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The nasal septum and the development of the midface. A longitudinal study of a pair of monozygotic twins*

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SUMMARY

The development of the nose and the growth of the midface has been followed in a pair of identical twins. One of them (twin A) had nasal septum destruction after septal haematoma and abscess at the age of 7 years, and was treated by immediate implantation of homologous septal cartilage from a tissue bank. From 7-17 years of age the growth and development of the nose and face were followed. Lateral cephalograms, photographs, acoustic rhinometry and rhinoscopy were performed. Twin B presented a normal nasal and facial growth and served as control. Twin A developed a saddle nose, an upward displacement of the anterior part of the maxilla, diminished vertical development of the nasal cavity, and a retrognathically positioned maxilla due to decreased anteroposterior maxillary growth. This case report seems to indicate that the cartilaginous nasal septum is an important factor influencing vertical and sagittal growth of the maxilla.

Keywords: nasal septum, growth, monozygotic twins, maxilla, nasal fracture

INTRODUCTION

The cartilaginous nasal septum has been shown, in animal experiments (Bernstein, 1973; Verwoerd et al., 1980; Verwoerd and Verwoerd-Verhoef, 1989; Meeuwis et al., 1993), to play an important role in the development not only of the nose but also of the maxilla. In humans, long-term follow-up studies are needed to evaluate the nasal and maxillary growth in patients who have had nasal trauma with or without surgery during childhood. The importance of genetic influence in the facial skeletal development has to be considered (Stuart-Hunter, 1965). Convincing studies that take these considerations into account are lacking.

Studies of identical twins have proved to be useful in separating the influence of "nature and nurture" (Galton, 1875; Masing and Hellmich, 1968). The study of identical twins is an ideal method to deal with the influence of genetic and environmental factors on facial growth. In non-operated adult identical twins, it has been found that the presence of traumatic deformity of the cartilaginous septum is related to underdevelopment of the cartilaginous middle-third of the nose and disturbed growth of the maxilla (Grymer et al., 1991).

The aim of this study was to assess and compare longitudinally the growth of the nose and the maxilla in a pair of identical twins. One of them had a partial nasal septal destruction after haematoma and abscess at the age of 7 years, whilst the other had no trauma and a normal facial growth and development.

MATERIAL AND METHODS

One pair of male identical twins were followed longitudinally from the age of 7 to 17 years. The monozygosity of the twins was determined by identifying several genetic indicators: the blood types ABO, MNS, and RH; the serum types HP and GC; and the enzyme types PGM-1, ACP-1, GPT, ESD, and GLO (Retsgenetisk Institut, Copenhagen University). At the age of 7 years, one of the twins (twin A) hit his nose on a wooden stair step. Three weeks later he was seen at the ENT Department because of flattening of the outer nose and impaired nasal breathing. A bilateral septal haematoma/abscess was found by anterior rhinoscopy and it was treated surgically. A defect in the middle inferoposterior part of the cartilaginous septum was found, leaving an un-interrupted rim under the nasal dorsum and at the basis of the septum. There was a vertical fracture going through the osteochondral suture and a horizontal partial fracture in the middle of the cartilage. Drainage of the haematoma/abscess was followed by immediate implantation of homologous septal cartilage from a tissue bank, tamponades and antibiotics. Photographs were taken.

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At the age of 12 years, twin A had adenoidectomy and tonsillectomy performed because of tendency to mouth-breathing. There was a mixed pattern of breathing, but no feeling of impaired nasal patency when examined at the age of 17 years. Twin A had the first right premolar extracted at 15 years of age, because it was abnormally positioned in the palate. At the ages of 12 and 17 years, standard lateral cephalograms, dental models, photographs *en face* and *en profile* of the face, acoustic rhinometry and anterior rhinoscopy were performed.

