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An animal model for training in endoscopic nasal and sinus surgery

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Abstract
An animal model has been devised to allow trainees in nasal and sinus endoscopy to develop basic instrument handling and psychomotor skills, without risk to patients.The sheep's head obtained from the abattoir was modified slightly to simulate more closely the human situation. The model permits nasendoscopy, foreign body removal, septoplasty, turbinate reduction, frontal and maxillary sinoscopy, antrostomy and an epistaxis exercise. To date the tissues have been used freshly thawed, and must be used on the day of preparation.

Key words: Paranasal sinuses; Endoscopy; Surgery; Sheep; Education

Introduction

Training in functional endoscopic sinus surgery and in the use and handling of endoscopes poses a number of problems. Supervised operating is invaluable, but presupposes both a basic competence in instrument handling by the trainee, and a trainer with sufficient expertise to monitor and teach.

While dissection of cadaveric human heads is essential in learning nasal and sinus anatomy, and in practising techniques, it is often difficult to obtain a supply of human heads that are accessible to trainees. Stammberger advises that trainees should have experience of thirty cadaver head dissections, before attempting any live operating (Stammberger, 1991). Other trainers consider that an initial ten cadaver head dissections are an adequate prerequisite for live operating (Bingham *et al.*, 1994). The Anatomy Act (HMSO, 1984) in the United Kingdom restricts where these tissues may be stored and used, and this may not always correspond with the ideal location for the trainee or their trainer. Furthermore, the Act states that such dissection should be for the purpose of gaining anatomical knowledge, rather than for gaining surgical skills.

We wished to develop a model that could be used for training in endoscopic nasal and sinus surgery which would allow development of the basic techniques of instrument handling, and the rudiments of sinus surgery. It was not our intention to use this to replace cadaver head dissection, but to complement the anatomical knowledge gained by cadaver head dissection with surgical skills attained using the model. This would enable trainees to move on with confidence to the use of rigid endoscopic equipment in out-patients and the operating theatre.

The Surgical Skills Unit at Ninewells Hospital and Medical School, Dundee, UK, has already developed a number of animal models for other endoscopic procedures (Carter *et al.*, 1994), and with their advice we looked at the heads of several animals that are commonly slaughtered and easily obtained.

Materials and methods

The sheep proved to be the most useful animal, both in terms of general nasal anatomy and in the depth of the nose being accessible to the endoscope used in humans.

Although the anatomy of the head of the sheep is evidently different from that of the human, the nasal cavity itself is very similar in appearance, though somewhat wider, and the main sinuses lie in approximately the same orientation as they do in man (Figure 1). It must be stressed, however, that the purpose of this animal model is to learn handling skills and basic endoscopic techniques, not to learn detailed anatomy.

The sheep heads are purchased fresh from an abattoir at a cost of £5 each. The anterior 10 cm of the muzzle are removed with a saw to shorten the nasal cavity and make it represent more approximately that of the human. The heads can then be frozen to await future dissection. When required, the heads are unfrozen, mounted using sandbags in a

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FIG. 1
A coronal CT section of the sheep head model, at the level of the posterior orbit.

sink (to allow drainage),and positioned facing the operator (Figure 2). The rigid endoscopes may then be used with a beam splitter attached to a television camera, allowing continuous observation by the trainer.

Use of the model

We have found a sequence of techniques useful in using the model, progressing from simple handling of the endoscope when examining the nose to more complex bimanual instrumentation. The slightly larger volume of the nasal cavity in the sheep, compared to that of the human, facilitates manipulation and, although the bone of the ethmoturbinal in the sheep is slightly thicker and more convoluted than the homologous structure in the human (Negus, 1958), this presents no problem in dissection.

Nasal endoscopy and foreign body removal

Firstly, we teach the correct method of holding the endoscope and stabilizing the arm so that a good view of the nasal cavity is obtained. Then, a bead or similar object is placed within the nostril and the trainee attempts to remove it. This starts to familiarize the junior endoscopist with the view seen through the endoscope and its relationship both to objects within the nose (such as the bead) and to the instrument they are using in their other hand to remove it (such as a hook). It is not easy at first to gain a perception of depth with the two dimensional view seen through an endoscope, and this exercise provides a start for the practise required to become proficient.

