Egyptian Journal of Anatomy, Jul. 2017; 40(2):381-390

Original Article

Endoscopic Sinus and Nasal Surgery Training Using Sheep as Animal Model

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ABSTRACT

Background: Endoscopic sinus surgery (ESS) is a technique which carries great potential benefits for the treatment of many nasal conditions. However, it also carries substantial risks. The key to safe surgery lies with adequate training .While dissection of cadaveric human heads is essential in learning nasal and sinus anatomy, and in practicing techniques, it is often difficult to obtain a supply of human heads that are accessible to trainees.

Aim of work: Was comparing CT scan of sheep nose and paranasal sinuses
with that of human and studying the anatomy of the lateral wall of the nose of the sheep and comparing with that of human.

Material and Methods: It was be performed on 14 heads of sheep (rahmani) purchased fresh from an abattoir. The 14 heads were classified into: Group (1) 4 heads were subjected to CT scan. Group (2) 6 heads were subjected to anatomical dissection. Group (3) 4 heads were subjected to Endoscopic examination. The following was performed: Coronal CT scan was done to 4 heads with cuts at 5 mm spacing 2 mm slice thickness . Scan was started just after the nares, 30 slices were acquired. Anatomical dissection of the head by :Heads were divided two subgroups: Subgroup A Included 3 heads and were dissected sagittally. subgroup B Included 3 heads and were dissected coronally. The endoscopic examination was carried out on group(3) using a rigid endoscope with a diameter of 4 mm. The endoscope was inserted into the ventral nasal passage of the left side and moved forward along the nasal septum up to the region of the pharynx.

Results: The CT scans and anatomical dissection showed that, the shape of sheep nose is conical, it is narrow anteriorly and wide posteriorly with a length ranging from (16-20) cm, a height was measuring 6-10cm and a width of 7.5-9cm at widest points. The opening of Para nasal sinuses lies in the middle meatus like that of the human. CT scan and anatomical dissection showed that the nasal cavity of the sheep was narrowed by the bullous nature of the inferior concha.

Conclusion: Using the sheep head model provides a cheap, practical and safe method for teaching basic nasal and sinus endoscopy techniques. 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.

Key Words: CT scan, endoscope of nasal cavity, nasal cavity of sheep

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INTRODUCTION

The Endoscopic sinus surgery (ESS) is a technique which carries great potential benefits for the treatment of many nasal conditions. However, it also carries substantial risks. The key to safe surgery lies on adequate training McFerran *et al*., (1998) .Training in functional endoscopic sinus surgery and in the use and handling of endoscopes posess a number of problems Gardiner *et al*., (1996). While dissection of cadaveric human heads is essential in learning nasal and sinus anatomy, and in practicing techniques, it is often difficult to obtain a supply of human heads that are accessible to trainees, Stamberger and Posawetz, (1990) adviced that trainees should have experience of thirty cadever head dissections before attempting any live operating. Other trainers consider that an initial ten cadaver head dissections are an adequate prerequisite for live operating Bingham *et al*., (1994).

Cowin *et al*., (2002) have shown that standard endoscopic sinus surgery techniques and instruments can be used in sheep. Gardiner

 DOI: 10.21608/EJANA.2018.16913

et al. (1996) developed a model that could be used for training endoscopic nasal and sinus surgery which would allow development of the basic techniques of instrument handling and the rudiments of sinus surgery. With the advice of the surgical skills unit in the United Kingdom, they looked at the heads of several animals that are commonly slaughtered and easily obtained.

MATERIAL AND METHODS

This study was carried out on 14 sheep heads Elrahmani (old Nerwigean type) with age above 6 months in the period from June to November 2010. The sheep heads were purchased fresh from an abattoir.

The 14 heads were classified into: Group (1) four heads were subjected to CT scan. Group (2) six heads were subjected to anatomical dissection. Group (3) four heads were subjected to Endoscopic examination.

Group (1):-

Technique of CT scan:-

CT scan was done by radiologist in private radiology center by Phillip. Coronal cuts at 5 mm spacing 2 mm slice thickness. Sheep heads were placed to simulate the position used in routine coronal scanning of the human heads. Scan view was done in the lateral position. Scan was started just after the nares, 30 slices were acquired.The coronal sections were obtained parallel to the oblique axis of the middle turbinate with the gantry tilted to 15 degrees to the canthomeatal line.

