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Differences in Movement of Temporomandibular Joints in Athletes With and Without Orofacial Injuries

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ABSTRACT

All sporting activities have an associated risk of orofacial injuries due to falls, collisions with players, devices, and hard surfaces. The purpose of this investigation was to determine is there alteration of condylar path and frontal guidance values in athletes with and without orofacial injuries. The sample consists of 34 athletes who were divided into two groups (Control and Examines group). "Control group" consists of 11 athletes without data of macrotrauma of the stomatognatic system (athletes who didn't get blow to the face). The second group is "Examines group" witch consists of 23 athletes with macrotrauma (athletes who get blow to the face), 11 of them were athletes with macrotrauma on the right side of jaw and 12 of them were athletes with macrotrauma on the left side of jaw. Athletes with anamnestic blow to the jaws, immediately after injury, have had stiffness/pain of masticatory muscles, pain in region of TMJ, and limitation of jaw movements. But all symptoms diminished and finally were gone after some days or weeks after injury. In time of investigation all of them were completely without any symptom of temporomandibular dysfunction according to RDC/TMD protocol, and were completely satisfied with function of their stomatognathic system. Athletes with macrotrauma have limitation of Bennett angle on the one side while on the opposite side Bennett angle is larger than the average values given in literature. As conclusion, if athletes with macrotrauma need prosthetic therapy, without individual articulator adjustment, prosthodontics work can cause iatrogenic interference. That interference during time may cause temporomandibular dysfunction. All patients need individual approach to their stomatognatic system, and only in that way damage to the system can be avoided.

Key words: *movement of temporomandibular joints, athletes, orofacial injuries*

Introduction

The greater popularity of sports and exercising, besides from having health benefits also leads to a larger possibility of dental and orofacial injuries[1,2,3]. All sporting activities have an associated risk of orofacial injuries due to falls and collisions with players, devices, and hard surfaces[4,5]. According to Clegg's[6] research, in the course of an athlete's career injuries to the stomatognatic system account for 33% to 56% of all injuries. Many of these orofacial injuries heal without any subjective symptoms but the consequences frequently remain. During prosthodontic rehabilitation procedures, individual occlusal morphology and stabile interocclusal contacts must be achieved. The measurement "in vivo" of a temporomandibular movements such as the Bennett angle is greatly important for a right prosthodontic and gnathological rehabilitation[7]. The aim of this investigation is to determine if there is an alteration of condylar path and frontal guidance values in athletes with injury to the stomatognatic system compared to the non-injured ones. The random sample consists of 34 athletes from the City of Zagreb and the Zagreb County. Before a questionnaire survey was conducted, the athletes had been given directions and explanations of the purpose of the survey. The questionnaires were completed personally with the help of a researcher. In all athletes, movements of mandibular condyle, mandibular movements at the point of mandibular incisors and the tracing of movements' paths were recorded using ultrasound device ARCUSdigma.

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Subjects and Methods

This survey includes 6 female and 28 male athletes divided into two groups. Examinees group consists of 11 athletes with macrotrauma on the right side of jaw and 12 athletes with macrotrauma on the left side of jaw. Immediately after injury, they experienced stiffness/pain of masticator muscles, pain in the region of temporomandibular joints, or limitation of jaw movements. In combination with these symptoms in some cases there were injuries to the teeth, lacerations, contusions and erosions of soft tissues. However, all symptoms diminished and finally disappeared several days or weeks after the injury. At the time of this investigation all of the athletes showed no subjective symptoms of temporomandibular dysfunction according to RDC/TMD protocol, and were completely satisfied with the function of their stomatognatic system. The control group consists of 11 athletes with no data of macrotrauma of the stomatognatic system in their medical histories. A descriptive statistic, means and standard deviations were used to clarify a difference between Control and two Test Groups with macrotrauma on different sides of jaw. Multivariate analysis of variance (MANOVA) was used to compare mean differences between three groups on Bennett angle.

