Bilateral Condylar Movement Patterns in Adult Subjects

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The purpose of this study was to determine if there was a difference between the temporomandibular condylar movement patterns of a symptomatic adult population and those of an asymptomatic adult population. Thirty-five volunteers who were not seeking treatment for TMD underwent two different assessments for TMD signs and symptoms: (1) a self-administered questionnaire and (2) a clinical examination. Based on the information obtained from the questionnaires, subjects were divided into "reported-symptomatic" and "reported-asymptomatic" groups. Based on the investigator's clinical evaluation of the same subjects, subjects were divided into "clinically symptomatic" and "clinically asymptomatic" groups. To compare condylar movement patterns, both groups of subjects then had their mandibular border condylar movements measured bilaterally using a sagittal recording device during maximum opening, maximum protrusion, and maximum left and right excursion movements. The patterns were separated into two broad groups, "symmetric" and "asymmetric." Symmetric gliding movements were defined as uninterrupted bilaterally mirror-like patterns of each condyle with a difference between left and right total length excursion not exceeding 2 mm during opening in the sagittal plane or horizontal plane. Our results show that 63% of the subjects who reported clinically asymptomatic for TMD demonstrated asymmetric condylar movements. However, 100% of the patients (n = 5) who reported clinically symptomatic for TMD exhibited asymmetric condylar movements. This finding suggests that, while a very high percentage of TMD subjects will have asymmetric condylar movements, condylar movements alone are not necessarily diagnostic of TMD, and the sagittal recording device may alert the clinician to abnormal movements.

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Temporomandibular disorders (TMD) include several subcategories of problems arising from disc derangements and condyle/eminence irregularities, which manifest clinically as mandibular deviations during movement.[1,2] Previous studies with magnetic resonance imaging (MRI) indicate a high correlation between disc displacement and asymmetric movement patterns of the condyle.[3] Internal derangements is an orthopedic term for disorders of the disc/condyle complex, causing mechanical disturbances and impediments to joint function and interfering with the smooth functional action of the joints.[1,2] Tumors, arthritides, ankyloses, skeletal muscle disorders, and other anatomic variations are mechanisms by which condylar movement patterns are affected.

Normal condylar movement is influenced physically by the articular eminence, the disc, and the ligaments encompassing the joint, as

well as the muscles, which provide both passive and active support.[4] Pioneering studies[12] of the condylar movement patterns during mastication using sagittal recording devices linked with occlusal support have demonstrated that normal asymptomatic adult subjects with normal occlusion (n = 4) exhibit curved condylar movement patterns. The distance traveled by the condyles amounts to approximately 40% of that recorded at the incisors.[5] Romanelli et al,[3] using a three-dimensional hinge-axis tracing system (Axiotron), compared bilateral joint movements in 16 control and 20 TMD subjects during maximum opening-closing, protrusive-retrusive, and mediolateral excursions of the jaw. They related an asymmetric pattern with disc displacement, and thus with TMD. They defined "normal" as symmetric gliding movements and "abnormal" as disc displacement with reduction or disc displacement without reduction as described by Slavicek.[6] While this interpretation has been accepted by other investigators analyzing condylar movement patterns,[7-10] none of them have retested the correlation of "normal" and symmetric.

Theusner et al,[11] using a sagittal recording device (SRD), have tracked condylar movements of an adult population not seeking TMD treatment. They reported that a high percentage (37/44) of their subjects demonstrated signs or symptoms of TMD. These TMD subjects had a longer condylar path during opening than their asymptomatic counterparts. However, these investigators did not define the prevalence of symmetric or asymmetric condylar movement patterns, which may be an important factor related to TMD. A more recent study by Krebs et al[12] provides a three-dimensional view of the movement of the condyle, in which the condylar movement is tracked in progressively increased openings using ^{1}H magnetic resonance images simultaneously with the tracking of three external points over the condyle. This method as yet only provides animated movement and is currently unable to detect real-time condylar motion.

Sagittal recording devices have been shown to exhibit reproducible results between operators[13] and, as such, have been widely used to study the position and movements of the condyles.[14] The investigators of this study used such a device to determine if differences in condylar movement patterns occur both in subjects who are symptomatic and those who are asymptomatic for TMD. This study also sought to determine whether a particular condylar movement pattern is associated with signs of TMD. This is of particular interest in light of studies by Westesson et al[15] indicating that disc displacement can occur in asymptomatic temporomandibular joints. Finally, this study sought to determine if asymptomatic subjects exhibit smooth and symmetric condylar movement patterns exclusively.

