

Improved Dissection Efficiency In Teaching Upper Respiratory System Of Goat Using Normal Cross-Sectional Anatomy And Computed Tomography Techniques

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ABSTRACT

Two heads of adult goats of native breed and of both sexes (one horned male and one unhorned female) clinically healthy goats, aging one and three years, were used for the present study.

The appropriate samples were frozen then cut by an electric saw to cross-sections at the same distance 2cm thick slabs and were perpendicular to the longitudinal axis of preserved specimens.

Cross-sectional anatomy and computed tomography of the head of goat were prepared, photographed, and compared with each other. Both shape and topography of the respiratory organs were demonstrated.

This work included several successive images with their declaration of the upper respiratory system of nostrils, nasal cavity and their contents.

The anatomical features of the respiratory organs were identified by both CT and cross-section images and denoted with the aid of anatomical texts. The obtained results explained that, both the cross sections and the CT images provided a good anatomical view and recent educational tool for study the respiratory organs of the goat.

INTRODUCTION

Anatomy education had always been regarded as an essential requirement in the medical curriculum (1).

Regarding laboratory experience, goat had been used as a good model of general ruminant anatomy because of its many anatomical similarities to other ruminants. Moreover, the smaller size of this animal was economical and convenient pattern for dissection (2). The teaching -learning methods had been adopted to reflect the curriculum design. Computed tomography had been defined as a three dimensional X-ray inspection method in which a cross sectional slices of the body were imaged. It had many advantages to the other diagnostic tools, because it produced high depiction of soft tissue and bones. There was meager literature about the CT of the goat's

head. The purpose of this investigation was to use a combination of normal cross-sectional anatomy and computed tomography to improve understanding of the anatomy of the normal goat upper respiratory system as a recent tool of education.

MATERIAL AND METHODS

Normal cross-sectional anatomy of the head of the goat

The two goats were used subsequently for the anatomical cross-sections. The animals were well bled via common carotid artery and were injected with 10% formalin, placed in ventral recumbency, until fixed. The fixed

cadavers were placed in a freezer in ventral recumbency, until frozen. The frozen cadavers were placed on the table of a band saw, and serial transverse sections were cut approximately 1cm thick. Slices were numbered and gently cleaned of debris with cold running water and light brushing. They were dry blotted and were photographed after placed in formalin (Plate 1/A).

Computed Tomography: (X-ray CT) is a technology that uses computer processed x-rays to produce tomographic images (virtual slices) of specific area of scanned object, allowing the two adult goats of native breeds of both sexes (one male and one female) weighing about 25–35 kg and aging 1&1.5 years were used for the current study. This work was carried out at DR Ahmed Farid Radiology Center Banha, Qaliubiya Province.

CT scans procedure

After physical examination, the goats were used for the CT scans; each goat was given intramuscular atropine sulphate (0.4 mg/kg) and after 5 minutes each was anesthetized by

intravenous injection of mixed ketamine and xylazine (2.2/0.11mg/kg). User to see inside without cutting. Digital geometry processing is used to generate a three dimensional image of inside of an object from a large series of two dimensional radiographic images.

The goat was positioned in sternal recumbency during scanning. Goat's head, neck and thorax were serially sectioned with the CT scanner using TOSHIBA 600HQ (third generation) from the level of the central incisors (center of rima oris) to the level of 9th intercostals spaces with 1 cm interval on the chest (scanning conditions of the thorax and head were 120Kv, 250mA). The scanning condition of the scout view of the whole body of the goat was 120Kv, 200mA. CT images were taken on CD and compared with the anatomic sections to assist an accurate identification of specific structures (Plate 1/ B).

Nomenclatures used in this study were adopted by (3).

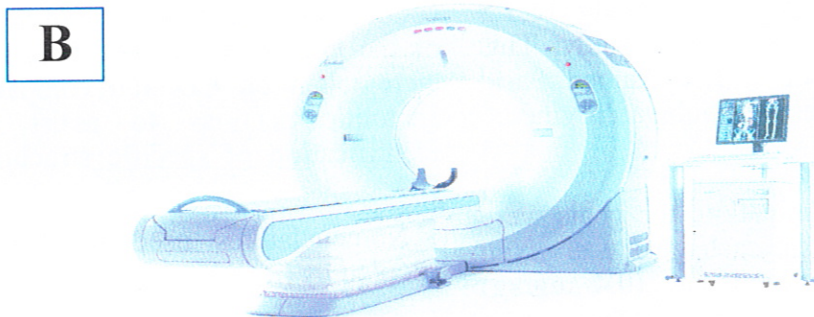
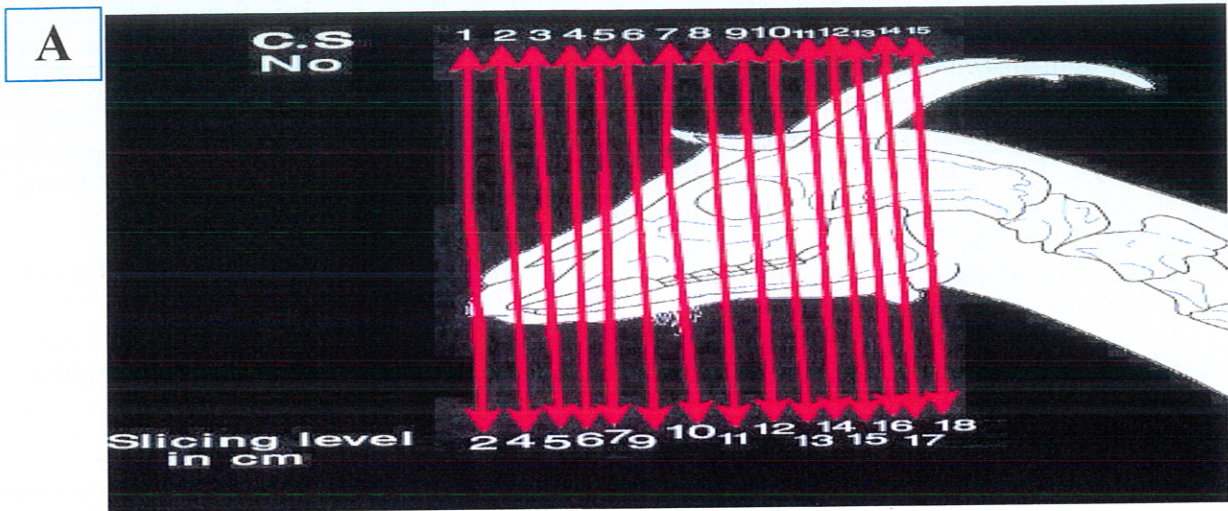


Plate (1)

- (A): Schematic diagram of the goat skeleton showing
Cross sectional anatomy for head.
CT slicing levels 1 to 15 slicing thickness was fifteen millimeters.
- (B): CT device after WWW.Toshiba-medical .edu.

RESULTS

Normal cross-sectional anatomy of the head of the goat: The results of this item consisted of 15 cross-sections through the head of goat. At the level of 2 cm caudal to rima oris showed the alar fold and the nasal septum (Plate 2/A).

