RESEARCH

Posteroanterior cephalometric changes in subjects with temporomandibular joint disorders

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Objectives: The aim of the study was to establish the changes in posteroanterior cephalometric variables in subjects with temporomandibular joint disorders (TMDs).

Methods: Posteroanterior cephalograms of 61 subjects (age range 16–36.6 years, standard deviation 4.88 years) were used to determine cephalometric differences. Subjects were classified according to the Research Diagnostic Criteria for Temporomandibular Joint Disorders into three groups: unilateral TMD, bilateral TMD and no TMD. 14 linear and angular measurements were assessed on the posteroanterior cephalogram. For assessing facial asymmetry, the asymmetry index for bilateral measurements was calculated between the right and the left side. In cases with unilateral TMD, the asymmetry index was calculated using the difference between the unaffected and affected side. The differences among multiple groups were analysed using the one-way analysis of variance test and Scheffé *post hoc* test.

Results: 47 subjects were females (77%) and 14 were males (23%). 19 subjects had unilateral TMDs and 16 subjects had bilateral TMDs. The asymmetry index of the distance from the horizontal plane to the antegonion was higher in subjects with unilateral TMD than in patients with bilateral or no TMD ($p < 0.05$). Also, the asymmetry index of the distances from the vertical plane to the condyle ($p = 0.05$), gonion (Go) ($p = 0.0004$), antegonion ($p = 0.002$) and chin (Ch) ($p = 0.02$) was higher in subjects with unilateral TMDs. The asymmetry index of the O point–Go–Go' and O point–Ch–Ch' angles differed significantly in subjects with unilateral TMDs ($p < 0.05$).

Conclusions: Unilateral TMDs are associated with changes in posteroanterior cephalometric measurements. The assessment of posteroanterior cephalometric variables could be used as a key factor for evaluating the presence of TMDs.

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Introduction

The problem of treating subjects with internal derangements of the temporomandibular joint (TMJ) is an everyday challenge. A tolerable degree of symmetry variation can be found in the head and neck area, which is however not distressing for clinicians or patients. In contrast, a perfect symmetry of the facial area would be perceived as disturbing.

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Studies have shown that a small amount of asymmetry in the maxillofacial region is common,^{1,2} the critical threshold distance for evaluating facial asymmetry being below 4 mm.³

TMJ disc displacement is positively associated with mandibular asymmetry. In a growing person, mandibular displacement can influence the modelling process of the TMJ, leading to asymmetry.⁴ Anterior disc displacement has been seen mostly in the deviated side of the mandible in patients with mandibular prognathism.⁵ When there is a left-right size difference between the maxilla and the mandible, a morphological difference in the TMJ can also be identified.⁶

Concurrently, temporomandibular disorders have been demonstrated to induce mandibular asymmetry.^{7–10} A study conducted by Emshoff et al,¹¹ has shown that TMJ disc displacements without reduction and osteoarthritis are important determinants of mandibular backward positioning. Disc displacement might induce skeletal changes in facial morphology.¹² Schellhas et al¹³ have suggested that joint degeneration may lead to a shortening of the condyle, leading to subsequent skeletal asymmetry. The posteroanterior cephalogram is the first choice method used for diagnosing facial asymmetry.¹⁴

The lateral cephalogram is used for analysing the anteroposterior or vertical relationships of the maxilla and of the mandible to the cranial base. In a study by Yang et al,¹⁵ using lateral cephalograms, the authors found that the sagittal skeletal characteristics of subjects with TMJ disc displacement are different from those of subjects with normal disc position.

The posteroanterior cephalogram can indicate facial asymmetry more accurately by comparing the left and right sides of the face.¹⁶ Facial asymmetry can be easily assessed on posteroanterior cephalograms using the analysis described by Reyneke,¹⁷ based on constructed triangles.

To our knowledge, triangle and angular analyses have not been used yet in the assessment of the facial asymmetry induced by temporomandibular joint disorders (TMDs). The purpose of this study was to quantify the changes in posteroanterior cephalometric variables in subjects with TMDs.

Materials and methods

Subjects

61 subjects who visited our orthodontic department were recruited for the study. TMJ function was clinically evaluated in each subject according to axis I of the Research Diagnostic Criteria for Temporomandibular Joint Disorders (RDC/TMD).¹⁸ The clinical assessment of the RDC/TMD agrees excellently with MRI diagnosis of the TMJ, as suggested by Manfredini and Guarda-Nardini¹⁹ in a review. Therefore, the RDC/TMD classification system was used in the present study for TMJ assessment, since MRI cannot be requested as a routine examination for all TMD patients.

