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The behaviour of nasal septal cartilage in response to trauma

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SUMMARY

Hyaline "glassy" cartilage possesses an internal interlocked stress system. This system is designed like a sandwich in which the outer layers hold in the inner layers under a degree of tension. This arrangement gives the cartilage the property of elasticity, allowing the cartilage to revert to its original form following limited deformation. If, however, the outer layer is breached, the system breaks down and the cartilage bends to the opposite side. Fry (1967, 1968, 1974, 1976) demonstrated on human septal and articular cartilage that cartilage does deviate in this manner when scored down one side with a scalpel. He then extrapolates this experimental finding into the clinical sphere to account for the deviated nasal septum. He feels that multiple minor breaches of one side of the outer layer of the septum produce a deviated septum. A challenge of this assumption forms the basis of this paper. Human septal cartilage was traumatised and left to deviate spontaneously in-vitro. If the Fry theory is correct, the cartilaginous septum should deviate. This did not happen and, on the evidence presented in this paper, the Fry theory of the pathogenesis of the deviated nasal septum is refuted.

INTRODUCTION

Human nasal septal cartilage is of the hyaline variety. It has been shown to possess the internal interlocked stress system by Fry (1967). The outer layers of the cartilage derive their tensile strength from protein polysaccharide complexes arranged parallel to the surface and anchored into the collagen network. The septum remains stable because of the internal expansile forces which depend on water retention. The outer mucoperichondrial layer of the septum is chondrogenic. If the chondrocytes are arranged in well defined layers laterally, as would be the case in the growing septum, there is an increased tendency of the cartilage to bend when the outer layers are breached. Fry (1968) demonstrated this latter phenomenon in rabbits. He scored one side of growing rabbits' septum and produced impressive septal deviations as a result in the fully grown animal. He also showed that a breach of the outer layer of one side of human nasal septal cartilage or articular cartilage produces bending in the opposite direction. The corollary to this work, i.e. scoring of the concave side of a deviated septum does not

unfortunately produce a straight septum. This technique which is widely used in the operation of septoplasty has disappointing results. Fry feels this assumption was unwarranted and pointedly disowned this claim which has been widely ascribed to him (1976). This experiment was designed to show the behaviour of the septum after nasal trauma sustained by a blow on the nose rather than the articial method of scoring one side of the septum.

METHODS AND MATERIALS

Ten cadaver bodies were used. They had been kept refrigerated and experiments were performed within 24 hours of death. Each of the bodies had been hit with a force to create a fracture of the nasal bones. The septum was then removed. Gross septal damage was restricted to the upper most part of the septum and this area was avoided. No obvious fracture was found in the areas of the septum tested. Five septums were also taken from control bodies which had not been traumatised. Great care was taken to remove the septums as atraumatically as possible. This included the mobilisation of the posterior end of the septum after part of the sphenoid had been removed. Each septum was then measured lengthwise from the bony end. Any excess over 5 cm was trimmed off. The mucoperichondrium was completely removed, otherwise the specimens became quickly foul. The septum was then divided into four horizontal strips of 1 cm height, nominated A, B, C and D. These strips included the cartilaginous septum and bony septum to a variable extent. Those strips higher up the septum contained relatively less bone compared with the lower strips which comprised about 50% bone owing to the curved shape of the bony cartilaginous interface. Each strip was then placed vertically on end on a perfectly straight line and allowed to adopt its natural position, i.e. the same plane as the septum in the human. The ends of the strip were aligned with this line. The point of maximum deflection was noted using a pin to record on the paper. The distance of these pin points from the straight line were subsequently measured using inside measuring Vernier calipers accurate to 0.1 mm (Figure 1). Each strip was then placed in a bath of oxygenated ringer-lactate solution and incubated at 37 °C for 72 hours. The temperature of the bath was constant and no preservative was placed in the solution to avoid undue influence in cartilage behaviour. If the cartilage was incubated for more than 80 hours it be-

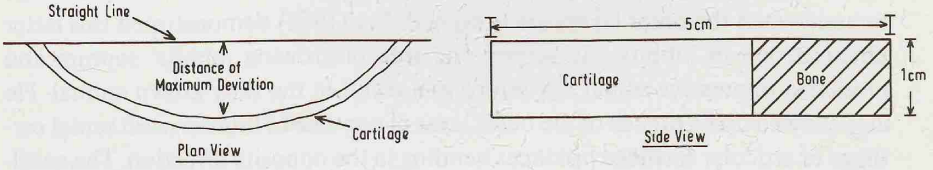

Fig. 1. Plan view and lateral view of the specimens.

came foul and by that time the chondrocytes have died. After 72 hours of incubation, the cartilage was removed from the bath, dried and the point of maximum deflection remeasured.