The vomeronasal organ appeared as two opened tubes extended from the center of rima oris to the level of second premolar tooth about 7 cm lengths (Plate 2/B, C and D).

The dorsal nasal concha of goat consisted of a basal lamella plate like in its rostral part which started from center of rima oris to the level of third pre molar tooth. Caudal to this level, a dorsal conchal sinus was presented to the level of third molar teeth and it expanded in the nasal vestibule by the straight fold (Plate 2/B, C and D) and (Plate 3/A, B, C and D).

The ventral nasal concha of goat stretched rostrally as fold called alar fold. It projected from basal lamella then appeared as dorsal

spiral lamella which enclosed a recess and the ventral spiral lamella which contained a bulla (Plate 2/B, C and D) and (Plate 3/A, B and C).

The middle nasal concha was located dorsocaudally in the nasal cavity appeared as sinus at the level of second molar tooth. The middle nasal concha comprised of a basal lamella and dorsal and ventral spiral lamellae. The dorsal spiral lamella prolonged rostrally and confined the middle conchal sinus. The ventral spiral lamella surrounded short sinus rostrally and recess caudally (Plate 4/A, B and C).

The ethmoidal conchae situated in the nasal fundus were numerous and supported by ethmoturbinate bone. The caudal ends of the dorsal and middle nasal conchae were a part of the ethmoid labyrinth of scrolls (ethmoidal conchae) (Plate 4/ D) and (Plate 5/ A).

The maxillary sinus expanded caudally at the level of fourth premolar and communicated with the palatine sinus above the infraorbital canal. The palatine sinus existed rostrally to maxillary sinus at the level of second premolar tooth (Plate 3/A, B, C and D) and (Plate 4/A, B and C).

The frontal sinuses presented caudally to maxillary sinus at the level of third molar tooth. The right and left frontal sinuses were separated by a complete septum. Each one was divided into large lateral and small medial portions. In the horned goat, the frontal sinus protracted inside the corneal process (Plate 4/ D), (Plate 4/A, B and C) and (Plate 5/A, B and C).

The nasolacrimal duct was found at the lateral wall of the nasal cavity, immediately lateral to the basal lamella of the ventral nasal concha (Plate 1/ C and D).

Computed Tomography (CT) of the head of goat

The results of this technique had been shown fourteen scans for the head of goat. In the images, the transverse view of each section had been photographed. The images had been started from rostral to the caudal aspects of the head respectively.

Correlation between the CT scans and normal cross sectional anatomy specimens was good in most cases. Bony structures of head including skull and mandible were clearly visualized and labeled.

The use of the cheek teeth as landmarks in this study was due to constant position and their easily recognition with cross sectional images.

The correlation between the CT scans and normal cross sections of goat head showed alar fold, straight fold, nares, nasal vestibule and anterior part of nasal cavity (Plate 6/A and B).

The nasal septum, the ventral nasal concha, the dorsal nasal concha, the middle nasal concha, ethmoidal conchae, the nasal meatus, the maxillary sinus and the frontal sinuses appeared nearly like the cross-sectional anatomy of the nasal cavity (Plate 6/B, C and D), (Plate 7/A, B, C and D), (Plate 8/A, B, C and D) and (Plate 9/A and B).

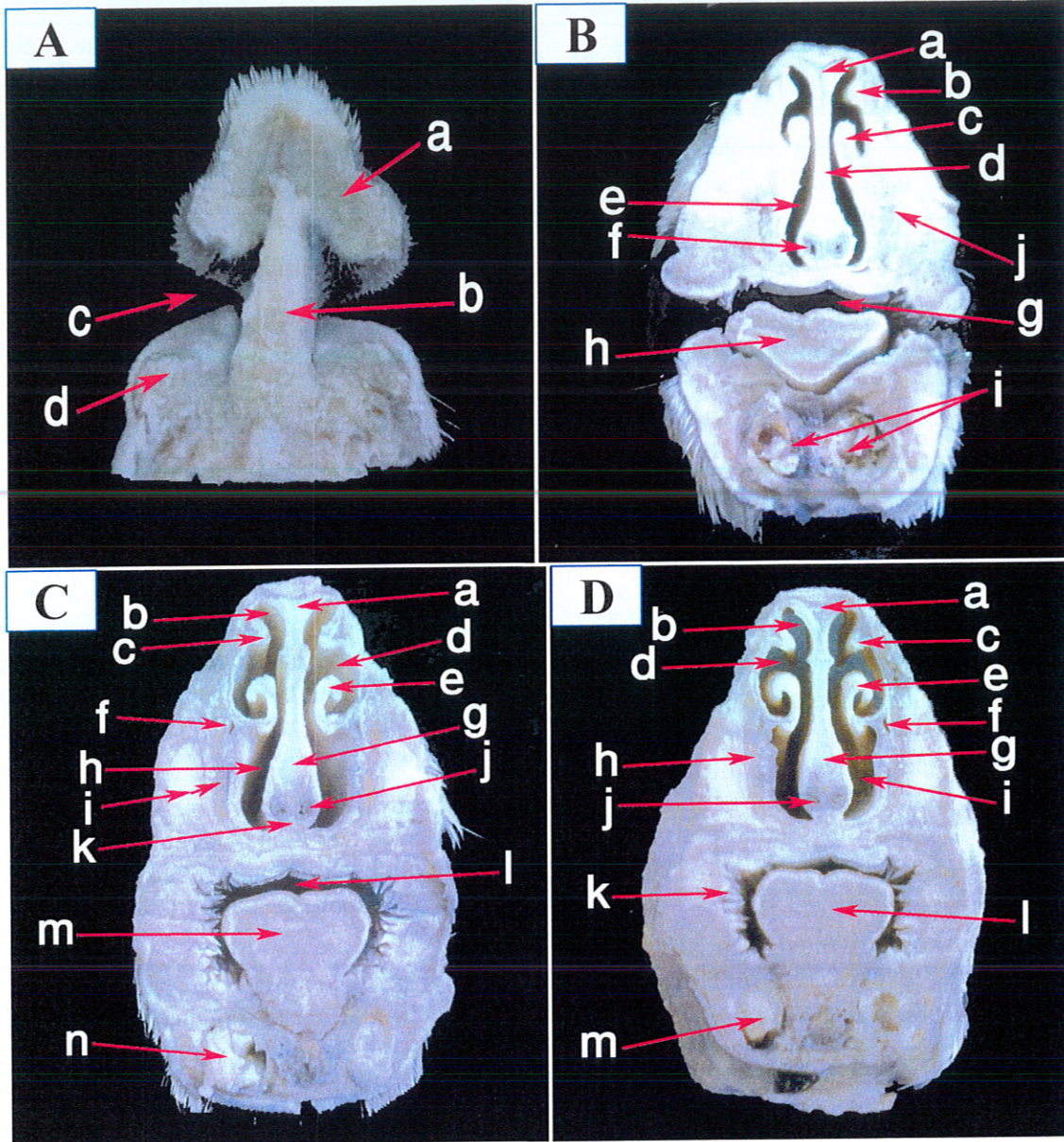


Plate (2)