In this investigation the average value of the sagittal condylar path for non-injures athletes was 49.05 degree on the right side and 48.33 degree on the left side. Gisy[8,9,10] established values of 33 degrees for sagittal condylar inclination with significant difference between the right and the left side. In this investigation values for the non-injured athletes differ from the values measured by Gisy by more than 15 degrees. Values revealed in this investigation differ from other electronically measured values by approximately 10 degrees. Electronically measured sagittal condylar path inclination was 40.6 degree as reported by Hobo and Takayama[11]. Cimic et al. were reported that the mean sagittal condylar inclination value was 41.0 degree for the right joint and 40.7 degree for the left joint[12]. In investigation of Cimic et al. condylar movement in the sagittal direction is not uniform[13]. They point out that mean left and mean right condylar inclination values do not necessarily describe the actual condylar path, nor do they give adequate information for articulator setup. Left-right side condylar inclination differences greater than 10 degrees can be considered as normal. In our investigation difference between mean left and right condylar inclination is within 1 degree. In investigation of Tannamala et al. the mean condylar guidance angle between the right and left side by protrusive record method and panoramic radiographic method was not statistically significant. The comparison of mean condylar guidance angles between the right side of the protrusive record method and the right side of the panoramic radiographic method and the left side of the protrusive record method and the left side of the panoramic radiographic method ($p= 0.071$ and $p= 0.057$, respectively) were not statistically significant[14]. Method of determining sagittal condylar path in our investigation and in investigation of the Tannamala et all. are not the same but shows that there is no different between left and right side. Godavarthi et all. estimated condylar guidance values obtained by the interocclusal method and radiographic method in dentate individuals on the right side and left side 40.55°, and 37.1°, and 40.15°, and 34.75°, respectively[15]. In this investigation interocclusal values are closer to our investigaton values electronically measured than values obtain by radiographic method. In investigation of Prasad at all.[16] the average condylar inclination measured by axiograph is 42.125° which value is close to our investigation. Both values are obtained electronically. The average value of the sagittal condylar path for athletes with macrotrauma was 38.53 degrees on the right side and 37.12 degrees on the left side. The average values for the examinees group are closer to Gisy's values. The significant difference between the control and the examinees group in this examination suggests that a trauma changes the normal function of temporomandibular joints, even without any noticeable symptoms. The statistical analysis of the control group, which consisted of 11 athletes, obtained an average value for the right Bennett angle of 14.44 degrees. The minimum value was 7 degrees and the maximum 25.8 degrees. The range of 18.8 degrees is very large and reweals large differences in joint movements between individuals. The average value of the Bennett angle on the left side was 12.89 degrees. The minimum angle was 5.8 degrees and the maximum 21.8 degrees with a range of values of 16 degrees, which is still a big difference and speaks to the diversity in joint movements between individual entities. The average value of the difference between the left and the right Bennett angle is 3.45 degrees. The specified value is the mean value obtained by summing up the difference between the left and the right Bennett angle of an entity in the control group and is divided by the total number of athletes in the control group (N = 11). The smallest difference between the left and the right Bennett angle was 1.2 degrees and the biggest 5.1 degrees. The resulting range of 3.9 degrees with a standard deviation of 1.34 shows high biodiversity i.e. of great individual differences. The difference between the average values of the left and the right Bennett angle is even lower measuring at only 1.55 degrees (Table 1.)

The statistical analysis of athletes with macrotrauma on the right side (N=11) obtained the average value for the right Bennett angle of 4.3 degrees. The minimum value of the right Bennett angle was 0 degrees, which was registered on five athletes, while the value of 4 degrees was

TABLE 1
DESCRIPTIVE STATISTICS FOR CONTROL GROUP (G1)

G1	N	Mean	Min	Max	Range	Std.Dev.
BENR	11	14.44	7.00	25.80	18.80	6.09
BENL	11	12.89	5.80	21.80	16.00	5.17
DIFF	11	3.45	1.20	5.10	3.90	1.34

N – number of athletes, BENR – Bennett angle on the right side, BENL – Bennett angle on the left side, DIFF – difference between left and right Bennett angle, Std.Dev. – standard deviation

registered on four athletes. The maximum value of the right Bennett angle was 16.6 degrees, which was measured on one athlete, while the next largest value was 14.7 degrees. In the mentioned respondents the value of the left Bennett angle was 30 degrees. This was also the maximum value measured for the left Bennett angle. In these athletes, the difference between the values of the Bennett angle in injured and non-injured joints was 13.4 and 15.3 degrees, which coincides with the difference between the injured and non-injured joints in the rest of the athletes. The average value of the Bennett angle on the left side was 17.76 degrees. The minimum value of the left Bennett angle was 8.30 degrees, and the maximum value 30 degrees (Table 2.)

