

ORIGINAL ARTICLE



Maxillofacial injuries among ice hockey players: a retrospective study from a Finnish trauma Centre

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ABSTRACT

Objective: Ice hockey players are at risk of a variety of injuries. In our investigation, we aimed to evaluate the types of facial fractures, injury mechanisms and need for surgical intervention in professional and recreational ice hockey players.

Material and Methods: This retrospective study included all patients presenting to a tertiary trauma centre with any ice hockey-related facial fracture during the period from January 2013 to July 2020. The primary outcome variable was the need for surgical treatment, and the primary predictor variable was the injury mechanism. Demographic and clinically relevant variables were statistically evaluated and presented.

Results: Of 66 total patients, the most frequent fracture type was isolated mandible fracture (56.1%). Males were overrepresented (98.5%) in the patient population. Puck strikes were the most common mechanism of injury (74.2%). Surgical intervention was performed in nearly half of the patients (48.5%), and was significantly more common in younger patients ($p = 0.006$). Associated dental injuries were present in 27.3% of the cases and they were significantly associated with puck strikes ($p = 0.027$).

Conclusions: Mandible fractures and puck strikes, the most common injury site and fracture mechanism respectively, sustained by ice-hockey players required surgical intervention in the majority of cases.

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Introduction

Ice hockey is a team contact sport popular in a multitude of countries, especially in Europe and North America. Due to the fast pace and physical nature of the game, ice hockey players are susceptible to a wide range of injuries [1,2]. These occur despite protective equipment, professional rules and regulations [3–5]. Traumatic sports injuries among both professional and recreational players have garnered great interest in the literature, however, the rate of publications in relation to maxillofacial injuries remains limited [2,6–9].

It has been shown that craniomaxillofacial injuries are common among professional hockey players [1,2,10]. Typical injury mechanisms include stick and puck hits, impacts to other players, skates, barriers and goalposts, fights as well as overuse injuries [2]. In particular, the force transmission of high-velocity puck shots to the face may cause devastating soft and hard tissue injuries. Studies of different causes of maxillofacial trauma have shown that there is a strong association between facial fractures and dentoalveolar injuries [11,12]. There are, however, few studies, which have examined the patterns of facial fractures and dental injuries in ice hockey players [13–15].

The lack of standardised protective equipment shielding the facial area has been a topic of discussion for some decades [9,16]. A high rate of compliance towards partial head protection has been achieved due to official rules and regulations mandating the use of a helmet in professional ice hockey games [3–5]. However, facial and dentoalveolar injuries remain a prevalent cause of admission to emergency departments [6,9]. This has been postulated to be due to the lack of comprehensive and mandatory protective equipment shielding the lower third of the face [3–5,17].

Ice hockey-related injuries confined to the facial soft tissues and dental areas are well documented, but there is a paucity of studies assessing which sport-related variables are associated with specific facial fracture patterns. The aim of this retrospective study was to evaluate clinically relevant variables, including fracture type and mechanism, among patients who sustained ice hockey-related facial fractures.

Materials and methods

This retrospective study included all patients admitted to a tertiary trauma centre (Trauma Unit of Helsinki University Hospital or Children's Hospital, Helsinki, Finland) who sustained a radiologically confirmed facial fracture while playing

ice hockey between 1 January 2013 and 31 July 2020. A population of approximately 1.7 million inhabitants was covered. Patient- and injury-related variables as well as specific fracture types were collected from the retrospective patient chart review. Due to the retrospective nature of the study, informed consent of the patients was not required.

The outcome variable was the need for surgical treatment. The primary predictor variable was the injury mechanism grouped as struck by puck versus other injury mechanisms. Additional predictor variables were the presence of mandibular fractures, the presence as well as type of dental injuries and level of play (professional or recreational). Descriptive statistics of facial fracture types and dentoalveolar injuries were also reported.

Facial fractures were divided into 6 complexes: Mandibular, unilateral zygomatico-maxillo-orbital complex (ZMO), bilateral zygomatico-maxillo-orbital complex (Combined midfacial), nasal, frontal bone and superior orbit exclusively (Upper third) and a combination of two or more facial thirds.