- (A): A photomicrograph showing cross section of formalinized nasal cavity of goat at the level of 2 cm caudal to rima oris (a) Plica alaris (b) Septum nasi (c) Nares (d) Labium superius.
- (B): A photomicrograph showing cross section of formalinized nasal cavity of goat at the level of 4 cm caudal to rima oris (a) Os nasale (b) Plica recta (c) Plica alaris (d) Septum nasi (e) Meatus nasi communis (f) Organum vomeronasale (g) Cavum oris proprium (h) Lingua (i) Pars incisiva of corpus mandibulae (j) Maxilla.
- (C): A photomicrograph showing cross section of formalinized nasal cavity of goat at the level of 5 cm caudal to rima oris (a) Os nasale (b) Meatus nasi dorsalis (c) Concha nasalis dorsalis (d) Meatus nasi medius (e) Concha nasalis ventralis (f) Ductus nasolacrimalis (g) Septum nasi (h) Meatus nasi communis (i) Maxilla (j) Organum vomeronasale (k) Vomer (l) Cavum oris proprium (m) Lingua (n) Corpus mandibulae.
- (D): A photomicrograph showing cross section of formalinized nasal cavity of goat at the level of 6 cm caudal to rima oris (a) Os nasale (b) Meatus nasi dorsalis (c) Concha nasalis dorsalis (d) Meatus nasi medius (e) Concha nasalis ventralis (f) Ductus nasolacrimalis (g) Septum nasi (h) Maxilla (i) Meatus nasi communis (j) Organum vomeronasale (k) Papillae buccales (l) Lingua (m) Corpus mandibulae.

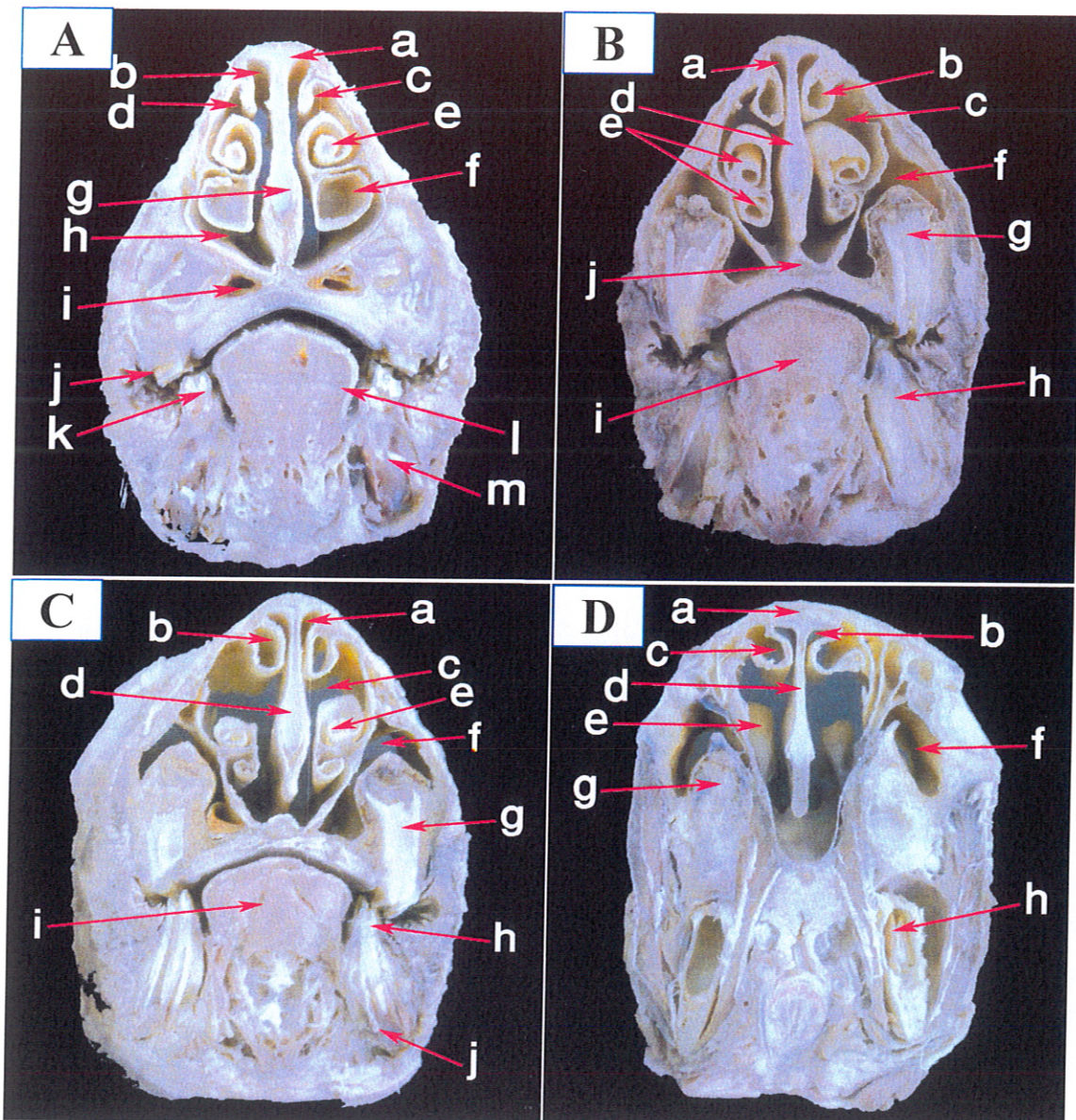


Plate (3)

- (A): A photomicrograph showing cross section of formalinized nasal cavity of goat at the level of 7 cm caudal to rima oris (a) Os nasale (b) Meatus nasi dorsalis (c) Concha nasalis dorsalis (d) Meatus nasi medius (e) Concha nasalis ventralis(bulla) (f) Concha nasalis ventralis(recess) (g) Septum nasi (h) Meatus nasi ventralis (i) Sinus palatinus (j) Dentes premolares superioris II (k) Dentes premolares inferioris II (l) Lingua (m) Pars molaris of corpus mandibulae.
- (B): A photomicrograph showing cross section of formalinized nasal cavity of goat at the level of 9 cm caudal to rima oris (fourth premolar tooth) (a) Meatus nasi dorsalis (b) Sinus conchae dorsalis (c) Meatus nasi medius (d) Septum nasi (e) Concha nasalis ventralis(f) Sinus maxillaries (g) Dentes premolares superioris IV (h) Dentes premolares inferioris IV (i) Lingua (j) Vomer.
- (C): A photomicrograph showing cross section of formalinized nasal cavity of goat at the level of 10 cm caudal to rima oris (first molar tooth) (a) Meatus nasi dorsalis (b) Sinus conchae dorsalis (c) Meatus nasi medius (d) Septum nasi (e) Concha nasalis ventralis (f) Sinus maxillaries (g) Dentes molares superioris I (h) Dentes molares inferioris I (i) Lingua (j) Pars molaris of corpus mandibulae.
- (D): A photomicrograph showing cross section of formalinized nasal cavity of goat at the level of 12 cm caudal to rima oris (third molar tooth) (a) Os frontale (b) Meatus nasi dorsalis (c) Sinus conchae dorsalis (d) Septum nasi (e) Concha nasalis ventralis (f) Sinus maxillaries (g) Dentes molares superioris III (h) Dentes molares inferioris III.

