

Reimplantation of autologous septal cartilage in the growing nasal septum

II. The influence of reimplantation of rotated or crushed autologous septal cartilage on nasal growth: an experimental study in growing rabbits

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SUMMARY

A series of experiments were carried out on growing rabbits to investigate the effect of rotation (through 90° and 180°) or crushing of autologous cartilage implants on growth of the nose.

Reconstruction of the nasal septum with rotated or crushed implants did not restore the normal growth of the nose. This is in accordance with the results of a previously described experiment in which the continuity was repaired with autologous cartilage in the same position (Nolst Trenité et al., 1987).

The crushed cartilage implants were as effective as the noncrushed implants in preventing septal perforations. The implants rotated through 90°, showed less intrinsic growth in dorso-ventral direction.

INTRODUCTION

In a previous article (Nolst Trenité et al., 1987) the effects on midfacial growth of resection and immediate reimplantation of septal cartilage in growing rabbits were reported. It was concluded that reconstruction of the continuity of the growing nasal septum with autologous septal cartilage, in the same position, did not restore normal growth of nose and upper jaw. In the adult stage the noses were fore shortened and had a flattened, sunken dorsum. The maxillae, although normal in length, showed a deflection.

In human nasal surgery reimplantation of rotated or crushed autologous septal cartilage is a common procedure. Since these techniques are used in young children, it is important to investigate, whether rotating or crushing of the autologous implant has any specific effect on the growth of the septum and indirectly on the development of the midface. Therefore in addition to the previously described experiments three other experiments (group III, IV and V) were performed in growing rabbits.

MATERIALS AND METHODS

As in previous experiments 15 female New Zealand white rabbits, four weeks of age, were used in each experimental group. Submucous resection of the middle 1/3 (height 8 mm, length 10 mm) of the septal cartilage was followed by re-implantation, either in an altered position or after a process of crushing.

In group III the resected piece of cartilage was rotated through 90° and repositioned (Figure 1-a). To assure a good fitting of the rotated implants to the cut ends of the remaining septal cartilage, height and length of the resected part were both 8 mm. In group IV the resected cartilage was rotated through 180° and re-implanted (Figure 1-b).

In group V the removed cartilage was crushed up to about 150% of the original size and replaced without rotation, after trimming to the appropriate size of 8-10 mm (Figure 1-c).

At the age of 24 weeks the full grown rabbits were sacrificed. The standard procedures of surgery, anesthesia, morphological, geometrical and statistical study were followed as described in a previous paper (Nolst Trenité et al., 1987).

RESULTS

From the 15 animals in each group 10 survived in group III, 13 in group IV and 14 in group V.

Observations on the nasal septum via orbita and apertura piriformis

The specimens of groups III, IV, V showed:

- no perforations of the mucoperichondrium, only "pinpoint" perforations of the cartilage on the side of the catgut fixation suture in the implants (Figure 2-a).

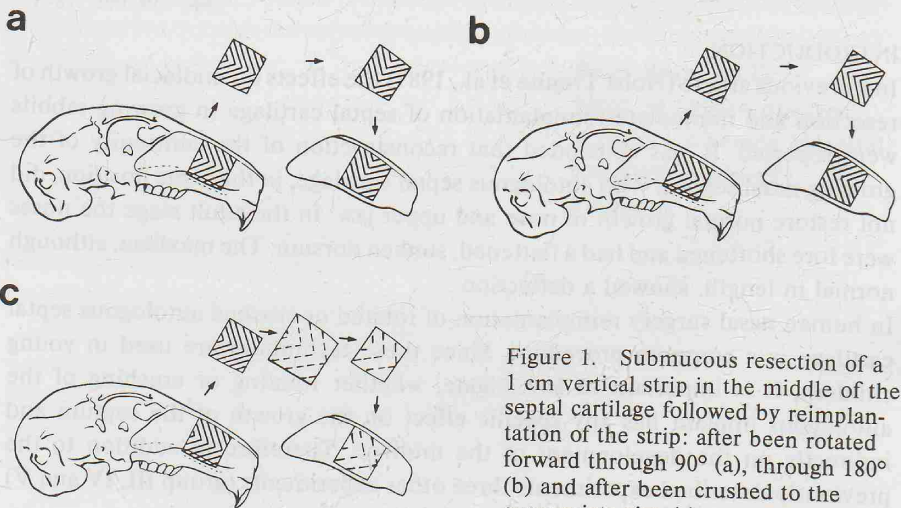


Figure 1. Submucous resection of a 1 cm vertical strip in the middle of the septal cartilage followed by reimplantation of the strip: after been rotated forward through 90° (a), through 180° (b) and after been crushed to the appropriate size (c).

