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Effect of packing on nasal mucosa of sheep

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Abstract

The effects of packing with ribbon gauze and neuropatties on the nasal mucosa was assessed using sheep as an animal model. Fourteen sheep either underwent ribbon gauze or neuropattie nasal packing. Trauma to nasal mucosa caused by ribbon gauze and neuropatties was compared to mucosa on the lateral aspect of the middle turbinate which was not in contact with any packing. This tissue was used as a control. Ribbon gauze packing resulted in significant loss of 68 per cent of the ciliated surface of the mucosa when compared with the control group with a 15 per cent loss of ciliated surface ($p<0.005$). Neuropattie packing also resulted in significant loss of 50 per cent of the ciliated surface of the mucosa when compared with the control group ($p<0.005$). There was no significant difference in loss of ciliated mucosa in the specimens packed with ribbon gauze or neuropatties ($p = 0.25$).

Nasal packing results in a significant mucosal injury with loss of cilia. This may influence the mucociliary clearance of the nose in the post-operative healing phase. Pre-operative nasal packing should be used circumspectly and if possible avoided.

Key words: Nose; Nasal mucosa; Occlusive dressings; Sheep

Introduction

Nasal packing is used as part of the pre-operative preparation for sinus surgery by many rhinologists.[1] Ribbon gauze has been used to pack the nose for many years[2,3] and more recently neuropatties have been used because they have been thought to cause less mucosal trauma. Packs are soaked with various types of local anaesthetics and vasoconstrictor agents in order to facilitate vasoconstriction and analgesia. This is thought to improve the operative field by improving both visualization and decreasing bleeding during surgery.[4,5] Much has been written on the use of different materials for post-operative packing for both stenting and haemostasis[2,3,6] but little on the effects of pre-operative packing.

In order to study the effects of nasal packing, a suitable animal model was identified. Gardiner *et al.*[7] showed that the sinus anatomy (including the placement of nasal cavity, turbinates, frontal and maxillary sinuses) in sheep is analogous to humans. The middle turbinate of the sheep is extensive and almost fills the nasal cavity. Histological study of the sheep's nasal mucosa showed it to be identical to that of humans.[8] The other advantage of the sheep model is that it allows endoscopes and instruments used in adult sinus surgery to be used in the animal model and therefore duplicates the conditions found in human sinus surgery.

The aim of this study was to investigate the effects of two of the more commonly used nasal packing materials, ribbon gauze and neuropatties, on the nasal mucosa.

Materials and methods

This study was approved by the animal ethics committees of the Queen Elizabeth Hospital and the University of Adelaide. The sheep were given a general anaesthetic (GA) by intra-venous pentobarbitone, intubation and ventilation. A statistical analysis showed that for a power of 80 per cent and an effect size of 25 per cent (loss of ciliated mucosa between packed and unpacked mucosa greater than 25 per cent), 14 sheep were required. Both nasal cavities were used. In each nasal cavity, packing was placed between the middle turbinate and septum under endoscopic control using a Weil's Blakesley forceps. The pack was soaked in two mls of 10 per cent cocaine solution. The lateral side of the middle turbinate was not in contact with any packing. The pack was left in place for 10 minutes before removal. Initially the sheep were packed with ribbon gauze

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TABLE I
PERCENTAGE OF INTACT CILIATED NASAL MUCOSA FOLLOWING RIBBON GAUZE PACKING

Sheep no.	Percentage intact ciliated mucosa
1 Right	10
2 Left	65
3 Right	0
Left	90
4 Right	0
5 Right	0
Left	60
6 Right	33
Mean	32.3
SD	35.4
S.E.M.	12.5
95% CI	± 29.6

