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Kineziographic Research of Patients with Cross Bite

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A B S T R A C T

The paper describes the use of an objective method for the quantitative analysis of the relationship between the posterior cross-bite and the occurrence of occlusive interferences and damages to the mandible muscle elevator. Two groups of subjects were selected for the analysis: 10 patients with unilateral cross-bite and 10 students without any symptoms of temporomandibular disorders (TMD). By means of the Robert Jenkelson K5A kinesiograph we measured maximal – opening velocity of the mandible (mm/s), maximal- closing velocity (mm/s), first tooth contact velocity and displacement in the vertical plane at the maximal intercuspidation (mm). The following values were obtained: maximal-opening velocity in the first group was 349 mm/s and 380 mm/s in the control group. This difference was incidental. The maximal closing velocity in the study group was 204.9 and 345.2 in the control group ($p < 0.05$). The first tooth contact velocity in the study group was 75.93 and 325 in the control group ($p < 0.01$). Displacements in the vertical plane at the maximal intercuspidation in the investigated group was 0.24±0.01 mm, while in control group that value was 012±0.012 mm.

Introduction

Kinesiology describes mandible movements on the basis of anatomic, physiological and mechanical principles. The movements of the mandible are primarily determined by the position of the cusps because the condyles have to move according to a certain trajectory whereas the mandible is moved by the muscle[1]. The teeth make possible the guidance of mandibular movements in several ways: the posterior teeth maintain vertical support during closing and guide into the position of maximal intercuspation[2], the anterior teeth participate in protruding movements, while the canines and premolars participate in lateral movements. We decided to study a group of patients with cross-bite, being a specific occlusive disorder usually occurring in primary and mixed dentitions. According to Kutin

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and Hawers (1969), this disorder accounts for 7.7% of cases, whereas Helm ascertained this occurrence in 17% of cases[3]. The causes of this disorder may be of skeletal and dental origin, and they give rise to a change in the mandible position and sometimes to a deviation of the center of the jaw. It has been generally recognized that the construction of the maxillary arc causes premature contacts giving rise to occlusive interferences. In order to avoid these obstructions, the mandible has to make a lateral movement resulting in functional posterior cross-bite. The electromyographic (EMG) research revealed also an asymmetric activity of *m. temporalis* during chewing and maximal intercuspation[4]. Occlusive interference is considered to be largely responsible for the occurrence of the TMD[5,6]. For this reason, we wanted to measure by an objective and noninvasive method the maximal velocity at opening, closing and first contact, which is indicative of the presence of occlusive interference. The introduction of electronic tehnology more than three decades ago has facilitated advanced kinetic analysis of the mandible. With his kinesiograph, designed to measure mandible movements, Jenkelson contributed greatly to the development of these analyses. There are two such instruments in commercial practice: syrognatograph, constructed by Lewin, and mandible kinesiograph (MKG), constructed by Jenkelson.

Material and Methods

Sample

The measuring of the movements of the mandible symphysis point was conducted in two groups of 10 selected individuals each. The study group consisted of young patients with unilateral crossbite. In cooperation with orthodontists of an Outpatient's Clinic in Rijeka we selected from their files a sample of 30 patients already treated. Upon our written request 10 patients consented to examination. The control group of 10 individuals was selected among the students of the School of Dental Medicine of Rijeka. Their medical history data revealed no orthodontic therapy, and clinical-functional analysis revealed no sign of any dysfunction of the temporomandibular system (TMD). Records of anamnesis, condition and functional analysis, according to the original diagnostic form of Myotronic Research Inc. 6/77, were taken.

K5A Robert Jenkelson Kinesiograph

The MKG is an integrated electronic system designed for the specific purpose of monitoring the position of an incisive point on the mandible in three dimensions within the range of functional and diagnostic movements. An array of sensors suspended on a lightweight headgear is sensitive to alterations in the magnetic field of a permanent magnet, which is affixed to the mandibular incisor with a quick curing acrylic. Data generated by the Kinesiograph represents the spatial position of the mandibular incisive point relative to the skull. The sensor array is maintained in a constant relationship to the skull, by the aluminum tubing supports and the eyeglass frames. The spatial position of the magnet relative to the incisive edge is a constant. Condylar position in the glenoid fossa is not obtainable with this system. A pure rotation about the incisive point would not involve a displacement of the magnet, so that no output signal will result.