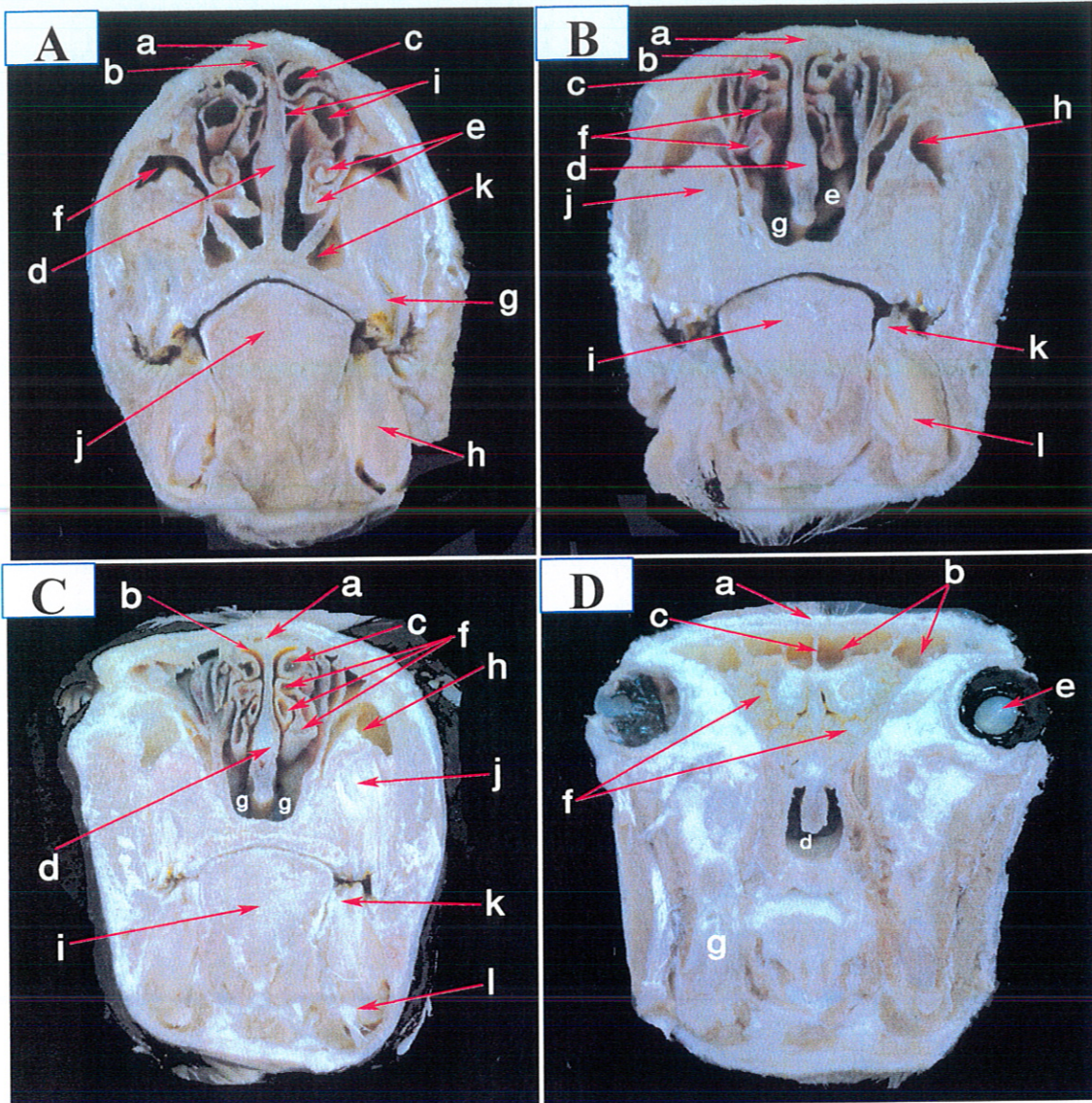


Plate (4)

- (A): A photomicrograph showing cross section of formalinized nasal cavity of goat at the level of 12 cm caudal to rima oris (third molar tooth) (a) Os frontale (b) Meatus nasi dorsalis (c) Sinus conchae dorsalis (d) Septum nasi (e) Concha nasalis ventralis (f) Sinus maxillaries (g) Dentes molares superioris III (h) Dentes molares inferioris III (i) Concha nasalis media (j) Lingua (k) Sinus palatinus.
- (B): A photomicrograph showing cross section of formalinized nasal cavity of goat at the level of 13 cm caudal to rima oris (third molar tooth) (a) Os frontale (b) Meatus nasi dorsalis (c) Sinus conchae dorsalis (d) Septum nasi (e) Concha nasalis ventralis (f) Concha nasalis media (g) Choana (h) Sinus maxillaries (i) Lingua (j) Dentes molares superioris III (k) Dentes molares inferioris III (l) Pars molaris of corpus mandibulae.
- (C): A photomicrograph showing cross section of formalinized nasal cavity of goat at the level of 14 cm caudal to rima oris just rostral to the cribriform plate (a) Os frontale (b) Meatus nasi dorsalis (c) Sinus conchae dorsalis (d) Septum nasi (f) Concha nasalis media (g) Choana (h) Sinus maxillaries (i) Lingua (j) Dentes molares superioris III (k) Dentes molares inferioris III (l) Pars molaris of corpus mandibulae.
- (D): A photomicrograph showing cross section of formalinized nasal cavity of goat at the level of 15 cm at the rostral border to supraorbital process (a) Os frontale (b) Sinus frontalis (medialis et lateralis) (c) Septa sinuum frontaliu (d) Nasopharynx (e) Lens (f) Conchae ethmoidales (g) Ramus mandibulae.