Group (2):-

- The heads were dissected in the dissecting room of the anatomy Department, Faculty of Medicine, Benha University by the Anatomist contributing in the study:

- The heads were washed by tape water and the nasal cavity is irrigated by saline using 10cm syringe. Heads were divided into two subgroups subgroup A Included 3 heads and were dissected sagittally and subgroup B Included 3 heads and were dissected coronally. Technique of anatomical dissection:- (A) sagittal dissection Removal of the skin using a blade and dissector was done. Cutting the head in the midline was also done extending from the nares to the orbit. Dividing the two parts were done so as the septum would be included in one half. Measuring all dimensions of the nasal cavity from the nares to the nasopharynx (length) from the roof to the palate (height) and the length of each concha. was then done with removal of the middle concha to view the opening of Sinuses. Photo images were using then taken a digital camera for Gross anatomy after each step. (B) Coronal dissection, The following was done; Removal of the covering skin using blade and dissector, Cutting of the head coronally into slides 2cm thick using a saw starting from just behind the nares anteriorly till the orbit posteriorly (figure 1) and Obtaining pictures to each cut with a digital camera.

Fig. 1: Sheep head fixed on the metal fixator showing the coronal section of the nasal cavity.

Group (3):-

Endoscopic equipment:- The endoscopic examination was carried out using a rigid endoscope with a diameter of 4 mm and angle 0. The instrument was equipped with a xenon light source, as well as recording devices, i.e., monitor and a video recorder Panasonic. An Endovision Video Camera transmitted the endoscopic picture to the color screen. Some endoscopic surgical instruments; septal elevator, forceps, scissor, Stumberger bunch. Metal fixator to fix the head on it during endoscopic maneuver, Technique of Endoscopic examination:- The anterior 10 cm of the muzzle of the head are removed with a saw to shorten the nasal cavity and make it resembling that of the human. The heads were fixed using a metal fixator, and positioned facing the operator. The rigid endoscopes may then be used with a beam splitter attached to a television camera, allowing continuous observation by the trainee. The endoscope was inserted into the ventral nasal

passage of the left side and moved forward along the nasal septum up to the region of the pharynx Stierschneider *et al*., (2007)

- **Endoscopic turbinate reduction**:- The anatomy of the sheep inferior turbinate is noted from the anatomical dissection and CT scan. One inferior turbinate is then reduced by removal of its ventral spiral lamella from anterior to its posterior end using curved and straight nasal scissors, under endoscopic control.

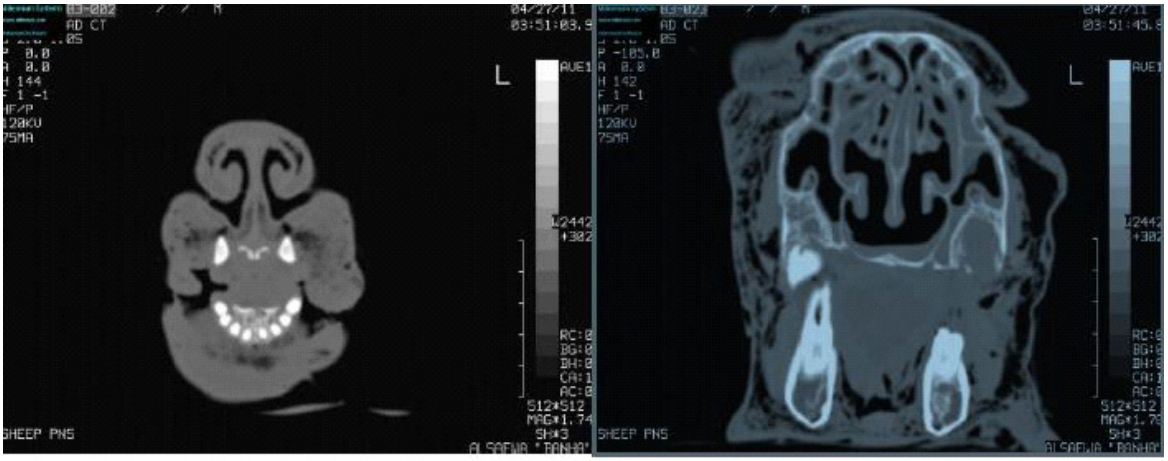
- **Endoscopic SMR**:- After removal of the anterior 10cm it was easy to perform submucous resection by elevation of mucoperichondrial flap from the both sides using septal elevator and then removal of the septal cartilage.