Materials and Methods

Subjects

The 35 subjects who participated in this study were selected according to their responses to a questionnaire on TMD signs and symptoms.[16] The project, which had received prior approval from the Committee on Human Research at the University of California at San Francisco, was described to the prospective subject, and a written consent was obtained after oral and written presentation. Fifteen women and 21 men with a mean age of 31.3 ± 9.7 years enrolled in the study. The mean age of the women was 29.3 ± 10.1 years, while the mean age of the men was 32.7 ± 9.2 years. None of the subjects was currently seeking treatment for TMD.

Screening Tests

Subjects underwent four types of tests: *(1)* a patient-derived report of potential TMD symptoms (Fig 1); *(2)* a clinical examination of the subject to identify TMD signs or symptoms and clinical external linear measurements of maximum mandibular opening, mediotrusion, and protrusion measured from a centric relation (Fig 2); and *(3)* condylar tracking during the same mandibular movements (Figs 3 and 4). A more detailed description of each of these tests follows.

Patient Questionnaire. To determine whether they perceived themselves to have TMD symptoms, each patient answered the questions listed in Fig 1. Subjects were defined as "reporting symptomatic" if one or more of the following characteristics was noted in their completed questionnaire: *(1)* one or more painful muscles of mastication; *(2)* one or more muscles of mastication that fatigues easily based on the patient's viewpoint; *(3)* noise within at least one temporomandibular joint (TMJ) during jaw movements; and/or *(4)* locking of the joint upon opening or closing the jaw.

Clinical Examination. After completing the questionnaire, each subject underwent a clinical examination conducted by one of two trained examiners at the Center for Temporomandibular Disorders and Orofacial Pain of the University of California at San Francisco. Presence of pain or dysfunction of the muscles of mastication was

Name: _____ Birthdate_____ Sex M F

(Circle response)

1. Have you ever had problems using your jaw during its function?	yes	no
2. Do you get painful jaw muscles?	yes	no
3. Does your jaw fatigue easily?	yes	no
4. Does your jaw ever get stuck momentarily while functioning?	yes	no
5. Have you ever had continuous facial pain associated with jaw function?	yes	no
6. Have you ever had noises in your jaw joints?	yes	no
7. Do you find yourself grinding your teeth and tiring your jaw?	yes	no
8. Have you ever had trauma to or fractured your jaw?	yes	no
9. Have you ever had orthodontic treatments?	yes	no
10. Have you had third molars removed?	yes	no

Fig 1 Questionnaire to assess potential signs and symptoms of TMD. Information from this questionnaire was used to determine which subjects were "reported-symptomatic" and which were "reported-asymptomatic."

assessed according to the subject's response to bidigital palpation. The TMJ was palpated bilaterally during mandibular movements. During these movements, subjects indicated the presence or absence of pain and the operator recorded joint sounds, such as popping, crepitus, or clicking, that could be sensed without the use of a stethoscope or other device. Starting at the incisors, the external linear measurement of maximum opening, left and right mediotrusion, and protrusion were measured by the clinician using a millimeter ruler and recorded to the nearest 0.5 mm. A subject was described as "clinically symptomatic" if one or more of the following three characteristics was noted in the investigator's examination: *(1)* pain or tenderness palpated within one or more of the muscles of mastication; *(2)* noises of any type within one or both joints on movement; and *(3)* deviation of greater than 2 mm in the mandible during opening or closing.

Sagittal Recording. Subjects were fitted to a mandibular clutch using the SAM Axiotron (Precision Technique GmbH, Munich, West Germany) and tracked bilaterally during all four motions to assess condylar motion as measured from centric relation. Subjects were described as having asymmetric condylar movement tracings with the SAM Axiotron if there was an abrupt change of direction from the predicted elliptical shape of condylar travel in the sagittal plane or if there was a difference of more than 2 mm in total distance traveled between right and left condyles in the sagittal or horizontal planes.