The statistical analysis of athletes with macrotrauma on the left side, which consisted of 12 athletes (G_3), obtained the average value for the left Bennett angle was 4.09 degrees. The minimum value of the left Bennett angle was 0 degrees, recorded in two athletes, while 4 degrees was recorded in eight athletes. The maximum value of the left Bennett angle was 9.9 degrees, which was measured in one athlete, while the next largest value was 7.2 degrees. The minimum value of the right Bennett angle was 7.2 degrees, and the maximum 30 degrees. The average value of the right Bennett angle of 20.06 degrees (Table 3.).

The multivariate analysis of variance revealed significant differences among the three independent groups of athletes: G_1 control group, G_2 group of athletes with macrotrauma on the right side and G_3 group of athletes with macrotrauma on the left side, in the case of three variables, and on the error level $p < 0.01$ (Table 4.).

TABLE 2
DESCRIPTIVE STATISTICS FOR ATHLETES WITH MACROTRAUMA ON THE RIGHT SIDE (G2)

G2	N	Mean	Min	Max	Range	Std.Dev.
BENR	11	4,30	0,00	16,60	16,60	5,94
BENL	11	17,76	8,30	30,00	21,70	7,88
DIFF	11	13,46	4,30	26,20	21,90	5,98

N – number of athletes, BENR – Bennett angle on the right side, BENL – Bennett angle on the left side, DIFF – difference between left and right Bennett angle, Std.Dev. – standard deviation

TABLE 3
DESCRIPTIVE STATISTICS FOR ATHLETES WITH MACROTRAUMA ON THE LEFT SIDE (G3)

G3	N	Mean	Min	Max	Range	Std.Dev.
BENR	12	20,06	7,20	30,00	22,80	6,69
BENL	12	4,09	0,00	9,90	9,90	2,64
DIFF	12	15,97	3,20	26,70	23,50	8,01

N – number of athletes, BENR – Bennett angle on the right side, BENL – Bennett angle on the left side, DIFF – difference between left and right Bennett angle, Std.Dev. – standard deviation.

TABLE 4
SIGNIFICANT F-TESTS FOR UNIVERSITY FOLLOW-UP TESTS (ALL SIGNIFICANT AT $p < 0.01$)

	Mean sqr Effect	Mean sqr Error	F(df1,2) 2,31	p-level
BENR	726,22	39,22	18,52	0,00
BENL	555,40	31,14	17,83	0,00
DIFF	494,32	34,89	14,17	0,00

BENR – Bennett angle on the right side, BENL – Bennett angle on the left side, DIFF – difference between left and right Bennett angle

After examining the results of the arithmetic mean of the group, the obtained values indicate statistically significant differences in the positive and negative direction among all three groups, depending on the side of the jaw affected by macrotrauma. The average values of the Bennett angle, which can be found in the literature, range from 10 up to 50 degrees[11,17,18,19]. Measuring significantly affects the result with the maximum measured value of the Bennett angle of 24 degrees when the measuring is performed with the teeth in contact[20]. Hobo and Takayama state the average value of the Bennett angle of 10.7 + /-6.4 degrees, when measuring is done with the teeth in occlusion, which is the case in our study[21]. In Cimic et all.[22] investigation the average value of Bennett angle, for all participants, was 7.7 degrees. This value differs a lot from our values obtain by the same method. Computerized axiography measurement in Piehslinger et all.[23] investigation reveals average range for Bennett angles at maximum excursion in free mediotrusive movement was between 0.41 and 5.89 degrees (mean 4.43 degrees) in the healthy population on the right side and between 2.45 and 10.07 degrees (mean 6.87 degrees), respectively, on the left side. The values for jaw patients amounted to 0.19-12.65 degrees (mean 6.93 degrees), on the right side and 1.71-14.15 degrees (mean 6.73 degrees) on the left side. Method of investigation was computerized axiography in both investigations, but values of Bennett angles in Piehslinger et all. differs a lot from our investigation in both groups

The average value of the Bennett angle used in the average programming articulator is 15 degrees[9,24]. The values obtained in this study in non-injured athletes are in the range of values mentioned in the literature[11]. There is an obvious difference between the average value of the Bennett angle on the injured joints (left 4.9 and right 4.3 degree) and the average values mentioned in the literature or the group of non-injured athletes in this investigation (Table 5.).

