Revista Odontológica Mexicana

Facultad de Odontología

Vol. 15, No. 4 ● October-December 2011

pp 214-218

ORIGINAL RESEARCH

Relationship between cranial base flexure and skeletal class

Relación entre la deflexión de la base del cráneo y la clase ósea

Aldo Jonathan Ruiz Rivera,* Joaquín Canseco Jiménez,§ Vicente Cuairán Ruidiaz||

ABSTRACT

It is stated in scientific literature that the entire craniofacial complex is influenced by the growth and displacement direction of the cranial base structures, at the same time exerting over them direct influence. Nevertheless, many times this is not the case, and this point is subject to great controversy. We must also bear in mind that studies have been carried out in population samples of different ethnic characteristics, facial biotypes, and growth types. For these reasons, a random sample of 80 cranial cephalometric radiographs were taken at the Orthodontic Department of the Hospital Infantil de Mexico Federico Gomez (HIMFG). Patients had not previously received orthopaedic or orthodontic treatment. Patients were divided according to skeletal class: 28 class I, 38 class II and 14 class III. In all patients, the N-S-Ar angle was measured. This angle indicates the inclination of the cranial base. Cases were divided into three types of angles: normal angles (120-125 °) associated to skeletal class I, open angles (> 125°) associated to skeletal class II, and closed angles (< 120 °) associated to skeletal class III). The aim of the present study was to assess the relationship between cranial base flexure and skeletal class. It was found that no significant relationship existed between cranial base flexure and skeletal class.

RESUMEN

Se afirma en la literatura que todo el complejo craneofacial está influenciado por el crecimiento y dirección de desplazamiento de las estructuras de la base del cráneo, teniendo sobre éstas una influencia directa. Sin embargo, en muchos casos esto no coincide, existiendo mucha controversia al respecto. Además, los estudios han sido realizados en poblaciones con diferentes características étnicas, biotipos faciales y tipos de crecimiento. Por lo anterior, se tomó una muestra aleatoria de 80 telerradiografías laterales de cráneo de pacientes del Servicio de Ortodoncia del Hospital Infantil de México Federico Gómez (HIMFG) sin previo tratamiento ortopédico u ortodóncico. Se dividieron los pacientes según su clase ósea: 28 clases ósea I, 38 clases ósea II y 14 clases ósea III. En todos se obtuvo el ángulo N-S-Ar que indica la inclinación de la base del cráneo y se dividieron en tres tipos de ángulos: ángulos normales (120°-125°) asociados a clases ósea I, ángulos abiertos (> 125°) asociados a clases ósea II y ángulos cerrados (< 120°) asociados a clases ósea III. El objetivo del estudio fue evaluar la relación entre la deflexión de la base del cráneo y la clase ósea. Se encontró que no existe una relación significativa entre la deflexión de la base del cráneo y la clase ósea.

Key words: Cranial base flexure, cranial base inclination, skeletal class.
Palabras clave: Deflexión craneal, inclinación de la base del cráneo, clase ósea.

INTRODUCTION

For over 50 years, it has been stated that there is a relationship between the development of the cranial base and facial structures.[1] In coordination with the rotation of the base and the cranial vault, there is a simultaneous rotation of the facial structures. It has been stated that a flattening or open angle of the cranial base will produce a posterior and superior implantation of the glenoid fossa, and therefore of the Temporomandibular Joint (TMJ) as well, thus placing the mandible in a retrusive position and gives a final result of convex profile and skeletal class II.[2] On the contrary a pronounced inclination or closed angle, will produce an anterior and inferior implantation of the glenoid fossa, of the TMJ, and will displace the mandible to a forward position, the final result then being a concave profile and a skeletal class III.[3]

In 1958 Björk[4] states that any change in the shape of the cranial base will have the result of displacing the glenoid fossa and, in consequence of a mandibular protrusion. According to Enlow[5] a forward tilted middle cranial fossa exerts protrusive mandibular action. In

* DDS, Orthodontics Specialist.
§ Professor and Chairman, Orthodontics Specialty, Mexico Children's Hospital Federico Gomez (Hospital Infantil de Mexico Federico Gomez).
|| Professor and Head of the Stomatology Department, Mexico Children's Hospital Federico Gomez (Hospital Infantil de Mexico Federico Gomez).

Received: 19 April 2006.
Accepted: 29 August 2006.

cases where it is tilted backwards it has a retrusive mandibular effect.