The experimental group consisted of 35 subjects with positive clinical signs of TMD (19 subjects with unilateral TMDs and 16 subjects with bilateral TMDs). 26 other subjects with no clinical signs of TMD and no congenital abnormalities in the maxillofacial region were included as a control group. The control group had a healthy, normal TMJ, with no history of joint pain or clicking, and no pain or limitations during lateral or frontal excursions of the mandible.

The procedures and protocol were approved by the Institutional Review Board at the University and by the Ethics Committee (no. 173/26.10.2010). Informed consent was obtained from each subject before entering the study.

Cephalometric measurements

All patients were investigated for facial symmetry using a posteroanterior cephalogram. The posteroanterior cephalograms were performed directly with a Pax Reve 3D device (Vatech, Hwaseong, Republic of Korea) using the cephalostat system (“one shot cephalometric system”, 50–90 kV, 2–10 mA, exposure time 0.5–1.0 s). During exposure, the subjects kept their teeth in centric occlusion. Cephalometric radiographs were printed on film using a laser printer (Carestream Dryview 5700 Laser Imager; Kodak, Rochester, NY). The posteroanterior cephalograms of all 61 subjects were analysed to quantify the differences between the right and the left side using cephalometric measurements.

Cephalometric radiographs were traced by hand on acetate sheets by a single investigator. 14 linear and angular measurements from the posteroanterior cephalogram were evaluated according to Reyneke and colleagues^{17,20} analyses, of which 13 were bilateral. Additional landmarks were used, based on previously published studies (Co, condylion; AGo, antegonion).^{21,22}

In order to assess the facial asymmetry, the asymmetry index for bilateral measurements was calculated using the following formula:

$$\text{Asymmetry index (\%)} = |(R - L) / (R + L)| \times 100, \quad (1)$$

where R is the value of the right distance and L is the value of the left distance.²² In cases with unilateral TMD, the asymmetry index was calculated using the difference between the unaffected and affected side.

The measurements were repeated three times with 2 week intervals between the image readings. The mean value of each measurement was used. The observer who made the cephalometric measurements was blinded to the TMD status of the subject.

The landmarks used in the study were Co (the most superior point of the condylar head); Go, gonion (the most inferior posterior point at the angle of the mandible); AGo (the highest point in the antegonial notch); Ch, chin (the most inferior lateral point on the anterior inferior border of the mandible); Me, menton (the most inferior point of the anterior mandibular area).

Figure 1 Landmarks used in the study: AGo, antegonion (the highest point in the antegonial notch); ANS, anterior nasal spine (the centre point at the base of the nose); Ch, chin (the most inferior lateral point on the anterior inferior border of the mandible); Co, condylion (the most superior point of the condylar head); Go, gonion (the most inferior posterior point at the angle of the mandible); ISM, internal sphenoid margin; Me, menton (the most inferior point of the anterior mandibular area); O point (middle of the line connecting the right and left ISM, in the middle of the horizontal plane)

Additional points were used for defining the horizontal and vertical reference planes: ANS, anterior nasal spine (the centre point at the base of the nose); ISM, internal sphenoid margin; O point (middle of the line connecting the right and left ISM, in the middle of the horizontal plane, on the skull base) (Figure 1).

Two reference planes were constructed in order to calculate the asymmetry index: the horizontal plane was constructed by connecting the right and left ISMs, having the O point in the middle; and the vertical reference plane was constructed by drawing a line through the middle of the horizontal reference plane (O point) and through the ANS.

We measured the following distances: the right and left distances from Co to AGo (a and a', respectively), from AGo to Me (b and b'), from Co to Me (g and g'), from Go to O (h and h'), from Ch to O (j and j'). The distances from the horizontal plane to Co (c and c') and to AGo (d and d') were assessed. The distances from the vertical plane to AGo (e and e'), to Co (f and f'), to Go (i and i') and to Ch (k and k') were also evaluated.

The following angles were calculated: Co–AGo–Me angle (1 and 1'), O–Go–Go' angle (2 and 2'), O–Ch–Ch' angle (3 and 3') and the angle between the vertical

reference plane and the line passing through ANS–Me (4) (Figure 2).

