Original Article

Glenoid Fossa Position in Class II Malocclusion Associated with Mandibular Retrusion

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ABSTRACT

Objective: To assess the position of the glenoid fossa in subjects with Class II malocclusion associated with mandibular retrusion and normal mandibular size in the mixed dentition.

Materials and Methods: A sample of 30 subjects (16 male, 14 female), age 9 years ± 6 months, with skeletal and dental Class II malocclusion associated with mandibular retrusion, normal skeletal vertical relationships, and normal mandibular dimensions, was compared with a matched group of 37 subjects (18 male, 19 female) with skeletal and dental Class I relationships. The comparisons between the Class II group and the control group on the cephalometric measures for the assessment of glenoid fossa position were performed by means of a nonparametric test for independent samples (Mann-Whitney *U*-test, $P < .05$).

Results: Subjects with Class II malocclusion presented with a significantly more distal position of the glenoid fossa, when compared with the control group as measured by means of three parameters (GF-S on FH, GF-Ptm on FH, and GF-FMN).

Conclusions: A posteriorly displaced glenoid fossa is a possible diagnostic feature of Class II malocclusion associated with mandibular retrusion. An effective cephalometric measurement to evaluate glenoid fossa position is the distance from the glenoid fossa to the frontomaxillonasal suture (GF-FMN).

KEY WORDS: Class II malocclusion; Glenoid fossa; Cephalometrics; Mandibular retrusion

INTRODUCTION

Malocclusions are the result of various combinations of underlying dental and skeletal disharmonies that involve several different components of the craniofacial region.[1] Since the relationship of the mandible to the cranial base influences both sagittal and vertical facial disharmonies, the position of the glenoid fossa in relation to surrounding skeletal structures deserves to be included in the analysis of the skeletal features of the individual patient.[2,3] The scientific contributions in this regard have indicated that the relative position of the glenoid fossa, ie, of the attachment of the mandible to the cranium, can affect the dentoskeletal features of malocclusions, for instance, a more distal position of the fossa can facilitate mandibular retrusion.[2–4]

The evaluation of the direction of growth of the mandibular condyle and/or its displacement within the glenoid fossa during masticatory function has emphasized the role of the relationship between the lower jaw and the cranial base in the establishment of occlusal relationships.[5] Experimental and clinical studies have also shown changes in the region of the glenoid fossa concurrent with the improvement or correction of dentoskeletal disharmonies.[6–9]

Despite the recognized role of the glenoid fossa in the etiology of malocclusions, as well as during orthodontic treatment, the literature provides only limited data about the significance or the quantification of the position of the temporomandibular joint within the human skull in orthodontic diagnosis.[2–4] It should be noted also that most of the research that evaluated the relationships between the temporomandibular joint position and malocclusions focused on the degree of cranial flexure in different sagittal discrepancies,[10–14] al-

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though this type of cephalometric measurement only allows for an indirect appraisal of glenoid fossa position. Moreover, although the position of the glenoid fossa affects primarily the relation of the mandible with the other craniofacial components,[15] investigations that analyzed glenoid fossa position by means of direct measurements[3,4] did not differentiate among the various diagnostic components of the dentoskeletal discrepancies investigated (eg, maxillary protrusion, mandibular retrusion, mandibular size deficiency).

The aim here was to assess the position of the glenoid fossa in a group of subjects with Class II malocclusion associated with mandibular retrusion in the mixed dentition in order to better clarify the role of this craniofacial component in Class II skeletal disharmony.

MATERIALS AND METHODS

A sample of 30 subjects (16 male, 14 female), age 9 years ± 6 months, with skeletal and dental Class II malocclusion associated with mandibular retrusion, normal skeletal vertical relationships, and normal mandibular dimensions, was selected from a parent sample of 2500 patients from the files of the Departments of Orthodontics at the Universities of Florence and Rome "Tor Vergata." The following selection criteria were applied:

- Skeletal Class II malocclusion due to mandibular retrusion (SNB < 73.0° for male subjects and SNB < 73.3° for female subjects) with normal sagittal position of the maxilla (76.0° < SNA < 83.5° for male subjects and 75.5° < SNA < 82.7° for female subjects);
- Normal skeletal vertical relationships (31.0° < SN-mandibular plane < 40.8° for male subjects and 31.8°< SN-mandibular plane < 41.6° for female subjects);
- Normal mandibular dimensions (94.8 mm < Co-Gn < 103.0 mm for male subjects and 93.7 mm < Co-Gn < 100.5 mm for female subjects);
- Full Class II molar relationship and excessive overjet (OVJ > 5.5 mm);
- Absence of tooth agenesis or supernumeraries;
- Absence of traumatic injuries;
- Absence of complex craniofacial deformities or syndromes.