(six sheep with eight specimens). However, once the histology was reviewed it was decided to try a less traumatic packing material (neuropatties). Neuropatties were chosen as they are the current material used in our department in the pre-operative preparation of the nose before endoscopic sinus surgery (ESS). Eight sheep with 16 specimens formed this group. A total of two mls of two per cent lignocaine with 1:80 000 adrenaline was injected into the anterior end of the middle turbinate prior to the insertion of packing. The middle turbinate was removed under endoscopic control with an ESS scissors. The turbinate was removed by cutting the insertion of the turbinate without damage to the lateral or medial surfaces of the turbinate. Once the middle turbinate had been removed, a 1 × 1 cm full thickness strip of mucosa was taken from the middle turbinate from an area that had been visually confirmed to have been in contact with the nasal packs. A 1 × 1 cm full thickness strip of mucosa was also taken from the lateral aspect of the middle turbinate which was not in contact with any packing. This tissue was used as a control. These specimens were held by fine forceps during separation from the underlying bone. The specimens were fixed in formalin for histological analysis. Two observers assessed the percentage of intact ciliated nasal mucosa in all specimens (packed and control). The entire specimen was assessed and the percentage of intact ciliated nasal mucosa determined.

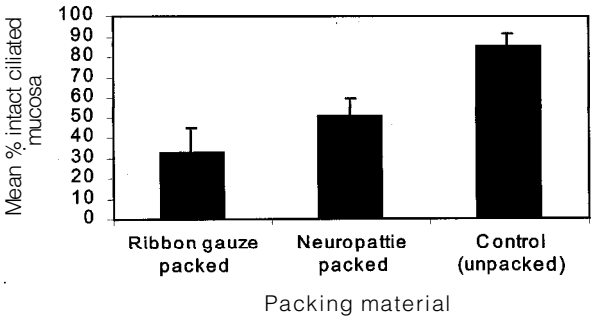

FIG. 1
Effect of nasal packing with ribbon gauze, neuropatties *vs* control (unpacked), on the percentage of intact ciliated nasal mucosa. Both ribbon gauze packing and neuropattie packing resulted in significant loss of the ciliated nasal mucosa when compared with the control group (unpacked) ($p<0.005$). Values are presented as mean ± S.E.M.

Results

The two blinded observers histological analysis were found to have a high degree of correlation (correlation coefficient $r = 0.93$). In group 1, there were eight specimens from nasal cavities packed with ribbon gauze. The percentage of intact ciliated nasal mucosa varied widely from complete absence of ciliated mucosa (cuboidal lining layer and the basement membrane only) in three to minimal epithelium loss (10 per cent loss of ciliated epithelium). The mean loss of ciliated nasal mucosa after ribbon gauze nasal packing was 32.3 per cent (standard deviation (SD) = 35.4; standard error of mean (SEM) = 12.5; 95 per cent confidence interval (CI) = ± 29.6). The results of this group are shown in Table I and Figure 1. A typical loss of respiratory epithelium after ribbon gauze packing is illustrated in Figure 2.