Statistical analysis

All statistical tests were two-sided at $\alpha = 0.05$ and were performed using SPSS 19.0 (SPSS, Chicago, IL). Summary statistics were calculated for all assessed parameters. The normal distribution of the data was tested by performing the Shapiro–Wilk test. In order to compare the means of groups with normal distribution and to detect differences between the absolute values of the asymmetry indexes, one-way analysis of variance was used to compare the three groups (unilateral TMD, bilateral TMD and no TMD) with respect to all cephalometric measurements. Comparisons between groups were performed with the Scheffé *post hoc* test. The level of significance was set at $p < 0.05$. To assess intrarater agreement, unweighted Cohen's kappa was calculated.

Results

The mean age of subjects with unilateral TMD was 24.87 years [range 16–36.6 years, standard deviation (SD) 6.3 years]; for subjects with bilateral TMD it was 25.7 years (range 19–34 years, SD 3.54 years); and of those without TMDs it was 22.88 years (range 17–32.6 years, SD 4.17 years). Of the 61 patients included in the study, 47 (77%) were females and 14 (23%) were males.

14 linear and angular measurements (13 bilateral and 1 unilateral) were assessed on the posteroanterior cephalograms. The mean values of the bilateral measurements of the affected and unaffected side in patients with unilateral TMD and of the right and left side in patients with bilateral or no TMD were calculated and are shown in Table 1.

Highly significant differences in the asymmetry index were obtained for 10 of the 14 evaluated linear and angular measurements (Table 2).

The asymmetry index of patients with unilateral TMD differed significantly from that of patients with bilateral TMD or without TMD when assessing vertical and horizontal facial asymmetry. A higher asymmetry index was found for the distance from AGo to the vertical plane than in the horizontal plane in patients with unilateral TMD. A significant difference was found between the unilateral and no TMD groups for the distance from AGo to the vertical plane and to the horizontal plane (Scheffé *post hoc* comparisons, $p < 0.05$). The asymmetry indexes of the distances from other points, Co, Go and Ch, to the vertical plane were found to be significantly higher in patients with unilateral TMD than in the other groups (Scheffé *post hoc* comparisons between unilateral and no TMD, $p < 0.05$). For further details see Table 2.

The asymmetry indexes of the distance from Co to the horizontal plane and of Co–AGo and Co–Me showed no significant difference among the three

Figure 2 Reference planes used in the study: the horizontal plane, a line connecting the right and left internal sphenoid margins; the O point in the middle; the vertical plane: a line through the middle of the horizontal plane (O point) and through the anterior nasal spine (ANS). Linear measurements used in the study: the right and left distances from Co to AGo (a and a', respectively), from AGo to Me (b and b'), from Co to Me (g and g'), from Go to O (h and h'), from Ch to O (j and j'); distances from the horizontal plane to Co (c and c'), to AGo (d and d'); distances from the vertical plane to AGo (e and e'), to Co (f and f'), to Go (i and i') and to Ch (k and k'). Angular measurements used in study: Co–AGo–Me angle (1 and 1'), O–Go–Go' angle (2 and 2'), O–Ch–Ch' angle (3 and 3'), the angle between the vertical plane and the line passing through ANS–Me (4). AGo, antegonion (the highest point in the antegonial notch); ANS, anterior nasal spine (the centre point at the base of the nose); Ch, chin (the most inferior lateral point on the anterior inferior border of the mandible); Co, condylion (the most superior point of the condylar head); Go, gonion (the most inferior posterior point at the angle of the mandible); ISM, internal sphenoid margin; Me, menton (the most inferior point of the anterior mandibular area); O point (middle of the line connecting the right and left ISM, in the middle of the horizontal plane)

groups. The Go and Ch position related to the O point (evaluated by the O point–Go–Go' and O point–Ch–Ch' angles) differed significantly in subjects with TMDs.

The asymmetry index of the distance from Ch to the O point showed no significant difference in patients with TMD. However, our results show that there is a

deviation of Me from the vertical plane in subjects with TMDs, highlighted by the significant differences of the angle from ANS–Me to the vertical plane among the three groups.

Inter-rater agreement values for the distances ranged from 0.762 to 0.910 and for the angles from 0.662 to 0.975 (Cohen's kappa).