The average Bennett angle on the contralateral joints i.e. the Bennett angle on the opposite side of the limited joint is larger than the average values given in the literature[9,24]. It is also larger than the average values obtained on the group of non-injured athletes in this study. On the contralateral joint, the maximum values for injured athletes (30.0 degrees) are higher than the maximum values for non-injured athletes (right 25.80 and left 21.80 degrees). The wider angle of the contralateral joint can com-

TABLE 5
MULTIVARIATE ANALYSIS OF VARIANCE (MANOVA)

Rao R (6,58)=24,38; Wilks'Lambda=0,08; df1(6); df2(58); p<,0000			
	BENR	BENL	DIFF
G1	14,44	12,89	3,45
G2	4,30	17,76	13,46
G3	20,06	4,09	15,97

G1 – control group, G2 – athletes with macrotrauma on the right side, G3 – athletes with macrotrauma on the left side, BENR – Bennett angle on the right side, BENL – Bennett angle on the left side, DIFF – difference between left and right Bennett angle

pensate for the limitations movement. At the time of the investigation all athletes were completely satisfied with the function of their TMJ movements, and all in all, with the function of their orofacial system. They did not feel any pain and they did not think that they had any problems. Obviously, the reason for this assessment lies in the compensatory mechanisms as Theusner et al. had pointed out[25]. The results of this investigation, albeit on a small sample, reveal that the injuries of the orofacial system could produce changes in the movement of temporomandibular joints and alter the protrusive paths and the values of the Bennett angle.

Conclusion

If the athletes with macrotrauma need prosthetic therapy, without individual articulator adjustment, iatrogenic interference will occur. That interference over time may cause temporomandibular dysfunction. All patients need an individual approach to their stomatognatic system during reconstructive procedures, and it is only in such a way that the damage to the system can be avoided. The results indicate the need for further research on a larger sample. A comparison of arthroscopic findings or nuclear magnetic resonance with electronic results would also be interesting.

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RAZLIKE U KRETNJAMA TEMPOROMANDIBULARNIH ZLOBOVA KOD SPORTAŠA SA I BEZ OROFACIJALNIH OZLJEDA

SAŽETAK

Orofacijalne ozljede nastaju tijekom svih sportskih aktivnosti zbog pada, sudara s igračima, uređajima i tvrdim površinama. Svrha ovog istraživanja bila je ustanoviti postoje li promjene sagitalnog nagiba kondilne staze i prednjeg

vođenja kod sportaša koji nisu i sportaša koji jesu zadobili orofacijalne ozljede. Uzorak se sastoji od 34 sportaša koji su bili podijeljeni u dvije skupine (Kontrolna skupina i Skupina ispitanika). Kontrolna skupina sastoji se od 11 sportaša koji nisu zadobili nikakvu makrotraumu stomatognatog sustava (sportaši koji nisu zadobili udarac u lice). Druga skupina je "Skupina ispitanika" koja se sastoji od 23 sportaša koji su zadobili makrotraumu (sportaši koji su zadobili udarac u lice), od toga 11 sportaša zadobilo je udarac u desnu stranu čeljusti, a 12 sportaša zadobilo je udarac u lijevu stranu čeljusti. Sportaši koji su zadobili udarac u lice, odmah poslije udarca imali su ukočenost/bol žvačnih mišića, bol u području temporomandibularnih zglobova i limitaciju kretnji mandibule. Nakon nekoliko dana ili tjedana svi simptomi su prvobitno umanjeni, a potom su u potpunosti nestali. U vrijeme istraživanja svi športaši bili su bez simptoma temporomandibularnih promjena prema protokolu RDC/TMD, i u potpunosti su zadovoljni funkcijom svojeg stomatognatog sustava. Sportaši s makrotraumom imaju limitaciju Bennettovog kuta na jednoj strani, dok na drugoj strani Bennettov kut pokazuje veći kut od prosječnog Bennettovog kuta pronađenog u literature. Možemo zaključiti da ukoliko je sportašima s makrotraumom potrebna protetska terapija, te ako se ona provodi bez atikulatora koji je individualno prilagođen, može doći do stvaranja jatrogenih interference. Upravo takve interference mogu prouzročiti disfunkciju stomatognatog sustava. Svim pacijentima potreban je individualni pristup stomatognatom sustavu i samo na taj način moguće je izbjeći štetu sustava.