

## Nasal glands in newborn infants

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### SUMMARY

*The entire mucosa of the nasal septum from four newborn infants was removed, stained by the PAS-alcian blue whole-mount method, and the density of mucous glands was determined in 12 different localities. The interindividual median density was 30.7 glands/mm<sup>2</sup> and the median count 13,500 glands. The glands were regularly distributed over the entire respiratory region, but with a significant decrease in density in the posterior half. It has been demonstrated that all glands are laid down before birth, that their density decreases with increasing age until it reaches 8.4 glands/mm<sup>2</sup> at an adult age, and that acute or recurrent acute catarrhal or inflammatory changes of the nose do not lead to the newformation of glands.*

IN the respiratory region there are numerous, small tubulo-alveolar, seromucous glands, and anteriorly in the vestibule, moreover, 100-160 serous anterior nasal glands (Bojsen-Møller, 1964). The olfactory region holds numerous, small serous, tubular Bowman glands. The secretion from the glands and from the epithelial goblet cells is an important factor in the physiology and pathology of the nose; and yet, our knowledge of these elements is limited. The objet of the present study was to determine the density of glands on the nasal septum in newborn infants whose mucosa has never been exposed to external physiological or pathological stimuli and is entirely normal. The results are to be compared with the normal adult septum in which the median density of glands is 8.4 glands/mm<sup>2</sup>, slightly decreasing into the anteroposterior and slightly increasing in the infero-superior direction (Tos and Mogensen, 1976 a).

We have been unable to find any previous reports on the distribution or density of the nasal mucous glands in neonates. In adults a few authors have found most glands on the tuberculum septi (Brunner, 1942 and Wagemann, 1964), in the lower half of the septum (Messerklinger, 1958), or on the medial aspect of the inferior turbinate (Schiefferdecker, 1900, Kubo, 1907 and Wagemann, 1964). Detailed references have been given in our previous papers (Tos and Mogensen, 1976 a and b).

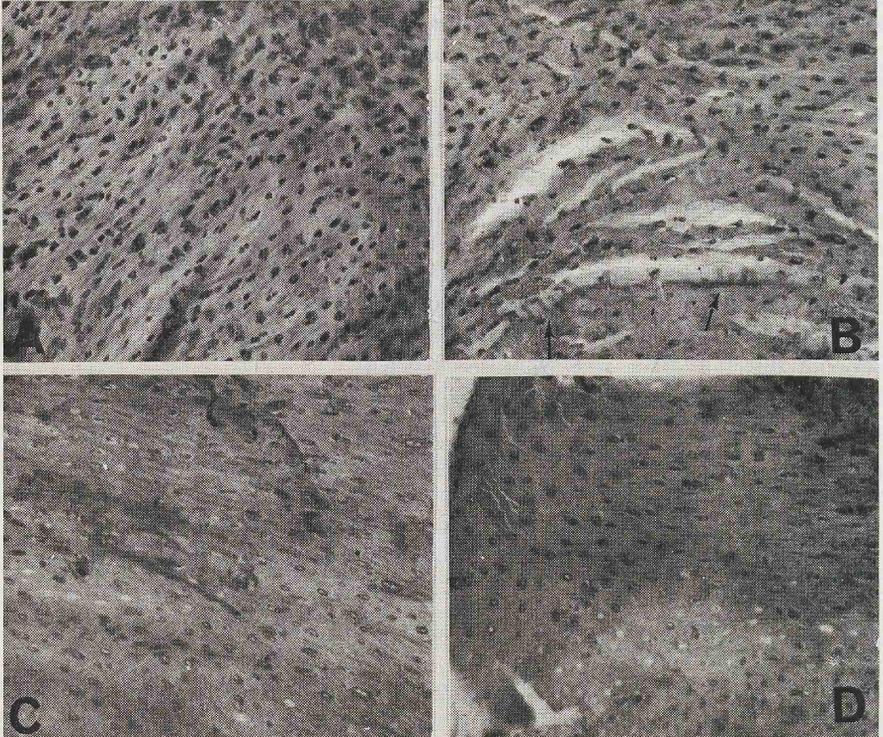
### MATERIAL AND METHOD

The material comprises four full-term newborns, birth weight 2600-3950 g and crown-heel length 48-55 cm. In the two smallest infants both aspects of the

septum were studied, in the others only the right. After fixation, the mucosa from the entire septum was fine-dissected into two layers: (1) The deeper layer comprising the perichondrium, vascular plexus, and the deepest glandular layer. (2) The superficial layer with the epithelium, basement membrane, part of the lamina propria with the superficially situated glands, and with torn ducts from the deepest glands. The superficial layer was stained by the PAS-alcian blue whole-mount method (Tos, 1970) which stains the glands and epithelial goblet cells blue on a pale blue background, the deeper layer by the PAS whole-mount method which sets out the glands red on a pale background.