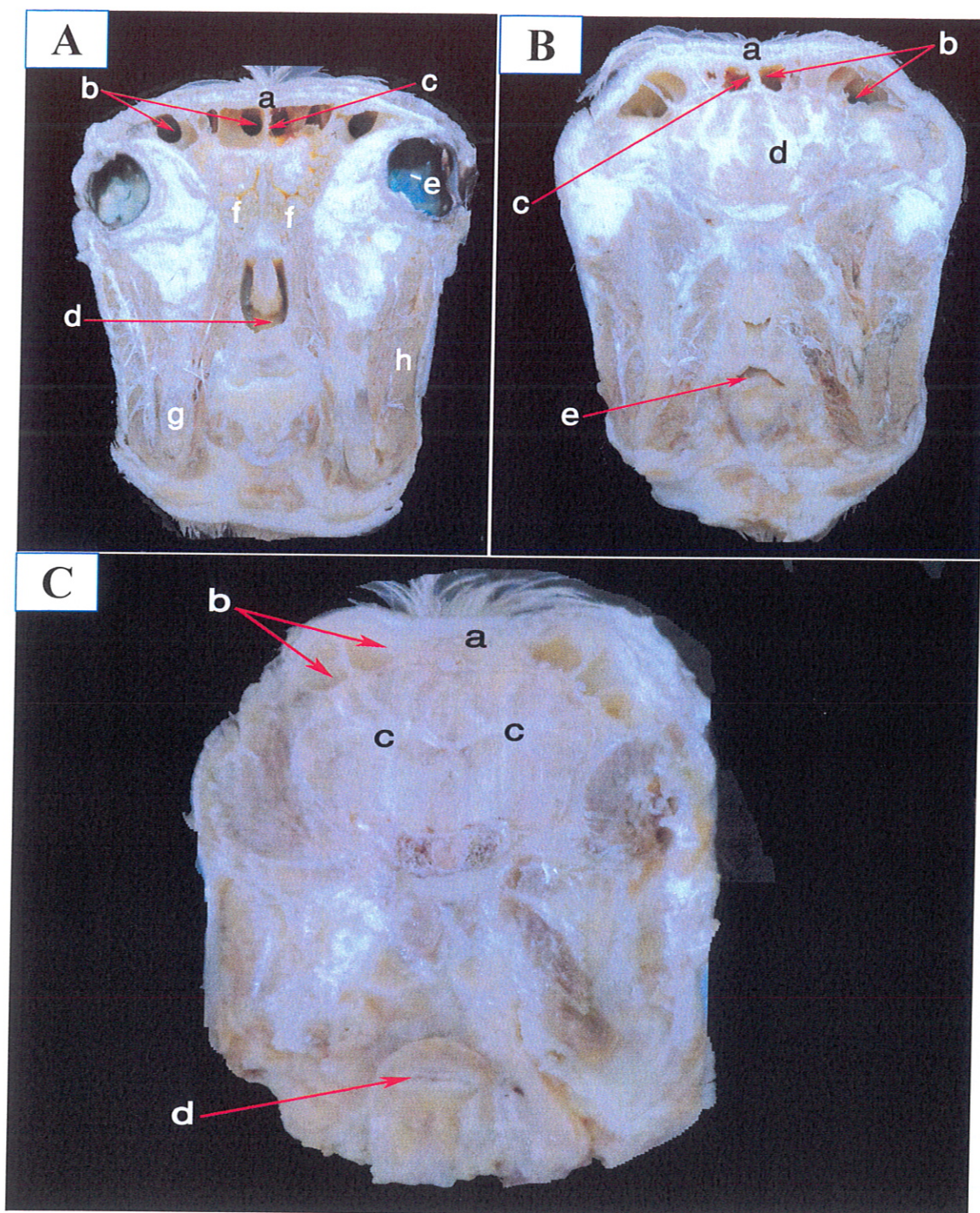


Plate (5)

- (A): A photomacrograph showing cross section of formalinized nasal cavity of goat at the level of 16 cm at the caudal border to supraorbital process (a) Os frontale (b) Sinus frontalis (medialis et lateralis) Cellulae ethmoidales (c) Septa sinuum frontalem (d) Nasopharynx (e) Oculus (f) Conchae ethmoidales (g) Ramus mandibulae (h) M. masseter.
- (B): A photomacrograph showing cross section of formalinized nasal cavity of goat at the level of 17 cm (a) Os frontale (b) Sinus frontalis (medialis et lateralis) (c) Septa sinuum frontalem (d) Cerebrum (e) Cavum laryngis.
- (C): A photomacrograph showing cross section of formalinized nasal cavity of goat at the level of 18 cm (a) Os frontale (b) Sinus frontalis (medialis et lateralis) (c) Hemispherium cerebri (d) Aditus esophagi.

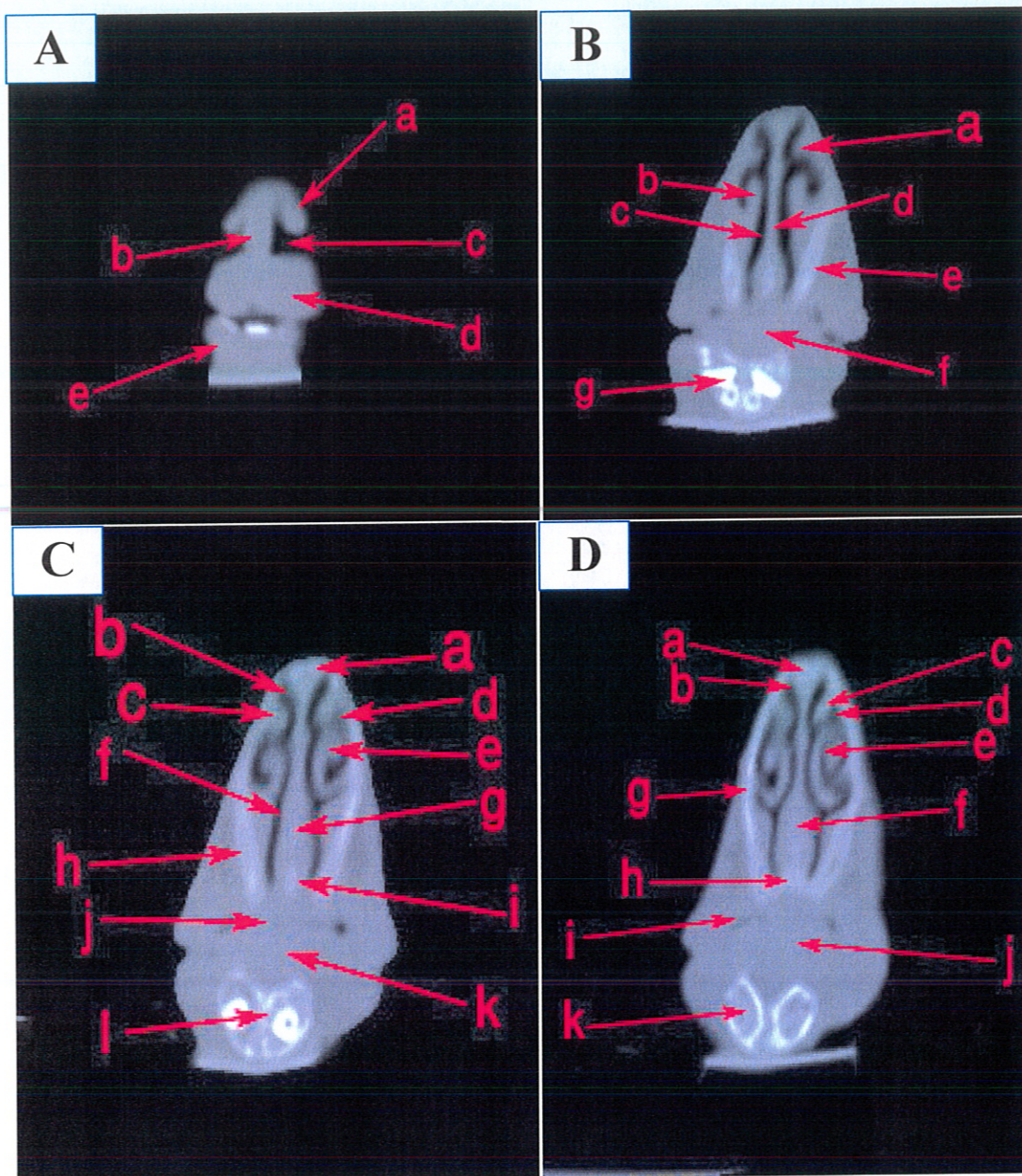


Plate (6)

