The maxillary rotation: Its relation to the cranial base and the mandibular corpus

An implant study

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A material of 22 patients with metallic implants was used in a longitudinal study, based on lateral head-plates, of the relationship between:
1) the maxillary rotation and the cranial base
2) the maxillary rotation and the different mandibular rotations.
No connection has been found between the variation of the maxillary rotation and the growth of the cranial base.
The correlation between the maxillary and the mandibular rotations is the highest when the rotation of the corpus is considered.
A strong correlation is found between the variation of the condylar growth direction and the variation of the maxillary rotation.

Key-words: Human; growth; orthodontics

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In a previous study (*Lavergne & Gasson*, 1977), it has been shown that the mandibular rotation was related to the difference of the growth rate between the jaws. This could also be the case for the maxilla relative to the anterior cranial base and the aim of the present investigation was to study whether the maxillary rotation was related to the difference of the growth rate between the maxilla and the anterior cranial base. To obtain a better understanding of the relationships between the jaws, the maxillary rotation was related to the different patterns of mandibular rotation previously defined (*Lavergne & Gasson*, 1977): the morphogenetic rotation of the corpus, the morphogenetic rotation of the mandible and the positional rotation of the mandible in relation to the anterior cranial base.

MATERIAL AND METHOD

The sample (thirteen boys and nine girls) belongs to the group of patients with metal implants from the Orthodontic Department, University of Bergen. The age distribution of the sample is shown in Fig. 1. The reference points and lines are shown in Fig. 2.

The following measurements have been made on each annual cephalometric head-film:

- The lengths SN (Sella-Nasion), Et-N (Ethmoid-Nasion), Fr-N (Foramen Rotondum-Nasion).
- In order to eliminate the influence of the nasal bone on the measurement of the sagittal dimension, the point M has been used and the length SM, Et-M, FR-M measured.

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- The length of the maxilla (X_1), between PNS and A'.
- The degrees of mandibular rotation are measured relative to the reference lines, NSL, CP, BiP and ML and are expressed by d °/NSL, d °/CP, d °/BiP and d °/ML. d °/NSL corresponds to the positional rotation of the mandible, d °/CP is the morphogenetic rotation of the mandible, d °/BiP and d °/ML correspond to the morphogenetic rotation of the corpus. (*Lavergne & Gasson*, 1977).
- The degree of maxillary rotation is measured in relation to NSL and to NL (d °/NSL Max., d °/NL Max.). Operational definitions are proposed for the maxilla in the same manner as for the mandible (*Lavergne & Gasson*, 1977). 1) «morphogenetic rotation of the hard palate», measured in relation to NL. 2) the positional rotation of the maxillary complex, relative to the cranial base, measured in relation to NSL.

These measurements of rotation were performed in the manner previously described (*Ødegaard*, 1970, *Gasson & Lavergne*, 1977).

The curve (E') was constructed for the maxilla in the same way as for the mandible (*Lavergne & Gasson*, 1977). (E') represents the difference of the growth rate between the maxilla (X_1) and the cranial base. The cranial base is represented by the values SN, SM, Et-N, Et-M, FR-N, FR-M. The following values express the sum of the annual differences between the maxillary and cranial base increments:

(1) Σ (ΔX_1–ΔSN)

(2) Σ (ΔX_1–ΔSM)

(3) Σ (ΔX_1–ΔEt-N)

(4) Σ (ΔX_1–ΔEt-M)

(5) Σ (ΔX_1–ΔFr-N)

(6) Σ (ΔX_1–ΔFr-M)

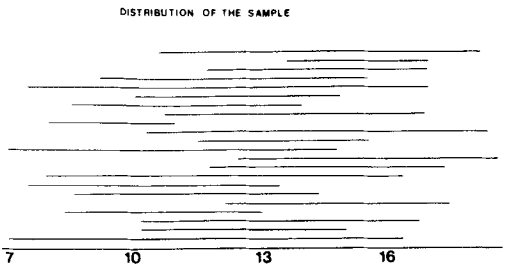


Fig. 1. Age distribution of the sample.