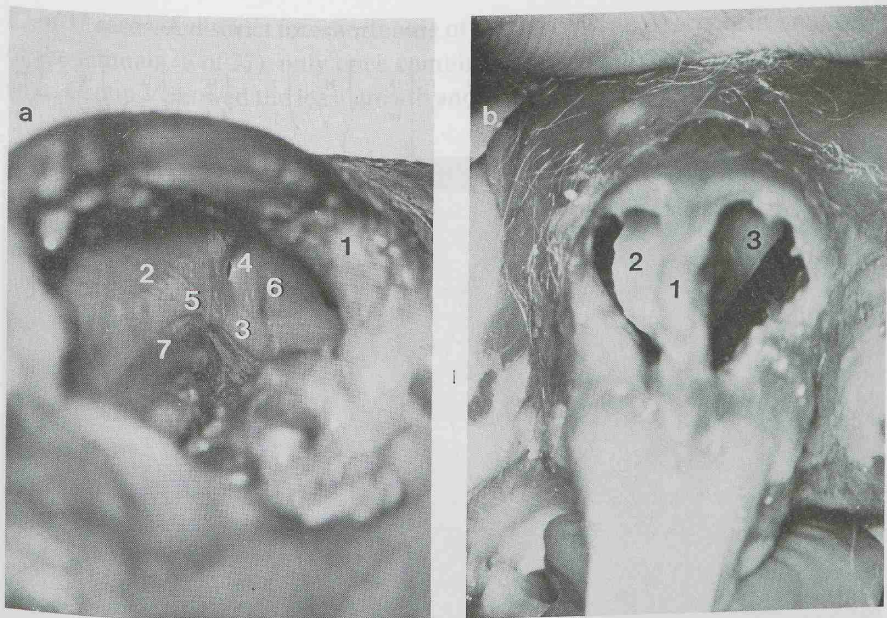


Figure 2.

a. Transorbital view (right side) of the septal cartilage with implant (skull T71, group III). 1. orbital rim, 2. dorsal part of the septal cartilage, 3. implant, 4. "pinpoint" perforation, 5. dorsal connection with small cartilage duplication, 6. ventral end-to-end connection, 7. vomer.

b. Frontal view via apertura piriformis (skull T73, group III). 1. ventral border of the septal cartilage, 2. ventral part of the septal cartilage with large deviation to the right at the site of connection between septal cartilage and implant, 3. implant with moderate deviation to the left at the site of its dorsal border.

- various degrees and types of deviation (Figures 2-b, 3A-b, 3B-b, 3C-b).
- a great number of inadequate connections between implant and cut ends of the septal cartilage (duplications and end-to-side connections).

In group III (reimplantation of the cartilaginous strip after forward rotation through 90°) deviations of the septal cartilage were less prominent than in the other experiments.

In group III and IV the deviations occurred at the connection of the implant with the remaining septal cartilage.

In group V deviations mostly concerned the crushed cartilage graft itself (Figure 3C-b).

In group III the increase in dorso-ventral length of the implant during the experimental period was small (0-2 mm).

In group IV and V the dorso-ventral diameter increased up to 150% (Figures 3B-b, 3C-b).