RESULTS

The similarity of facial appearance between twins A and B at the age of 7 years, three weeks after the traumatic episode had occurred in twin A is seen in Figure 1. Facial growth disturbance is already obvious in twin A at the age of 12 years, when compared to twin B (Figure 2). The differences in facial appearance between both twins are more pronounced at the age of 17 years, denoting a progression of the influence of trauma on maxillary and nasal growth and development (Figure 3). The following facial features are worthy to note in the twin who had trauma: a retrusive and underdeveloped maxilla, a flattened nose with saddling, underdevelopment of the middle-third of the nose, and columella retraction. Cephalometric measurements (Figure 4, Table 1) from standardized lateral cephalograms taken in

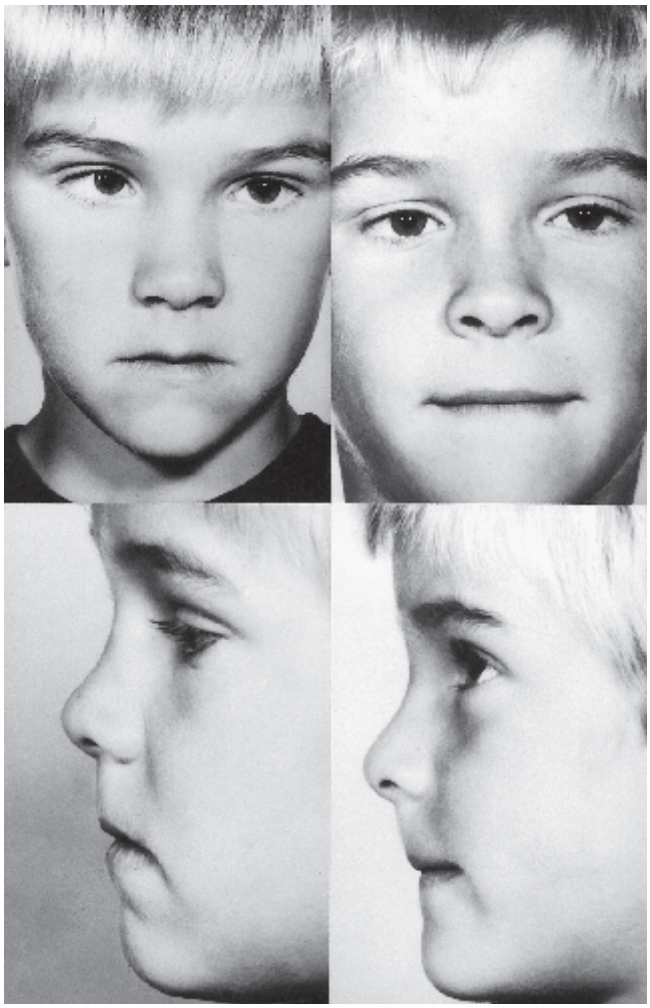

Figure 1. Monozygotic twins 7 years old. Twin A (left) had nasal trauma 3 weeks before; twin B (right) is normal.

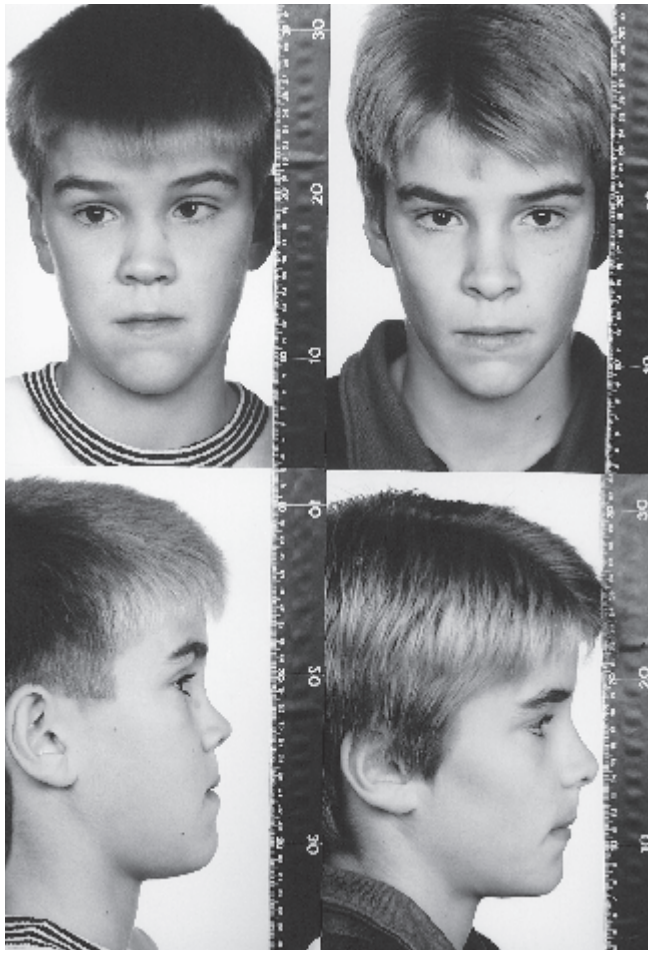

Figure 2. Twin A (left) and twin B (right) at 12 years of age.

