Partial Resection of the Cartilaginous Nasal Septum in Rats; its Influence on Growth

STEINAR KVINNSLAND, Dr. Odont.

The role of the cartilaginous nasal septum as an influential factor in facial growth has received considerable attention in the literature.[1,2,6,7,8] Experimental extirpation of the nasal septum in laboratory animals has not led to universal results.[3,5,6,8] The reason for this is difficult to assess, but factors like the age of the animals at the time of operation, and the regenerative capacity of the nasal septum may be of some importance.

Stenström and Thilander[6] could find only moderate facial deformities after fairly extensive septal extirpation on 4-7 day-old guinea pigs, whereas Kvinnsland and Breistein[3] found marked reduction in facial growth when the midportion of the nasal septum was removed at birth and at 14 days in young rats; the deformities observed when the animals were operated at 7 days, 21 days, and 28 days were very moderate suggesting that growth of the septum is more active in certain periods than in others.

In a later publication, Stenström and Thilander[7] could find negligible regeneration after removing a small portion of the septal cartilage just in front of the perpendicular plate of the ethmoid in 3-6 day-old guinea pigs. Kvinnsland and Breistein found extensive regeneration of the septal cartilage after removing approximately half of the cartilage farther anterior to the perpendicular plate of the ethmoid in newborn and 1 week-old rats.

As a previous investigation[3] has shown that facial deformities were severe when the midportion of the nasal septum was removed at birth in rats, the present investigation was undertaken to examine which facial dimensions are affected and at which developmental stage the deformities occur.

MATERIAL

One hundred eighty-one rats of the Möll Wistar strain were operated on the day of birth; 102 animals survived the experimental periods. In addition five rats were included as operated controls in each group; the control material consited of 48 rats. (Table I).

METHODS

The cooling method of anaesthesia[9] was used. The approach to the septum was standard in all the experimental animals.

After soft tissue incision in the midline of the dorsal aspect of the snout, a narrow opening was created by cutting bone on either side of the internasal suture just in front of the frontonasal suture with sharp microscissors. The bone was removed and direct access to the dorsal aspect of the nasal septum could now be achieved. With two

TABLE I

Age in days	experimental animals	operated controls	controls
0	102	40	48
7	15	5	6
14	13	5	6
21	13	5	6
28	15	5	6
35	11	5	6
42	12	5	6
49	12	5	6
56	11	5	6

From the Institute of Anatomy, University of Bergen, Norway.

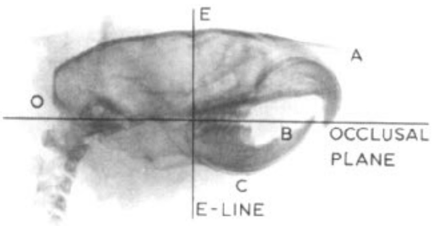

Fig. 1 Reference points and reference lines used in the radiographs. E, the frontonasal suture. A, the most anterior point on the nasal bone. B, the most anterior bony point on the lower jaw. C, the most caudal point on the lower jaw. O, the most posterior point on the occipital bone. The occlusal plane, a tangent to the molar and premolar teeth. The E line, a line through E perpendicular to the occlusal plane.

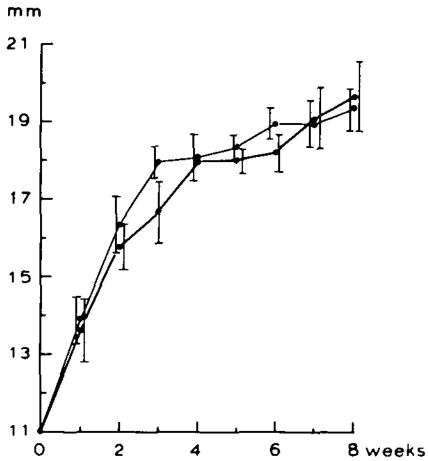

Fig. 2 Graphical representation of increase in the length of the visceral cranium, O—E. The heavy lines represent the experimental groups and the thin lines the control groups. Each group is represented by the dotted mean value and one standard deviation added and subtracted.

vertical cuts with the microscissors the middle portion of the septal cartilage could be loosened and removed in one piece. The mean size of the septum removed was 1.84 mm, S.D. 0.42 in length and 1.96 mm, S.D. 0.19 in height. On each operated control the soft tissue incision in the midline and the narrow opening on the snout were made in the same manner; the bone was removed and the wound was closed with soft tissue suturing.