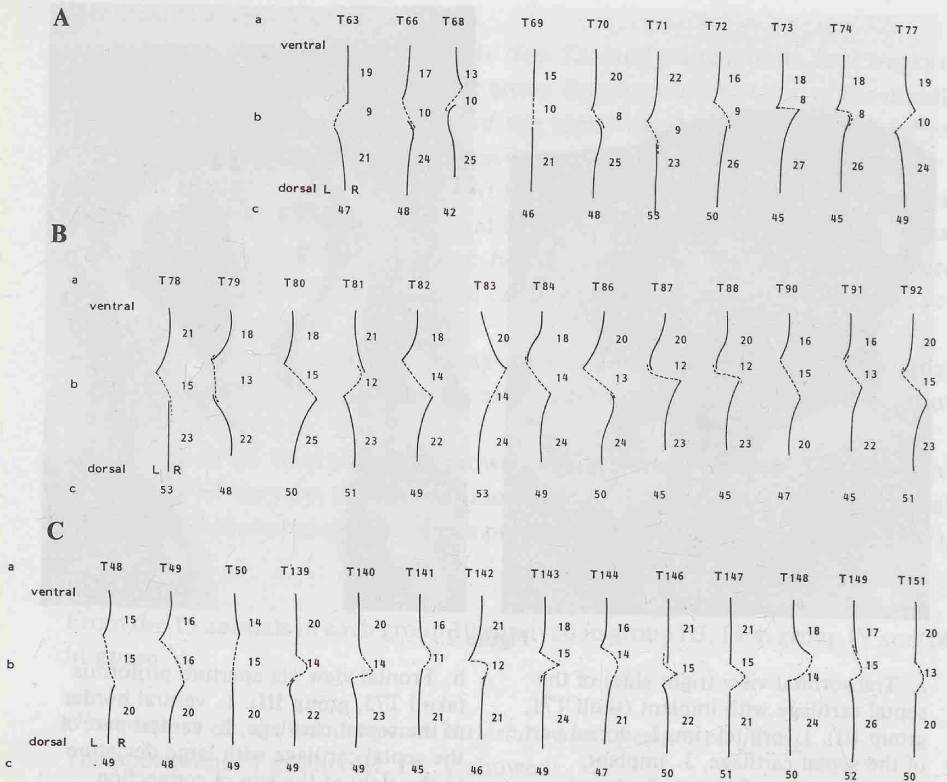


Figure 3. Diagrams of the adult septal cartilage after reimplantation of resected cartilage:

- A. implant rotated forward through 90° (group III),
 - B. implant rotated forward through 180° (group IV) and
 - C. implant crushed and trimmed to the appropriate size (group V).
- a. Code of the experimental animals,
 - b. Section of the septal cartilage (continuing line) with implant (dotted line) in a horizontal plane (half way the height) with length in mm of the dorsal and ventral parts of the septal cartilage and implant,
 - c. Distance in mm between the most dorsal and ventral point of the septal cartilage. Deviations to the left (L) and right (R).

The connection between the crushed graft (group V) and the cut ends of the septal cartilage is better (less duplications, more end-to-end connections) than in the other experimental groups, in which the cartilage implant was not crushed.

Observations on the skull

In all three experimental groups the rabbit skulls revealed in general the same characteristic growth disturbances:

The noses were foreshortened to a various degree with a sunken nasal bridge in

27 of 37 cases. A distinct foreshortening of the maxilla was observed in a minority of the animals (6 of 37), only once combined with a moderate frontal malocclusion. Group V showed the least growth anomalies of the nasal dorsum (Figure 4).

