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The Role of Mouthguards in Preventing Temporomandibular Joint Injuries During Contact Sports: A Prospective Study

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A B S T R A C T

Objectives: Injuries to the maxillofacial region during contact sports is a well-known issue. Protective measures have been advised to prevent and reduce these problems. Awareness regarding the role of mouthguards in preventing temporomandibular joint (TMJ) injuries during contact sports, is limited. The aim of the present study was to assess awareness regarding the use of mouthguards during contact sports and incidence of TMJ injuries in sportspersons.

Materials and Methods: Eighty-six individuals training in contact sports were enrolled in the present study based on our inclusion and exclusion criteria. A questionnaire and clinical examination were used to assess TMJ pain, clicking, deviation, mouth opening, and locking.

Results: The percentage of sportspersons aware of various protective gears was 23.8%. The awareness of TMJ injuries following contact sports was 6.9%, and 70.3% of the sportspersons were estimated to wear mouthguards. Clinical assessment of sportspersons using mouthguards revealed pain in 18.6% and clicking in 17.4% of the study subjects. The incidence of TMJ pain and clicking in individuals who did not use mouthguards were 81.4% and 82.6%, respectively.

Conclusion: Application of mouthguards can reduce the incidence of TMJ injuries in contact sports. They also contribute significantly to the overall dental health of the athletes, as well as improving their overall athletic performance and decreasing the likelihood of other types of oral and facial injuries.

Keywords: Mouth Protectors; Athletic Injuries; Temporomandibular Joint

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INTRODUCTION

Contact sports, either as a profession or as a hobby, constitute a very important part of the life of most youngsters. Its different types include karate, martial arts, mixed martial arts, boxing, rugby, football, etc. During the course of training or practice, a sportsperson may sustain numerous injuries in the form of fractures, sprains, concussions or shoulder dislocations [1]. The common injuries associated with the maxillofacial region are discoloration, fracture or avulsion of the teeth, as well as soft tissue injury and jaw fractures [2]. These injuries are well known, clinically evident and are hence promptly managed by conservative or surgical methods. Further, numerous measures have been followed to prevent the above-mentioned injuries by using various protective gears such as helmets, shoulder pads, knee pads and mouthguards [3]. Helmets prevent injury to brain, eyes, jaws and ears. Shoulder pads and knee pads protect the respective joints from

strain and dislocation, but injury to the temporomandibular joint (TMJ) is often missed and left undetected [4]. Clinically, TMJ injuries result in dysfunction which may manifest either in acute (immediate) or chronic states (after many days or months). TMJ dysfunction presents as a multitude of symptoms and signs like pain, clicking, dislocation and subluxation, which can greatly impair the quality of life and performance of a sportsperson [5]. TMJ injuries can be protected by certain mouthguards with specific inbuilt features. However, awareness regarding TMJ–protective mouthguards is limited.

Mouthguards commonly used by sportspersons are the readymade and boil & bite types [6], which do not offer adequate protection. There is a need to increase athlete awareness of TMJ injuries during contact sports and the role of TMJ-protective mouthguards in preventing these injuries. Therefore, this study was designed to assess [1] the awareness of the association between TMJ injuries and contact sports among sports-persons, [2] the percentage of sportspersons using custom-made mouth-guards and [3] the incidence and severity of TMJ dysfunction among sportspersons.