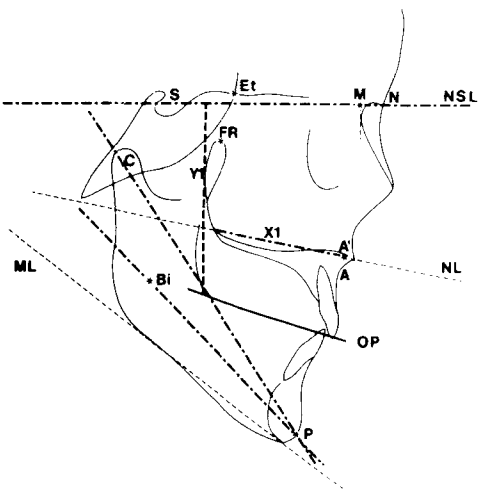
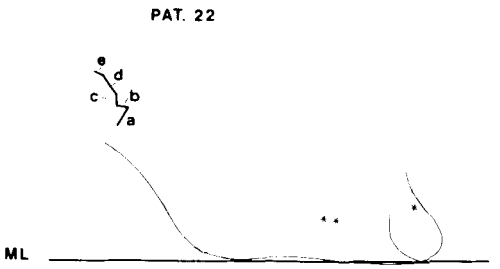


Fig. 2. Reference points and lines.

M: intersection of NSL with the perpendicular to NSL passing by the most posterior point of the nasal bone.
Et: intersection of the sphenoid bonde with the anterior cranial base line.
FR: the most superior point of fossa pterygopalatina.
A': intersection of NA line with NL.
Bi: mid-point of the mandible on the bisecting line of the gonial angle.
P: point on the anterior part of the symphysis tangent to a perpendicular to ML.
C: center of the condyle.
Y_1: distance from the occlusal plane (OP) to NSL, measured on a line tangent to the posterior wall of fossa pterygopalatina.
X_1: length between the posterior nasal spine and A'.



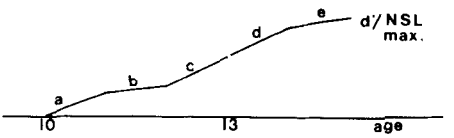


Fig. 3. Diagram showing the relationship between the apparent movement of the condyle during growth and the variation of the maxillary rotation.

A diagram has been constructed for each of these values.

Rotational diagrams have been constructed showing the annual variation of the maxillary and mandibular rotation. In all these diagrams, the first value of each longitudinal series was taken as the origin (base line) and the following values of the series plotted in relation to this base line.

In order to compare the curves, a Spearman Rank Correlation Test was used.

With the tracings of the mandible superimposed on the implants, the successive centers (C) of the condyle were plotted, and a curve representing the movements of C was obtained. The slope of each segment of this curve related to the mandibular line (ML) of the first cephalogram, was plotted and compared with the rotational diagram (Fig. 3).

RESULTS

The curves representing the values (1) and (2), (3) and (4), (5) and (6) had a very similar shape. Therefore either point N or M may be used as reference points. The Spearman Rank Test did not show any correlation between these six curves (describing the difference of growth rate between the maxilla and the cranial base) and the rotational diagram of the maxilla. On the other hand, a correlation was found between the degree of maxillary rotation related to NSL and the different degrees of mandibular rotation (d °/NSL, d °/ML, d °/BiP, d °/CP). Table I shows that the correlation between the maxillary and the mandibular rotation is highest when the morphogenetic rotation of the corpus mandibularis is considered (d °/BiP). This fact is also illustrated in Fig. 4.

Table I. *Correlation between maxillary and mandibular rotation*

Mandibular	Correlation with maxillary rotation: d°/NSL	Correlation with maxillary rotation: d°/NL
d°/NSL	9++ 4+ 9 0	8++ 4+ 10 0
d°/CP	9++ 4+ 9 0	8++ 4+ 10 0
d°/BiP	10++ 5+ 7 0	8++ 4+ 10 0
d°/ML	10++ 5+ 7 0	8++ 4+ 10 0

++: Significant at the 0.01 level.
+ : Significant at the 0.05 level.
0 : Not significant.

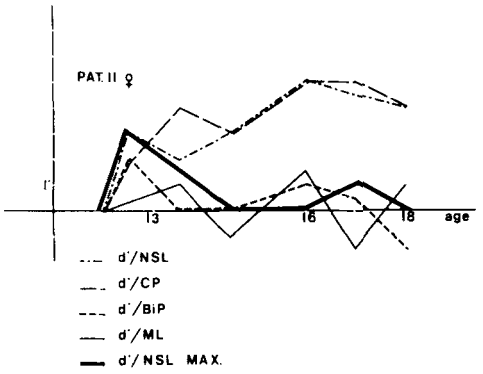


Fig. 4. Rotational diagrams. The curves (d °/BiP) and (d °/NSL MAX) are the most similar.

