Trauma to the Cartilaginous Skeleton of the Nose

Graeme M. Clark, F.R.A.C.S.
Victoria, Australia

Many ear, nose and throat disorders that were of frequent incidence some years ago, are now rarely seen in clinical practice. Nasal injuries remain a common diagnostic and therapeutic problem, however, especially when the nasal cartilages have been damaged. Consequently, this paper deals with the problem of trauma to the cartilaginous skeleton of the nose.

Injuries to the cartilaginous skeleton of the nose are common, especially during childhood, and not infrequently lead to nasal deformities. The patient seen in Figure 1 had no definite history of trauma, but during periods of active growth the nose became very broad and saddle-shaped. This history is typical, and highlights the fact that many minor injuries in childhood are not diagnosed or adequately treated. Particularly in neonates, treatment is often delayed because of other more pressing issues and a tendency for the deformity to right itself.

In childhood, a greater proportion of the skeleton of the nose is cartilaginous; this is one reason why trauma to cartilage is common. Examination of the dorsal profile line during postnatal development shows that the bony nasal arch only becomes prominent after the seventh year of life. Therefore, it is only after this period that adequate protection is provided by the osseous skeleton of the nose. During the first years of life, the nasal septum is not fully ossified, as the replacement of cartilage by bone in the perpendicular plate of the ethmoid is not complete until the fifth year.

An injury to the nose is due to a force transmitted to various cartilaginous structures which are then strained, and often permanently damaged. A deformity can thus develop if an ossification center or growing area of cartilage is injured. The nasal bones, vomer and maxillae are all ossified in membrane. Histological studies reveal that the osteoblasts and intercellular material are interconnected by delicate processes which could be disrupted when the breaking strain is exceeded. This could lead to deformity.

The extent of the damage to the cartilaginous nasal skeleton will be appreci-
Figure 1A (left): Photograph of patient at the age of 10. Figure 1B (right): Photograph of patient at the age of 17.

ated better if there is knowledge of the direction of the force, the prestressing of the cartilage and lines of transmission of the force through the cartilage. Nasal cartilage is under tension, and the direction of this strain is important in determining whether cartilage will resist a force which is brought to bear on the nose from a certain direction. For example, if the quadrilateral cartilage is under tension in a direction along the length of the nose, it will tend to resist a force applied to the dorsum; that is in a direction at right angles to the lines of tension.

Internal tension in nasal structures was first investigated by Ilberg, in 1935. An awl was introduced into cartilage, bone, perichondrium and periosteum and then withdrawn. Lines of tension in cartilage, or weaknesses in bone, were indicated by the direction in which the tissue split, and are shown in Figure 2. They reveal a mosaic-like distribution of lines in the nasal septum. These lines on the vomer ran obliquely backwards from the arch of the hard palate to the body of the sphenoid bone. The perpendicular plate of the ethmoid bone showed vertical lines in its cephalic portion, and oblique lines in the more caudal portion. These lines probably did not indicate lines of internal tension or prestressing, but weaknesses of the bone. As bony buttresses usually alternate with weaker areas, these lines could indicate how the internal structure of the bones has been modified to withstand compressional stresses according to "Wolff's Law."

This would suggest that the more caudal and anterior part of the perpendicular plate of the ethmoid bone is subjected to compressional stresses from above and in front in the region of the upper part of the dorsum of the nose. On the other hand, the vomer does not appear to be subjected to these stresses, but may be compressed by different forces during, for instance, its postnatal development.
The lines of tension shown in the quadrilateral cartilage (Figure 2D) are more complex and difficult to explain. The vertical lines would indicate there is a distracting force pulling in a vertical direction. On the other hand, the more horizontal lines are due to forces at right angles to the above. As mentioned previously, the cartilage will tend to resist forces at right angles to the direction of prestressing; consequently, the inferior portion of the septum could be more important than the superior portion in resisting a force applied to the dorsum of the nose.

The lines of tension in the nasal bone and lateral cartilages in Ilberg's studies, are shown in Figure 2A and B, and they do not appear to follow any uniform pattern. Ilberg also studied the lines of tension in the perichondrium and periosteum (Figure 2C) and found them different again.

The intrinsic stresses and strains in cartilage were further investigated by Gibson and Davis. Their studies were made on human costal cartilage and demonstrated the presence of "interlocked stresses." They found that internal tension in cartilage was greatest just beneath the perichondrium, so that when this was removed the cartilage bent towards the opposite side. These findings have been demonstrated in nasal cartilage by Fry.

The manner in which the cartilaginous skeleton of the nose is prestressed is, therefore, important in determining how it will resist a force from a certain direction, and in which direction the deformity will occur.