- (A):** A photomacrograph showing C T scan of the nasal cavity of goat at the level of 2 cm caudal to rima oris showing (a) Plica alaris (b) Septum nasi (c) Nares (d) Labium superius (e) Labium inferius.
- (B):** A photomacrograph showing C T scan of the nasal cavity of goat at the level of 4 cm caudal to rima oris (a) Plica recta (b) Plica alaris (c) Meatus nasi communis (d) Septum nasi (e) Maxilla (f) Lingua (g) Pars incisiva of corpus mandibulae.
- (C):** A photomacrograph showing C T scan of the nasal cavity of goat at the level of 5 cm caudal to rima oris (a) Os nasale (b) Meatus nasi dorsalis (c) Concha nasalis dorsalis (d) Meatus nasi medius (e) Concha nasalis ventralis (f) Meatus nasi communis (g) Septum nasi (h) Maxilla (i) Vomer (j) Cavum oris proprium (k) Lingua (l) Corpus mandibulae.
- (D):** A photomacrograph showing C T scan of the nasal cavity of goat at the level of 6 cm caudal to rima oris (a) Os nasale (b) Meatus nasi dorsalis (c) Concha nasalis dorsalis (d) Meatus nasi medius (e) Concha nasalis ventralis (f) Septum nasi (g) Maxilla (h) Vomer (i) Cavum oris proprium (j) Lingua (k) Corpus mandibulae.

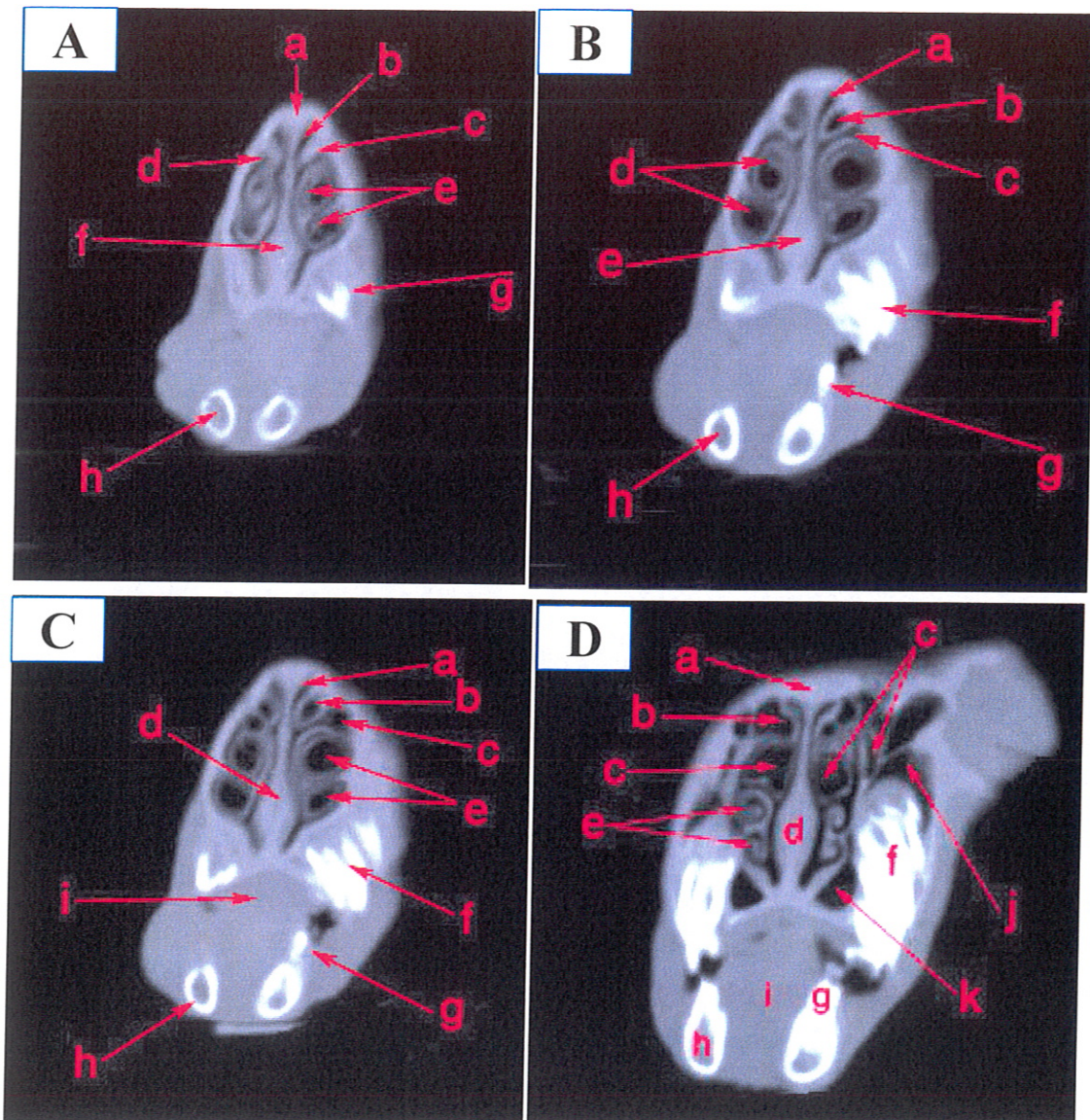


Plate (7)

- (A): A photomacrograph showing C T scan of the nasal cavity of goat at the level of 7 cm caudal to rima oris (a) Os nasale (b) Meatus nasi dorsalis (c) Concha nasalis dorsalis (d) Meatus nasi medius (e) Concha nasalis ventralis (f) Septum nasi (g) Dentes premolares superioris II (h) Pars molaris of corpus mandibulae.
- (B): A photomacrograph showing C T scan of the nasal cavity of goat at the level of 9 cm caudal to rima oris (fourth premolar tooth) (a) Meatus nasi dorsalis (b) Sinus conchae dorsalis (c) Meatus nasi medius (d) Concha nasalis ventralis (e) Septum nasi (f) Dentes premolares superioris IV (g) Dentes premolares inferioris IV (h) Pars molaris of corpus mandibulae.
- (C): A photomacrograph showing C T scan of the nasal cavity of goat at the level of 10 cm caudal to rima oris (first molar tooth) (a) Meatus nasi dorsalis (b) Sinus conchae dorsalis (c) Meatus nasi medius (d) Septum nasi (e) Concha nasalis ventralis (f) Dentes molares superioris I (g) Dentes molares inferioris I (h) Pars molaris of corpus mandibulae (i) Lingua.
- (D): A photomacrograph showing C T scan of the nasal cavity of goat at the level of 12 cm caudal to rima oris (third molar tooth) (a) Os frontale (b) Sinus conchae dorsalis (c) Concha nasalis media (d) Septum nasi (e) Concha nasalis ventralis (f) Dentes molares superioris I (g) Dentes molares inferioris I (h) Pars molaris of corpus mandibulae (i) Lingua (j) Sinus maxillaries (k) Sinus palatinus.