The respiratory region was divided anteroposteriorly into four quarters: First (anterior), second, third, and fourth quarter. Inferosuperiorly it was divided into three thirds — inferior, middle, and superior third. In the stereo-microscope, magnification  $\times 50$ , 2—6 counts of glands were done in  $4 \text{ mm}^2$  fields of these twelve localities scattered regularly over the locality, whereupon the mean density (glands/ $\text{mm}^2$ ) in each locality was calculated.

Figure 1. Different appearance and density of glandular orifices from nasal septum. PAS-alcian blue stained whole mount  $\times 30$ . a) Case 1 posteriorly, b) middle, ducts are visible (arrows), c) case 3 superiorly, d) case 4 anteriorly. Difference in density and size of the orifices between a and d are evident.



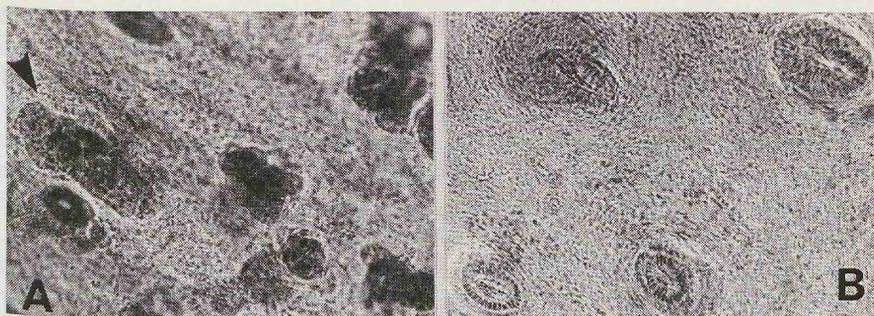


Figure 2. Orifices in magnification  $\times 300$ . a) case 1, with a superficial gland (arrow), b) case 4.

### RESULTS

On the whole mount the glandular orifices are seen from above. They present as round, pale dots surrounded by a blue ring, and their diameter is  $50-75 \mu$ . Anteriorly, especially in the vestibule, there were more large orifices than posteriorly in the nose. From the orifice it was possible to trace the glandular duct, seen as a blue canal and coursing vertically or somewhat obliquely down into the lamina propria. The great majority of ducts were straight, a few slightly curved, while a few described a kink, sharply altering their course. However, the shape and direction of the duct did not show major deviations, and the glandular body was always immediately beneath the orifice. The ductal lumen was of uniform calibre, only a few having minor, subepithelial dilatations. In about one-third there was mucous in the lumen and orifice, indicating that transport of secretion to the surface was in progress. The length of the main duct depended upon the situation of the glandular body. In the deepest glands the duct was up to  $500 \mu$  in length before dividing into two side ducts and tubules. In the quite superficial glands, which were generally small, the main duct was just on  $100 \mu$  in length. In each locality there were long ducts from the deep glands as well as short ducts from the superficially situated glands, but their mutual quantitative relations varied

Table 1. Mean density of glands in different localities of the four quarters. (I) inferior; (M) middle; (S) superior third of the septum.

Case No. sex	First			Second			Third			Fourth			Median
	I	M	S	I	M	S	I	M	S	I	M	S	
1 R ♀	33.3	34.8	35.5	34.1	32.9	33.6	33.5	34.2	33.7	30.0	27.5	28.0	33.5
1 L ♀	33.6	37.1	39.1	34.1	34.7	32.3	32.3	34.6	30.5	32.7	34.0	30.0	33.8
2 L ♂	30.1	33.1	29.0	28.6	32.9	32.0	33.1	32.0	29.8	31.2	31.5	30.6	31.3
2 R ♂	30.9	32.3	32.6	32.0	32.2	30.4	32.4	28.5	28.0	29.7	28.3	29.0	30.1
3 ♂	29.0	29.8	32.6	28.5	27.2	29.4	26.5	26.5	28.6	25.4	26.0	27.3	27.2
4 ♀	23.3	24.5	24.0	22.8	23.3	24.5	24.0	23.9	27.0	23.0	23.3	22.4	23.3
Median	30.5	32.7	32.6	30.3	32.6	31.2	32.4	30.3	28.9	29.8	27.9	28.7	30.7