Endoscopic turbinate reduction.

The anatomy of the sheep inferior turbinate is noted from the CT scan. One inferior turbinate is

FIG. 2
The model mounted for dissection with the television monitor in use.

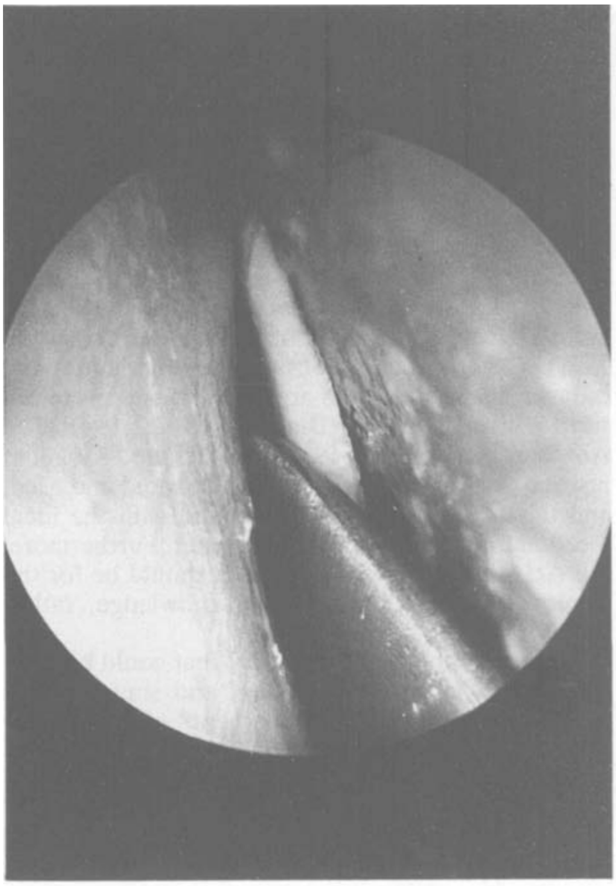

FIG. 3
An endoscopic view of a septoplasty being performed on the model.

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then reduced using curved and straight nasal scissors, under endoscopic control.

Endoscopic SMR/septoplasty.

The modification of the specimen that has already taken place gives immediate access to both sides of the anterior nasal septum. It is not advocated that septoplasty should be performed endoscopically, rather that this exercise allows development of endoscope instrumentation skills and depth perception.

The mucoperichondrium may be elevated and a standard septoplasty performed (Figure 3). A septal fracture can then be created, allowing the student practise in excising the fracture and attempting stabilization with sutures.

Simulated epistaxis.

A cannula is placed by the tutor through the 'canine' fossa into the maxillary sinus. Water with red dye is then run into the sinus which subsequently pours out through the maxillary sinus ostium. This allows the trainee to identify the ostium and to attempt to arrest the flow with a sinus tampon, inserted endoscopically.

Middle meatal antrostomy.

Having performed the previous exercise, the student now has an idea of the location of the maxillary sinus ostium. This area is now examined with a 30° endoscope to visualize the ostium or, if this is difficult to see, probed with a curette.The curette is used to enlarge the ostium slightly, and correct positioning checked by passing through an angled sinus suction tube. A Stammberger Ostrum punch forceps is then used to create the antrostomy.

Middle turbinate reduction.

In the sheep, the middle turbinate is invariably cystic. The cystic middle turbinate (concha bullosa) is theoretically a cause of ostio-meatal complex obstruction in humans, and this 'anomaly' may occasionally need to be reduced. A sagittal split is made in the anterior end of the middle turbinate, and the inferior free edge is divided until the medial and lateral laminae of the concha are separated. The air cell is then marsupialized by removing the lateral lamina completely.

An anterior segmental middle turbinate reduction may be performed on the opposite side to form a middle meatal 'meatoplasty', allowing easy post-operative inspection of sphenoethmoidal cavities and reducing the risk of adhesions in the real post-operative situation.

