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Nasal vascularization: Experiences using the microcorrosion technique in human foetuses

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SUMMARY

The authors have studied the three-dimensional aspect of the vascular architecture of the nasal mucosa, using the microcorrosion method followed by scanning electron microscopical observation of casts of the vascular networks in both the septum and the lateral part of the nose. Batson's compound was introduced into the vascular system through the ascending aorta, in order to obtain a replica of the nasal mucosa vessels. Twelve- to 24-week-old foetuses obtained from spontaneous abortions were used for this purpose.

INTRODUCTION

Since the complex mechanism which regulates nasal function depends on the anatomical integrity of the vascular structures involved, a precise knowledge of the mucosal vascular architecture is of decisive importance. In all fields of medicine a physiopathological evaluation of clinical symptoms is essential for the morphological study of an organ. Injection methods, in particular the microcorrosion technique, together with the study of casts by scanning electron microscopy (SEM) make it possible to identify the three-dimensional aspect of the vascular blood system as is shown in Figures 1 and 2 (cf., Grevers and Hermann, 1986; 1987). A microcorrosion study of the vascular structures of the nose will clearly illustrate the role of these structures in the humidification and thermoregulation of inhaled air.

MATERIAL AND METHODS

For the first time during our research we used 12- to 24-week-old foetuses (average length 15 cm), obtained from spontaneous abortions.

The first step was to enter the ascending aorta; the thorax was opened ("box"-incision) and the blood vessels in the wall of the chest clamped with haemostatic

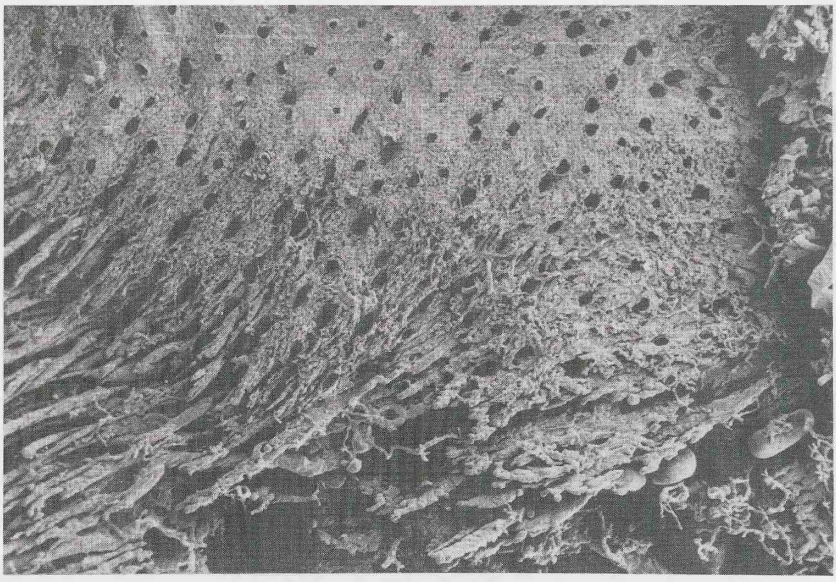

Figure 1. A general view of the nasal septum. It is possible to identify the locations of the nasal glands (X30).

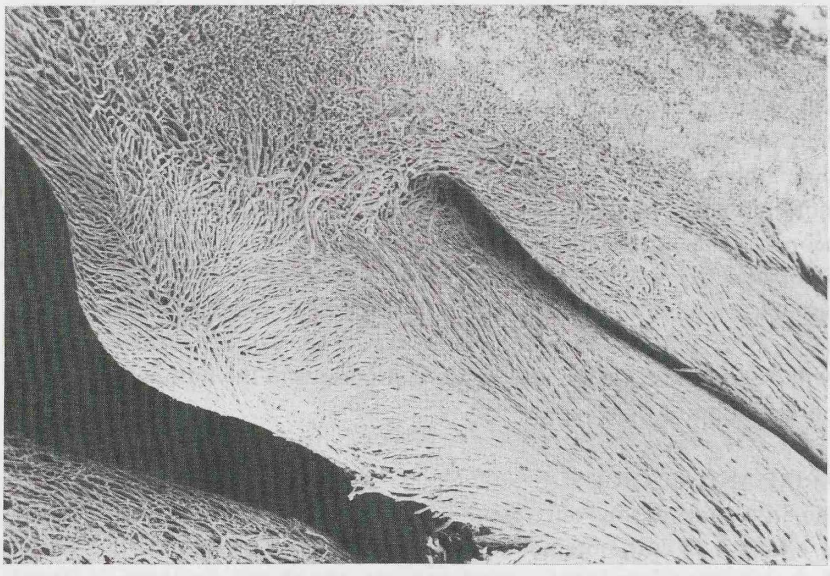

Figure 2. Vascular corrosion cast; the lateral part of the nose with nasal concha and meati (X20).