- **Middle meatal antrostomy**:- The position and shape of maxillary ostium was noted from the anatomical dissection. A Stammberger punch forceps was then used to make an uncinectomy and a middle meatal antrostomy.

- **Foreign body removal**:- A piece of metal is placed within the floor of the nasal cavity under the posterior end of ventral concha and the attempts to remove it using forceps under endoscopic guidance.

RESULTS

- Coronal CT scan was done for 4 sheep heads and was showing , the nasal cavity to be triangular in shape with its base directed inferiorly and formed of the hard palate, the cavity was narrow anteriorly and became wider posteriorly, and this was shown in figure (2).



A B

Fig. 2: CT scan of sheep nose coronal sections: A; anterior section; B posterior section.

The nasal cavity was found to contain a nasal septum in the centre which is extending from the hard palate inferiorly to the nasal bone superiorly. The septum appeared to have a bony part toward the hard palate and the rest was cartilaginous (Figure 3). The septum was found to lose its contact with the hard palate posteriorly, it divided the cavity into two symmetrical halves, and this is shown in Figure (4). Each half contained three projections (conchae) from the lateral wall; the dorsal nasal concha appeared in more anterior level than the other and was located under the floor and started as simple projection and it became progressively larger and bullous as we go posteriorly, this is shown in figure (4). The ventral nasal concha appeared after the dorsal one, it appeared as one basal lamella. It run medially and then was divided into two lamellae (ventral, dorsal). Each one turned upon it to enclose a sinus. The middle nasal concha appeared at more posterior level between ventral and dorsal concha and appeared to be formed by basal lamella and its origin appeared at the most posterior part of the cavity and contained two sinuses one dorsal and one ventral. This is shown in figure (3). There were four nasal meati, the dorsal nasal meatus above dorsal nasal concha between it and roof of the nose, ventral nasal meatus below ventral concha between it and the floor of the nose, middle nasal meatus lied between dorsal and

ventral nasal conchae anteriorly; and posteriorly, it was divided into two passages ventral and dorsal by the appearance of the middle concha. A common nasal meatus lied between nasal septum and the turbinate and communicate with ventral nasal meatus. (Figure 3). CT scan also showed maxillary, frontal, palatine and lacrimal sinuses; the maxillary sinus was lateral to the cavity excavating maxilla and become larger as we go posteriorly. (Figure 4). It was communicated with the palatine sinus which was excavating hard palate and appeared more anterior to the maxillary sinus. (Figure 3). The frontal sinus appeared at a posterior level at the same level of appearance of the orbit. It was lying above the orbit and was divided into a lateral and medial compartment (Figure 5).

Fig. 3: CT scan coronal section at the level of 2nd premolar tooth showing:1; nasal septum (cartilaginous part), 2; nasal septum(bony part, 3; dorsal spiral lamella of ventral concha, 4; ventral spiral lamella, 5; dorsal nasal concha, 6; dorsal meatus ,7; middle nasal meatus, 8; palatine sinus, 9; common meatus.

Fig. 4: CT scan coronal view at the level of last molar tooth showing: 1; maxillary sinus (lateral compartment) 2; nasal septum 3; ventral nasal concha 4; dorsal nasal concha. 5; middle nasal concha 6; middle meatus, 7; maxillary sinus (medial compartment) 8; common meatus 9; dorsal conchal sinus. 10; dorsal meatus.

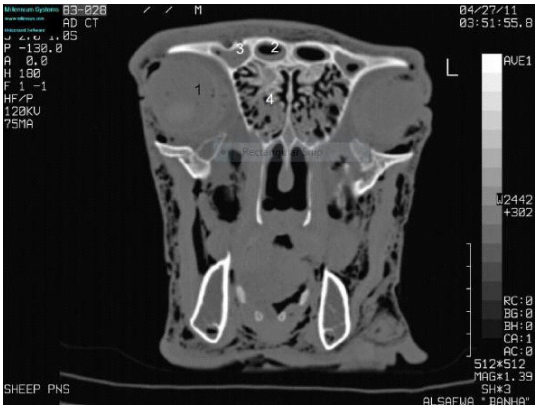


Fig. 5: CT scan coronal section at the level of orbit showing: 1: orbit 2; medial compartment of frontal sinus 3; lateral compartment of frontal sinus 4; ethmoid meatuses.