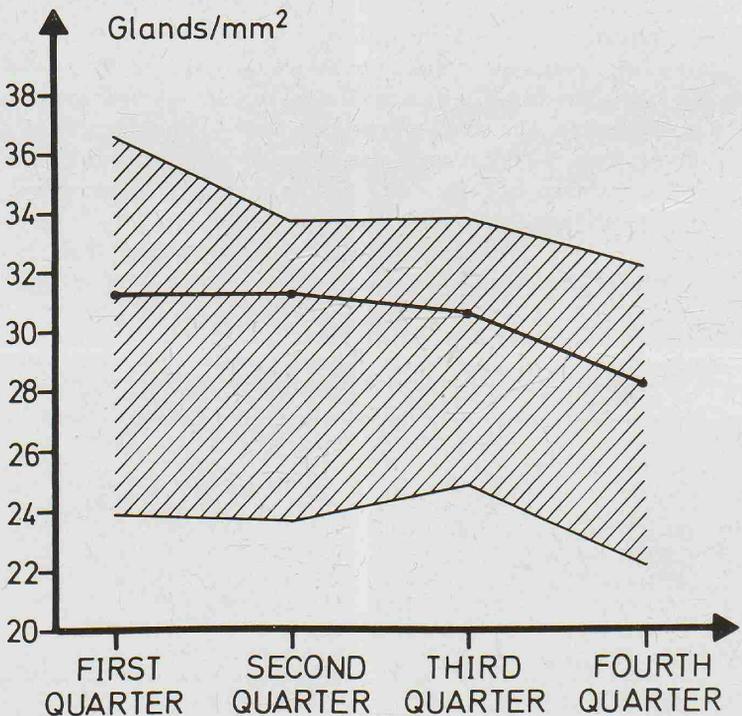
widely from region to region. In the superior and posterior parts there were more superficially situated glands than in the inferior and anterior parts. The explanation is that the glands are laid down at different junctures (Tos and Poulsen, 1975): In the anterior and inferior parts they are laid down at an early juncture, when the mucosa is thin, and they can grow deepest down. In the posterior and superior parts they are laid down at a later juncture, when the mucosa has grown thicker, so that they are unable to grow right down into the depth before dividing.

On the whole, most glands in newborns are small, built up mainly of tubules. The majority of the acini form in step with the growth of the nose and glands after birth.

#### DENSITY OF GLANDS

The mean density of the individual localities of the same septum did not vary much, indicating a regular distribution of the glands. On the other hand, the median density on the individual septa exhibited marked variations (Table I) due to a change in density with increasing age and size of the infant. In Cases 1 and 2, showing a high density, the glands were smaller and younger than in

Figure 3. Interindividual density and range in different quarters of the septum of newborn infants.