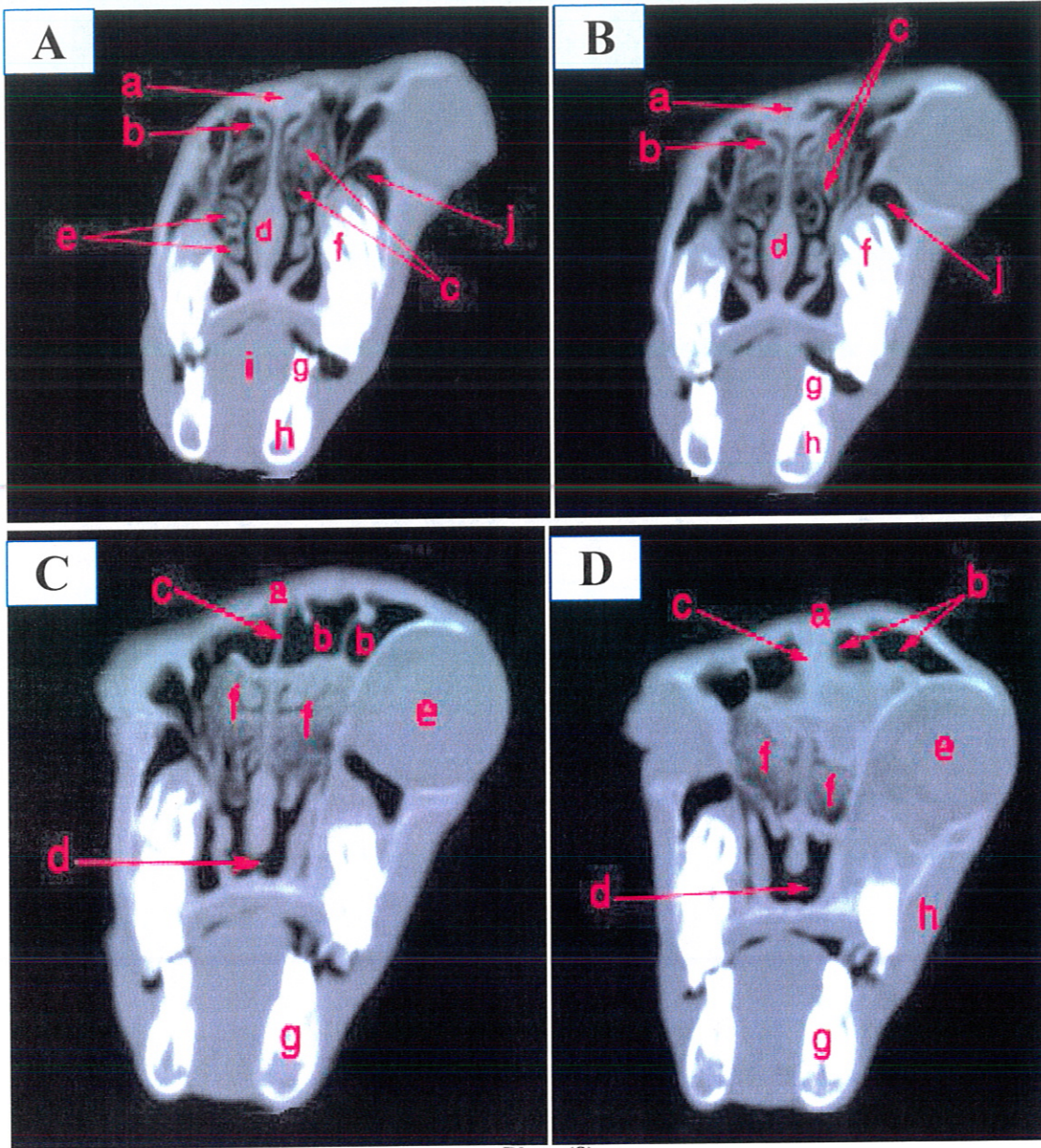


Plate (8)

- (A): A photomacrograph showing C T scan of the nasal cavity of goat at the level of 13 cm caudal to rima oris (third molar tooth) (a) Os frontale (b) Sinus conchae dorsalis (c) Concha nasalis media (d) Septum nasi (e) Concha nasalis ventralis (f) Dentes molares superioris I (g) Dentes molares inferioris I (h) Pars molaris of corpus mandibulae (i) Lingua (j) Sinus maxillaries.
- (B): A photomacrograph showing C T scan of the nasal cavity of goat at the level of 14 cm caudal to rima oris just rostral to the cribriform plate (a) Os frontale (b) Sinus conchae dorsalis (c) Concha nasalis media (d) Septum nasi (f) Dentes molares superioris I (g) Dentes molares inferioris I (h) Pars molaris of corpus mandibulae (i) Lingua (j) Sinus maxillaries.
- (C): A photomacrograph showing C T scan of the nasal cavity of goat at the level of 15 cm at the rostral border to supraorbital process (a) Os frontale (b) Sinus frontalis (medialis et lateralis) Cellulae ethmoidales (c) Septa sinuum frontium (d) Nasopharynx (e) Bulbus oculi (f) Conchae ethmoidales (g) Ramus mandibulae.
- (D): A photomacrograph showing C T scan of the nasal cavity of goat at the level of 16 cm at the caudal of supraorbital process (a) Os frontale (b) Sinus frontalis (medialis et lateralis) (c) Septa sinuum frontium (d) Nasopharynx (e) Bulbus oculi (f) Conchae ethmoidales (g) Ramus mandibulae (h) M. masseter.