Instrumentation

Bilateral condylar movements were recorded with a SAM Axiotron. A computer and printer were used to obtain hard copies for measurement of the condylar movements. The condylar tracking device consisted of a two-piece lightweight metal frame. The reference or upper frame was adjusted to fit the cranium and held in position by a nosepiece adjusted to fit the subject's nasion. The reference frame was attached to two arms that fit snugly to the temporal bone just above the pinna. A rubber strap was attached to these arms distal to both pinna and passed inferiorly to the occipital protuberance to secure the reference arms during measurements. A 4 × 4 cm electronic grid was attached to the cranial reference arms just anterior to the pinna so that it was laying over the temporal fossa and was sufficient to cover the complete range of condylar motion. The lower member was attached to the mandibular teeth with an occlusal clutch filled with plaster (Kerr #2 Fast Set, Romulus, MI). A stylus was placed lateral to the head of each condyle and in a position such that it was in contact with the 4 × 4 cm electronic grid.

The examiner first positioned the condyles in centric relation, and then rotated the mandible until it was open only 1 cm at the interincisor distance. With this information the computer determined the center of rotation of the condyle (centric relation), which was graphically represented on the computer screen. The examiner was able to adjust the styli until they corresponded to the center of rotation of each condyle in centric relation. From this reference point, all movements were measured. For this study, the track-

Clinical Examination

Name: _____ Date: _____ Sex: M F

Phone No. _____ Birthdate: _____

Maximum opening _____ mm Maximum protrusion anterior _____ mm

Vertical overlap _____ mm Total opening vertical _____ mm

Maximum lateral-trusion right _____ mm left _____ mm

			WNL (CIRCLE IF PRESENT)
Clicking	right	left	
Crepitus	right	left	

WNL

Deviation

Palpation response

Masseter	R	L	
Temporalis	R	L	WNL
TM Joint	R	L	

Guidance				Facial type		
	R	L	Cuspid			
	R	L	Lateral			
	R	L	Protrusive	doli	meso	brachy

Occlusion

Class (molars)	1R	1L	2R	2L	3R	3L	div. i	div. ii
Class (cuspids)	1R	1L	2R	2L	3R	3L		

Signs of wear

None Mild Moderate Severe

Teeth missing (not erupted into occlusion)

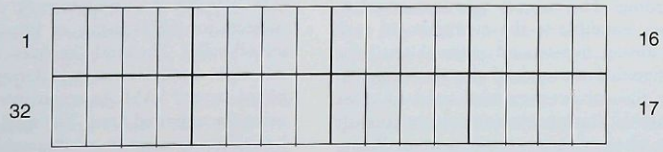


Fig 2 Clinical screening form to assess potential signs and symptoms of TMD. Information from this questionnaire was used to determine which subjects were "clinically symptomatic" and which were "clinically asymptomatic."

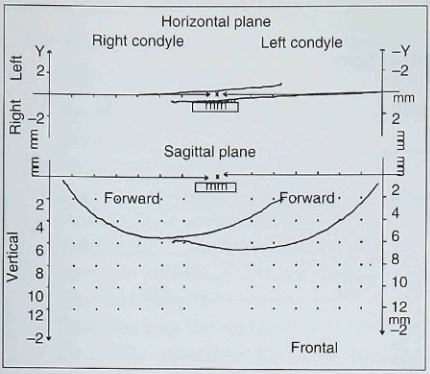


Fig 3 An Axiotron tracing depicting maximum opening for the right and left condyles in a normal asymptomatic subject. The movement of both condyles is shown in the horizontal and sagittal planes.

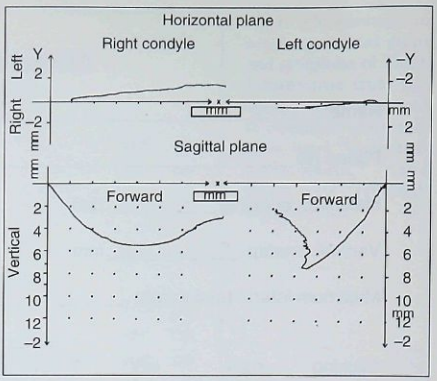


Fig 4 An Axiotron tracing depicting maximum opening for the right and left condyles in a symptomatic subject. The movement of both condyles is shown in the horizontal and sagittal planes. Notice that the left condyle interrupts its normal smooth pattern and shifts its pathway as compared to the right condylar tracking.

ing movements were displayed at 5× magnification produced by an Epson HX-20 printer, which is incorporated into the Axiotron system.