Table 1 Mean values for bilateral measurements in unilateral, bilateral and no temporomandibular joint disorder (TMD) (on posteroanterior cephalograms)

Parameter	Group I unilateral TMD (n = 19)				Group II bilateral TMD (n = 16)				Group III no TMD (n = 26)			
	Affected		Unaffected		Right		Left		Right		Left	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Distances (mm)												
Co to horizontal plane ^a	26.34	4.44	27.18	4.67	27.84	8.85	26.72	8.08	28.46	5.31	28.88	5.66
AGo to horizontal plane	90.87	7.10	91.16	7.44	93.40	5.59	92.81	5.00	94.80	9.19	94.94	8.39
AGo to vertical plane ^b	42.87	3.68	44.68	3.65	44.56	3.99	45.38	3.27	43.98	3.20	44.54	2.91
Co to vertical plane	51.18	2.55	53.28	3.92	52.91	3.18	55.6	3.38	53.50	2.93	53.88	2.41
Co to AGo	64.58	7.80	65.16	7.31	66.21	5.82	66.97	6.35	67.03	7.40	66.52	7.25
Co to Me	100.21	10.23	100.45	9.03	102.13	6.80	103.78	7.16	101.52	8.28	101.98	9.02
Go to O point	99.86	6.73	101.39	6.34	102.94	5.96	102.72	5.58	103.81	8.68	103.38	8.16
Go to vertical plane	48.66	3.80	50.13	4.20	49.88	4.26	51.00	4.15	49.62	3.58	50.40	3.63
Ch to O point	113.32	9.15	113.18	8.64	115.22	8.53	115.03	8.29	115.54	10.99	115.71	10.62
Ch to vertical plane	9.68	4.69	10.24	6.23	9.50	3.41	10.90	3.98	9.32	3.97	9.57	3.32
Angles (degrees)												
Co-AGo-Me	123.34	7.64	123.39	7.66	122.53	4.40	123.88	4.49	123.33	7.11	122.31	7.02
O point-Go-Go'	59.95	2.56	61.34	2.61	60.59	2.23	60.94	1.87	60.60	2.02	61.13	2.64
O point-Ch-Ch'	85.34	3.66	86.05	3.88	84.06	2.27	85.66	2.39	85.38	1.74	85.21	2.23

AGo, antegonion; Ch, chin; Co, condylion; Me, menton; O point, middle of the line connecting the right and left internal sphenoid margin, in the middle of the horizontal plane, on the skull base; SD standard deviation.

^aHorizontal reference line: the line connecting right and left internal sphenoid margins, with O point in the middle.

^bVertical reference line: the line perpendicular to the horizontal reference line, passing through anterior nasal spine.

Discussion

Skeletal mandibular asymmetry results from many factors: morphological disorder, growth disharmony, trauma, tumours, or condyle or hemimandibular hypertrophy.⁶ Functional factors, such as bruxism, masticatory dysfunction or occlusal abnormalities, may also play a role.²³

The aetiology of the internal derangements of the TMJ is still unclear. In the present study we aimed to analyse cephalometric changes on posteroanterior cephalograms in subjects with TMDs using the asymmetry index.

According to de Leeuw *et al*²⁴ subjects with unilateral disc displacement are known to have differences in mandibular vertical height compared with healthy subjects, the difference being attributed to the shortening of the affected side of the mandible due to the osteoarthrotic degeneration of the condyle as a result of disc displacement. This suggests that disc displacement may induce mandibular asymmetry.

Our results showed a higher asymmetry index of the distance from AGo to the vertical plane in subjects with unilateral TMD than that of bilateral TMD or no TMD subjects (Scheffé *post hoc* comparisons between unilateral and no TMD and between unilateral and bilateral TMD, $p < 0.05$). The Co-AGo and Co-Me distances were not influenced by TMD. These results could be explained by a possible readjustment pattern effect of the mandible caused by the internal derangement of the TMJ.

Previous studies have shown that disc displacement may be an important determinant in horizontal and vertical ramus deficiency on lateral cephalograms.²⁵ Buranastidporn *et al*²⁶ have reported a relationship between the vertical asymmetry of the mandible and the occurrence of TMD signs due to the disruption of the normal load of the TMJ. On the other hand, TMDs may cause growth disturbances which may result in mandibular asymmetry. Baik²⁷ reported that the length of the mandible of the TMD patient is shorter than that of normal patients, whereas Nebbe *et al*²⁸ suggest that the vertical ramus height and length of the mandible are related to TMDs.