RESULTS

From Table 1, it is obvious there has been little change in the septal deviation with incubation. The total deflection, i.e. from A, B, C and D was summed and the Wilcoxon Rank Sum test found the change non-significant. The difference between the experimental and control septums was not significant.

Table 1. Sum of measurements (centimetres). Maximum deviation for A+B+C+D.

before incubation		after incubation	difference
Septum			
1	1.33	1.22	0.11
2	1.46	1.57	−0.11
3	2.27	2.20	0.07
4	1.65	1.73	−0.08
5	1.53	1.52	0.01
6	1.93	1.88	0.05
7	2.19	2.18	0.01
8	1.45	1.47	−0.02
9	2.57	2.59	−0.02
10	2.50	2.54	−0.04
Controls			
11	1.38	1.45	−0.07
12	2.35	2.45	−0.10
13	1.92	1.82	−0.10
14	1.25	1.23	0.02
15	1.68	1.62	0.06

DISCUSSION

The deviated nasal septum has held rhinologists' interest for centuries. Quelmalz (1757) is credited with one of the first decriptions of an operation to remove cartilaginous spurs with a chisel in the mid eighteenth century. The formation of the septum is as yet poorly understood. Increasing evidence suggests that parturition may produce a number of so-called congenitally deviated septums (Gray, 1974). Other poorly supported theories include thumb sucking (Hein, 1972), genetic (Post, 1969) and evolution (Takahashi, 1977). Ali (1965) described an increasing incidence of deviations with age and, although the paper was not statistically or scientifically valid, produced the same conclusions as many rhinologists would testify to. The most likely theory to "fit the facts" is, therefore, trauma although there are many instances of patients with a deviated septum who catagorically deny trauma.

Trauma may deviate the septum by fracturing it in the various ways described by Aubry et al. (1966), including the eponymous fractures of the Chevallet and Jarjavay. An incomplete fracture does not produce the sharp angulation typical of the complete fracture. The maxillary crest may be congenitally absent permitting the septum to truly dislocate off as compared with the fracture of Jarjavay which is a fracture dislocation. Woakes (1890) ascribed the commonly placed spur at the vomerine angle to trauma and this has been confirmed experimentally more recently (Murray, 1982). Fry (1976) believes the traumatically deviated septums not induced above, occur as a result of a unilateral breach of the interlocked stress system. Our experiment does not support this. A similar experiment to this was conducted by Harrison (1979). He traumatised noses and stored bony cartilaginous septums in normal saline at room temperature for three months. Photographic comparison before and after storage showed no change in the deviation. Attempts by this author to reproduce Harrison's experiment were unsuccessful. The specimens became foul. In the absence of a preservative in the normal saline, the reasons for the non-reproducability of this experiment are obscure.
Other experiments have confirmed that the influence of trauma on the septum is linked more to its shape than the behaviour of the materials.

CONCLUSIONS

The presence of an interlocked stress system in nasal septal cartilage is neither confirmed or refuted in this paper but its influence on the septum in trauma in this in-vivo experiment is negligible.

RÉSUMÉ

Le cartilage hyalin a un système de tension interne et relie. Ce système est construit comme un sandwich où les couches extérieures gardent les couches intérieures sous un certain degré de tension. Le cartilage est donc élastique ce qui permet au cartilage de retourner à sa forme originale après une déformation limitée. Si la couche extérieure est voilée le système cess cependant de fonctionner et le cartilage se courbe vers l'autre côté. Fry (1967, 1968, 1974, 1976) a démontré que le cartilage dévie de cette façon quand l'on en égratigne l'un des côtés. Notre thèse dans lette étude est l'exposition du contraire. Le cartilage de la cloison nasale humaine était traumatisé et laissé à dévier spontanément in vitro. Cette déviation n'a pas eu lieu. L'auteur conclue donc que la théorie de Fry de la pathogenese de la cloison nasale déviée est refutée.

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