MATERIALS AND METHODS

The study was designed as a prospective questionnaire-based and clinical study to assess the awareness regarding use of mouthguards in contact sports and incidence of TMJ injuries in sportspersons. Approval for the study was obtained from the Institutional Review Board (IRB NO: SRMU/M&HS/SRMDC/2017/B.D.S-UGstudent/003). The sample consisted of 86 athletes undergoing training in contact sports recruited from three sports academies. Inclusion criteria consisted of patients aged 8-25 years with a minimum of 2 years of training. Patients with previous history of TMJ problems or patients undergoing orthodontic treatment were excluded from the study. The study was done in two segments: part 1 consisted of a questionnaire survey and part 2 constituted our clinical investigation. The questionnaire was designed in English and its validity were confirmed. There were no issues in understanding the questionnaire by the participants. The questionnaire included questions regarding the awareness of the players regarding TMJ injuries during contact sports and the various protective gears. The responses of the sportspersons were recorded and tabulated by investigator 1. The second part of the study was clinical and included physical assessment of the TMJ, soft tissue injury, teeth fracture and non-vital teeth by investigator 2, who was blinded to the findings of investigator 1. Non-vital teeth were assessed by identification of discoloration, mobility, and confirmed using pulp vitality testing. The TMJ was examined for the presence or absence of pain, clicking or deviation in mouth opening. Any history of subluxation or dislocation during the training period was also recorded. Pain was evaluated by visual analogue scale (VAS) score while clicking and deviation were assessed by palpation and scale (mm), respectively. The assessment was performed at only a single time-point after sample selection.

Data was entered systematically in Microsoft Excel sheet version 2010. Descriptive statistics was computed using SPSS version 20.0. Chi-square tests were used to evaluate the associations between dependent and indepen-dent variables using the same software. Significance was set at 5% (α=0.05).

RESULTS

The study sample consisted of 47 males and 39 females with a mean age of 25.55 years, selected from 3 sports academies. The awareness status of sportspersons regarding the various types of protective gears is demon-strated in Table 1. Only 23.8% were aware of all the protective gears and 70.3% of the sports-persons were estimated to use mouthguards. Of this group, none of the sportspersons used custom-made mouthguards; the mouthguard worn by all athletes was the readymade type only (100%). The number of the sportspersons who were aware of custom-made mouth-guards was 37 (43%). However, the percent-age of sportspersons who were aware of TMJ injuries following contact sports was only 6.9%. Parameters such as presence of tooth fracture, soft tissue injury and non-vitality were compared between persons who wore mouthguards and

Table 1. Awareness status regarding protective gears

Awareness regarding types of guards		Awareness about protection offered by mouthguards	
Guards	**Percentage**	**Organ**	**Percentage**
Helmet alone	8.9	Teeth	9.9
Mask alone	3	Facial bones	2
Mouthguard alone	39.6	TMJ	6.9
Helmet, Mouthguard	9.9	Teeth, TMJ	1
Helmet, Mask, Mouthguard	23.8	Teeth, Facial bones	56.4
		Teeth, Facial bones, TMJ	8.9

those who refrained from mouth guard usage. Sportspeople using mouthguards revealed tooth fracture in 16.9%, soft tissue injury in 25.4% and non-vitality in 2.8%. This was in contrast to non-wearers who revealed tooth fracture in 33.3%, soft tissue injury in 55.6% and non-vitality in 11.1%. Avulsion or luxation of teeth was not found to be present in any of the participants of our sample. Awareness among sportspersons regarding TMJ injuries and the use of custom-made mouthguards was found to be poor and the incidence of TMJ injury was as high as 61.2%. The distribution of symptoms among the TMJ parameters is given in Table 2.

Table 2. Assessment of temporomandibular joint related symptoms

Parameter	With MG (%)	Without MG (%)	P
Pain	18.6	81.4	< 0.001
Clicking	17.4	82.6	< 0.001
Dislocation	0	5.6	---
Deviation	24.7	75.3	< 0.001

MG: mouthguard

DISCUSSION

Biomechanics of TMJ injury:

The TMJ is vulnerable to injury due to its anatomic configuration. Micro or macro trauma to the joint which may be direct or indirect could result in dysfunction that can be debilitating (Figure 1a). Contact sport is one of the leading causes of injury to TMJ. There are not many studies assessing the awareness among sportspersons regarding TMJ injuries that result from contact sports. This study was therefore designed to create awareness among sportspersons.

Sports injury to TMJ can result in micro and macro trauma. Macro trauma includes- TMJ fracture, displacement and dislocation. Micro trauma includes synovitis, internal derangement, capsulitis and tendonitis. Clinical symptoms of TMJ injury are pain, arthralgia, myalgia, TMJ sounds such as crepitus, popping, deviation of mouth, reduced mouth opening, otalgia, head and cervical pain, tinnitus, ear blockage, reduced functional and masticatory efficiency. The TMJ may be protected during contact sports by use of mouthguards. Mouthguards are resilient intraoral devices that can be worn during contact sports to reduce the possibility of injury to the teeth and associated tissue. [3].