Statistical analysis

Descriptive statistics are presented as absolute values and percentages. Continuous variables that were not normally distributed were analysed using the Mann–Whitney U test. Pearson's Chi Square test or Fisher's Exact test were used to assess the significance of differences in categorical variables. Statistical significance was set at 0.05. Statistical tests were performed using SPSS version 25.0 (IBM Corp., Armonk, NY, USA).

Ethical considerations

The study was approved by the Internal Review Board of the Head and Neck Centre, Helsinki University Hospital, Helsinki, Finland (HUS/356/2017 and HUS/54/2019).

Results

A total of 66 patients sustained facial fractures while playing ice hockey during the study period. Demographic statistics and mechanism-related data are shown in Table 1. Patient age ranged from 12.5 to 56.6 years. The most common injury mechanism was being struck by a puck ($n = 49$, 74.2%).

Collected data on the injury profiles affecting the facial and dental areas are displayed in Table 2. Fractures of the mandible ($n = 37$, 56.1%) were the most frequent facial fracture type, followed by unilateral Zygomatico-maxillo-orbital complex (ZMO) fractures ($n = 19$, 28.8%). A total of 41 dental injuries occurred in 18 (27.3%) of the included patients. The most common type of dental injury was tooth luxation ($n = 21$, 51.2%), the next most common was tooth fracture ($n = 18$, 43.9%), while the least encountered dental injury was dental avulsion, which occurred in 2 patients and accounted for 4.9% of recorded dental injuries.

A comparison of additional predictor variables on injury mechanism are displayed in Table 3. Fractures of the mandible were the most frequent facial fracture type regardless of injury mechanism. Dental injuries were almost entirely

Table 1. Demographic- and mechanism-related data in ice hockey-related facial fracture patients.

<i>Sex</i>	
Male (<i>n</i> , (%))	65 (98.5)
Female (<i>n</i> , (%))	1 (1.5)
<i>Age (years)</i>	
Mean $\pm$ Standard deviation	28.6 $\pm$ 11.0
<18 years (<i>n</i> , (%))	6 (9.1)
≥ 18 years (<i>n</i> , (%))	60 (90.9)
<i>Facial fracture requiring surgical intervention</i>	
No (<i>n</i> , (%))	34 (51.5)
Yes (<i>n</i> , (%))	32 (48.5)
<i>Mechanism</i>	
Struck by puck (<i>n</i> , (%))	49 (74.2)
Tackle or collision (<i>n</i> , (%))	14 (21.2)
Hit by stick (<i>n</i> , (%))	3 (4.5)
<i>Level</i>	
Recreational (<i>n</i> , (%))	52 (73.1)
Professional (<i>n</i> , (%))	14 (26.9)

Notice: Some percentages may not add up to 100.0% due to rounding.

Table 2. Frequency of facial fractures in 66 ice hockey-players and their associated dental injuries.

<i>Facial fractures by complex</i>	<i>Patients</i>	<i>Fractures requiring surgical intervention</i>
Mandibular (<i>n</i> , (%))	37 (56.1)	19 (51.4)
Unilateral ZMO (<i>n</i> , (%))	19 (28.8)	9 (47.4)
Combined midfacial (<i>n</i> , (%))	4 (6.1)	1 (25.0)
Nasal (<i>n</i> , (%))	3 (4.5)	1 (33.3)
Upper third (<i>n</i> , (%))	2 (3.0)	1 (50.0)
Combination of facial thirds (<i>n</i> , (%))	1 (1.5)	1 (100.0)
<i>Dental injuries</i>		
Present (<i>n</i> , (%))	18 (27.3)	
Mean, affected teeth	2.3	
Avulsion (<i>n</i> , (%))	2 (9.5)	
Luxation (<i>n</i> , (%))	11 (52.4)	
Dental fracture (<i>n</i> , (%))	8 (38.1)	

Notice: Some percentages may not add up to 100.0% due to rounding. Unilateral ZMO stands for unilateral zygomatico-maxillo-orbital complex. Please see definitions for facial fracture complexes in Materials and Methods.

confined to puck-related fractures (94.4%, $p = 0.027$). Injuries sustained by professional ice hockey players were most often caused by being struck by a puck ($n = 12$, 85.7%).