INJURIES IN CHILDREN

Injury to the cartilaginous skeleton of the nose is common during or even before birth. It has been estimated that gross lateral displacement of the nose occurs in 6% of Caucasian births, but in many of these infants the displacements correct themselves spontaneously within a short period of time. Damage to the cartilage of the nose, particularly in the early period of life, can lead to later deformities. This has been confirmed in rabbits in which deformities resulted from dislocation of the septal cartilage out of the groove on the superior border of the vomer. Therefore, it is usually recommended that, if the deformity does not correct itself spontaneously within a few days, a manipulative reduction should be carried out. This is not always successful. In the infant shown in Figure 3A, only a partial reduction could be achieved. The deviated nose was kept in a corrected...
position by adhesive strapping anchored to the cheek. The postoperative result is shown in Figure 3B. The strapping was well tolerated and applied traction for some hours before needing replacement. Since modern adhesive tapes are well tolerated by the skin, it is suggested that this method be considered the treatment of choice, as the continued traction is more likely to overcome persistent internal strains than a single manipulation. Initially, however, it is probably still wise to perform a manipulation, taking care to avoid damage to the ossification centers. If a complete reduction is not achieved, the nose should be strapped.

One of the more difficult problems concerning injuries to the cartilaginous skeleton in childhood, is to differentiate subperiosteal hematomata from generalized edema and bruising of soft tissues. A subperichondrial hematoma elevates the perichondrium from the surface of the cartilage and this leads to impaired nutrition and growth. The deformity which results may be due to either atrophy, hypertrophy or fibrous tissue replacement of cartilage. Therefore, all children who have swelling of the nose following an injury should have the interior of the nose inspected and palpated and, if in doubt, an exploratory incision should be made. A
hematoma of the upper lateral cartilages does not usually have the boggy, fluctuant feel of a hematoma of the septum. A useful sign, however, is obliteration of the groove between the upper and lower lateral cartilages and inability to palpate the lower edge of the upper lateral cartilage with a blunt probe. This sign was present in the child shown in Figure 4A. An exploratory incision was made and a hematoma of the upper lateral cartilage was evacuated. The postoperative result can be seen in Figure 4B.

**INJURIES IN ADULTS**

In adults, injuries to the cartilaginous skeleton are more likely to be associated with fractures of the bone. Deformities of the cartilaginous structures are also more pronounced because the injury releases tension that has built up during the growing period. For example, a deviated quadrilateral cartilage becomes more pronounced during adolescence and exerts a greater force on the upper lateral cartilages and skeletal structures. If their attachments are damaged following an injury, the force exerted by the septum will be unopposed and a deformity will develop. When this has taken place, the reduction of the fracture is difficult, and a corrected position cannot be maintained. In these cases, it is often necessary to perform a septoplasty, or even a rhinoplasty, to release or counteract these forces.

Injuries to the nose may also damage the elasticity of supporting cartilage leading to saddling of the nasal dorsum. If saddling of the cartilaginous portion of the nose is associated with nasal fractures and general weakening of nasal support, it can often be elevated and the nose maintained in a corrected position until firm union of the tissues has occurred. This can be done with intranasal packing, some form of suspension apparatus, or an intraseptal splint. An intra-

![Figure 6: An anterior rhinoscopic view of a case of dislocation of the caudal margin of the nasal septum. An arrow indicates the dislocated septum.](image)

septal splint of heterogenous cortical bone (Boplant) has been used to reduce a saddling of the nose which was associated with nasal fractures and general loss of support. At the moment, this is not recommended as treatment of a saddling of the cartilaginous nose where this is the only deformity, for tension will develop when the deformity is corrected. It will continue until the intraseptal transplant is absorbed by pressure. In Figure 5A, the saddle was treated with an autogenous cartilage transplant to the supra-tip region. Septal cartilage was used because there was less absorption and tissue reaction. It was no longer required for support to the supra-tip region for septal support had been lost.

Finally, a view of internal nose (Figure 6) of a patient is shown to illustrate that mechanical factors such as support must always be considered when treating patients who have received trauma to the nose. This patient received a blow from below to the distal part of the nose leading to rupture of the membranous septum and dislocation of the caudal margin of the quadrilateral cartilage. If the free portion of the septum had been excised, it could have led to loss of support and recession of the columella. Instead, a new pocket was fashioned in the tissue above
the medial crura and the cartilage sutured back into place.

SUMMARY
The frequent incidence of injuries to the cartilaginous skeleton of the nose has been emphasized, and the importance of early and adequate treatment to reduce subsequent deformities has been stressed. The presence of tensile forces in the cartilage of the nose has been described, and their application to the management of injuries of the cartilaginous skeleton has been discussed. These principals have also been discussed in relation to an infant with a deviated nose, a child with a subperichondrial hematoma of the upper lateral cartilage, an adult with saddling of the cartilagenous nose, and a patient with a tear of the membranous septum and dislocation of the caudal margin of the quadrilateral cartilage.

REFERENCES

669 Burke Road, East Hawthorn
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Author/s:
Clark, Graeme M.

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