Nevertheless, recent studies state that the cranial base flexure does not have an important effect in the establishment of the type of malocclusion. Andria et al[6] found that the angle of the saddle or cranial base does not have a statistically significant relationship with the position of the chin in the profile, and, consequently, in the skeletal class or type of malocclusion. Dhopatkar et al,[7] in their study, determined that the angle of the cranial base, by itself, does not have a fundamental role in the establishment of malocclusion.

In 2002, Nanda et al[8] found that cranial base flexure is associated with a specific facial pattern, but exerts only limited effect in the development of mandibular sagittal discrepancies. They likewise determined that relationship between cranial base flexure and skeletal pattern of the jaws is established before the fifth year of life.

Wilhelm et al[9] did not find statistically significant differences in cranial base angle among subjects with skeletal class I and II. His findings did not corroborate what Jarabak[10] establishes in his cephalometric analysis. In it, he uses the value for the saddle angle (S) or N-S-AR along with other measurements to determine the existence of a prognathic or retrognathic skeletal pattern. They reached the conclusion that individuals with class II skeletal patterns did not present a cranial base angle significantly more obtuse.

Based on the aforementioned data, a research was conducted in a group of Mexican patients seeking treatment at the Orthodontics service of the Federico Gomez Children s Hospital in Mexico City (FGCHM). The aim of this study is to assess the relationship between cranial base flexure and skeletal class. The research hypothesis guiding this research maintains that skeletal class I patients have a 120°-125° cranial base flexure angle; skeletal class II patients have an angle larger than 125° and skeletal class III patients an angle lower than 120°.

MATERIALS AND METHODS

80 lateral cephalometric radiographs of the skull in the head's natural position (HNP) were selected. Patients were male and female age range 9-20 years. Patients came from the Orthodontics Service of the Federico Gomez Children's Hospital, and had not previously received orthopaedic or orthodontic treatment. Exclusion criteria were the following: patients with craniofacial alterations, cleft lip and palate and associated syndromes.

One of the researchers traced and measured all radiographs. All angles were measured twice, and mean values were obtained. The following points were used for the cephalometric analysis: point A (A), point B (B), saddle (S), nasion (N) and articular (Ar). With these points planes N-A, N-B, N-S and S-AR were traced, and the following angles were obtained:

- N-S-Ar or saddle (S) angle: determines inclination or cranial base flexure *(Figure 1)*.

Figure 1. N-S-Ar angle. Measured between N-S and S-Ar planes. It indicates cranial base flexure.

Figure 2. ANB angle, obtained between N-A and N-B planes. It determines skeletal class.

- SNA angle: Indicates the anterior-posterior position of the upper jaw with respect to the cranial base.
- SNB angle: Indicates anterior-posterior position of the mandible with respect to the cranial base.
- ANB angle: indicates anterior-posterior discrepancy between upper and lower jaws.[11] Determines skeletal class *(Figure 2)*.

Patients were divided into three groups according to skeletal class or ANB angle. Group I: skeletal class I patients. Group II, skeletal class II patients. Group III: skeletal class III patients.

According to the N-S-AR angle measurement and its resulting value, it was divided into three types: normal saddle angles with values between 120° and 125°, open angles, with values above 125° and closed angles with values under 120°.

STATISTICAL METHOD

All data were preliminarily analyzed through central tendency and dispersion measurements, as well as relative frequencies.

Dummy variables were built to correspond with skeletal classes and categories related to cranial base angles (open, normal and closed). *Kappa* weighted statistical was used for discordant data. All data were collected, assessed and processed in the statistical SPSS program version 11.0 and Strata, version 8.8.

RESULTS

Of the total sample 45 patients were female (56.3%), mean age 12.9 years ± 0.28, and 35 cases were male (43.7%), mean age 12.8 years ± 0.34.

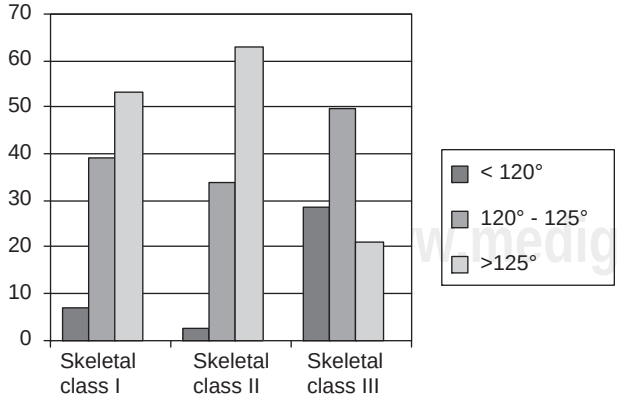

Figure 3. Graph showing matches between N-S-Ar angle and different skeletal classes. Observe that in skeletal class II the angle matches in the majority of patients according to their skeletal class. In skeletal class I and II angles don't match.