The reference values for the cephalometric measures at the age of 9 years ± 6 months were derived from the atlas by Bathia and Leighton,[16] that reports data for large communities of European subjects with a strong prevalence rate of subjects with Italian ancestry. The selected age of 9 years ± 6 months corresponds to the period in which a Class II malocclusion is frequently evaluated for treatment planning.[17]

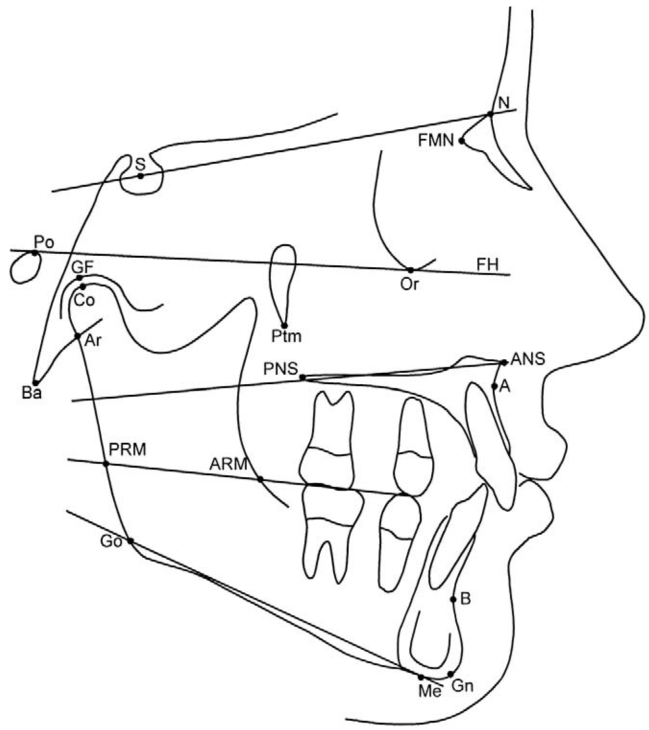

Figure 1. Cephalometric landmarks and planes.

The sample group was compared with a control group of 37 subjects (18 male, 19 female; average age 9 years ± 6 months) selected from the Department of Orthodontics of the University of Florence. These subjects were characterized by dental and skeletal Class I occlusion, normal skeletal vertical relationships, ie, they presented with features that matched those of the Class II sample group with the exception of the molar relation, overjet (2.5 mm < OVJ < 5.5 mm), and mandibular position (73.0° < SNB < 79.7° for male subjects, and 73.3° < SNB < 79.7° for female subjects).

Cephalometric Analysis

For each subject lateral cephalograms were traced by the same operator (Dr Giuntini) and checked by another operator for landmark location (Dr Franchi). Computer-assisted cephalometric analysis was carried out by means of a digitizer (Numonics 2210, Numonics, Lansdale, Pa) and of a software (Viewbox 3.1, copyright D. Halazonetis, Athens, Greece). Post digitization, all linear measures were standardized to life size (0% enlargement) in order to match reference data.[16]

By means of the computerized cephalometric analysis the following angular and linear measurements were calculated (Figure 1):

SNA—angular measurement.

SNB—angular measurement.
ANB—angular measurement.
Co-Gn—linear distance between point Co (condylion) and point Gn (gnathion).
Co-Go—linear distance between point Co and point Go (gonion).
Go-Gn—linear distance between point Go and point Gn.
Wits—"Wits" index.[18]
GF-S on FH—distance between the projections of point GF (glenoid fossa, most superior and posterior point on the bony contour of the glenoid fossa, facing point Co) and point S (sella) onto Frankfort horizontal plane (FH).
S-Ptm on FH—distance between the projections of point S and point Ptm (pterygomaxillary fissure) onto FH.
GF-Ptm on FH—distance between the projections of point GF and Ptm onto FH.
GF-FMN—linear distance between GF and FMN (frontomaxillonasal suture) point.
Mandibular ramus width—distance between the projections of anterior ramus point (ARM, point of intersection between the occlusal plane and the anterior contour of the mandibular ramus),[16] and posterior ramus point (PRM, point of intersection between the occlusal plane and the posterior contour of the mandibular ramus)[16] onto the mandibular plane (Go-Me).
Mandibular body length—distance between the projections of point B and ARM onto Go-Me.
Co-Go-Me—mandibular angle.
FH-palatal plane—angular measurement between FH and the palatal plane (PNS-ANS).
SN-palatal plane—angular measurement between sella-nasion plane (SN) and PNS-ANS.
SN-mandibular plane—angular measurement between SN and Go-Me.
Palatal plane-mandibular plane—angular measurement between PNS-ANS and Go-Me.