forceps. The pericardium was then opened and a catheter inserted through the left ventricle into the ascending aorta, which was firmly secured with a ligature. Foetal circulation makes it possible to inject a foetus with Batson's compound through the left ventricle into the ascending aorta or through the umbilical vein (Batson, 1954), the choice of one or the other method depending on the research in question. A heparinized, isotonic saline solution (Ringer's) was introduced into the systemic circulation system in order to wash out the blood through an incision in the right auricle. Batson's compound No. 17 was then introduced into the system. The foetus was placed into hot water (60 °C) for several hours in order to polymerize the resin.

An optimal injection of compound is characterized by regular staining of the skin and visible mucosa as well as the uniform filling of the small vessels and capillaries. Ruptures in vessel walls are usually caused by the compound being injected too fast or in an excessively dense state. As a consequence, the results obtained cannot be studied and interpreted accurately (Sokolowska-Pithuchowa et al., 1980). Complete or partial failure can also result from defects in the foetal tissue itself (delivery lesion, autolysis, maceration, malformation, intravascular thrombus).

The facial muscles, nasal pyramid, maxillary bone and palatine bones were then excised from the speciment and the two lateral parts of the nose and the septum detached. The bony- and soft tissues were removed by maceration and digestion using 20% KOH. The specimen were then rinsed under hot running tap-water followed by delicate and thorough cleansing by spraying water from a syringe. They were then immersed in a solution of formic acid and water. Prior to coating with gold-palladium sputter, the corrosion casts were placed in a vacuum dryer. Finally, the casts were studied by means of SEM.

RESULTS AND CONCLUSIONS

Since interest in more detailed anatomical research into the nasal region has increased, the aim of this study was to obtain a better knowledge of the various aspects of the vascular architecture. It was possible to identify three vascular layers in the septal and lateral part of the nose (Figures 3-6):

1. the most superficial layer, located in the subepithelium;
2. the intermediate layer;
3. the deepest layer most probably composed of vessels supplying the perichondrium and periostium.

In agreement with Grevers and Ulrich (1989) who carried out a study on the nasal vascularization in rabbits, and Tange (1986) who used the microcorrosion technique in Mongolian gerbils, in a recent study we have also identified different arrangements in vascular architecture in various areas of the nose (Buccella et al., 1990). A capillary network was observed within the superficial subepithelial stratum, made p of vessels which are lower in density and fewer in

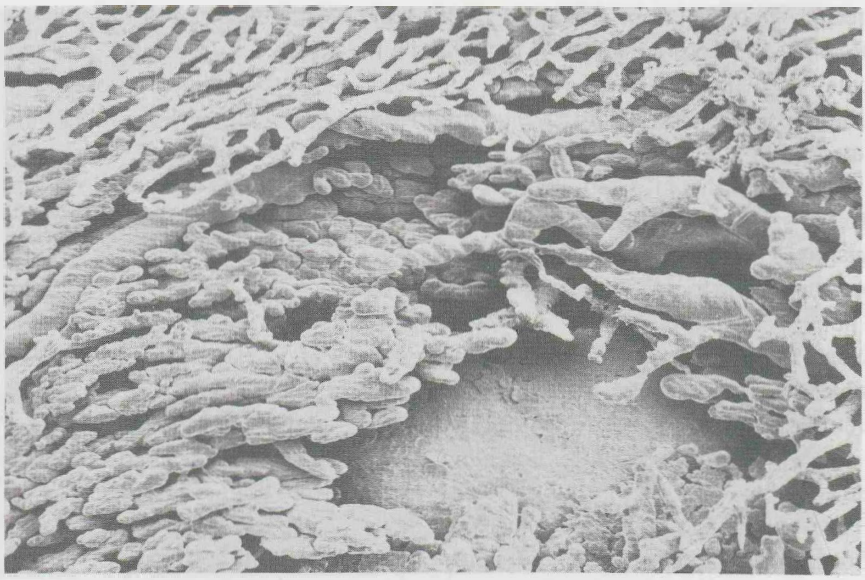

Figure 3. The three different vascular layers; the superficial or subepithelial layer, the intermediate layer and the deep layer (X 130).