The MKG readout consists of one or two simultaneous planes of movement (sagittal, frontal, or horizontal) or a simultaneous sweep of two, three, or four channels, selected from three mutually perpendicular axial components of the mandible position and the vertical component of mandible velocity. The kinesiograph consists of three parts[7,8]:

1. A magnet which should be affixed with self-curing acrylic to the vestibular plate of the lower incisors taking care that the magnet gets no contact with the upper teeth. Its weight is 21.6 mN and dimensions are 12×6×3 mm.

2. Magnetic sensors. There are three pairs of sensors mounted on an aluminum frame. One pair of sensors registers the changes of the magnetic field in the saggital, the second in the frontal, and the third in the horizontal plane. The sensors weight 912.3 mN, aluminum frame weights 1255.7 mN, being altogether affixed to eyeglasses.

3. Oscilloscope – transformer of the magnetic field into electric signal. The oscilloscope is Tektronix 5110 Model modified for the purpose of the Myotronic Research. For movement registration the Tektronix C-5C camera adapted to the oscilloscope screen is used.

The screen simultaneously displays the velocity (vertical projection) and lateral projection of the frontal plane in x-y system. Dual Display Selector is set on vert./vel. position. Lateral gain control 10mm/div. Leave vertical gain control 10mm/div. Vertical velocity gain control 100mm/s/div. Thus prepared the MKG records movements in xy coordinate system. The velocity is displayed in the left and frontal projection in the right part of oscilloscope. Each division represents 10 mm. The patient keeps his mouth closed, he is instructed how to open and close quickly his mouth and the MKG is turned on.

TABLE 1
MAXIMAL OPENING VELOCITY (MM/S)

Study group	Control group
390	409
518	354
212	309
450	512
162	287
512	400
275	250
300	312
312	512
359	462

No significant statistically significant difference. x = 349 x = 380.7
Sx = 38.02 Sx = 29.57

Results

TABLE 2
MAXIMAL CLOSING VELOCITY (MM/S)

Study group	Control group
227	345
247	354
125	281
275	462
125	312
262	325
187	237
215	237
180	462
206	437

There was a significant difference $p < 0.05$.
x = 204.9 x = 345.2
Sx = 16.41 Sx = 26.84

TABLE 3
VELOCITY AT THE FIRST TOOTH CONTACT (MM/S)

Study group	Control group
45.4	327
72.7	318
50	245
156	462
50	300
62.5	362
112	237
62.3	200
70.1	437
78.3	362

There was a significant difference, $p < 0.01$.
x = 204.9 x = 345.2
Sx = 16.41 Sx = 26.84

TABLE 4
VERTICAL DISPLACEMENTS AT MAXIMAL INTERCUSPIDATION

Study group	Control group
0.27	0.00
0.18	0.00
0.25	0.00
0.25	0.00
0.25	0.00
0.25	0.00
0.25	0.00
0.25	0.00
0.23	0.00
0.25	0.00
0.25	0.12

There was a significant difference, $p > 0.01$.
x = 0.24 x = 0.012
Sx = 0.0 Sx = 0.012

Discussion

Based on the analysis in which one of the squares of the coordinate system measured 10 mm/s, we assessed that the maximal opening velocity in the study group was 349±38.02 and 380±30 in the control group. The difference was incidental and not statistically significant. In the relevant literature we have come across some data of maximal velocity reading 253±48.7[13], 250–350[9], 221.7–263.4 mm/s[9]. Such results show that the mandible opening muscles are preserved, not participating in avoiding occlusive interference.