Exercise Protocol

Each subject was asked to follow a protocol established by the manufacturer of the SAM Axiotron. Each subject was seated upright in a standard chair without head support. The mandible was positioned by the examiner in centric relation with the teeth apart. The examiner then released pressure to the jaw to allow it to begin movements from a normal position. The subject then performed the desired movements. Before each movement, the subject was repositioned in centric relation and then with the jaw not held. All movements were done without the examiner's assistance. The examiner explained the movement to be measured and triggered the computer to begin recording. The subject was instructed to move his/her mandible to the maximum of each movement during a 5-second interval until the computer signaled the end of the recording, at which time the subject was instructed to relax his/her mandible. Each subject opened maximally three times, then completed one left mediotrusion, one right mediotrusion, and one maximum protrusion.

SAM Axiotron Measurements

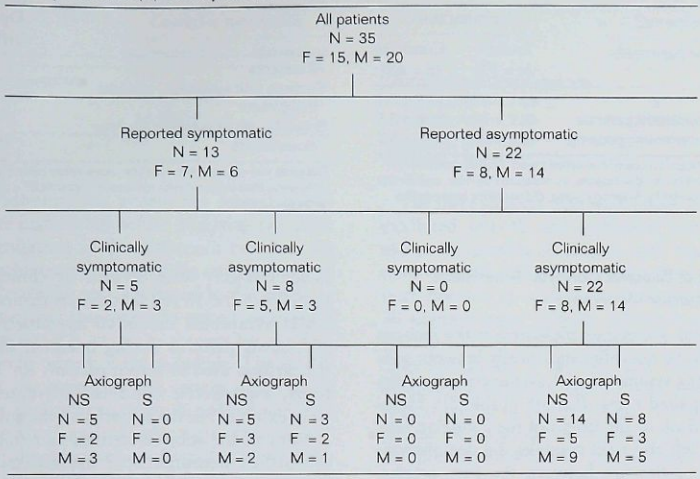
The actual distances traveled by left and right condyles were measured for their respective total distances using a rolling map measurer. The linear measuring device was calibrated against a known distance of 10 mm. The distances traveled by the condyles were measured in three planes: frontal, sagittal, and horizontal. In this paper, only the results from opening in the sagittal plane are reported.

Statistical Analysis

The incisor and bilateral condylar movement patterns were measured for total distance in the sagittal plane for each subject. The linear distance traveled by the mandibular incisors from the point of maximum intercuspation was measured by an investigator using a ruler. The total distance during opening in the sagittal plane was compared statistically between the asymptomatic and symptomatic subjects for TMD using an unpaired two-tailed t test ($P < .05$). The total distances traveled in the left and right condylar tracings during opening as depicted by the SAM Axiotron were also compared using the unpaired t test. The total distance traveled by incisor opening in a horizontal plane was then compared to the total distance of the condylar tracings using linear regression analysis.

Direct comparisons were made between the left

Table 1 Distribution of Subjects by Gender into the Categories Asymmetric (NS) and Symmetric (S) Condylar Movement Patterns



condylar movement pattern and the right condylar movement pattern for each subject, and any differences were noted. Group comparisons were then made between those with and those without symmetric condylar movement patterns using the unpaired *t* test.

Finally, the condylar movements defined in binary form as symmetric or asymmetric were compared to patient-reported symptoms using the nonparametric McNemar test for two related samples with a two-tailed test ($P < .05$). The same procedure was used to compare the condylar movement patterns to the clinically determined symptoms.

Hypotheses

Hypothesis 1. Do *asymptomatic* TMD subjects *as defined by patient report* exhibit only symmetric condylar movement patterns during mandibular opening movements?

Hypothesis 2. Do *asymptomatic* TMD subjects *as defined by clinical evaluation* exhibit only symmetric condylar movement patterns during mandibular opening movements?

Hypothesis 3. Do *symptomatic* TMD subjects *as defined by patient report* exhibit only asymmetric condylar movement patterns during mandibular opening movements?

Hypothesis 4. Do *symptomatic* TMD subjects *as defined by clinical evaluation* exhibit only asymmetric condylar movement patterns during mandibular opening movements?