Anatomical dissection was done of six heads both sagittaly and Coronally: A sagittal section showed the conical shape of the nasal cavity with a length ranging from 16-20cm. It is narrow anteriorly and wide posteriorly. The nasal septum which divided the nose into two halves, extended from the hard palate ventrally to nasal bone dorsally. It has two parts; the bony part which was posterior and ventral consisted of a perpendicular plate of ethmoid bone and Vomer respectively and the rest of the septum is cartilaginous. It lost its contact with the hard palate at the level of the first molar tooth (Figure 6).

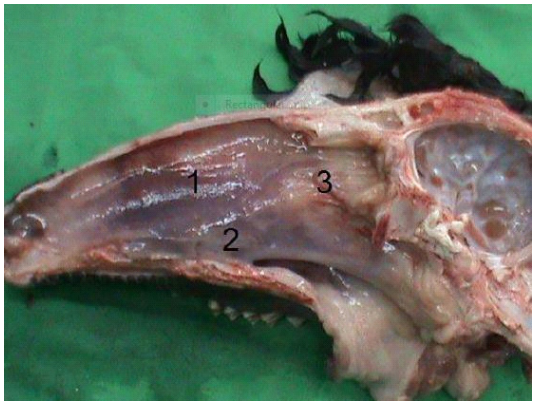


Fig. 6: A sagittaly dissected sheep head showing: 1; septal cartilage, 2; vomer bone, 3; perpendicular plate of ethmoid.

The lateral nasal wall was occupied by three elevations (conchae). The dorsal nasal concha below the roof of the nose was extending from the perpendicular plate of ethmoid posteriorly to the level of first cheek tooth. It was wide in the middle and narrowed towards both ends and it was solid in the anterior part and more bullous in the posterior part. Ventral nasal concha was

lying below the dorsal nasal concha anteriorly and below the middle nasal concha posteriorly. It was broader than the dorsal concha its and length ranged from 10-14 cm. The middle nasal concha was lying between the dorsal and ventral ones extending from the level of the second premolar tooth; and divides the middle meatus into two passages (ventral and dorsal). Three passages or meatuses were found to lie between these conchae; a dorsal nasal meatus was lying above the dorsal nasal concha, a ventral nasal meatus was lying below the ventral nasal concha and it was the largest one and was found to communicate with middle meatus in its posterior end to form a common passage leading to the nasopharynx. The middle nasal meatus was lying between the dorsal and ventral conchae anteriorly and was found to bifurcate by the middle nasal concha at the level of second premolar tooth into ventral and dorsal passages above and below the middle concha, (Figure 7).

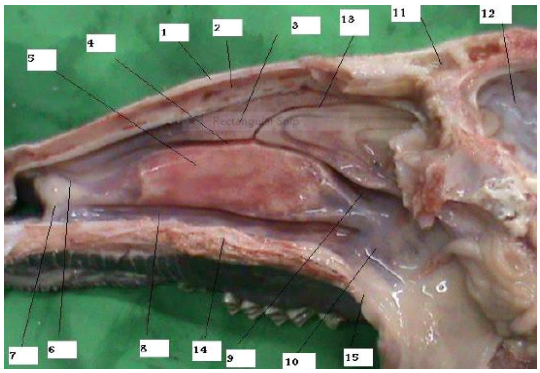


Fig. 7: A sagitally dissected nose of sheep-:1-nasal bone,2- dorsal nasal meatus,3- dorsal nasal concha,4- middle nasal meatus, 5- ventral nasal concha, 6- alar fold,7- basal fold, 8- ventral nasal meatus, 9- middle nasal meeatus split caudally,10- choana, 11- lateral frontal sinus,12- cranial cavity,13- middle nasal meeatus split caudally, 14- palatine process of maxilla and horizontal plate of palatine bone, dorsal to them cut edge of vomer, 15- soft palate.