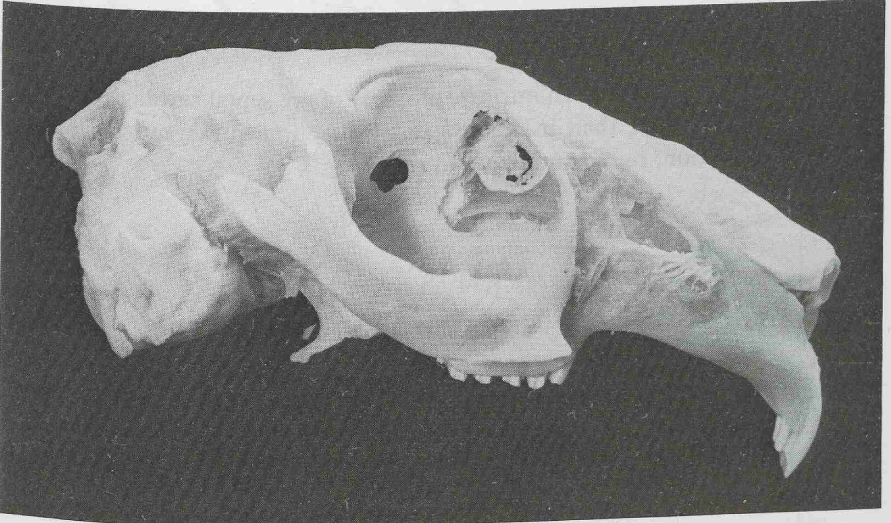


Figure 4. Lateral side of an adult skull (T143) from group V with nearly normal development of the nose.

Geometrical and statistical results

The geometrical study, as presented in the diagrams (Figure 5) demonstrates a statistically significant foreshortening of the nose in all three experimental groups.

In group III the 95% confidence areas of the points related to the nose and maxilla are larger than in the other groups. This may suggest a greater variety of the growth disturbances in this group.

COMMENTS AND CONCLUSIONS

Resection of the middle 1/3 of the septal cartilage in young rabbits (four weeks of age) results in an underdevelopment of the nose. In the adult stage (24 weeks after birth) the noses are foreshortened and show a flattened, sunken dorsum (Nolst Trenité et al., 1987).

In the reported experiments the surgical gap, after the resection, was filled in various ways. Reimplantation of the resected cartilage in the same position or rotated through 90° or 180° and reimplantation of crushed cartilage leads up to specific results. None of the reconstructions of the nasal septum appears to restore the normal growth of the nose. The noses of the fullgrown experimental

animals operated upon are generally characterized by foreshortening and flattening of the dorsum. The surgical procedure does not prevent further growth of the implants. The increase in size in the dorso-ventral axis of the non-crushed implants is about 50%.

The increase in the cranio-caudal diameter, rotated to a dorso-ventral position (group III) is less (0-25%).

These observations point to an intrinsic property of the septal cartilage, growing more in dorso-ventral, than in cranio-caudal direction, preserved during the process of resection, reimplantation and rotation.

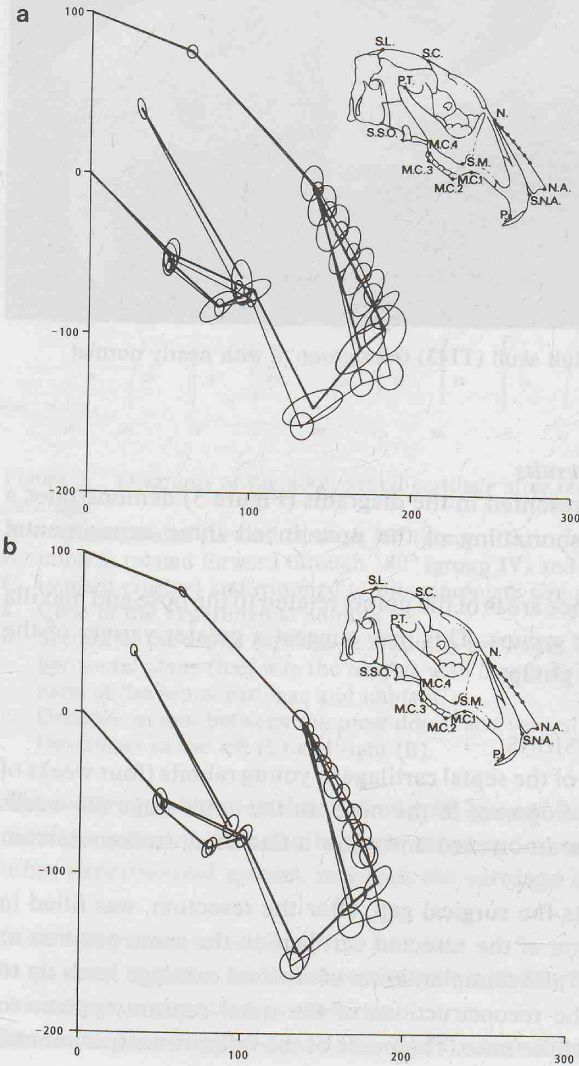
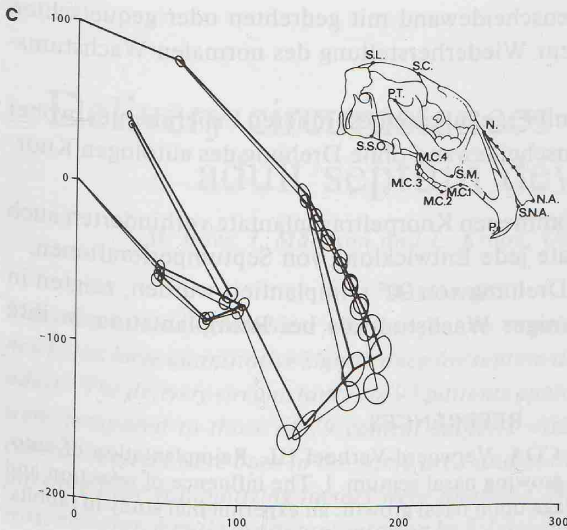