In our study we found a higher asymmetry index of the distance from AGo, Go, Co and Ch to the vertical plane in subjects with unilateral TMDs, suggesting a more important transverse asymmetry of the mandible in the case of unilateral TMDs. Our results highlight significant differences in the asymmetry index between the unilateral TMD compared with the bilateral and no TMD groups for the distances from Go and AGo to the vertical plane (*post hoc* comparisons between unilateral and no TMD groups (Scheffé method, $p < 0.05$)).

Significant differences in the mean asymmetry index of the distance from Go to the vertical plane were found (asymmetry index 4.77 in subjects with unilateral TMD *vs* 2.23 in subjects with bilateral TMD and 2.10 in subjects with no TMD, $p < 0.05$), which were similar to those found by Hwang *et al*.²⁹

Ahn *et al*¹⁶ have studied the mandibular asymmetry in five patient groups: without TMD and with unilateral or

Table 2 Asymmetry index of the measurements in unilateral, bilateral and no temporomandibular joint disorder (TMD) (on posteroanterior cephalograms)

	Group I unilateral TMD (n = 19)		Group II bilateral TMD (n = 16)		Group III no TMD (n = 26)		<i>p</i> -value (ANOVA)
Asymmetry Index	Mean	SD	Mean	SD	Mean	SD	
Linear relationships							
Co to horizontal plane ^a	3.04	2.57	3.12	3.88	2.07	1.80	0.36
AGo to horizontal plane ^d	2.16	2.85	0.82	0.68	0.98	0.9	0.04
AGo to vertical plane ^{b,d,e}	5.56	4.98	1.87	1.84	2.45	1.99	0.002
Co to vertical plane ^d	3.44	3.43	2.43	1.93	1.79	1.36	0.05
Co to AGo	3.09	4.36	1.29	1.38	1.68	1.22	0.10
Co to Me	2.11	2.25	1.40	0.61	1.16	0.99	0.09
Go to O point ^d	1.38	1.33	0.72	0.68	0.75	0.64	0.05
Go to vertical plane ^{d,e}	4.77	3.04	2.23	1.78	2.10	1.72	0.0004
Ch to O point	0.36	0.44	0.27	0.29	0.18	0.25	0.21
Ch to vertical plane ^d	32.88	25.42	18.01	16.67	18.14	15.01	0.02
Angular relationships							
Co–AGo–Me ^d	1.90	1.55	1.16	1.22	0.97	0.88	0.04
O point–Go–Go' ^{d,e}	2.54	2.12	1.15	0.89	1.46	1.06	0.01
O point–Ch–Ch' ^{d,e}	2.51	2.87	1.79	1.57	0.98	1.22	0.04
ANS–Me to vertical plane ^{c,d,e}	3.45	4.31	1.47	1.33	1.21	1.26	0.02

AGo, antegonion; ANOVA, one-way analysis of variance; ANS, anterior nasal spine; Ch, chin; Co, condylion; Me, menton; O point, middle of the line connecting the right and left internal sphenoid margin, in the middle of the horizontal plane, on the skull base; SD, standard deviation.

^aHorizontal reference line: the line connecting right and left internal sphenoid margins, with O point in the middle.

^bVertical reference line: the line perpendicular to the horizontal reference line, passing through anterior nasal spine.

^cAsymmetry index not applicable, the mean angle showing the Me deviation from the vertical plane.

^dPost hoc comparisons between unilateral and no TMD groups (Scheffé method, $p < 0.05$).

^ePost hoc comparisons between unilateral and bilateral TMD groups (Scheffé method, $p < 0.05$).

bilateral TMD, with or without disc displacement. The authors evaluated the difference between the right and left side of the mandible and showed that there were significant differences in the Co–AGo distance between the two sides of the mandible in patients with unilateral TMD compared with bilateral TMD or no TMD.

In our study we also found a smaller asymmetry index of the distance from Co to AGo in patients with bilateral or no TMD than in those with unilateral TMD. The condyle point was found to be more displaced in subjects with TMDs. This might be because TMDs may induce a higher and more medial position of the condyle. It has been suggested that in the absence of any disc displacements in subjects with positive RDC/TMD signs, abnormal condylar morphology might be suspected.³⁰

We found a higher asymmetry index of the distance from AGo to the vertical plane in subjects with unilateral TMD than those with bilateral or no TMD. Unlike our results, Trpkova *et al*³¹ found a significantly increased asymmetry of the vertical position of AGo in bilateral TMD when exploring the asymmetry in young female patients aged between 10 and 17 years. These opposite results could have been generated by the different age and pathology of the studied groups.