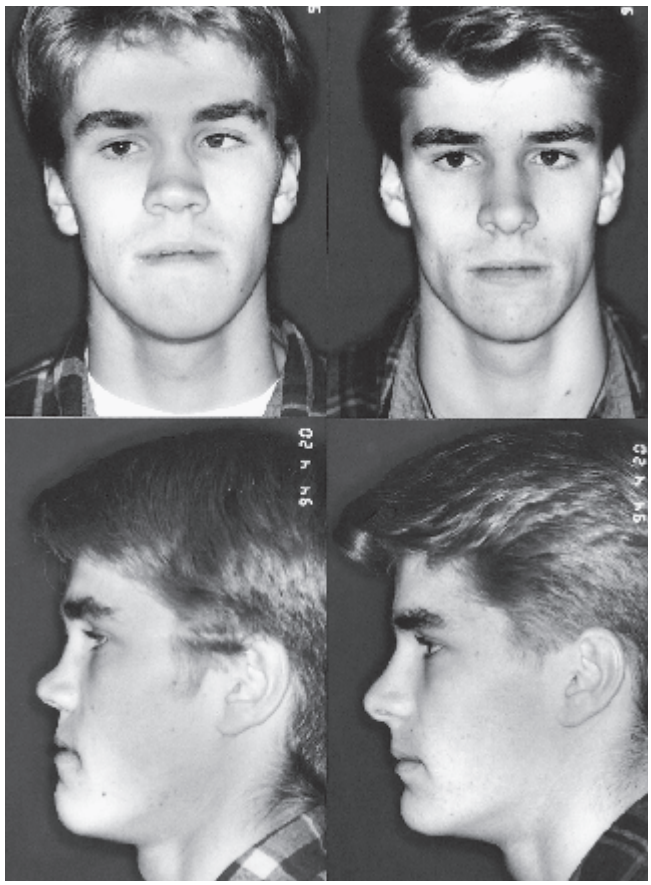

Figure 3. Twin A (left) and twin B (right) at 17 years of age.