Statistical Analysis

Descriptive statistics were calculated for each cephalometric parameter in both Class II and Class I groups. The comparisons between the Class II group and the control group were performed by means of a nonparametric test for independent samples (Mann-Whitney *U*-test, $P < .05$). All statistical tests were carried out with statistical software (SPSS for Windows, Version 12.0, SPSS Inc, Chicago, Ill).

Method error was calculated by means of the Dahlberg formula on 40 repeated cephalograms, and the error ranged from 0.2 mm to 1.1 mm for linear measurements and from 0.2° to 1.2° for the angular ones.

The relatively small size of the Class II and Class I samples (n = 30 and n = 37, respectively) was a consequence of the strict inclusion criteria that were adopted. The power of the samples, however, exceeded 0.90 as calculated based on the sample size and the standard deviation of a linear distance from the glenoid fossa to a vertical line dropped from sella in a previous study by Droel and Isaacson.[3] The determination of the power assumes the sample to be distributed normally. In that this is not the case in the present study, and the power of a non-parametric test is approximately 95% that of a parametric test, the power of the present study was 0.85.

RESULTS

Table 1 shows the descriptive statistics and the results of comparisons with statistical significance.

The value for SNB angle was significantly smaller in the Class II group, whereas the values for both the Wits index and the ANB angle were significantly greater in the Class II group compared with normal controls. Subjects with Class II malocclusion presented with a significantly more distal position of the glenoid fossa, when compared with the control group as measured by means of three parameters (GF-S on FH, GF-Ptm on FH, and GF-FMN). No other significant difference between groups was found.

DISCUSSION

In the cephalometric appraisal of the glenoid fossa position, subjects with Class II malocclusion associated with mandibular retrusion can present with a posteriorly displaced glenoid fossa as part of their craniofacial characteristics. In the present study, the position of the glenoid fossa was evaluated according to its distance from sella (on Frankfort horizontal line, mm), from pterygomaxillary fissure (GF-Ptm on Frankfort horizontal line, mm) and from frontomaxillonasal suture (GF-FMN, mm), and it was compared in subjects with Class II malocclusion and normal occlusion. Subjects with Class II malocclusion presented with a significantly more distal position of the glenoid fossa, when compared with the control group as measured by means of three parameters (GF-S on FH, GF-Ptm on FH, and GF-FMN).

The distance between the glenoid fossa and point FMN is much more indicative of the differences between Class II and Class I subjects for this skeletal characteristic than the distance between the glenoid fossa and sella. GF-FMN length appeared to be a more sensitive parameter to evaluate the position of the glenoid fossa with respect to GF-S on FH, a parameter that Wylie[19] suggested in 1947. This is probably because GF-FMN has a geometrical and anatom-

Table 1. Descriptive Statistics and Statistical Comparisons (Mann-Whitney *U*-Test) Between Class II and Class I Groups