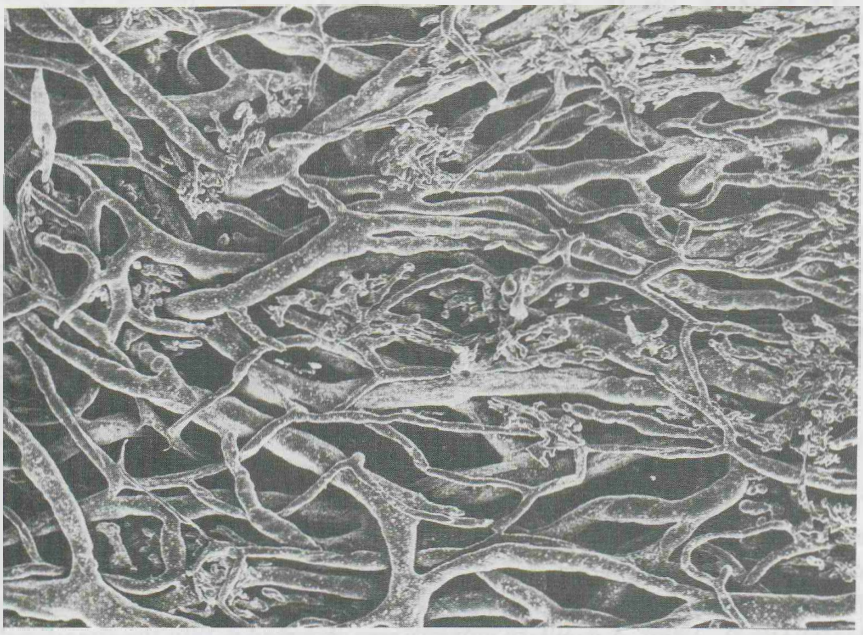

Figure 4. The superficial or subepithelial vascular layer in the lateral part of the nose. The capillaries are less dense and fewer in number than in the other two layers (X120).

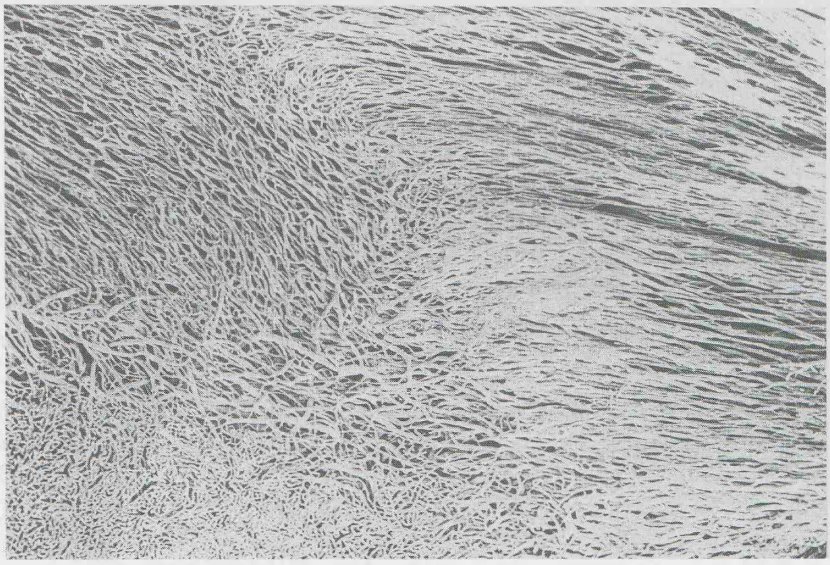

Figure 5. The intermediate vascular layer; the vessels are straight and rectilinear (X20).