The middle nasal concha was removed using an ordinary scissor and its bone appeared delicate and easily to be removed and after removal, the openings of maxillary and frontal sinuses appeared. The opening of maxillary sinus was partially covered by the uncinate process which was hook like in shape and projecting from the lateral wall, (Figure 8). In a saggital section, the frontal sinus appeared above the cranial cavity excavating the frontal bone, and opened in the middle meatus behind the maxillary ostium, (Figure 8).

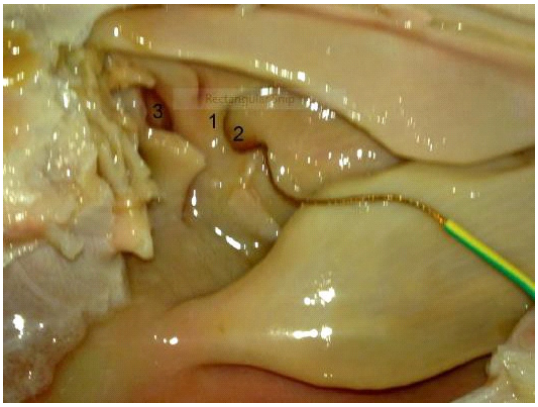


Fig. 8: opening of paranasal sinuses: 1; uncinate process, 2; nasomaxillary aperature, 3; opening of frontal sinus.

In coronal dissection, 2cm thick section were cut until reaching 10cm from nares. It was found that the height of the nasal cavity is about 8-10 cm with a maximal width ranging from 7.5-9.0 cm.

The nasal septum was completely separating the nasal cavity into two halves and it was bony in its inferior part (Vomer bone) and cartilaginous in its anterior part (septal cartilage) and the cartilage was covered by mucoperichondrium. Each halve of the nasal cavity contained two nasal turbinates (ventral and dorsal). The ventral nasal concha originated from the lateral wall by a basal lamella and inside the cavity the basal lamella was divided into ventral and dorsal lamella) spiral lamella); each one was curved dorsally laterally and then ventrally to form a sinus or a recess. The dorsal nasal concha was not divided and contained a sinus (dorsal nasal sinus). The nasal cavity contained four nasal meati; common, dorsal, ventral and middle nasal meati (Figure 9).

The common nasal meatus was a narrow passage between the nasal concha and the nasal septum. The dorsal nasal meatus was lying above dorsal concha under the roof.The middle meatus was lying below the dorsal concha and above the dorsal lamella of the ventral concha, and at this level there was no middle turbinate yet. The ventral meatus was the wider one and was continuous with the common nasal cavity. At this level the palatine sinus appeared excavating the hard palate, the maxillary sinus was small at this level (Figure 9). At the level of the third molar tooth, the middle concha appeared and the maxillary sinus was larger and connected with the palatine sinus, and at this level, the nasal septum lost its contact with the hard palate (Figure10). At The posterior part

of the nasal cavity, the maxillary sinus became larger, and multiple ethmoidal conchae appeared with multiple meatuses between them (figure 11).

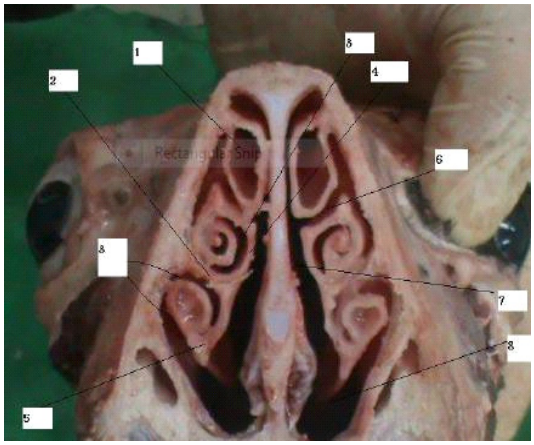


Fig. 9: Details of conchae in coronal section of the nose 1 -dorsal nasal concha 2- ventral nasal concha 3- recesses 4- spiral lamella dorsal part 5- spiral lamella ventral part 6- middle nasal meatus 7- common nasal meatus 8- ventral nasal meatus.