After decapitation the head was radiographed in the sagittal plane. The central ray was perpendicular to the median sagittal plane and the film; the focus film distance was constant. Analysis of growth was carried out. Tracings of the operated animals, operated controls, and controls were superimposed along the occlusal plane with a reference line going through the frontonasal suture perpendicular on the occlusal plane (Fig. 1). The horizontal dimensions were measured from the E line projected on the occlusal plane. Vertical dimensions were measured from the occlusal plane and projected on the E line.

Results

Growth in length of the visceral cranium (O-E) does not seem to be affected by extirpation of the nasal septum (Figs. 2 and 3). Although there seems to be a lagging behind in growth in the experimental group in the 3rd and 6th weeks, the difference is small, and the end result is practically the same.

The snout length (E-A) shows a significant reduction one week after operation, and this reduction in snout length is accentuated with age (Figs. 3 and 4). The control animals show rather rapid uniform growth up to 6 weeks and thereafter reduction and cessation. The operated animals show very little growth after the 5th week.

Lower jaw prognathism (E-B) is significantly affected by the operation (Figs. 3 and 5). Reduction in lower jaw prognathism can be the result of a shortened lower jaw, a posterior-positioned jaw, or a posterior rotation of the jaw. In the experimental animals it seems that the reduced lower jaw prognathism is a result of a posterior

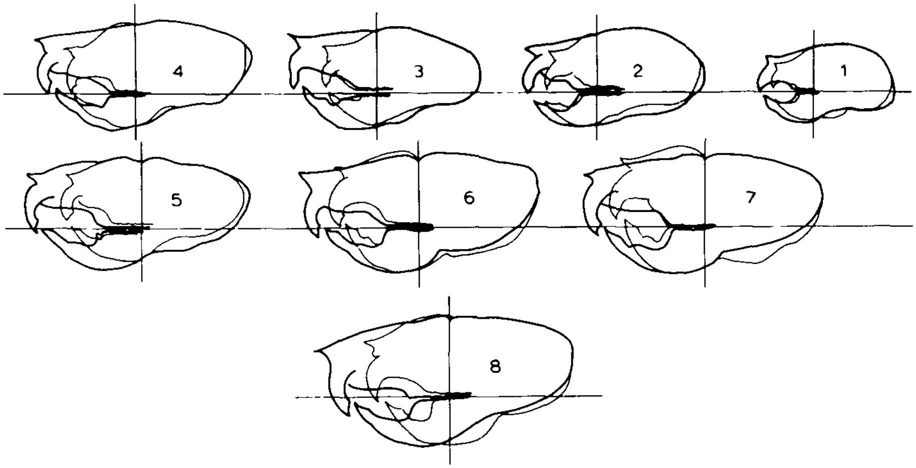

Fig. 3 Superimposition of experimental animals and controls from 1 week — 8 weeks. The heavy lines represent control animals and the thin line the experimental animals. The tracings are superimposed along the occlusal plane and the E-line.

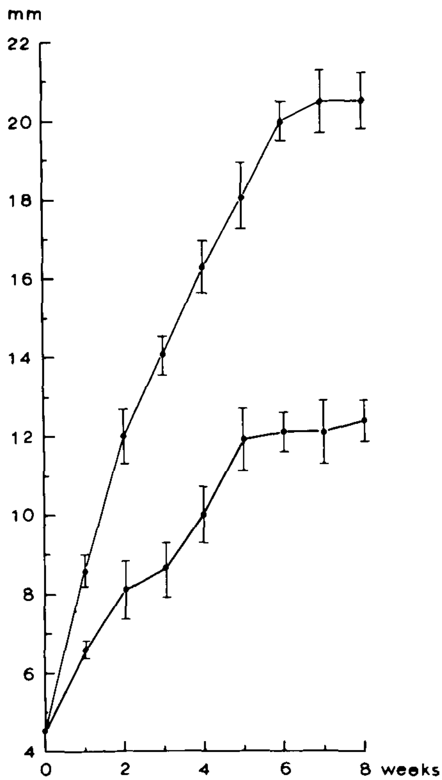

Fig. 4 Graphical representation of increase in length of the snout, E-A. The heavy lines represent the experimental groups and the thin lines the control groups. Each group is represented by the dotted mean value and one standard deviation added and subtracted.