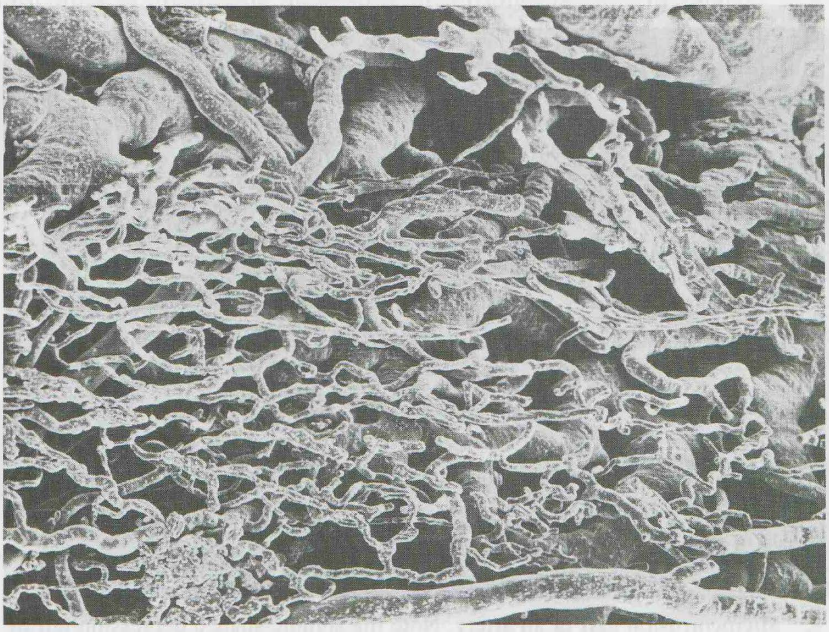

Figure 6. The three different vascular layers (X 100).

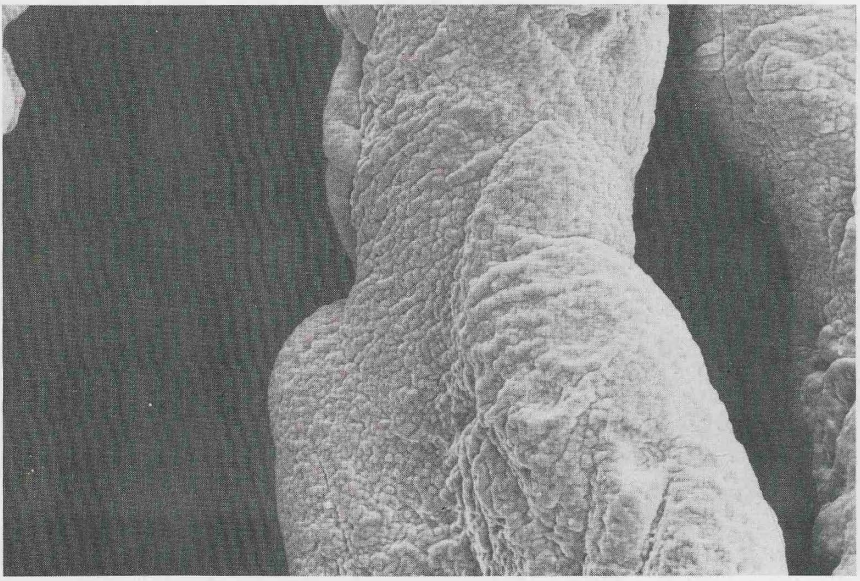

Figure 7. Microcorrosion cast of a venous blood vessel. Note the round depression of the nuclei of the endothelial cells (X1,000).