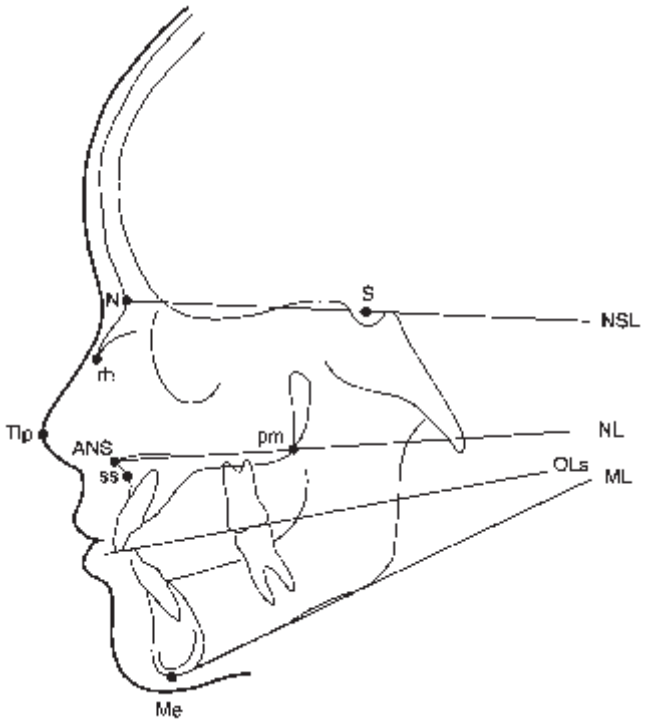

Figure 4. Cephalometric measurements.
Nasal measurements: N-rh: distance between nasion and rhinion expressing the length of the nasal bones; cart-nose: distance between rhinion and nose tip expressing the cartilaginous nose; tot-nose: distance between nasion and nasal tip expressing the total length of the nose; nose-prom: nose prominence measured as the distance between the perpendicular to ss-SN from the most prominent part of the nose.
Maxillary measurements: ANS-length: length of the anterior nasal spine, measured from the projection of subspinale in the nasal line to anterior nasal spine (ANS); ANS-rh: height of the piriform aperture from ANS to rhinion; ss-SN: distance of a perpendicular from subspinale to nasion-sella line, expressing the height of the anterior nasal cavity; pm-SN: distance of a perpendicular from pterygomaxillare to nasion-sella line, expressing the posterior height of the nasal cavity; choana-height: measured from pterygomaxillare to sella at the intersection with the anterior wall of the sphenoidal sinus; ANS-pm: distance between the anterior nasal spine and pterygomaxillare, expressing the antero-posterior length of the maxilla; N-Me: distance between nasion and menton expressing total facial length; NL/ML: angle between the palatal and mandibular plane; NSL/NL: angle between the nasion-sella line, representing the cranial base and the palatal plane; NSL/ML: angle between the nasion-sella line and the mandibular plane; NL/OLs: angle between the palatal plane and the occlusal superior plane.

natural head position show skeletal and dentoalveolar differences between both twins at the age of 12 years (Figure 5) and 17 years (Figure 6). Concerning the nose of the affected twin: the distance from anterior nasal spine to rhinion *(apertura piriformis)* and the vertical dimension of the choana are decreased. The length of the nasal bones is similar, but the total length of the nose (from the nasal root to the nasal tip) is diminished. Nose prominence (distance from anterior nasal spine to nose tip) is similar. In reference to the maxilla, twin A has a decreased distance between the anterior nasal spine and the cranial base, but similar distance from the posterior nasal spine. The effective anteroposterior maxillary dimension is decreased which results in a retrognathically positioned maxilla and, moreover, an underdeveloped anterior nasal spine.

Table 1. Values of the cephalometric values of the midface in the affected twin A and the normal twin B at 17 years of age.

variable	twin A	twin B
nasal measurements		
N-rh	23.7 mm	23.9 mm
cart-nose	24.3 mm	32.0 mm
tot-nose	48.0 mm	56.0 mm
nose-prom	32.0 mm	33.5 mm
maxillary measurements		
ANS-length	1 mm	3 mm
ANS-rh	32.6 mm	36.2 mm
ss-SN	54.4 mm	62.0 mm
pm-SN	49.6 mm	50.7 mm
choana-height	26.7 mm	31.8 mm
ANS-pm	48.9 mm	56.5 mm
N- Menton	129 mm	128 mm
NL/ML	28.1°	21.2°
NSL/NL	1.5°	5.4°
NSL/ML	29.7°	26.7°
NL/OLs	13.0°	10.2°