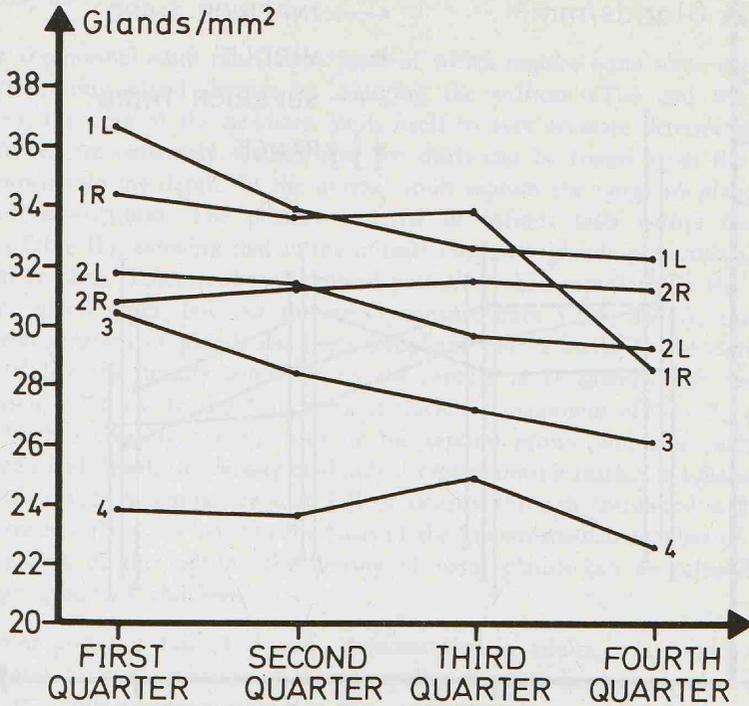


Figure 4. Individual density curves.  
Individual density curves.

Cases 3 and 4 in whom the density was low. The difference in age is apparent also from the birth weight was 2600 g, corresponding to 36 weeks (Streeter, 1921), in Case 2 and 3500 g, corresponding to 40 weeks, in Case 3.

*Anteroposterior variation:* The interindividual median density (Figure 3) decreased in the posterior half, especially in the posterior quarter. This fall was statistically significant ( $p < 0.01$ , Friedmann's analysis of variance) and was observed in all the infants (Figure 4).

*Inferosuperior variation:* There were no significant differences in density ( $p > 0.05$ , Friedmann's test) between the inferior, middle, and superior third of the septum. In all thirds the density was lowest in the posterior part (Figure 5).

*Right-left variation:* In the two youngest infants the right as well as left side of the septum was studied. Differences in median density between the two sides were negligible (Table I, Figure 4).

#### NUMBER OF GLANDS

The area of the respiratory region was measured directly and the number of glands calculated on the basis of the median density in each septum (Table II).

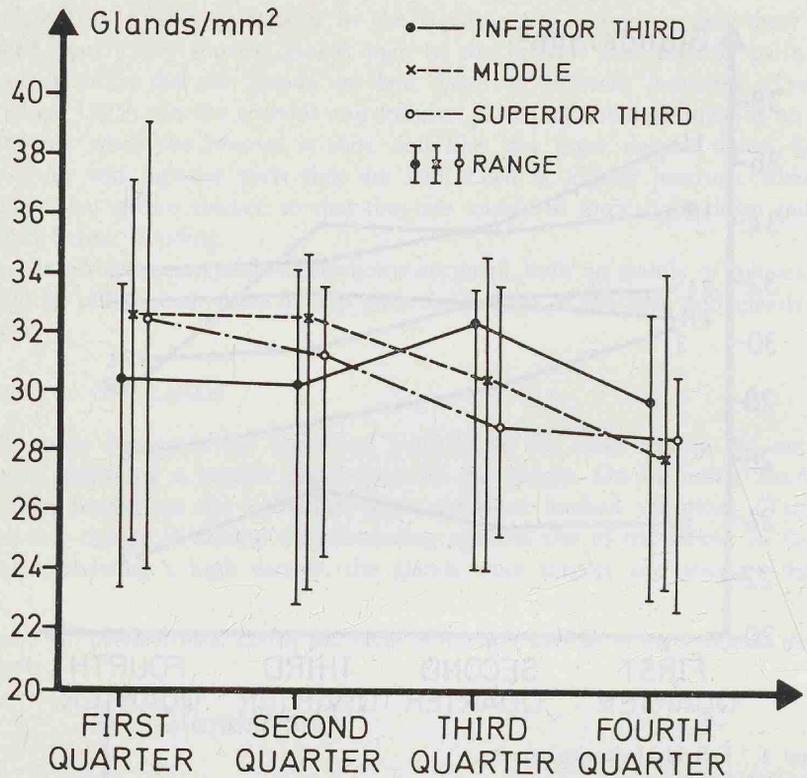


Figure 5. Interindividual density and range in the inferior third, middle, and superior third of the respiratory region.

The area increased with increasing size of the infants, and there was a corresponding fall in density. The median number was 13,500 glands, the maximum 18,500.

Table II: Area, mean density, and number of glands in the respiratory region of the septum.