Nearly half ($n = 32$, 48.5%) of the patients required surgical intervention for their facial fractures (Table 4). The most common facial fracture types — mandible fractures and unilateral ZMO fractures — required surgical intervention in 19 (51.4%) and 9 (47.4%) cases, respectively. Significant differences between need for surgical treatment and variables, including type of facial fracture and injury mechanism, were not found.

Discussion

We were able to show that of patient cases, which required operative treatment, nearly 60% concerned the mandible and almost one-third the ZMO complex. Nearly 75% of ice hockey related facial fractures were induced by a puck strike. Additionally, puck strikes required surgical intervention in the majority of cases (53.1%) regardless of injury site while mandible fractures had a surgical intervention rate of 51.4% irrespective of injury mechanism. Puck strikes had largest range in patient age, but this is likely explained by said patient population being the most

Table 3. Comparative data displaying characteristics of puck strikes versus other mechanisms of ice hockey players with facial fractures.

Variable	Struck by puck	Other injury mechanism	p Value
<i>Facial fracture</i>			
Mandible (n, (%))	30 (61.2)	7 (41.2)	0.151
Unilateral ZMO (n, (%))	15 (30.6)	4 (23.5)	0.759
Combined midfacial (n, (%))	2 (4.1)	2 (11.8)	0.271
Nasal (n, (%))	1 (2.0)	2 (11.8)	0.160
Upper third (n, (%))	1 (2.0)	1 (5.9)	0.452
Combination of facial thirds (n, (%))	0 (0.0)	1 (5.9)	0.258
<i>Dental injuries</i>			0.027
No (n, (%))	32 (65.3)	16 (94.1)	
Yes (n, (%))	17 (34.7)	1 (5.9)	
<i>Total teeth</i>	30	1	
<i>Injury type</i>			
Avulsion (n, (%))	2 (6.7)	0 (0.0)	1.000
Luxation (n, (%))	20 (66.7)	0 (0.0)	0.053
Dental fracture (n, (%))	8 (26.7)	1 (100.0)	0.669
<i>Level</i>			0.327
Recreational (n, (%))	37 (75.5)	15 (88.2)	
Professional (n, (%))	12 (24.5)	2 (11.8)	

Notice: Some percentages may not add up to 100.0% due to rounding.

Table 4. Comparative data displaying need for surgical intervention in different populations and injuries of ice hockey players with facial fractures.

Variable	Surgical intervention	No surgical intervention	p Value
<i>Facial fracture</i>			
Mandible (n, (%))	19 (59.4)	18 (52.9)	0.599
Unilateral ZMO (n, (%))	9 (28.1)	10 (29.4)	0.908
Combined midfacial (n, (%))	1 (3.1)	3 (8.8)	0.614
Nasal (n, (%))	1 (3.1)	2 (5.9)	1.000
Upper third (n, (%))	1 (3.1)	1 (2.9)	1.000
Combination of facial thirds (n, (%))	1 (3.1)	0 (0.0)	0.485
<i>Dental injuries</i>			0.688
No (n, (%))	24 (75.0)	24 (70.6)	
Yes (n, (%))	8 (25.0)	10 (29.4)	
<i>Mechanism</i>			
Struck by puck (n, (%))	26 (81.3)	23 (67.6)	0.207
Tackle or collision (n, (%))	4 (12.5)	10 (29.4)	0.093
Hit by stick (n, (%))	2 (6.3)	1 (2.9)	0.608
<i>Level</i>			0.465
Recreational (n, (%))	24 (75.0)	28 (82.4)	
Professional (n, (%))	8 (25.0)	6 (17.6)	

Notice: Some percentages may not add up to 100.0% due to rounding.

numerous. Dental injuries, if present, were multiple and severe. In the case of professional players, the results translate to nearly 90% of facial fractures requiring surgical intervention being localised to areas not protected by the mandatory safety equipment. This suggests that the exposed facial areas, especially in the lower third of the face, are at a high risk of sustaining high-energy injuries regardless of mechanism. In agreement with our results, Lee et al. reported that 33% of patients sustaining ice hockey-related facial fractures required a surgical approach [18]. However, there are no other reports evaluating which fracture sites require surgical intervention in this patient population. Based on our results, mandibular and ZMO fractures are frequent and more likely lead to surgical intervention in this patient population.