Maximal closing velocity in the study group was 204.9±16.6 and 345.2±26.84 in the control group with $p < 0.05$. While measuring the maximal closing velocity we arrived at an interesting discovery which confirmed Moyers – Schreder's observations regarding the presence of premature contacts due to which the patients with cross-bite have habitual occlusion with forced lateral movement of the mandible in its terminal phase of closing[3,10]. As a consequence the patient had traumatic occlusion with damaged closing muscles. An average closing velocity was 10.6±1.93% and it was slower than the average closing velocity in the control group, whereas in the study group this velocity was 39.07±2.85. According to Tsolka[9] the maximal closing velocity ranged from 267.5 to 299.9 and according to Tsukiyama it was 311.9±48 [11]. On the oscilloscope screen the traces of the incisive point during such movement are very specific. An elliptic tracing changes into an irregular circle with deep depression in the fourth quadrant, i.e. the terminal phase of the closing trajectory.

The highest rate of the slowdown was observed at the first tooth contact. In the study group this rate was 75.93±10.75, whereas in the control group it was 325± 26.77 with $p<0.01$, i.e. the velocity at the first contact in the control group was by 76.64% higher than such velocity measured at the first tooth contact in the study group. By recalling sensor and motoric paths which control occlusive relationships of the teeth and their changes we can see the reason why the act of closing slowed down at such a great rate, and why in four patients *m. temporalis* was so sensitive. This was the consequence of occlusive precontacts. The patients with miofacial pain moved their mandible at a lower speed than those without such pain, which corresponds to the well-known fact that a painful muscle can perform quick movements with great difficulty[12].

In addition to the appearance of occlusive interference, the following results were obtained: in the group of patients displacement occurs at vertical plane and at frequent tapping the teeth for 0.24± 0.01 mm. The mandible is never placed in the same position at maximal intercuspidation, since there is an obstacle at occlusive interference, which makes the mandible deviate.

Conclusions

Kinesiography as an objective method makes possible the analysis of the mandible movements, as well as accurate quantitative diagnosis. We have confirmed the findings of the authors who closely rate the cross-bite to numerous occlusive interferences and closing muscle alterations. Orthodontic therapy is therefore required to prevent the TMD in advanced age population. Clinical research has revealed that the subjects undergoing orthodontic therapy experience far fewer disturbances in their temporomandibular system[13]. The advantage of the described method was in its reproducibility, objective presentation of the relationship between the two jaws without producing occlusive interferences. The main fault was nonlinearity[12]. Hannah observed that in spite of the producer's instructions the occurrence of error increases with the mandible departing from its position of maximal intercuspidation. This error could be avoided by constructing a new linear K6MKG.

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KINEZIOGRAFSKA ANALIZA PACIJENATA S KRIŽNIM ZAGRIZOM

S A Ž E T A K

Polazeći od činjenice o direktnoj povezanosti križnog zagriza u stražnjoj regiji s pojavom okluzalnih interferenci i oštećenja mišića zatvarača mandibule, željeli smo objektivnom metodom to kvantitativno utvrditi. Uzeli smo dvije grupe ispitanika: 10 pacijenata s jednostrano križanim zagrizom i 10 studenata bez simptoma temporo-

mandibularne disfunkcije. Kineziografom Robert Jenkelson K5A izmjerili smo maksimalnu brzinu otvaranja mandibule (m/s), maksimalnu brzinu zatvaranja (m/s), brzinu pri prvom kontaktu zuba i vertikalne pomake pri maksimalnoj interkuspidaciji (mm). Dobili smo sljedeće vrijednosti: maksimalna brzina otvaranja ispitivane skupine je 349 mm/s, a kontrolne 380 mm/s. Razlika među njima je slučajna. Maksimalna brzina zatvaranja u ispitivane skupine je 204,9, a kontrolne 345,2 mm/s s $p < 0,05$. Brzina pri prvom kontaktu zuba u ispitivanoj skupini je 75,93, a u kontrolnoj 325 mm/s s $p < 0,01$. Vertikalni pomaci pri maksimalnoj interkuspidaciji u ispitivanoj skupini iznosili su 0,24±0,01 mm a u kontrolnoj skupini 0,012±0,012.