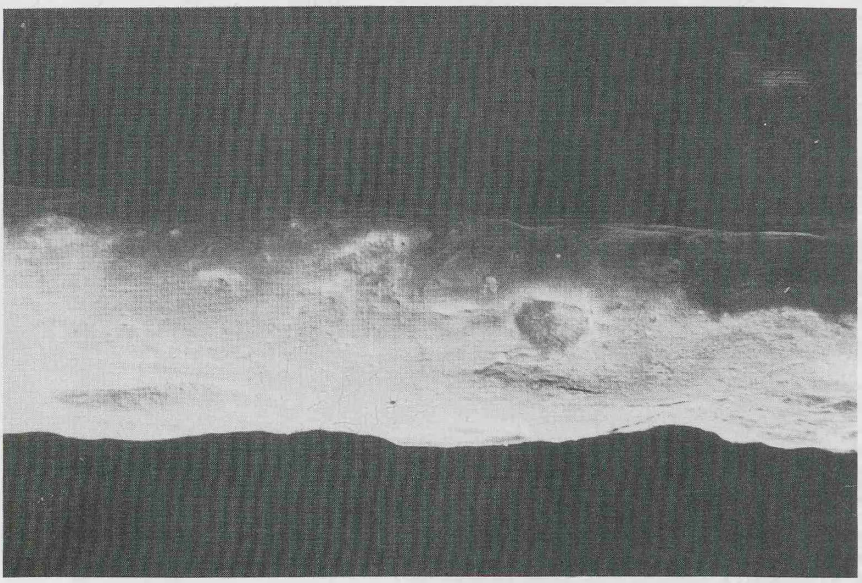

Figure 8. Microcorrosion cast of an artery. Note the spindle-shaped depression left by the nuclei of the endothelial cells (X2,600).

number than in the other two deeper vascular layers (Figure 4). The intermediate stratum is formed of rectilinear parallel vessels (Figure 5). Finally, the deepest stratum appears to contain the greatest number of vessels and a dense capillary network, from which small veins branch out and converge to form (as in the turbinate) the cortical stratum. These venous vessels form plexus which contain irregular lacunae with sacciform dilatations, and make up the richly anastomized venous sinuses.

The microcorrosion technique has made it possible to identify the nature of the vessels (morphological aspects) which form the capillary network (Grevers and Heinzmann, 1988). An initial comparison between veins and arteries can be made by examining casts at low magnifications (Grevers and Ulrich, 1989; Grevers et al., 1989). Veins usually follow an irregular course, and arteries a straight course. This difference is confirmed, at higher magnifications, by the remnants of the endothelial cells. These are flattened and thin, and consist of a single stratum; the nuclei in veins are roundish and spindle-shaped in arteries (Figures 7-8).

Using the microcorrosion technique it is sometimes possible to observe the arteriovenous anastomoses as illustrated in Figure 9 (Kishi et al., 1989; Lijima et al., 1988). We agree with Tange (1986) that it is possible to identify anastomotic nasal structures using this technique. However, both Staubesand (personal communication) and, later, Grevers and Ulrich (1989) experienced difficulties in identifying these structures using the same method.

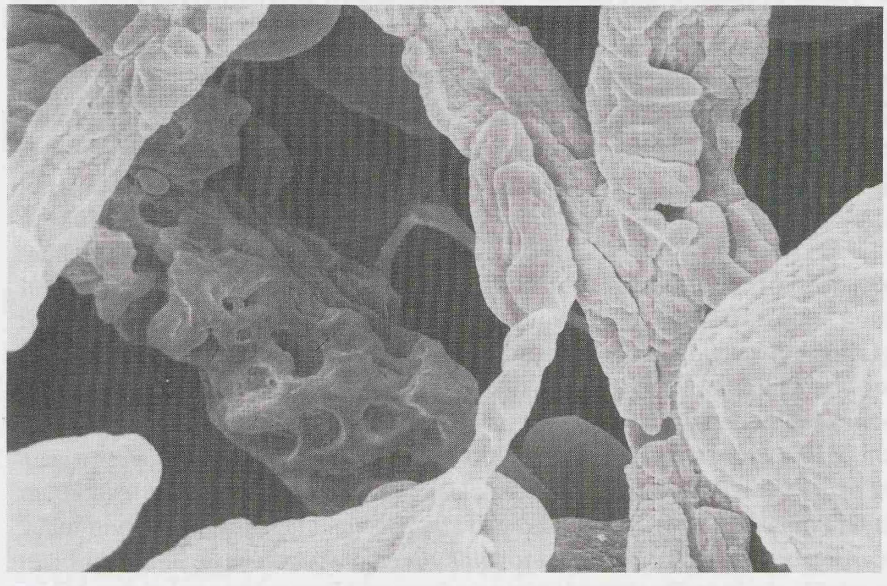

Figure 9. Arteriovenous anastomosis located in the deeper strata (Xl,300).

It is important to note that the degree of visualization is not influenced by the kind of resin used, but depends strictly on the time elapsed between the interruption of the blood flow and the filling of the vessels, as well as the difficulty incurred in identifying the anastomoses that are located in the deepest strata.

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