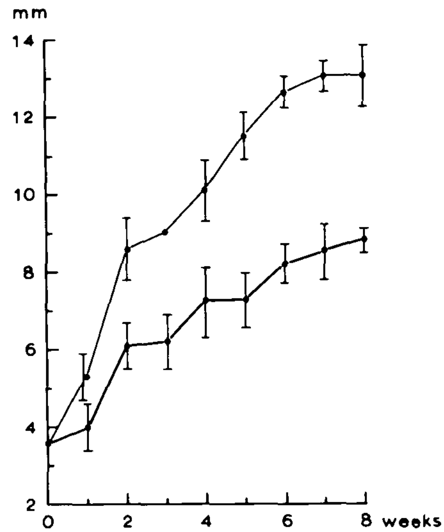

Fig. 5 Graphical representation of increase in the lower jaw prognathism, E-B. The heavy lines represent the experimental groups and the thin lines the control groups. Each group is represented by the dotted mean value and one standard deviation added and subtracted.

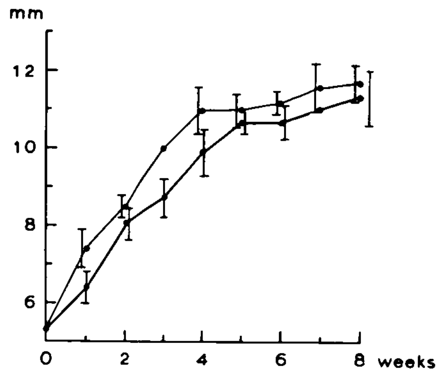

Fig. 6 Graphical representation of increase in the posterior height of the upper face, E-occlusal plane. The heavy lines represent the experimental groups and the thin lines the control groups. Each group is represented by the dotted mean value and one standard deviation added and subtracted.

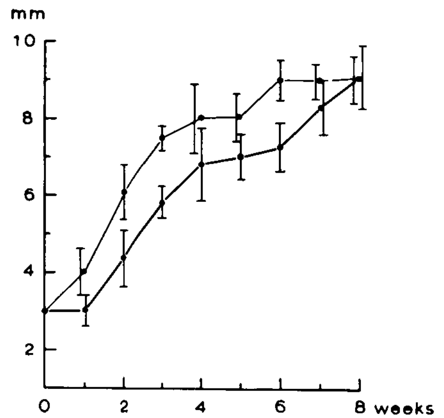

Fig. 7 Graphical representation of increase in the anterior height of the upper face, A-occlusal plane. The heavy lines represent the experimental groups and the thin lines the control groups. Each group is represented by the dotted mean value and one standard deviation added and subtracted.

position of the lower jaw possibly together with a slight posterior rotation. This is just a hypothesis as the length of the lower jaw has only been measured on a few radiographs because the posterior aspect of the lower jaw is very indistinct on the radiographs, especially in the younger animals.

In the control material there is a

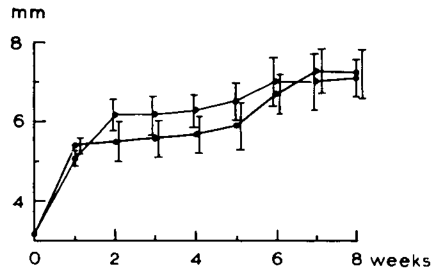

Fig. 8 Graphical representation of increase in the height of the lower face, C-occlusal plane. The heavy lines represent the experimental groups and the thin lines the control groups. Each group is represented by the dotted mean value and one standard deviation added and subtracted.

rapid increase in the posterior facial height (E-occlusal plane) up to 4 weeks and thereafter only a slight increase up to 8 weeks (Fig. 6). In the experimental animals the corresponding rapid increase continues up to 5 weeks and thereafter shows a corresponding slight increase. Although the experimental animals show slightly less growth of the posterior facial height in all groups, the difference is small, so that the effect of nasal septum extirpation in this dimension seems to be of little importance, if any.