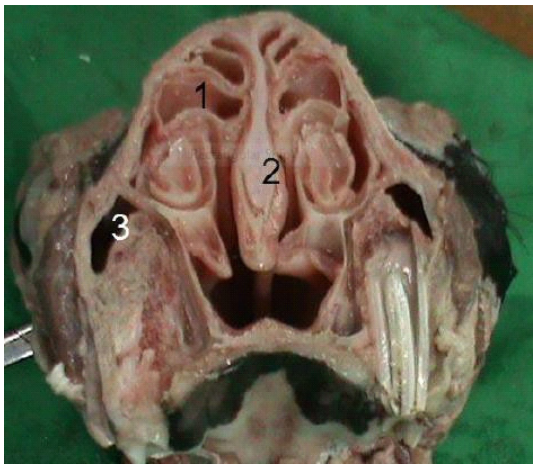


Fig. 10: Coronal view of the sheep head at the level of the third molar tooth showing: 1- middle nasal concha 2- nasal septum 3- maxillary sinus.

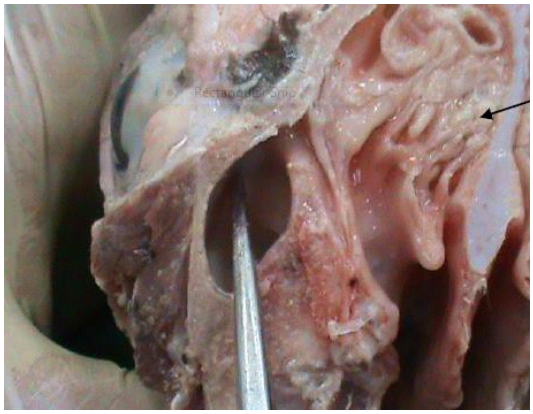


Fig. 11: Showing a forceps in the maxillary sinus and: ethmoidoturbinate bone. An arrow points to basal lamella of ethmoid conchae.

The nasal cavity of the sheep was found to be longer than that of the human and it was narrow in its anterior part. Therefore the anterior part which is about 10 cm from the muzzle, was removed to prepare it for an endoscopic study Endoscopic examination was performed to four heads after preparing them. Submucous resection of the septum, (Figure 13-14), inferior turbinectomy, (Figure12), middle meatal antrostomy, (Figure 15), and foreign body removal, (figure 15) were done. It was found that the tissues were soft and easy to remove using an ordinary instrument with no need for any special instrument. The orbit was found to be not in close contact to the lateral wall. This made endoscopic manipulations to be performed with confidence because there was no fear of injury to orbit.

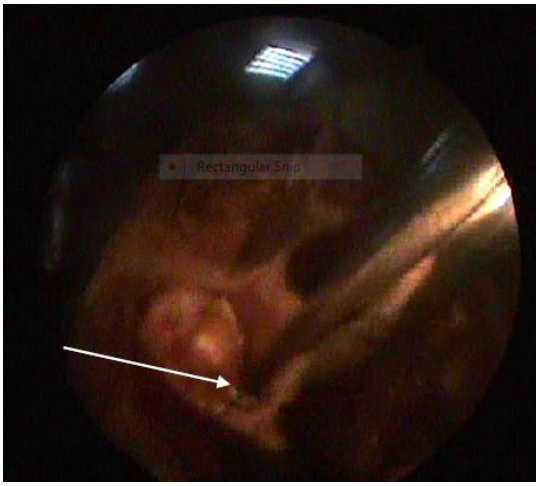


Fig. 12: Inferior turbinectomy (arrow).

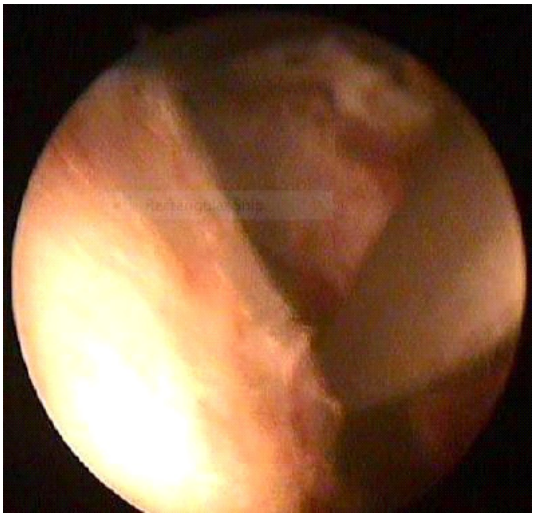


Fig. 13: Endoscopic elevation of septal flap.