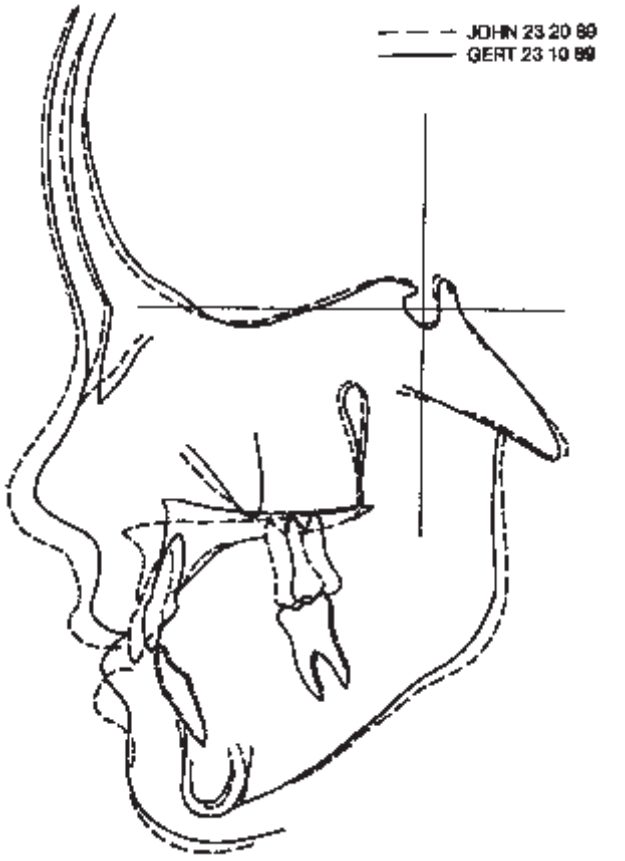

Figure 5. Superimposition in sella-nasion line fixed at sella of the lateral cephalograms of the affected twin A (Gert, continuous line) and the unaffected twin B (John, dashed line), at 12 years of age.

Twin A presents an anterior inclination of the palatal plane in relation to the cranial base, while it is in the normal range in twin B. These findings are in agreement with the maxillary distances reported above. There is a tendency to a dentoalveolar compensation of the anterior maxillary inclination in twin A,

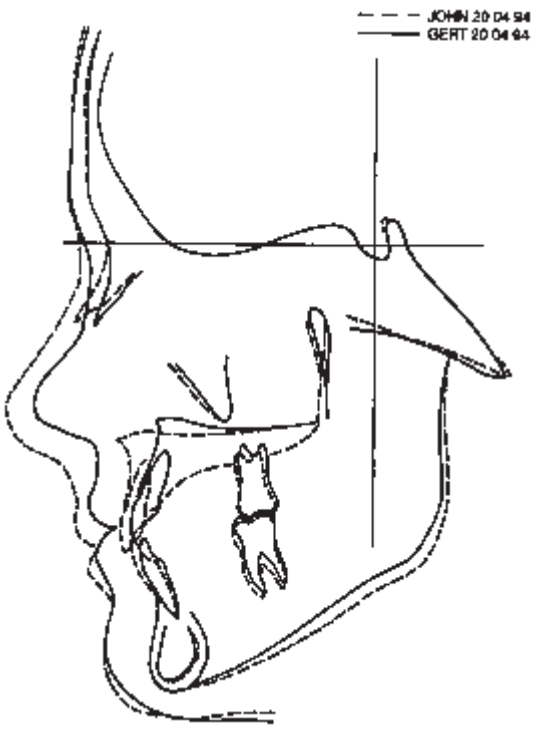

Figure 6. Superimposition in sella-nasion line fixed at sella of the lateral cephalograms of Twin A (Gert, continuous line) and Twin B (John, dashed line), at 17 years of age.

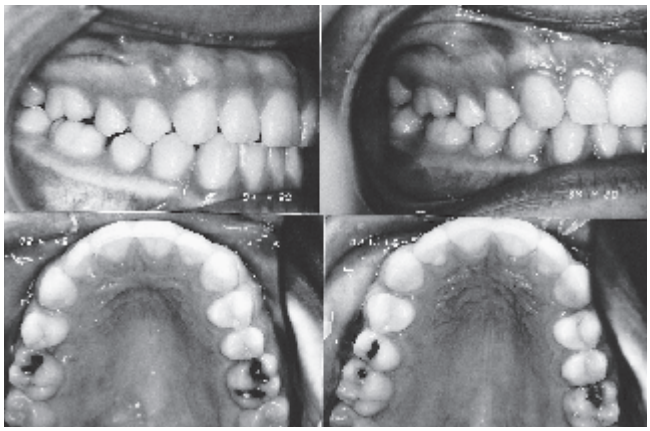

Figure 7. Dental occlusion of twin A (left) and twin B (right) at 17 years of age.

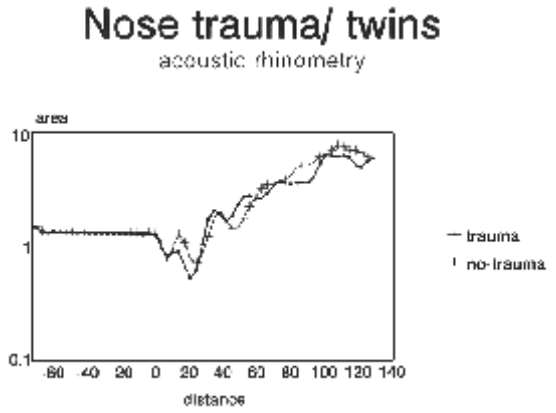

Figure 8. Acoustic rhinometry curve, decongested right side, of twin A (trauma) and twin B (no trauma), at 17 years of age.

expressed by an increased angle between the palatal plane and the superior occlusal plane. The inclination of the mandibular plane in relation to the cranial base is normal in both twins.