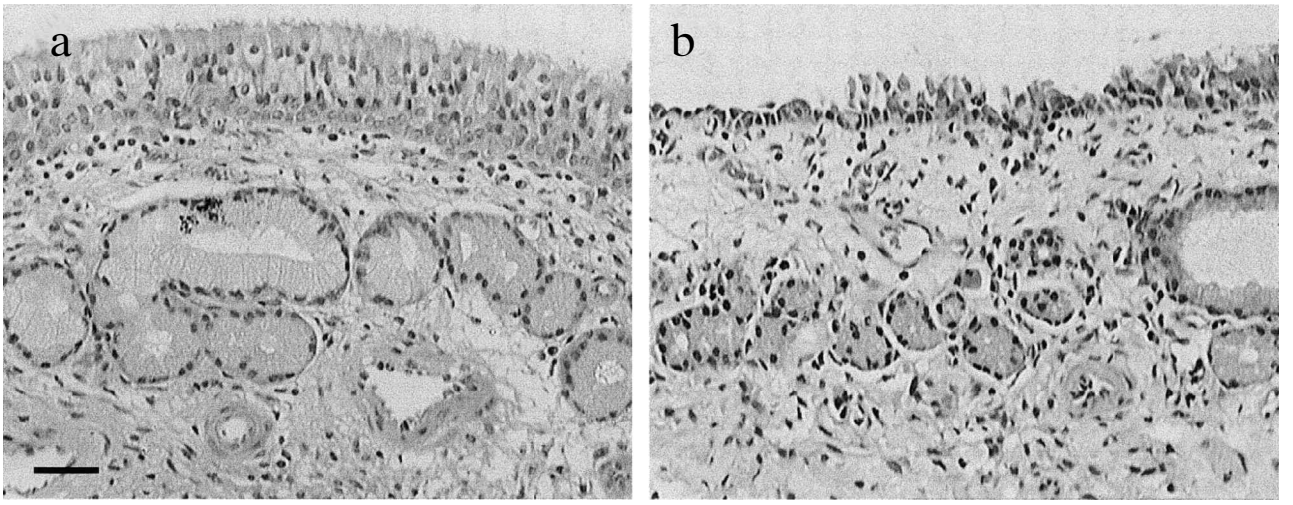

FIG. 2
(a) Haematoxylin & Eosin (H&E) stained specimen from control (unpacked) mucosa showing 100 per cent intact ciliated nasal mucosa. (b) H & E stained specimen from ribbon gauze packed mucosa showing approximately 15 per cent intact ciliated mucosa. Magnification bar = 80 μm.

TABLE II
PERCENTAGE OF INTACT CILIATED NASAL MUCOSA FOLLOWING NEUROPATTIE PACKING VS CONTROL

Sheep no.	Mucosa packed with neuropatties: percentage intact ciliated mucosa	Control (unpacked mucosa): percentage intact ciliated mucosa
7 right	0	100
left	0	
8 right	95	100
left	67	
9 right	30	71.7
left	100	
10 right	0	75.7
left	70	
11 right	10	78.3
left	100	
12 right	75	100
left	50	
13 right	60	54.1
left	70	
14 right	20	100
left	60	
Mean	50.4	85
SD	35.9	17.6
S.E.M	8.9	6.2
95% CI	±19.1	±14.7

In group 2, there were 16 specimens from sheep that had neuropatties inserted as packing. The percentage of intact ciliated mucosa varied from complete absence of ciliated respiratory epithelium (only cuboidal lining layer and the basement membrane visible) in three specimens to complete preservation (100 per cent) of the ciliated mucosa. The mean of the percentage of intact ciliated mucosa after neuropattie nasal packing was 50.4 per cent (SD = 35.9; SEM = 8.9; 95 per cent CI = ±19.1). The results of this group are shown in Table II and Figure 1. There was no statistically significant difference between the means of the ribbon gauze-packing group and the neuropatties-packing group ($p = 0.25$). A typical loss of respiratory epithelium after neuropattie packing is illustrated in Figure 3.

Specimens ($n = 8$) from the lateral sides of the middle turbinate mucosa (unpacked surface) were examined as a control. The percentage of intact ciliated mucosa of the specimen varied from 54.1 to 100 per cent with a mean of 85 per cent (SD = 17.6; SEM = 6.2 95 per cent CI = ±14.7). The results of this control group are shown in Table II and Figure 1. When analysed by the unpaired students *t*-test the control group had a significantly higher percentage of intact ciliated respiratory epithelium than the ribbon gauze-packed group ($p<0.005$) or the neuropatties-packed group ($p<0.005$).

Discussion

Both ribbon gauze and the neuropatties are very common nasal packing materials for a wide variety of nasal surgery and ESS. The results from this study showed that both types of packing material resulted in significant loss of nasal mucosa with a mean percentage loss of more than 50 per cent of mucosa. The control (unpacked) group had significantly less