It has been well established that ice hockey players are at a significant risk of sustaining facial and dental injuries [16,19]. However, we and others have recently reported that ice hockey players are still more likely to sustain facial fractures compared to other common sports and recreational activities, suggesting that current safety measures to protect players from injuries are insufficient [7,20].

Numerous studies have highlighted the head region as one of the most frequently injured sites in ice hockey-related trauma [6,8,13]. However, the amount of facial fractures sustained are not always known as they are often grouped together with other injuries of the head region. Indeed, lacerations, contusions and other soft tissue injuries of the facial area are much more frequent than bony injuries, as fractures have been reported to account for less than one-third of all ice hockey-related facial injuries [13,14]. Additionally, the incidence of dental injuries in ice hockey-related traumas is concerning. The most common injury type was tooth luxation, and dental injuries typically involved multiple teeth. Interestingly, our results suggest a somewhat low rate (27.3%) of associated dental injuries in patients with facial fractures. This is most likely due to the inclusion criteria of the study. It is important to note that in our study population, patients with dental injuries without facial fractures were treated at other centres and not included in this study. A previous report published by our own institution highlighted that in their ice hockey playing patient population diagnosed with dental and maxillofacial injuries, facial fractures were only encountered in 1.25% of patients [15]. Thus, it can be surmised that a majority

of ice hockey-related maxillofacial injuries are relatively minor, and most likely are not treated at tertiary care units. However, the authors opine that the severity and long treatment periods of dental injuries may burden the patient more than the surgical intervention itself.

In the present study, nearly three-quarters of the included patients were recreational players, and in these patients, the surgical intervention rate was less than 50%. In contrast, just over 25% of the patient population consisted of professional players, and their frequency of operative treatment was nearly 60%. This discrepancy between patient populations could be due to infrequency in the number of professional games compared to recreational events. Additionally, professional games are conducted by highly trained adult athletes under physically tougher competitive conditions in spite of mandatory protective equipment.

The International Ice Hockey Federation, North American National Hockey League and Finnish Liiga rules mandate the use of a helmet for all players and referees, as well as a full-face shield for goaltenders [3–5]. Moreover, every ice hockey player born after 31 December 1974 has to wear at least a partial visor, and use of a mouth guard is mandatory for all players under 20 years old, according to standing International Ice Hockey Federation (IIHF) rules [4,5]. However, National Hockey League (NHL) rules dictate the use of a visor only for players with less than 25 games played [3]. The use of a mouth guard is optional. In relation to this, it has been shown that any type of face shield reduces the incidence of craniomaxillofacial injuries among ice hockey players [16,17]. Cimba and colleagues recently showed that face shields reduced the amount of craniomaxillofacial injuries in professional hockey players [17]. However, these changes were only seen in the upper third of the facial skeleton. As many professional leagues do not mandate the use of safety equipment protecting the whole of the facial skeleton, it is possible that the lack of voluntary use of protective gear among players is due to a lack of awareness and safety education.

The usage of a full visor or cage can be justified, as nearly three-quarters of facial fracture cases were caused by puck strikes. In comparison to diffuse physical contact (i.e. a tackle, collision or hit by stick), the kinetic energy of a puck is concentrated to a small surface area, thus increasing the risk of a fracture. In addition, the puck is likely to be travelling at a high velocity, to be flying at the height of the face, and therefore consistently leads to higher energy transfers upon impact.

The retrospective nature and selection bias are the main limitations of this work. Additionally, we could not reliably report and describe the use of the safety gear worn by players during the time of injury. Furthermore, the evaluation of dental injuries requires a different study setup. However, our results provide valuable information concerning the need for surgical intervention in players sustaining ice hockey-related facial fractures.

In conclusion, puck strikes accounted for almost three-quarters of facial fractures in this patient population and in the majority of these cases operative treatment was required.

Fractures of the mandible and, secondly, the unilateral mid-face were the most common fracture types encountered among all levels of players. The majority of mandibular fractures required surgical intervention. The aforementioned two facial fracture complexes correspond to the middle and lower thirds of the face that are not generally protected by mandatory professional safety equipment. Associated dental injuries are commonly encountered and likely multiple, if present. We propose and recommend that protective equipment shielding the lower third of the face should also be mandated at professional levels to protect players, and awareness of the risks associated with not wearing proper protective equipment should be promoted at all levels.

Disclosure statement

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