The anterior height of the upper face (A-occlusal plane) shows a significant difference in the younger groups (Fig. 7). The later stages, 7 and 8 weeks, show no significant difference in anterior facial height. A depression of the nasal bones in the operated area was a constant finding.

The height of the lower face, (C-occlusal plane) does not seem to be affected by extirpation of the nasal septum (Fig. 8).

The operated control groups did not differ radiographically from the control groups.

Discussion

Previous experiments after extirpation of the midportion of the nasal

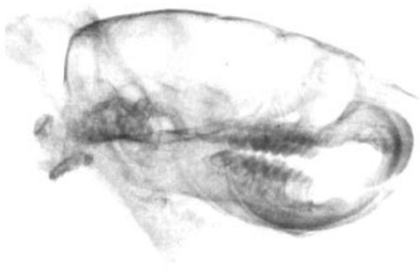

Fig. 9 Radiograph of experimental animal 6 weeks after operation showing anterior crossbite.

septum in young rats have shown that the most serious effect on the snout growth was found when the operation was carried out at birth and at 2 weeks, and it was deduced from these findings that growth of the septum was more active in certain periods than in others.[3] Furthermore, it has been shown that autotransplanted nasal septa show a considerable increase in size both in height and length after 30 days.[4] The present investigation tends to show that growth in length of the snout is more active in certain periods than in others in that the snout length in the control animals increased as much in the first two weeks as it did in the next three and a half weeks (Fig. 4). In the experimental animals the increase was about equal in the first two weeks and the next three. This tends to show that the growth activity of the snout is most active in the first two weeks after birth. Furthermore, the findings show that the removal of the midportion of the nasal septum at birth seriously affects the normal growth of the snout in the rat.

In this material it was found that two-thirds of the experimental animals had a normal relationship between the continuously erupting central incisor teeth while the rest had an anterior crossbite (Fig. 9). The finding that the lower jaw showed a definite reduction in prognathic development compared with the controls was somewhat surprising and this was the case both in animals showing a normal, and an abnormal, incisor relationship. It is suggested that this reduction in lower jaw prognathism is partly due to a posterior displacement and, possibly, also partly due to a slight posterior rotation of the lower jaw. It seems that when growth of the upper face is impaired, at least in length of the snout, the lower jaw will tend to accommodate to this.

The length of the visceral cranium, the height of the posterior upper face, and the height of the lower face were seemingly unaffected by the nasal septum resection.

The effect on the anterior facial height was less than expected and, although the younger stages showed a definite reduction in height, this reduction was not significant at 7 weeks and not even present at 8 weeks. The nasal bones, however, showed a definite depression in the operated area. This has probably been initiated in the growth period immediately after the operation, before the cartilage has regenerated and filled in the missing gap. After regeneration, this depression has then probably been retained by the collapsed nasal bones in the operated area. This finding tends to agree with the idea that the nasal septum also acts as a mechanical support for the nasal bones.

The results tend to show that the effect of partial nasal septum resection is local, primarily disturbing the normal anterior growth of the upper face and, secondly, by the reduced anterior growth of the snout causing a reduction in lower jaw prognathism. These findings again show that the nasal septum in the rat seems to be a structure of great importance not only in upper facial growth, but also in growth of the face as a whole, at least in an anterior growth direction.

SUMMARY

The effect of craniofacial growth after partial extirpation of the nasal septum at birth was studied at various developmental stages in the rat. The findings show that the extirpation has a local effect primarily disturbing the anterior growth of the upper face and, secondly, by the reduced growth of the snout causing a reduction of lower jaw prognathism.

Institute of Anatomy,
University of Bergen,
Aarstadvn. 19, 5000 *Bergen,*
Norway

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