for more than two years) and 64 sex- and age-matched control group members (none of the who were athletes) were examined in our Oral Diagnosis and Radiology clinic. Participants who were currently undergoing any type of orthopedic or orthodontic treatment or who suffered from systemic health diseases were excluded from the study.

A special questionnaire was answered directly by the athletes, and it addressed the following points:

1. Maxillofacial trauma: whether the athletes experienced maxillofacial injury such as dental, nasal, zygoma, and TMJ incidents while playing combat sports.
2. Mouth guard use (MG) during training and/or competitions and preferred type of MG.

TMD: The signs and symptoms of TMD were assessed. The athletes were classified into two categories based upon their responses: no signs or symptoms present (5), or at least one sign or symptom present (9).

Non-athletes only answered questions regarding prior experience with maxillofacial trauma and the signs and symptoms of TMD were assessed.

Intraoral and extraoral examinations were done. The panoramic radiographs were obtained with a digital panoramic device (65 kV, 5 mA; J. Morita MFG, Corp., Kyoto, Japan). Panoramic radiographs of the athletes and the control group were examined by two maxillofacial radiologists. Before reaching a consensus, the two radiologists independently evaluated all of the participants based on the checklists, and then they reviewed the images together to come to a final decision.

Evaluation of the digital images was carried out using software features such as filtering, contrast adjustment, and sharpness. All images were evaluated for the presence of position anomalies of the impacted teeth, eruption anomalies, idiopathic osteosclerosis (IO), pulp sclerosis/stones, root dilacerations, external/internal resorption, stylohyoid ligament calcification, hypercementosis, turner hypoplasia, tooth/mandible fracture, and traumatic bone cysts that could be caused by local pathologic changes or maxillofacial trauma.

IO was evaluated on the basis of the following criteria: 1: A well-defined radiopacity in the jaw bones located in the vicinity of sound teeth, near teeth with small restorations, or away from the teeth; 2: Round or elliptical shape and more than 3 mm in size; 3: No surrounding radiolucent rim(23).

Stylohyoid ligament calcification was investigated according to O'Carroll's classification (20). The results were analyzed according to the presence or absence of calcification or elongation.

The radiographs were examined for dilacerated teeth using Hamasha et al.'s criteria (15). For the statistical analysis, the proportion test, risk estimate, and chi-square test were conducted.

This study was approved by the Research Ethics Committee of Ondokuz Mayıs University in Samsun, Turkey (Number: B.30.2.ODM.0.20.08/732). The experiments reported in the manuscript were performed in accordance with the ethical standards of the Helsinki Declaration.

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RESULTS

Table 1 shows the comparison between the three groups in terms of trauma. There was no statistically significant difference between males and females regarding maxillofacial injury ($p<0.05$). Both athlete groups experienced significantly more dental ($p=0.013<0.059$), TMJ injury ($p=0.00<0.05$) and nasal injury ($p=0.00<0.05$) than non-athletes. In addition, boxers reported more TMJ ($p=0.039<0.05$) and nasal injury ($p=0.023<0.05$) than non-athletes. There was only one zygoma fracture, and it was experienced by a male boxer.

The question is findings of the boxers and taekwondo athletes are shown in Table 2. In this study, all of the athletes (100%) were aware of MG as a protective device. Although MG use is mandatory in sports matches, 96.9% of the athletes wore them in competitions and 9.4% used them while training. Most of them preferred to use type 2MGs (athletes: 80.0%; boxers: 90.6%, taekwondo athletes: 68.8%).

When comparing the athletes who presented at least one symptom of TMD to the control group, a statistically significant difference was found ($p=0.001<0.05$; $x^2=10.494$), and the incidence of TMD in athletes was 2.059 times more than that reported by non-athletes. However, no statistically significant difference between boxers and taekwondo athletes was found($p=0.451>0.05$).

Table 3 shows the possible panoramic radiographic findings of dental and bone pathology that can be caused by repetitive head (jaw) impacts like those experienced by boxers and taekwondo athletes. There was no evidence of turner teeth, hypercementosis, internal resorption, traumatic bone cyst, mandible fracture, etc. Eruption anomalies and external root resorptions were only seen in boxers.