Case No.	Area mm <sup>2</sup>	Density glds./mm <sup>2</sup>	Number
1 R	390	33.5	13,065
1 L	390	33.8	13,182
2 R	459	31.3	14,366
2 L	459	30.1	13,816
3	648	27.2	18,585
4	551	23.3	12,783
Median	459	30.7	13,499

## DISCUSSION

Unlike the normal adult nose, some parts of which require quite some experience for determining gland density by counting the orifices (Tos and Mogensen, 1976 a), the nose of the newborn lends itself to very accurate determination, as the orifices are extremely distinct and the ducts can be traced from the orifice right down into the depth. In the normal adult septum the range of gland count was 10,800—21,800. The present material of infants falls within the adult range (Table II), showing that in the normal nose new glands presumably do not form after birth. True, newborns showed posteriorly and superiorly in the septum younger gland types, but not the very youngest ones (Tos, 1966), indicating that newformation of glands has been completed before birth. In the 23rd week of foetal life the density anteriorly on the septum is 28 glands/mm<sup>2</sup> (Tos and Mogensen, 1976 c). In the 36th week it reaches a maximum of 31—33 glands/mm<sup>2</sup>. With increasing age the area of the septum grows, and since all glands have been laid down, the density gradually decreases until it reaches 8.4 glands/mm<sup>2</sup> at an adult age. A similar, regular fall of density through childhood was found in the trachea (Tos, 1970). On the basis of the known median number of glands and the area of the septum, the density of nasal glands can be calculated for each age group of children.

The anteroposterior fall of density, demonstrated in adults, was found also in the present material, whereas an inferosuperior increase in density, also demonstrated in adults, was not found in the newborns.

Determination of gland density in 12 different localities of the septum may throw light upon the growth of the septum through childhood. As newborn infants have the same number of glands as adults, and as the distribution of glands in newborns as well as adults is regular, without concentration in given areas, the septum seems to grow regularly in size, and all its parts appear to take equal part in the growth. If, for instance, the septum grew mainly at the junction between its bony and cartilaginous part, this area in newborns would show a considerably higher density of glands than sites in which the growth rate was lower. In adults, on the other hand, there would be considerably less glandular density in areas with a high than in those with a low growth rate. As already mentioned, such differences in density were not found, either in children or in adults, especially not at the junction between the bony and cartilaginous part of the septum.

Investigations on adults were done on autopsy specimens from persons over 60 years of age who had not at death shown any signs of acute or chronic diseases of the nose. However, it is beyond doubt that these persons had previously, especially in childhood, had up to several acute attacks of catarrhal disease. As the number of glands in entirely normal newborns is the same as in adults, acute recurrent acute, and perhaps also subacute catarrhal disease does not seem to lead to newformation of glands. Whether this applies also to chronic diseases is for similar quantitative studies to decide.

## ZUSAMMENFASSUNG

Die ganze Schleimhaut der Nasenscheidewand von 4 Neugeborenen wurde entfernt, mit PAS-Alzianblau Ganzpräparatmethode gefärbt und die Dichte der mukösen Drüsen in 12 verschiedenen Lokalitäten bestimmt. Die interindividuelle Mediandichte war 30.7 Drüsen/mm<sup>2</sup> und die Medianzahl 13.500 Drüsen. Die Drüsen waren über die ganze Regio respiratoria regelrecht verteilt, doch mit signifikanten Fall der Dichte in der hinteren Hälfte. Es wurde demonstriert dass die Drüsen vor der Geburt angelagt sind, dass die Dichte mit zunehmenden Alter fällt, bis sie bei Erwachsenen 8.4 Drüsen/mm<sup>2</sup> erreicht, und dass akute oder rezidivierend akute inflammatorische Veränderungen der Nase nicht zur einer Neubildung der Drüsen führen.

## RÉSUMÉ

La muqueuse du septum nasal a été enlevée dans son entièreté chez quatre enfants nouveau-nés; elle a été colorée par la réaction P.A.S.-bleu alcian et la densité des glandes muqueuses a été déterminée à douze endroits différents. La densité moyenne est de 30,7 glandes par mm<sup>2</sup> et le nombre total moyen de 13.700 glandes. Celles-ci sont distribuées régulièrement dans la muqueuse de type respiratoire avec cependant une diminution significative de la densité dans la moitié postérieure. Les auteurs démontrent que toutes les glandes sont présentes dès avant la naissance et que leur densité décroît avec l'âge pour atteindre un nombre de 8,4 glandes par mm<sup>2</sup> chez l'adulte; les inflammations aiguës ou récidivantes du nez n'entraînent pas de néoformation glandulaire.

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