We found a higher asymmetry index of the distance from Ch to the vertical plane in subjects with unilateral TMD than in those with bilateral or no TMD. These results are in agreement with those of Ali *et al*,³² who showed that mandibular deviation was significantly higher in subjects with TMD than in those with no TMD. When evaluating chin asymmetry in subjects with TMDs, Buranastidporn *et al*³³ also demonstrated a significant difference in the angle between ANS–Me

and the vertical plane in subjects with TMD. In our study there was also an increased mean angle between ANS–Me and the vertical plane ($p < 0.05$), showing a more deviated chin in subjects with unilateral TMD. Also, Schellhas *et al*³⁴ showed that adult patients with a deformed condyle and degenerative joint disease had a deviation of the chin towards the affected side.

Kambylafkas *et al*³⁵ report that symptomatic adults with unilateral TMD have a mandibular notching on the affected side. The authors, studying mandibular asymmetry in subjects with unilateral joint disease, found no significant difference in total ramal height, although the condylar height was reduced. The authors explain the maintenance of total ramal height by the compensatory mechanism that takes place at the gonial angle.³⁵ In our study we found significant differences in the asymmetry index of the distance from the horizontal plane to AGo in subjects with unilateral TMD, suggesting a shorter ramus height. Although the distances from Co–Me and Co–AGo were shorter in subjects with unilateral TMDs, the asymmetry index did not significantly differ among the three groups.

Overall, in our study, we found an increased asymmetry index and significant differences in patients with unilateral TMDs compared with the other groups. This is accordance with the findings of Inui *et al*,²³ who showed that facial asymmetry is an important characteristic in the aetiology of the internal derangement of the TMJ, owing to a mandibular lateral deviation.

Mandibular asymmetry might influence the functionality of the TMJ,^{4,33} which could suggest a correlation between mandibular asymmetry and the internal derangements of the TMJ.³⁶ However, Buranastidporn *et al*²⁶ have shown that there are many patients with

mandibular asymmetry who do not show disc displacement, and that there are many subjects without asymmetries who have disc displacements. Previous studies showed that patients with disc displacement might be at risk for developing more frequent TMJ symptoms than healthy individuals.^{37–39}

We conducted our study based on the analysis described by Reyneke¹⁷ for posteroanterior cephalometric radiographic evaluation. This analysis is based upon triangle assessment for the evaluation of facial structures. Triangles can easily reveal any amount of asymmetry and can also highlight the direction of rotation of the mandible or chin.¹⁷

In addition to Reyneke's recommendations for measuring the triangle's legs, our study assesses the angles of the constructed triangles. The O–Go–Go' angle showed significant differences between unilateral TMD and bilateral or no TMD, whereas the O–Ch–Ch' angle was significantly different between unilateral and no TMD. We consider that angles are more reliable to changes induced by asymmetry of a certain point than distances, because the assessment of the distances must be related to the facial baseline dimensions. The angular analysis could be very useful for the clinician, in the assessment of facial asymmetry in TMJ pathology.

It is of clinical importance to reveal the relationship between facial asymmetry and internal derangements of

the TMJ, because TMJ pathology could induce changes in facial morphology. It is essential to detect facial asymmetry in a growing person, because if the asymmetry remains untreated it may worsen with growth and could influence the modelling process of the TMJ, especially on the affected side.

Owing to these findings, we consider that the assessment of the TMJ in subjects with facial asymmetry could have a high clinical importance and can be helpful in proper diagnosis and treatment planning for these patients.

In subjects with mandibular asymmetry, further investigation for establishing TMJ status is recommended.

Conclusions

This study suggests that unilateral TMD is associated with changes in posteroanterior cephalometric measurements. Assessment of facial asymmetry should be associated with clinical examination of the TMJ in subjects with internal derangements of the TMJ for an accurate diagnosis and treatment plan. The Reyneke analysis and the angles of the constructed triangles could easily be used for the assessment of facial asymmetry especially in unilateral TMD.

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