Utility of various protective gears:

Protective gears perform the following functions, (1) reduce the impact of external force on the teeth & TMJ, (2) provide a cushioning effect to the joint and peri-joint structures and (3) distribute forces to adjacent structures. Presently the mouth-guards available are of 3 major types, readymade, boil-and-bite, and custom-made. Readymade type mouthguards are easily available over the counter in various sizes and colors. They have a thickness of about 1-2mm and are less expensive. However, they do not adapt properly to the oral cavity and require that the individual continuously bite the mouthguard to retain it. Further they may also interfere with speech and breathing [6]. Maeda et al [7] demonstrated that the breathing capacity of athletes is significantly affected in readymade

mouthguard users, whereas the custom mouthguards have negligible impact on breathing capacity.

Comparison between different types of mouthguards:

The boil-and-bite mouthguard is a variant of the readymade type. It is modified to fit the dental arches of the sportspersons by boiling the mouthguard and biting down on it. Though they provide better retention than the readymade type and are cost-effective, they are less effective in providing protection and are associated with increased wear and tear due to improper thickness [8]. Custom-made mouthguards are fabricated by the dentist to provide the best fit possible to the sportsperson. The various advantages associated with these mouthguards are, comfort and non-interference with speech and breathing. The main drawback of the custom-made type is the cost and time involved in fabrication. The highest level of protection offered by custom-made mouthguards is due to its efficacy in maintaining the interocclusal distance. When the interocclusal distance is increased, the TMJ moves downwards and reduces the load to joint, provides a luxation effect and prevents injury to retro-discal tissues [9] (Figure 1b).

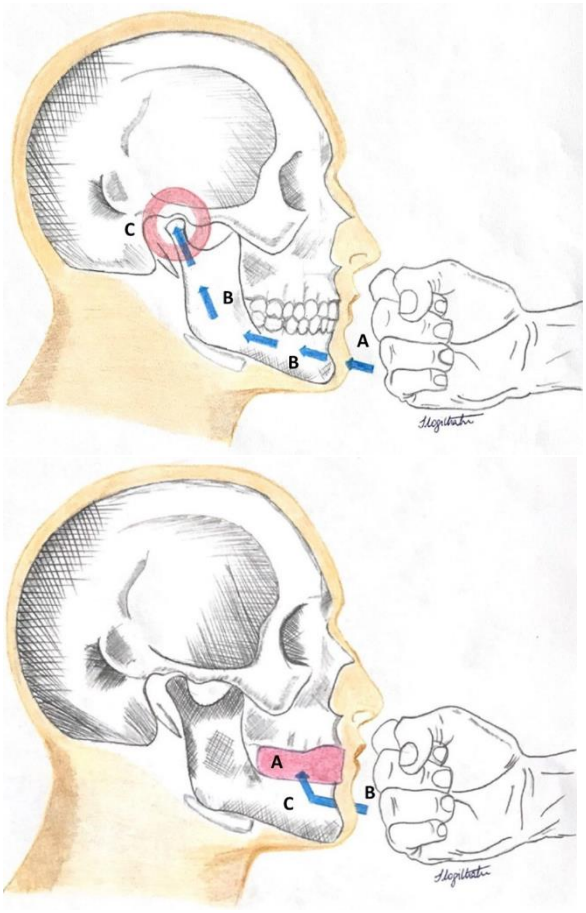

Fig 1. Mechanism of injury to the temporomandibular joint. Upper image shows impact of injury without mouthguard; (A) impact to the chin, (B) direction of force transmission, (C) impact delivered to the condyle. Lower image shows impact of injury with mouthguard; (A) mouthguard, (B) impact to the chin, (C) direction of force transmission. Drawing courtesy of Dr. Logitha Sri.