Results

Comparison Between Patient-Derived and Examiner-Derived TMD Information

Thirteen (women = 7, men = 6) of the 35 subjects reported symptomatic for TMD symptoms based on their questionnaire. Of the 13 who reported symptoms, the clinical evaluation identified only 5 subjects as exhibiting TMD signs (Table 1). No TMD signs were found clinically in the subjects who reported no symptoms.

Comparison of Bilateral Condylar Tracking Movements

Twenty-four subjects exhibited asymmetric condylar movement tracings or patterns with at least one condyle (Fig 4). The asymmetric pattern would present as a sudden change horizontally from the predicted elliptical condylar pattern while the contralateral condyle would continue in its single-direction path; or, both condyles would change directions at different times during their translations. While this study was only concerned with changes in the sagittal plane, the asymmetric pattern would also appear in the frontal and horizontal planes.

Table 2 Mandibular Condylar and Incisor Movements

	Opening (mm)	
	Incisors (n = 72)	Condyles (n = 68)
All subjects	49.1 ± 6.6	18.7 ± 3.7
Subjects with symmetric patterns	48.7 ± 7.5	19.6 ± 3.5
Subjects with asymmetric patterns	49.3 ± 6.1	18.3 ± 3.7

$P > .05$, not significant (unpaired two-tailed t test). During maximum opening, the excursion for the incisors, as measured by ruler, and for the condyles, as measured by Axiotron tracing, did not differ between the two groups.

Table 3 Differences Between Left and Right Condylar Movements (mm)

	Opening/closing (left minus right)
All subjects	2.8 ± 2.4
Subjects with symmetric condylar movements	0.8 ± 0.7
Subjects with asymmetric condylar movemennts	3.8 ± 2.4

Subjects with asymmetric condylar movements have a significantly larger difference than subjects with symmetric patterns ($P < .001$, unpaired two-tailed t test).

Comparison of Bilateral Condylar Movement Patterns to Incisor Movement

The maximum opening as measured at the incisors and condyles did not differ statistically between subjects exhibiting symmetric and asymmetric condylar motions (unpaired t test, $P > .05$ [Table 2]). However, comparison of the length of the condylar path between the left and right condyles did demonstrate a significant difference between the two groups. Subjects with asymmetric motion had a significantly higher difference between left and right condylar movement patterns ($P < .001$ [Table 3]).

Comparing the maximum condylar movements during opening as tracked in the sagittal plane to that of the incisor movement using linear horizontal correlation indicated a low-to-moderate correlation coefficient ($r = .473$) between the two groups. However, if subjects were divided into those exhibiting bilateral symmetric condylar movements versus those who exhibited at least one asymmetric condylar movement during opening, the correlation coefficients changed. Subjects with bilateral symmetric condylar tracking movements exhibited a higher correlation coefficient ($r = .596$) between their total distance traveled by the condyles during opening and the maximum incisor opening. Subjects with asymmetric condylar movement patterns during opening-closing demonstrated a lower correlation coefficient ($r = .427$).

Comparison of Patient-Reported TMD Symptoms and Condylar Movement Patterns

Comparing the subjects by symptoms to the type of condylar movement pattern demonstrated that asymmetric bilateral condylar movements occurred in the majority (n = 24, 67%) of the 35 subjects. When subjects were divided by patient-reported TMD symptoms, 14 of the 22 (64%) subjects reporting no symptoms exhibited asymmetric condylar movements in at least one condyle during opening. When subjects were divided by clinical examination, 19 of the 30 (63%) subjects demonstrating no TMD symptoms exhibited asymmetric condylar movement patterns during opening. Regardless of the method used to screen patients for TMD symptoms, asymmetric condylar movement patterns were exhibited in the majority of the subjects.

Most of the subjects defined as exhibiting TMD symptoms demonstrated asymmetric condylar movement patterns during opening. A high percentage of subjects with patient-reported TMD symptoms (10/13 = 77%) exhibited asymmetric condylar movements. An even higher percentage of subjects identified clinically as exhibiting TMD symptoms (5/5 = 100%) exhibited the asymmetric condylar movements.

The relationship of the two methods to assess TMD symptoms (patient-reported and clinical) in these 35 subjects to the two types of condylar movement patterns (symmetric and asymmetric) was then compared using a decision-matrix method. Comparison of the two movement patterns with the two patient-reported groups showed that the sensitivity of the subject reporting any of the TMD symptoms to the type of condylar tracking movement was relatively low (42%). Specificity was higher at 73%, but not sufficiently high to suggest a strong correlation (Table 4).