Frontal sinus endoscopy/CSF leak repair.

An opening is created in the superomedial orbital rim with a Stammberger drill as would be performed for a frontal sinus trephine. A trochar and cannula are then inserted. Once the cannula is correctly placed, the frontal sinus is endoscoped. Visualization of the frontal sinus ostium requires a 70° endoscope and permits the light emitted to be used as a guide for endonasal frontal recess dissection from below.

Repair of a CSF leak may also be attempted; a small iatrogenic perforation is created endonasally through into the anterior cranial fossa using the nasal drill. Another small hole is made externally into the vertex of the skull, a cannula inserted, and the red-coloured water supply previously used for the epistaxis exercise is connected to run intracranially. Soon, a red-coloured 'CSF' leak appears through the defect, and repair can be attempted using a fascial plug.

Endoscopic dacrocystorhinostomy.

A lacrimal light pipe is introduced through the sheep's lacrimal canaliculus into the lacrimal sac. The area of the agger is then viewed through the zero degree endoscope and the bone overlying the lacrimal sac is seen clearly illuminated by the light pipe. The mucoperiosteum is elevated and the area of bone illuminated is removed using a Stammberger drill. A sickle knife is then used to cut down onto the light pipe thus opening the lacrimal sac into the nose.

Endoscopic ligation of the internal maxillary artery.

The middle meatal antrostomy previously fashioned is enlarged posteriorly and inferiorly to allow endoscopic instruments to pass through and allow access to the posterior wall of the maxillary sinus. Visualization of the posterior wall of the sinus is achieved through a 'canine' fossa approach using a zero degree endoscope. An inferiorly based flap of posterior wall mucosa is then elevated with a sickle knife passed through the wide middle meatal antrostomy. The bone of the posterior wall is infractured and partially removed with Hajek's forceps. A cruciate incision is made in the periosteum of the fossa behind, and the artery and its branches identified. The artery may then be clipped with a liga clip applicator.

Discussion

Endoscopic sinus surgery is a relatively new development in ENT practice and requires a different approach to, and range of skills from, other areas of the speciality. Endoscopes are also being used more and more frequently as diagnostic tools in out-patients, so it is important that surgeons wishing to use them have a firm understanding of the basic techniques involved. It is essential that patients are not placed at risk by surgeons taking their first steps in acquiring these new skills. From an ethical point of view, it is unacceptable for surgical skills training, or the lack of it, to become a significant risk factor in the patients outcome (Carter *et al.*, 1994). There is no substitute for learning the complexities of human anatomy by operating on the human, either in the operating theatre or on the dissection table, but the model described allows basic skills to be acquired and developed under controlled conditions and without risk to patients.

There has been much debate and publicity over the last few years about minimal access/endoscopic surgery being performed by surgeons who are not experienced or properly trained in the techniques (Cuschieri, 1992). Many institutions now insist that surgeons who wish to undertake minimal access surgery must attend a recognized training course or workshop before they are allowed to perform the procedures themselves (Dent, 1991). Such courses provide a more structured approach to technical training in surgery. The use of simulated models or cadavers with an emphasis on 'hands on' experience is also rated highly by trainees (Steele *et al.*, 1989).

Endoscopic nasal and sinus surgery requires a detailed working knowledge of both sinonasal anatomy and the safe deployment of instrumentation. The former may be gained by cadaver dissection and the latter may be assisted by the use of models. Models for training in endoscopic sinus surgery must possess certain attributes. There must be a realistic representation of the anatomy and tissue quality. It must also be possible to reproduce the restricted endonasal access and the component steps of an operation giving an overall similar level of technical difficulty to the live situation. We believe that the model described fulfils these criteria, and is an effective medium for training in basic endoscopic nasal and sinus surgery.

Conclusion

Using the sheep head model we have developed a cheap, practical and safe method for teaching basic nasal and sinus endoscopy techniques. The procedures can be constantly monitored by the trainer, and it allows the trainee rapidly to gain the necessary psychomotor skills involved in endoscopic surgery.

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