Occlusal analysis in twin B shows a neutral molar and canine relationship and a good interdigitation, while twin A is neutral in the right side, but has a distal molar relationship in the left side where the premolar was extracted (Figure 7).

Acoustic rhinometry (decongested curve) in twin A shows a minimal cross-sectional area (MCA) of 0.53 and 0.62 cm^2 at the right and left sides, respectively, and 0.74 and 0.93 cm^2 in twin B. The volume from nostrils to 5 cm was 6.28 and 6.86 cm^3 at the right and left side in twin A, and 6.33 and 7.67 cm^3 in twin B (Figure 8).

DISCUSSION

Based on the results of a previous study of identical twins (Grymer et al., 1991), with deformities of the cartilaginous septum, it was suggested that the cartilaginous septum has an influence on the growth of the nose and the maxilla.

The present case is a long-term follow-up of the influence of the nasal septum upon the development of the nose and the midface. The comparison of the facial growth and development between twins A and B suggests that the cartilaginous septum plays an important role on the development of the midface. Trauma due to surgery was minimal. The surgical procedure was limited to incision of the mucosa, drainage of the abscess and implantation of homologous bank cartilage. Since we compare two genetically identical twins, the disturbed nose and facial growth and development must be linked to the traumatized cartilaginous nasal septum. The growth and development disturbance in the maxilla is expressed as a shorter horizontal anteroposterior and vertical anterior dimension, which is followed by an anterior rotation of the maxilla. The normal maxillary growth pattern in a forward and downward direction (Enlow and Bang, 1965) has been modified by the traumatized cartilaginous septum. Nevertheless, both twins have achieved a similar normal dental occlusion. In spite of the anterior rotation of the maxilla in twin A, he has not developed an open bite due to a vertical compensation of the maxillary dento-alveolar process. The total vertical length of the face, from nasion to menton is identical. These findings support the genetic influence upon vertical facial development as claimed by Stuart-Hunter (1965). Our results support also the findings in experimental surgical interventions in animals (Bernstein, 1973; Meeuwis et al., 1993) and the clinical findings of adults submitted to septorhinoplasty (Brain and Rock, 1983).

The difference in the outer nose between twins is located at the middle-third of the nose. The upper lateral cartilages of the affected twin were shorter and lacking support, resulting in saddling, in agreement with experimental results obtained in rabbits (Verwoerd et al., 1980). The length of the nasal bones and the prominence of the nasal tip (i.e. the lower lateral cartilages) were not different, suggesting a genetic influence on the growth of the upper- and lower-third of the nose, as found in a previous twin-study (Grymer et al., 1991). Typical columella retraction and a smaller nasolabial angle in the affected twin may be

explained by the shorter and anteriorly rotated maxilla and by a lack of development of the anterior nasal spine.

It has been advocated to use homologous cartilage in septal abscess. In our case the immediate implantation of cartilage in the septal defect probably prevented septal perforation, but it did not stimulate normal growth in the middle-third of the nose and maxilla as it has been reported by Huizing (1984), and this is in agreement with the results in animal experiments (Nolst Trenité et al., 1987).

The decreased growth of the nose and the maxilla is reflected in the internal dimensions of the nasal cavity. The values of acoustic rhinometry show a smaller minimum cross-sectional area and volume in the affected twin. Even the septum was straight and there was not sign of obstructive turbinate or adenoids, twin A had a tendency to mixed nasal and oral breathing. Pure nasal breathing might not be achieved in cases where, by any reason, the nasal cavity has not developed to normal size (Grymer and Melsen, 1989).

In this work it is suggested that when the cartilaginous septum is interrupted in any way by fracture or luxation, traumatically and/or surgically, the forward thrust of the septum upon nose- and midface growth slows down and results in decreased growth of the midface. Therefore, the cartilaginous nasal septum might be one of the growth centers of the midface, responsible for sagittal and vertical maxillary growth.

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