The clinically symptomatic and asymptomatic groups were also compared to their respective condylar tracking results (Table 5). The sensitivity of the clinical assessment reporting any of the TMD symptoms to the type of condylar tracking movement was low (21%). However, specificity was much higher at 100%.

Discussion

Sagittal tracking devices, such as the SAM Axiotron, are consistent and easy-to-use instruments that record basic information on the movement of the

Table 4 Comparison of Condylar Movement Patterns to Patient-Reported Symptoms

	Condylar movement	
	Asymmetric	Symmetric
Patient-reported symptoms		
Symptomatic	10*	3 (27%)
Asymptomatic	14 (58%)	8†

*Sensitivity = 42%.
†Specificity = 73%.

Table 5 Comparison of Condylar Movement Patterns to Clinically Determined Symptoms

	Condylar movement	
	Asymmetric	Symmetric
Clinically determined symptoms		
Symptomatic	5*	0 (0%)
Asymptomatic	19 (79%)	11†

*Sensitivity = 21%.
†Specificity = 100%.

mandible. However, this system has several limitations that we understood before analyzing our data. The first limitation is the difference between the point of attachment to the mandible and the point of recording. Recording at a site lateral to the region of the condyles causes the system to record averages of some movements; it is unable to account for any flexion, yaw, pitch, or roll of the mandible. The second limitation is the weight of the system itself, which may or may not influence these border movements. The same system and weight were used for all patients, but the relationship of weight to mandibular weight, jaw muscle size, and facial skeletal type was not standardized. The last limitation is the difficulty in finding and maintaining the center of rotation during movements. With an asymmetrically shaped object, such as a condyle, the center of rotation will be different at various points along its path of movement. The center of rotation can never be at the surface of the skin where the stylus of the Axiotron is recording. These limitations primarily affect the accuracy of the true movement measurements of the condyle. However, we maintained the same parameters for all measurements in our subjects, and we identified an obvious reproducible pattern, to which the SAM system was sensitive.

An SRD is capable of depicting asymmetric movements of condyles of a mandible. It is not able to assess if these movements are pathologic. It did show in our study that asymptomatic as well as symptomatic subjects have a high probability of asymmetric movements. From a clinical perspective, this simple device can assist the clinician in documenting the "normal" movements of a subject prior to orthodontics or full-mouth reconstruction. Prior knowledge may help the clinician with treatment plans that involve abnormal loading and changes in dynamics of the TMJs. On a longitudinal basis, this study may show that recordings change over time. A normal, consistent sagittal movement may not exist in nature, since so many of our examined asymptomatic subjects had abnormal tracings. We also caution the clinician that normal-looking sagittal movements do not indicate normal soft tissue configurations of the TM discs as indicated by studies such as that by Romanelli et al.[3]

The three subjects who were under 21 years of age exhibited smooth and symmetric condylar movements. In contrast, all subjects with signs and symptoms of TMD had condylar movement patterns that were nonsmooth and asymmetric. However, 19 of 30 asymptomatic subjects exhibited nonsymmetric tracings. While SRDs such as the SAM Axiotron have limitations, it appears that such instruments can provide relatively user-friendly approaches in a clinical setting to establish some fundamental information on a condyle's movement. While studies may not provide information on the relevance of asymmetric condylar movements to TMD, the effect of such asymmetric patterns in condylar functions will need to be studied. This study, like others, suggests that condylar dysfunctions can exist without the patient's or clinician's knowledge. The adaptability of the TMJ is evident but not predictable.

More sophisticated three-dimensional jaw-tracking devices are now providing methods to assess the three-dimensional movements of the incisors, molars, and condyles simultaneously during maximum border movements.[12,17] Such studies may provide a method to determine how changes in internal derangements, aging, and anatomic adaptation within the TMJ may alter mandibular functions throughout a lifetime.