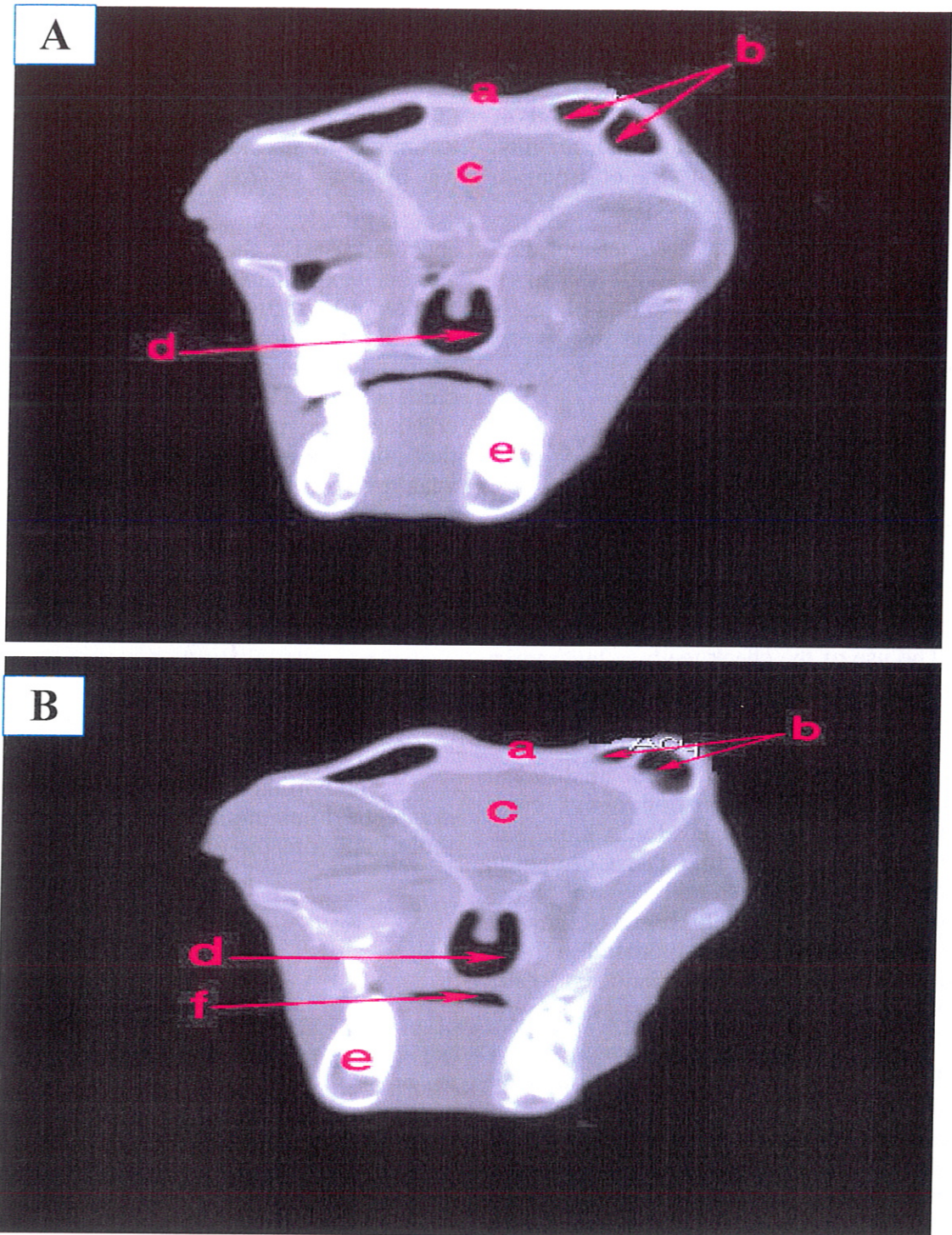


Plate (9)

- (A): A photomacrograph showing C T scan of the nasal cavity of goat at the level of 17 cm (a) Os frontale (b) Sinus frontalis (medialis et lateralis) (c) Cerebrum (d) Nasopharynx (e) Ramus mandibulae
- (B): A photomacrograph showing C T scan of the nasal cavity of goat at the level of 18 cm (a) Os frontale (b) Sinus frontalis (medialis et lateralis) (c) Hemispherium cerebri (d) Nasopharynx (e) Ramus mandibulae (f) Aditus esophagi.

DISCUSSION

In the present study, the vomeronasal organ appeared as two opened tubes extended from the center of rima oris to the level of second premolar tooth about 7 cm lengths. Such extension was similar to the observation of (4-6) in goat and (7, 8) in sheep.

In our specimens, the nasolacrimal duct was located at the lateral wall of the nasal cavity, immediately lateral to the basal lamella of the ventral nasal concha. This result was consistent with previous studies in sheep (7).

In the course of these studies, the cross section of the head and especially upper respiratory structures images as the nasal conchae, the nasal meatuses and the paranasal sinuses were compared to goat head described in text books (9-11). Such comparison denoted a good visual correlation among cross sections and text book of anatomy.

The use of the cheek teeth as landmarks in this study was due to constant position and their easily recognition with cross sectional images. This finding was essentially coincided with the report of (12). The anatomical significance of the information about cross sectional anatomy of goat head was important for evaluation of CT scans. The Correlation between the CT scans and normal cross sectional furnished complete details of the goat head. Also, the CT scans prepared a good separation and distinguishing between bones and soft tissues. This study was supported with the report of (7).

With respect to the nasal cavity and the adjoining paranasal sinuses their appearance in CT scans were clear more than other parts of the body. These findings confirmed the existence of these sinuses in previous studies of (12-14). In keeping with the pattern of formation of the frontal sinuses, they existed caudally to maxillary sinus at the level of third molar tooth. The right and left frontal sinuses were separated by a complete septum and each one was divided by septum into large lateral and small medial frontal sinus. In the horned goat, frontal sinus extended inside to the

corneal process. These findings were coincided to those reported by (7, 12).

The present investigation revealed that, the CT could be acceptable and alternative technique to normal anatomy, similar result was observed by (15).

Finally, the present work was in accordance with the statements of (16). The author explained that well developed (radiology) software could be used for teaching sectional or imaging anatomy for better understanding of CT scans in coming clinical years. This would act as supplement in understanding relations of various structures, thus adding a radiological perspective to gross anatomy. A number of studies of senior medical students had revealed a need to broaden various knowledge of clinically oriented Anatomy, as imaging anatomy.

CONCLUSION

The normal cross-sectional anatomy and computed tomography were good educational tool of upper respiratory system of goat.

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المخلص العربي

تحسين كفاءة تدريس تشريح الجهاز التنفسي العلوي للماعز باستخدام تقنيات التشريح القطاعي
المستعرض والاشعة المقطعية

خالد زكريا سليمان ، صلاح الدين عبد العزيز أحمد، عطية احمد عطية مصيلحي
قسم التشريح والاجنة- كلية الطب البيطري- جامعة الزقازيق-مصر ٤٤٥١١

في هذه الدراسة يتم توضيح دور القطاعات العرضية والاشعة المقطعية لرأس الماعز كوسيلة تعليمية
للجهاز التنفسي العلوي للماعز.

استخدمت في هذه الدراسة عدد اثنين من الماعز الحية في حالة صحية سليمة، ذكر بقرون و انثي
بدون قرون تراوحت اوزانها بين ٢٥-٣٥ كياوجرام و اعمارها سنة و ثلاث سنوات. تم إعداد قطاعات
عرضية باستخدام جهاز الاشعة المقطعية وتصوير هذه القطاعات بصورة متتالية ومتعامدة علي المحور
الطولي للجسم من مركز الشق الشفهي (فتحة الفم) الي مستوي اللقمتين القفويتين.

تم تجميد العينات و تقطيعها بواسطة منشار كهربائي الي قطاعات عرضية متتالية بنفس المسافة البينية
ومتعامدة علي نفس المحور الطولي التي تم استخدامهما في التصوير بالاشعة المقطعية.

اظهرت الدراسة القطاعات العرضية والاشعة المقطعية، التصوير المقطعي للرأس في الماعز
وتشتمل علي مجموعة من الصور لمقاطع متتالية من الامام الي الخلف و من مستوي مركز الشق الشفهي
(فتحة الفم) الي مستوي اللقمتين القفويتين وتم ادراج البيانات الخاصة بالجهاز التنفسي العلوي من انف
ومكوناتها والتجويف الانفي بما فيه من الأنسجة الرخوة، الغضاريف، العظام، وممرات الهواء الأنفية.