Raquel et al [10], compared the electro-myographic (EMG) activity of temporal and masseter muscles among karate athletes. The EMG values were recorded before and after training, with the use of both readymade and custom-made mouthguards and without mouthguard usage. The use of custom-made mouthguards caused significantly lower muscle activity than the readymade and without using mouthguard while clenching during training. Ebben et al [11] stated that by reducing the muscle activity mouthguards help in preserving energy reserves during muscle group recruitment. Adenosine triphosphate when preserved, can be utilized for future muscle movements. Daily clenching by athletes would impact performance. Custom-made splints also provided a homogenous distribution of occlusal contacts and forces resulting in orthopedic balance and comfort with regard to masticatory muscles. However, the role of mouthguards in preventing TMJ injuries is not well known among sportspersons. Our study demonstrated a poor state of awareness regarding these protective gears which reflected in the percentage of sportspersons using them. The differences in clinical features observed between the sportsmen using the readymade splints and the sportsmen not using the splints clearly demonstrate the risk associated with non-usage of mouthguards. The commonly observed signs and symptoms of TMJ injuries are pain, clicking, dislocation and deviation [12]. The subjects of this study

who were not using mouthguards also had similar features. TMJ injuries can affect a person's personal and social life resulting in psychological and physical instability. Adequate awareness measures are therefore important to improve the well-being of the sportsperson. Glass et al [13] described the disadvantages associated with the use of mouthguards. These were mainly related to soft tissue reactions ranging from erythema and hyperkeratosis to ulceration. The authors have also expressed concern over opportunistic microbial infections which are associated with prolonged usage or improper disinfection of the mouthguard. It is advisable to discard the mouthguards when it demonstrates ragged ends or rough surfaces because of a higher incidence of microbial colonization associated with such devices. The microbes not only initiate localized mucosal reactions but also allergic reactions and asthma. Hence sterilization with a disinfectant and discarding after 14 days of regular use is clinically important. Chaconas et al [14] performed in vivo comparison of various thermoplastic mouthguard materials. Dimensional changes were recorded for mouthguard fabricated with (1) poly (vinyl acetate-ethylene) copolymer clear thermoplastic; (2) polyurethane; and (3) laminated thermoplastic. The mouthguards were measured before and after usage by athletes, using a caliper with 0.01mm accuracy to show changes in thickness that occurred with wear. The thickness of the materials was recorded at the incisal edges and cuspal tips of the canines formed on the material. Laminated clear thermoplastic material had the ability to withstand impact forces and provide the effective protection to the athletes.

Bochnig et al [15] performed an invitro study to investigate and evaluate the shock absorbing capacities of custom-made mouthguards fabricated from different materials. Mouthguards made with ethylene vinyl acetate (EVA) and labial inserts (Polyethylen-terephthalate - Glycol Copoly-ester [PET -G], Nylon mesh, air space) were tested with different combination with varied labial thickness between 2mm and 11mm. The mouthguards fabricated with soft materials (EVA with nylon mesh) showed slightly better protection than the more rigid mouthguards of similar thickness (PET-G). However, on increasing the energy force, their protective function decreased to a greater extent than the stiffer mouthguards. It was concluded that the combination of increased labial thickness and incorporation of labial inserts with airspace offered better durability and protection against hard and small object collisions.

The results of our study concurred with numerous other studies which demonstrated the effectiveness of mouthguards in reducing dental injuries during sports. The overall risk of an orofacial injury was reported as being 1.6 to 1.9 times higher when a mouthguard was not worn [16]. However, our study additionally assessed the incidence and severity of TMJ injuries. The higher incidence of injuries in sportspersons who did not use custom-made mouthguards indicate that the usage must be made mandatory during sports. This would greatly eliminate the development of major complications of TMJ injuries such as ankylosis, chronic TMJ dysfunction etc., and the necessity to undergo complex treatment procedures [17].

CONCLUSION

The use of custom-made mouthguards can reduce the incidence of TMJ injuries in contact sports. However, the awareness regarding these devices is not adequate among the sportspersons. It is suggested that the use of custom-made mouthguards be made mandatory during contact sports to prevent long term complications involving the TMJ.

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CONFLICT OF INTEREST STATEMENT

None declared

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