Patients of group I represented 35% (28/80). 18 females, 10 males, mean age 12 years 8 months. Patients of group II were 47.5% (38/80), 23 females, 15 males, mean age 12 years 6 months. Patients of group III represented 17.5% (14/80), 4 females, 10 males, mean age 13 years 6 months.

In females, SNA angle average was 81.4°; SNB 77.4° and ANB 4.0°. In males, SNA angle average was 81.6°, SNB 79.0° and ANB 2.6°.

In N-S-Ar angles, it was found that for skeletal class I 39.3% was within corresponding values according to skeletal class (120°-125°) 53.6% recorded greater values (> 125°) and 7.1% reported lesser values (< 120°) *(Figure 3)*. In skeletal class II 63.2% matched values corresponding to skeletal class (> 125°), 34.2% showed lesser values (120°-125°) and 2.6% values for skeletal class III (< 120°). With respect to skeletal class III 28.6% matched values corresponding to skeletal class (< 120°), 50% showed values above corresponding skeletal class I (120°-125°) and 21.4% showed values corresponding to skeletal class II (> 125°).

The aforementioned data are confirmed in *table I*, with the establishment of weighted *kappa*. Out of 28 skeletal class I patients, 11 matched normal angle. Out of 38 skeletal class II patients, 24 matched open angle and out of 14 skeletal class III patients, only four cases matched a closed angle.

DISCUSSION

No relationship was found between cranial base flexure and skeletal class. Therefore we suggest there is a very limited influence as etiological factor in the establishment of the latter. These results agree with results obtained by several authors.[6-9]

When assessing *table I* it is evident that many angles do not coincide with their respective skeletal class. There is a numerous amount of these cases, therefore the weighted *kappa* statistical analysis was used, to give a certain weight to non concordant cases. The result of the analysis indicated that concordance between cranial base angle and skeletal class was not statistically significant (*kappa* = 0.1047 and *p* = 0.1077). The same situation arises when examining *table II* with assessment of concordance with category pairs with *kappa* statistical in which values close to cero indicate poor concordance among different angles of cranial base and their respective skeletal classes.

Evaluation of results in this study indicate that in skeletal class II patients there is the tendency to pres-

Table I. Match between cranial base angle and skeletal class.

	Normal	Open	Closed	Total
Skeletal class I	11	15	2	28
Skeletal class II	13	24	1	38
Skeletal class III	7	3	4	14
Total	31	42	7	80

Kappa = 0.1047 p = 0.1077

Discordances weighting matrix:

1.0	0.5	0.0
0.5	1.0	0.5
0.0	0.5	1.0

Table II. Concordance evaluation by category pairs.

Kappa statistical	*p* value	
Skeletal class I *vs* normal angle	0.008	0.471
Skeletal class II *vs* open angle	0.202	0.035
Skeletal class III *vs* closed angle	0.299	0.002

Kappa statistics were calculated from 2 x 2 tables

ent open angles (63.2%). This is in agreement with Renfroe's[29] findings. Nevertheless, in most cases there is no match in skeletal class I patients (39.3%) and class III (28.6%) and this contradicts statements of other authors.[1,3-5,10-13]

Based on this, we can state that it is more probable that a skeletal class I patient presents an open angle and not a normal angle; or that a skeletal class III patient presents a normal angle, instead of a closed one. This can be due to differential growth in the craniofacial complex structures. Very clear examples of this are skeletal class III patients with maxillary hypoplasia and mandibular hyperplasia. In these cases, irrespectively of angle or cranial base flexure, bone discrepancy will be dictated by a deficiency in the anterior-posterior growth of the upper jaw, and a growth excess and projection of the mandible. Its aetiology is a disharmonious differential growth of the jaws, and not the inclination of the cranial base. Nevertheless, it is important to state that in this specific example, dentofacial disharmony can be increased besides these differential growths of the aforementioned structures, the cranial base presents a closed angle.