Fig. 14: Endoscopic resection of septal cartilage (arrow).

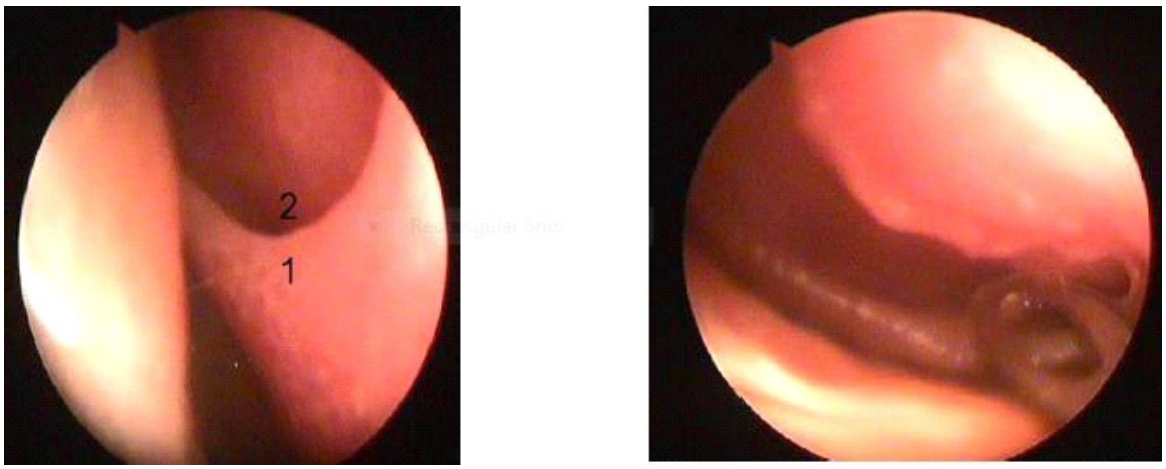


Fig. 15: Middle meatal antrostomy. A; nasomaxillary aperature before antrostomy; 1- Uncinate process 2-naso maxillary aperature , B aperature after antrostomy.

DISCUSSION

In the last 10 years, there has been a major swing from traditional - nasal surgical techniques to endoscopic techniques Shaw *et al*. (2001). It is important 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 an 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 Gardiner *et al*. (1996).

The CT scans and anatomical dissection of the sheep head showed that, the shape of sheep nose to be conical. It was narrow anteriorly and wide posteriorly with a length ranging from (16-20) cm, a height measuring 6-10cm, and a width of 7.5-9cm at widest points. In humans, the length of the nasal cavity is 5-7cm; the height is about 5cm and the width is 1.5cm transversily near the floor Tuli *et al*. (2005). Illum. (1996) stated that the nasal cavity of sheep has a slightly triangular

shape; its length is about 18 cm according to studies done by Screider, (1983) Gopinath *et al*., (1978) and Wagnar and Manning (1976).

In the present study, the nasal cavity was incompletely divided into two halves by the nasal septum (figure 12). The cavity is occupied by three nasal conchae; inferior, middle and dorsal resembling that of the human and between these conchae was lying three meatuses; dorsal, middle and inferior. The opening of paranasal sinuses lies in the middle meatus like that of the human (figures 15-16). According to Acar *et al*.(2010), the nasal cavity of the sheep was seen to be very similar in appearance, although somewhat wider than that of the human.

In the present study, the first 10cm of the muzzle was removed to make it more similar to the human model. This was also done by Gardiner *et al*. (1996) and Acar *et al*.(2010).

In the present study 4 heads were subjected to endoscopic procedures after removal of the first 10 cm of the muzzle and fix it with metal fixator (Figure 9). The bony and cartilaginous part of the septum could be seen. This modification of the specimen has given immediate access to both sides of the anterior nasal septum Gardiner *et al*.(1996).

Submucous resection of the septal cartilage was done by elevation of mucoperichondrium on both sides (Figure 21) and resection of septal cartilage (Figure 22). This exercise allows development of endoscope instrumentation skills and depth perception Gardiner *et al*. (1996).