Cephalometric Measurements	Class II Group (n = 30)		Class I Group (n = 37)			Mann-Whitney *U*-Test
	Mean	SD	Mean	SD	Diff.	*P* value
SNA, degrees	80.4	2.2	80.4	2.5	0.0	.870
SNB, degrees	73.5	1.6	76.5	2.1	−3.0	.000
ANB, degrees	6.8	1.7	3.9	1.6	+2.9	.000
Co-Gn, mm	94.5	3.1	95.4	3.2	−0.9	.084
Co-Go, mm	43.8	2.9	44.7	2.7	−0.9	.094
Go-Gn, mm	62.2	2.7	63.2	2.9	−1.0	.130
Wits, mm	1.7	3.1	−1.7	3.4	+3.4	.000
GF-S on FH, mm	12.5	3.4	10.9	2.2	+1.6	.008
S-Ptm on FH, mm	18.9	2.7	18.8	2.3	+0.1	.980
GF-Ptm on FH, mm	31.4	3.0	29.7	2.6	+1.7	.010
GF-FMN, mm	71.0	4.1	67.6	3.5	+3.4	.000
Mandibular ramus width, mm	30.2	1.5	29.8	2.6	+0.4	.734
Mandibular body length, mm	40.2	2.2	40.8	2.7	−0.6	.284
CoGoMe, degrees	126.6	4.6	126.7	3.8	−0.1	.970
SN-palatal plane, degrees	8.7	2.5	8.4	2.6	+0.3	.734
SN-mandibular plane, degrees	37.5	3.3	37.5	2.6	0.0	.930
Palatal plane-mandibular plane, degrees	28.8	4.1	29.1	3.3	−0.3	.623

ical correspondence with the angulation between the anterior and posterior portions of the cranial base. Various studies in the past have reported a tendency to a skeletal Class II pattern in subjects presenting with a large cranial base angle[10–13] in association with a distal position of the temporomandibular joint within the skull.[3,4]

The average distance from the glenoid fossa to frontomaxillonasal suture, as measured in the Class II group, was 3.5 mm longer than the same average distance in the control group. This result is significant not only from a statistical point of view, but also from a clinical one, as it shows clearly that in certain clinical cases and in the absence of other dentofacial discrepancies (eg, mandibular size deficiency, vertical disharmonies) Class II malocclusion in the individual patient can be related to a distal position of the glenoid fossa with the consequence of a significant mandibular retrusion. These findings corroborate a previous report by Droel and Isaacson[3] who found approximately 2.5 mm of posterior displacement of the glenoid fossa in skeletal Class II subjects when compared with skeletal Class I subjects. It should be noted, however, that, in the study by Droel and Isaacson[3] Class II subjects included both cases with maxillary protrusion and cases with mandibular retrusion/deficiency. By focusing on Class II malocclusion associated exclusively with mandibular retrusion, the present study was able to find a significant difference in glenoid fossa position between Class II and Class I samples. Further research is needed to establish reference values for measurements involving glenoid fossa position in subjects at different ages and with different dentoskeletal relationships.

The selection criteria of this study explain directly some of the other significant differences that were found between the Class II malocclusion and control group. The values for SNA and SNB angles, and the Wits index showed both the absence of maxillary protrusion in the Class II sample as well as the presence of mandibular retrusion, also confirmed by the ANB angle. The value for this angle was greater than 4° in all Class II subjects. Mandibular parameters like Co-Gn, Co-Go, Go-Gn, mandibular ramus width, and mandibular body length did not reveal statistically significant differences between the two groups. Once again, these data reflected the selection criteria for the Class II group (normal mandibular dimensions). Likewise, SN-mandibular plane angle, and palatal plane-mandibular plane angle, that are related to skeletal vertical relationships, were normal in both groups and, therefore, not significantly different between the two groups.

The findings of the current study also recommend assessing glenoid fossa position in those Class II cases that can be recognized otherwise as subjects with "functional Class II malocclusion." This type of Class II malocclusion is characterized by a posterior shift of the mandible from postural rest to occlusion.[20] In these cases the distal position of the glenoid fossa may entail a diagnostic importance for two aspects, ie, a "structural" aspect due to the influence of the glenoid fossa position on sagittal skeletal relationships, and a "functional" aspect that has been indicated in the literature in the past.[5,20] The distal position of the glenoid fossa allows for movements of the mandibular condyle in a superior and posterior direction during the switch from rest position to maximal intercuspation.[5]

It deserves to be highlighted that the distal position of the glenoid fossa, as an anatomical condition predisposing to Class II malocclusion, can become a therapeutic target for dentofacial orthopedics. The literature reports significant changes that can be induced in the structural features of the posterior wall of the glenoid fossa following mandibular advancement and mechanical stimulation of condylar growth. These changes can contribute significantly to the correction of Class II malocclusion associated with mandibular retrusion.[6–9]

CONCLUSIONS

- A posterior position of the glenoid fossa is a possible diagnostic anatomic feature of Class II malocclusion associated with mandibular retrusion.
- An effective measurement to evaluate glenoid fossa position within the craniofacial relationships is the cephalometric distance from the glenoid fossa to the frontomaxillonasal suture (GF-FMN).

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