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Resumen

Patrones de Movimiento Condilar Bilateral en Personas Adultas

El propósito de este estudio fue el de determinar si existía una diferencia entre los patrones del movimiento condilar temporomandibular de una población adulta sintomática y aquellos de una población adulta asintomática. En este estudio participaron 35 voluntarios quienes no estaban buscando tratamiento para desórdenes temporomandibulares (DTM). Estas personas fueron sometidas a dos evaluaciones diferentes en cuanto a los signos y síntomas de DTM: (1) un cuestionario auto-administrado y (2) un examen clínico. Basados en la información obtenida de los cuestionarios, las personas fueron divididas en dos grupos: "los que dijeron ser sintomáticos" y "los que dijeron ser asintomáticos." Basados en la evaluación clínica de las mismas personas efectuada por el investigador, estos fueron divididos en dos grupos: clínicamente sintomáticos y clínicamente asintomáticos. A ambos grupos de personas se les midieron bilateralmente sus movimientos condilares limitantes mandibulares,con el propósito de comparar los patrones del movimiento condilar, utilizando un dispositivo de registro sagital durante la apertura máxima, protusión máxima, y los movimientos máximos de las excursiones derecha e izquierda. Los patrones fueron separados en dos grupos amplios, "simétrico" y "asimétrico". Los movimientos deslizantes simétricos fueron definidos como patrones espejados bilateralmente ininterrumpidos de cada cóndilo con una diferencia entre la longitud total de las excursiones izquierda y derecha sin exceder 2 mm durante la apertura en el plano sagital u horizontal. Nuestros resultados demuestran que el 63% de las personas que dijeron ser clínicamente asintomáticas en relación a los DTM, mostraron movimientos condilares asimétricos. Sin embargo, el 100% de los pacientes (n = 5) que dijeron ser clínicamente sintomáticos en relación a los DTM mostraron movimientos condilares asimétricos. Este hallazgo indica que, mientras un porcentaje muy alto de personas con DTM tendrán movimientos condilares asimétricos, los movimientos condilares por sí mismos no son necesariamente entidades diagnósticas de los DTM, y el dispositivo de registro sagital puede alertar al clínico sobre los movimientos anormales.

Zusammenfassung

Bilaterale Bewegungsmuster der Kondylen bei erwachsenen Personen

Das Ziel dieser Studie war es, zu bestimmen, ob es einen Unterschied zwischen dem Bewegungsmuster des Kiefergelenkskondylus bei einer symptomatischen Erwachsenenpopulation und jenem bei einer asymptomatischen Erwachsenenpopulation gibt. Fünfunddreissig Freiwillige, welche keine Behandlung für TMD wünschten, unterzogen sich zwei verschiedenen Beurteilungen für TMD-Zeichen und Symptome: *(1)* ein selbstverwalteter Fragebogen und *(2)* eine klinische Untersuchung. Die Personen wurden basierend auf den aus den Fragebögen erhaltenen Informationen in "angegebenen-symptomatische" und "angegebenen-asymptomatische" Gruppen eingeteilt. Basierend auf der klinischen Evaluation derselben Personen durch den Untersucher wurden die Probanden in "klinisch-symptomatische" und "klinisch-asymptoamtische" Gruppen eingeteilt. Um die kondylären Bewegungsmuster zu vergleichen, wurden bei beiden Gruppen die mandibulären Grenzbewegungen des Kondylus beidseitig gemessen indem eine sagittale Aufzeichnungsvorrichtung während maximalem Oeffnen, maximaler Protrusion und maximalen Exkursionsbewegungen nach links und rechts verwendet wurden. Die Muster wurden in zwei breite Gruppen, "symmetrisch" und "asymmetrisch," aufgeteilt. Symmetrische Gleitbewegungen wurden definiert als ununterbrochene, beidseitig spiegelbildliche Muster von jedem Kondylus mit einer Differenz zwischen der linken und rechten totalen Längenexkursion von höchstens 2mm während dem Oeffnen in der Sagittal- oder Horizontalebene. Unsere Ergebnisse zeigten, dass 63% der Personen, welche klinisch asymptomatisch für TMD angaben, asymmetrische kondyläre Bewegungen aufweisen. Dagegen zeigten 100% der Personen (n = 5), welche klinische symptomatische für TMD angaben, asymmetrische kondyläre Bewegungen. Diese Befunde lassen vermuten, dass—obschon ein sehr hoher Prozentsatz von TMD-Personen asymmetrische Kondylenbewegungen aufweisen—die kondylären Bewegungen alleine nicht notwendigerweise diagnostisch sind für TMD, und die sagittale Aufzeichnungsvorrichtung mag den Kliniker zu abnormalen Bewegungen verleiten.