Figure 5. Diagram of the mean co-ordinates of the measuring points SSO, SL, SC, N, N1-6, NA, SNA, P, MC₁, MC₂, MC₃, MC₄, SM and PT on the lateral side of the skulls of the control group (thin line) and experimental group (thick line) with the 95% elliptiform confidence areas of the variety of the X and Y co-ordinate of the measuring points (U_x, U_y).

a. group III (reimplantation of the resected cartilage, rotated forward through 90°),
 b. group IV (cartilage strip rotated forward through 180°),
 c. group V (reimplantation of the cartilage strip after being crushed).



Crushed cartilage implants also demonstrate considerable increase in dorso-ventral length during the experimental period.

These implants are as effective as the other non-crushed autologous cartilage implants in preventing septal perforations. Growth of the remaining septal cartilage and the cartilaginous implants do not result in a congruent increase of the total nasal septum, because of the formation of duplications and deviations. So, the critical point in reconstruction of the growing nasal septum is not only realizing a proper end-to-end connection of the various parts, but also, in the long term, preventing the formation of deviations and duplications.

The implications for clinical use of these experimental results could be a possible adjustment of the operation technique in children to achieve a better connection between parts of septal cartilage with a prolonged fixation of the septum in a straight midline position.

As long as experimental work and clinical observations of surgery on the growing nose do not indicate how to prevent surgery-induced growth disturbances of the midface, the surgeon has to weigh the advantages of short-term improvement of the nasal function against the risk of growth anomalies with recurrence of nasal disfunction in the long run.

ZUSAMMENFASSUNG

Es wurde eine Serie von Experimenten bei junge Kaninchen ausgeführt, um die Folgen der Rotation (90° und 180° nach vorne) und Quetschung von autologen Knorpeltransplantaten in der Nasenscheidewand auf das Wachstum der Nase zu studieren.

Die Rekonstruktion der Nasenscheidewand mit gedrehten oder gequetschten Transplantaten führte nicht zur Wiederherstellung des normalen Wachstumsverlaufes der Nase.

Das ist in Übereinstimmung mit Ergebnisse eines früheren Experimentes, wobei die Rekonstruktion der Nasenscheidewand ohne Drehung des autologen Knorpels ausgeführt wurde.

Ebenso wie die original entnommenen Knorpeltransplantate verhinderten auch die gequetschten Transplantate jede Entwicklung von Septumperforationen.

Transplantate, die mit einer Drehung von 90° reimplantiert wurden, zeigten in dorso-ventraler Richtung weniger Wachstum als bei Reimplantation in ihre ursprüngliche Position.

REFERENCES

1. Nolst Trenité GJ, Verwoerd CDA, Verwoerd-Verhoef HL. Reimplantation of autologous septal cartilage in the growing nasal septum. I. The influence of resection and reimplantation of septal cartilage upon nasal growth: an experimental study in rabbits. *Rhinology* 1987; 25: 225-236.

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