No statistically significant differences between athletes and non-athletes and between boxers and taekwondo athletes and between males and females were found in position anomalies of the impacted teeth, osteosclerosis, pulp sclerosis, root dilaceration, and stylohyoid ligament calcification or elongation ($p>0.05$).

DISCUSSION

Most sporting exercises and disciplines are associated with certain health risks. The prevalence of facial trauma is high in combat sports (13,17,30). Sports accidents were responsible for six times as many facial injuries compared with work accidents, and they account for three times more injuries than violence or traffic accidents (33).

Table 1. Groups were compared in terms of prior severe trauma to the maxillofacial structures and also in regards to TMD.

Type of injury	Athletes						Non-athletes	
	Taekwondo		Boxing		Total		Total	
	n	%	n	%	n	%	n	%
Dental	12	37.5	10	31.3	22	34.4	9	14.1
Nose	9	28.1	18	56.3	27	42.2	5	7.8
TMJ	8	25.0	16	50.0	24	37.5	5	7.8
Zygoma	-	-	1	0.3	1	1.6	-	-
TMD	16	50.0	19	59.4	35	54.7	17	26.6

Table 2. Questionnaire findings of athletes who take part in boxing and taekwondo.

Features		Taekwondo athletes	Boxers	Total
Male		20	24	44
Female		12	8	20
Mean age		19.68	19.72	19.7
Mean age when starting sports		11.6	12.4	12,03
Using MG in competitions		30	32	62
Using MG during training		2	4	6
Preferred type of MG to use	Type 1	-	-	-
	Type 2	22	29	51
	Type 3	10	3	13

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Table 3. Radiographic findings of dental and bone pathology on panoramic radiographs of athletes and how they compare with the non-athletes group.

Radiographic findings	Athletes		Non-athletes
	Taekwondo	Boxing	
Position anomalies of the impacted teeth	6	5	19
Eruption anomalies	2	1	1
Osteosclerosis	2	4	4
Pulp sclerosis	11	5	18
Root dilaceration	3	2	5
External root resorption	-	2	1
Stylohyoid ligament calcification or elongation	8	9	21

The type of contact may be classified as direct contact with rival competitors (taekwondo, jiu-jitsu, kickbox, boxing, etc.), indirect contact with rival competitors (handball, basketball, football, soccer, ice hockey, etc.), and no contact with rival competitors (volleyball, badminton, etc.) during the sport activity. The reason why we chose taekwondo and boxing (direct contact with the rival competitors) was our curiosity about the difference types of contact to the maxillofacial area. The differences between boxing and taekwondo sports are that boxing is primarily a head-oriented striking event, whereas taekwondo has traditionally been a sport where points are principally awarded for body shots (9).

While athletes in both sports try to win by accumulating the most points or knocking out their opponent, there are distinctions between the two, such as round time constraints and impact mechanisms, which must be taken into consideration. The length of an Olympic boxing match may consist of up to three 3-minute rounds, while taekwondo typically includes three 2-minute rounds (37). El Ashker (8) found that a mean of 3.71 punches per minute was delivered to the other boxer's head by winners during Olympic boxing bouts, which amounts to 33.4 hits per match. In contrast, this number is three times less in taekwondo (16), which averaged 1.22 head blows every 60 seconds (7.32 each match). Sustaining head impacts repetitively can have deleterious effects for boxers, and these injuries are also well documented and supported in other sports, such as ice hockey (22) and American football (21). While the number of head impacts per competition in taekwondo is typically much lower than that for boxing, just one strike could produce severe head injury (6).

The prevalence of dental trauma varies based on the type of sport. Previous studies (3,18,19, 22,34) with different groups of athletes in different countries have demonstrated that sports-related dental trauma ranges from 8% to 44, 2%. In this study, both types of athletes experienced significantly more dental (34.4%), TMJ (37.5%), and nose injury (42.2%) than non-athletes ($p<0.05$). For boxing and kickboxing, broken noses appeared to be characteristic results from facial blows (7). In addition, this study foundthat56.3% of the boxers experienced sports-related nose injury, and50% of them had TMJ injury ($p<0.05$).While some studies have reported that males demonstrated a higher prevalence than females (14,28), in this study there was no statistically significant difference between genders ($p>0.05$).