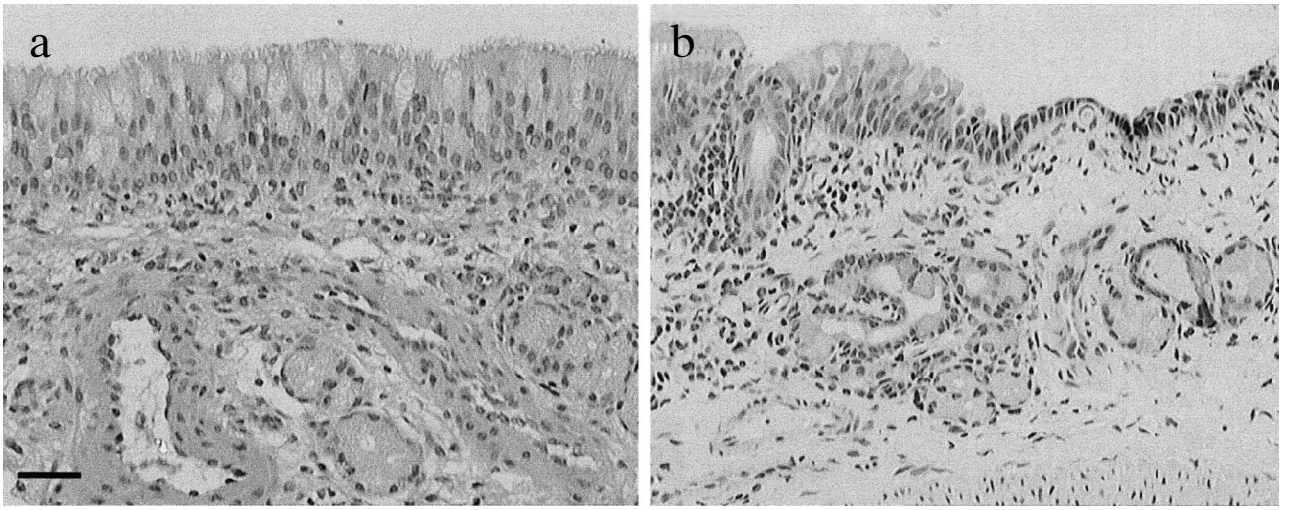

FIG. 3

(a) H & E stained specimen from control (unpacked) mucosa showing 100 per cent intact ciliated nasal mucosa. (b) H & E stained specimen from neuropattie packed mucosa showing approximately 57 per cent intact ciliated mucosa. Magnification bar = 80 μm.

loss (15 per cent) of ciliated mucosa. There was no statistically significant difference between the nasal packing materials in the amount of nasal mucosa lost on histology. The study was performed by investigators who are experienced with nasal packing techniques and every attempt was made to place the packing material in the nose without damaging the mucosa. It was thought that there might well have been a difference between the packing materials as the ribbon gauze has a much more abrasive feel than the neuropatties. However, while blinded pathology assessments failed to confirm this, there was a trend showing less mucosal loss with the neuropatties than with the ribbon gauze (Figure 1). It remains to be seen if other packing materials such as cotton wool would cause a similar traumatic mucosal injury. Considering the care with which the neuropatties were placed in this study, it would be surprising if there was no mucosal damage. It would also be of interest to evaluate the effect of cocaine placed with a cotton-tipped probe on the nasal mucosa. It was interesting to note that the control group also had a 15 per cent mucosal loss. This can probably be explained in part due to the need to very gently hold the specimen with a very fine pair of forceps during removal. In addition there may have been small areas of unintentional injury during the removal of the middle turbinate as the lateral surface (unpacked surface) was adjacent to where the turbinate was cut at its attachment.

During the placement of the nasal packing the surgeons (C-KLS, PJW) used ESS instruments under endoscopic control. Care was taken to avoid unnecessary mucosal contact between the packing and the mucosa as the packing was placed. However, there seems to be an unavoidable trauma (with these packs) that results in a varying degree of mucosal injury. This loss of cilia may result in impaired mucociliary clearance and subsequent crusting which may increase the overall mucosal injury sustained during the nasal surgery and prolong the healing period.

Surgeons who wish to continue to pack the nose should do so with gentleness in an attempt to limit the nasal mucosal injury as much as possible. This should preferably be done under endoscopic control with the minimum of force. An alternative to packing is to decongest the nose with oxymetazoline or xylometazoline nasal spray in the anaesthetic holding area.[9,10] This should shrink the nasal mucosa and allow an improved endoscopic view. Once the patient is under general anaesthetic, local anaesthetic with adrenaline can be used to infiltrate the operative areas and in so doing minimize the possibility of bleeding intra-operatively.[5] This would also allow the use of topically applied cocaine to be minimized and decrease the potential for toxicity.[5,11] If bleeding becomes problematic during ESS, patties soaked in cocaine could be placed in the operative field for haemorrhage control.[5] By using packing only in the surgical area, the trauma to the non-operated areas would be minimized.

In conclusion, ribbon gauze and neuropatties cause a significant mucosal injury in sheep when these packs are placed under endoscopic control with endoscopic instruments. Alternatives to packing the nose pre-operatively should be considered.

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