Another fact to consider is that the N-S-Ar angle can vary due to changes in the height of the anterior cranial base.[6] This is due to the fact that this angle depends on the location of three points: nasion, saddle, and articular. If one of these points changes position, the value of the resulting angle will be equally modified. This means that, if nasion is placed in a more superior position, the anterior cranial base, or S-N plane will tilt upwards, and this will open the angle of the cranial base. The opposite result takes place when nasion is located in lower position.

Another variation which must be taken into account is the length of the posterior cranial base which can compensate any cranial flexure.[6] For example, the effect of a closed cranial base angle which will locate glenoid fossa and lower jaw in an anterior position, could be countered by an increased length of the posterior cranial base, which would displace the articular point and consequently the mandible, to a posterior position.

It has also been stated that, when the N-S-Ar angle opens or closes, there is a compensatory effect in the ramus and the mandibular body.[8,10,12] This reflects in the articular angle (S-Ar-Go) which is formed between the posterior cranial base and the tangent to the posterior border of the mandibular ramus. If the angle of the saddle opens the articular angle closes and vice versa.

Likewise, findings of our study contradict results found by Wilhelm et al,[9] since the majority of patients with skeletal class II presented an obtuse or larger than 125° N-S-Ar angle. This could be due to different facial biotype, type of growth and ethnic characteristics of included populations in both studies. This forces us to rethink new theories, build more refined theoretical models and conduct further and deeper research in our population.

CONCLUSIONS

1. There is no relationship between cranial base flexure and skeletal class.
2. Cranial base flexure is not the cause and cannot be considered as single etiological factor. Individual variations must be considered as well as differential growth in the growth pattern of the different craniofacial complex structures in every person.
3. It is necessary to conduct more extensive and deeper studies in search for evidence which confirm the findings of this research, and thus determine the standards that apply to our population.

REFERENCES

1. Hopking GB, Houston WJB, James GB. The cranial base as an aetiological factor in malocclusion. *Angle Orthod* 1968; 38: 250-5.
2. Renfroe EW. A study of the facial patterns associated with class I, class II, division 1, and class II division 2 malocclusions. *Angle Orthod* 1948; 18: 12-5.
3. Moss ML. Correlation of cranial base angulation with cephalic malformations and growth disharmonies of dental interest. *NY State Dent* 1955; 24: 452-4.
4. Björk A. Cranial base development. *Am J Orthod* 1958; 44: 498-506.
5. Enlow D. Crecimiento maxilofacial. Editorial interamericana McGraw-Hill. México, D.F. 3a ed. 1990: 218-9.
6. Andria LM, Leite LP, Prevatte TM, King LB. Correlation of the cranial base angle and its components with other dental/skeletal variables and treatment time. *The Angle Orthodontist* 2004; 74 (3): 361–6.
7. Dhopatkar A, Bhatia S, Rock P. An investigation into the relationship between the cranial base angle and malocclusion. *The Angle Orthodontist* 2002; 72 (5): 456–63.
8. Nanda R, Klocke A, Kahl-Nieke B. Role of cranial base flexure in developing sagital jaw discrepancies. *Am J Orthod Dentofacial Orthop* 2002; 122: 386-91.
9. Wilhelm BM, Beck FM, Lidral AC, Vig KWL. A comparison of cranial base growth in class I and class II skeletal patterns. *Am J Orthod Dentofacial Orthop* 2001; 119: 401-5.
10. Gregoret J, Tuber E. *Ortodoncia y cirugía ortognática: diagnóstico y planificación*. Barcelona: Editorial Espaxs; 2003: 175-98.
11. Steiner CC. The use of cephalometrics as an aid to planning and assessing orthodontic treatment. *Am J Orthod* 1960; 46: 721-35.
12. Anderson DL, Popovich F. Correlations among craniofacial angles and dimensions in class I and class II malocclusions. *Angle Orthod* 1989; 59: 37-42.
13. Argyropoulos E, Sassouni V, Xeniotou A. A comparative cephalometric investigation of the Greek craniofacial pattern through 4,000 years. *Angle Orthod* 1989; 59: 195–204.

Mailing Address:
Joaquín Canseco Jiménez, MD
Dr. Márquez 162, Col. Doctores,
Deleg. Cuauhtémoc, 06720
Phone number. 52-28-99-17. Ext.2460 and 9030
E-mail: drjcanseco@yahoo.com.mx.