In the present study, CT scan and anatomical dissection showed that the nasal cavity of the sheep was narrowed by the bullous nature of the inferior concha. Illum, (1996) documented that the nasal cavity was relatively narrow and that narrowing was enforced by the turbinate bones which were attached to the lateral wall. In this present study, a partial turbinectomy was done by removal of the ventral spiral lamella from the anterior end backward to its posterior end as this lamella has the same configuration as the human inferior turbinate. The same procedure was done by Gardiner *et al*. (1996) using the same instruments (curved and straight nasal scissors), under endoscopic control.

In the present study and after removal of the dorsal spiral lamella of the inferior turbinate, we could enter the middle meatus to reach the maxillary ostium and a middle meatal antrostomy and uncinectomy were performed using Stamberger punch. It was found that the middle meatal antrostomy and uncinectomy could be done without need to do middle turbinectomy. This was in contrast to the results of Acar *et al*. (2010) who found that the middle concha was adherent to the lateral wall and it should be removed before antrostomy.

In our present study, a foreign body in the form of metal piece was inserted in the floor of nose near the posterior end of the inferior turbinate and was removed by a curved forceps. This started 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), Gardiner *et al*.(1996).

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التدريب على منظار الجيوب الانفية باستخدام الخراف كنموذج حيوانى

ا.د. مسعد السيسى، ا د. ابو بكر الشافعى، د. على محمد على، د. امير حسين محمد علام

استاذ الانف و الاذن والحنجرة طب بنها، استاذ مساعد الانف و الاذن و الحنجرة طب بنها ، مدرس التشريح طب بنها، بكالوريوس الطب والجراحة طب بنها

ملخص البحث

المقدمة: تعد جراحة الجيوب الانفية بالمنظار من الاساليب ذات الفائدة الكبيرة لعلاج امراض عديدة بالانف. مع ذلك ,فانة يحمل فى طياتة ايضا مخاطر كبيرة ولذا فان مفتاح الجراحة الامنة يتمثل فى التدريب الكافى. فى حين ان تشريح رؤوس الجثث الادامية امر اساسى فى عملية تشريح الانف والجيوب الانفية ,واساليب الممارسة ,غالبا ما يكون من الصعب الحصول على امدادات الرؤوس البشرية لتكون فى متناول المتدربين.

هدف الدراسة : دراسة الاشعة المقطعية للتجويف الانفى والجيوب الانفية للخراف ودراسة تشريح الجدار الجانبى لانف الغنم ومقارنتها مع الانسان لاظهار التشابه فى التشريح والتدريب على بعض العمليات باستخدام المنظار وذلك لاثبات ان الخراف هو نموذج مناسب للتدريب.

طرق البحث : تم تنفيذ هذه الدراسة على اربعة عشر راس اغنامو قسمت الى

مجموعة (1) وتشمل اربعه رؤوس وتم عمل اشعة مقطعية لهم .

مجموعه (2) وتشمل ستة رؤوس تم عمل تشريح لها ثلاث رؤوس طوليا وثلاث رؤوس عرضيا

مجموعة (3) وتشمل اربعة رؤوس تعرضوا للفحص بالمنظار وتم عمل التالى ازالة المحاره الانفية والغضروف ,تعديل الحاجز الانفى ,فغر غار الصماخ الانفى الاوسط وازالة الاجسام الخارجية.

النتائج: استخدام نموذج راس الخراف يوفر طريقة رخيصة وعملية وامنة لتعليم اساسيات منظار الانف والجيوب الانفية اثبتت الخراف كونها اكثر الحيونات فائدة من حيث التشريح العام للانف وفى كون عمق الانف ملائم لوصول المنظار المستخدم فى البشر على الرغم من ان التركيب التشريحى لراس الخراف يختلف بوضوح عن الانسان فان تجويف الانف نفسها هى مشابهه جدا فى المظهر ,وان كانت نطاق اوسع الى حدا ما.

التوصية: يمكن استخدام الخراف كنموذج امن من اجل تقنية المنظار للانف والجيوب الانفية توسيع الدراسة على عدد اكبر من الحيونات دراسة استخدام الخراف فى الاجراءات التى تخص جراحات الانف والاذن والحنجرة الاخرى.