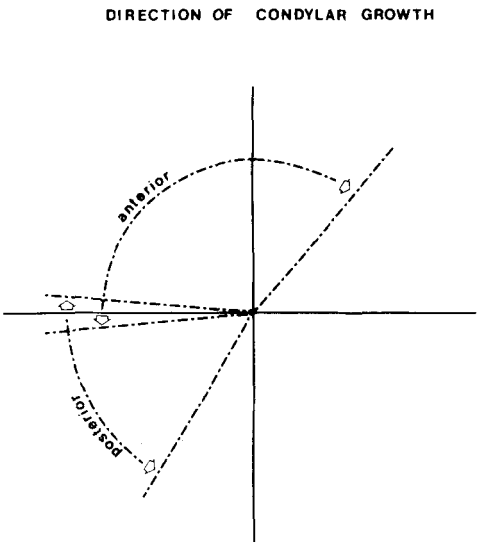


Fig. 5. Diagram showing the relationship between the direction of condylar growth and the maxillary rotational pattern.

For th total sample, the mean annual degree of morphogenetic rotation of the corpus and the mean annual degree of rotation of the maxilla are shown in Table II, A.

For eleven patients with anterior rotation in both jaws, the different rotational values are given in Table II, B.

Twelve patients were selected from this sample taking into consideration the criteria for stable vertical and sagittal development previously defined (*Gasson & Lavergne*, 1977). The calculated means are shown in Table II, C. For most of these patients, the individual mean annual degree of rotation of the maxilla and the degree of the morphogenetic rotation of the corpus calculated for the whole period of observation showed very similar values. A Spearman Rank correlation Test indicated a significant correlation at the 0.01 level in six cases, a correlation at the 0.05 level in five cases and no correlation at all in one case, between the rotational diagrams of the maxilla and the corpus.

In eight treated cases, an increase of the «posterior functional height» (Y_1) (*Lavergne & Gasson*, 1977), was observed during the wearing of the face-bow, associated with a posterior rotation of the mandible.

A relationship has been established between the variation of the condylar growth direction and the variation of the maxillary rotation (Fig. 5). The mixed zone where the condylar growth direction is associated with both directions of maxillary rotation (anterior and posterior) is small. This means that the two areas corresponding to anterior and posterior rotation are well defined.

DISCUSSION

It has been suggested (*Lavergne & Gasson*, 1977) that the mandible shows an adaptive process to the maxilla through the rotational pattern. In the present investigation it was shown that the maxilla did not follow the same adaptive pattern relative to the cranial base.

Table II. *Mandibular and maxillary mean annual degrees of rotation. In each group, the mean annual degree of morphogenetic rotation of the corpus and the mean annual degree of rotation of the maxilla exhibit close values, especially in groups B and C*

		A	B	C
Mand. rotat.	d°/NSL	0.81	1.30	0.34
	d°/BiP	0.35	0.58	0.32
	d°/ML	0.43	0.61	0.41
Max. rot.	d°/NSL	0.21	0.54	0.34
	d°/NL	0.28	0.68	0.36

A: Total sample.
B: Anterior rotation in both jaws.
C: Sample with stable vertical and sagittal relationship.

This study has established that the variation of the maxillary rotation is correlated with the variation of the three types of mandibular rotations. The Spearman Rank Correlation Test has shown the highest correlation between the variation of the maxillary rotation and the variation of the morphogenetic rotation of the corpus (d °/BiP).

The mean annual values of the maxillary rotation and of the morphogenetic rotation of the corpus showed a closer resemblance when the sample was restricted to patients with anterior rotation in both jaws, compared with the means of the total sample (Table II, B). An even better resemblance could be seen when the mean was calculated for the patients with stable vertical and sagittal interjaw relationships.

It seems that a good facial development includes, not only a harmonisation of the maxillary rotation with the rotation of the corpus, but also a close absolute value of their degrees of rotation. This is in agreement with Koski et al.'s findings (*Koski*, 1973, *Vinkka et. al.*, 1975) which stated that in faces showing a harmonious development, the canalis mandibularis and the canalis infra-orbitaris were parallel. *Bjørk* (1972) has also shown that the variation of the inferior occlusal plane is strongly correlated with the variation of the maxillary rotation. It is reasonable to believe that the two dental arches must have parallel supports to maintain a stable occlusion.

The wearing of the face-bow resulted in a change of the mandibular rotation, which would have been expected from the formula given in a previous paper (*Lavergne & Gasson*, 1977). The fact that an action on the maxilla gives rise to a mandibular response, leads to the suggestion of the existence of a causal relationship between the «posterior functional height» of the maxilla and the mandibular rotation.

In the present investigation a strong correlation between the variation of the maxillary rotation and the variation of the rotation of the corpus has been shown. In an earlier paper (*Lavergne & Gasson*, 1977), a strong relationship between the variation of rotation of the corpus and the condylar growth direction was established. A connection which could be expected between the condylar growth direction and the maxillary rotation has been demonstrated in this study. Such a correlation has also been shown by *Bjørk* (1972), not in an annual longitudinal study but during the whole period of observation in a longitudinal series.

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