MGs have been determined to be the most effective way of preventing dental injuries during sports. Three types of MGs are available: (i) stock MG;(ii) boil and bite MG and (iii) custom-made MGs made by dentists (27). Kececi et al. (18) reported that 44.12% of the athletes were aware of the different MG types in Turkey. In another study (34) mentioned that the overall MG using was 55,8%. In this study, all of the athletes (100%) were familiar with the MG as a protective device, and overall use of MGs in competitions reported among this sample was high (96.9%). This difference may be because of the high awareness of the mandatory requirement for MG and headgear usage in competitions in the last years.

The type and quality of MG may influence the athletes' compliance (12). Kececi et al. (18) reported that none of the athletes was aware of custom-made MGs made by a dentist for individual use in Turkey in 2005.Tulunoglu et al. (34) mentioned that all athletes were using type 2 MG. Among Pan American Games athletes, 42.6% used type 3, and 44.1% used type 2MGs (2). In this study most of the athletes (80%) preferred to use type 2MGs, and few of them (20.3%) used type 3 (custom-made)MGs, which may be due to the high costs of a custom-made MG. Unfortunately, only 9.4% of the athletes reported using MGs during training. However,

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maxillofacial injuries do not occur only during competitions. Up to 25–30% of these accidents take place during training sessions (29). Therefore, the use of MGs should be encouraged not only in competitions but also in training sessions, and its importance should be explained repeatedly by sports doctors.

According to data published by the American Dental Association in 1990, 44–99% of TMJ problems are caused by trauma(1). The significant force that is transmitted to the temporomandibular disc and supporting structures may result in severe injuries(31). In this study, a statistically significant difference was found between the athletes and non-athletes regarding the TMJ injury, and the athletes had more TMD than the control group ($p<0.05$). This result supports the finding (5) that athletes engaging in combat sports are more exposed to TMJ trauma. More safety and protective guards seem warranted to protect temporomandibular structures in athletes engaging in combat sports. In addition, taekwondo and boxer headgear manufacturers and sport governing bodies must consider improving the design of certain devices, especially anterior helmet properties (24).

Some dental anomalies/pathologies seen in radiographs can be attributed to trauma; Pulpal sclerosis is a form of calcification in the pulp chamber and the canals of teeth that may occur as a part of local pathologic changes. Dilaceration of a tooth is the result of mechanical trauma to the calcified portion of a partially formed tooth. Additionally, one of the etiologic factors of internal and external resorption is acute trauma to the tooth. Hypercementosis is the excessive deposition of cementum on the tooth roots. It has been occasionally associated with teeth that are in hyper occlusion or that have been fractured. Trauma-hemorrhage theory has many advocates for the widely used designation of a traumatic bone cyst. IO refers to a focal area of increased radiodensity (23). Although the term "idiopathic" describes the generally unknown etiology of this lesion, it is also possible that repetitive jaw impacts may increase the number of these dense bone islands. Therefore, we aimed to investigate any possible radiographic findings of dental and bone pathology that could be caused by repetitive impacts to the maxillofacial structures may result from a long-term effect of trauma experienced by boxers and taekwondo athletes by taking panoramic radiographs of these athletes and comparing them with non-athletes. However, we could not find any significant difference between the panoramic findings of athletes engaging in combat sports and non-athletes and also between the two groups of combat sports athletes.

In conclusion; combat sports athletes experienced significantly more dental, TMJ, and nasal injuries than non-athletes. Bowers sustained more TMJ and nose injuries than taekwondo athletes. Sports physicians and coaches should make a combined effort to encourage the use of MG in competitions and training. In addition, more safety and protective guards (headgear)should be worn if dental, TMJ, and nose injuries and TMD are to be prevented.

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