

COMPUTED TOMOGRAPHY AND NORMAL CROSS SECTIONAL ANATOMY OF THE HEAD OF THE SHEEP

HATEM BAHGAT, AHMED A. KASSAB

Correspondence

Hatem Bahgat, Department of Anatomy and Embryology, Faculty of Veterinary Medicine, Benha University, Moshtohor, Toukh, 13736, Egypt.

E-mail: drhatembh@yahoo.com, drhatembh@hotmail.com

Received: 18.4.2007.

Accepted: 5.6.2007.

SUMMARY

The objective of the present study was to define the detailed description of the anatomy of the head in the native sheep breed in Egypt by computerized tomography (CT) for use by radiologists and veterinary clinicians.

Normal five heads of adult sheep of different ages (2-4 years) and sexes (three females and two males) were used in this study. sheep were killed and the heads were sectioned at the level of atlantoaxial joint. 10-mm contiguous transverse CT images were acquired with a third-generation CT scanner. Frozen cross-sectional slices of sheep head were photographed and compared with the CT images.

The important anatomic structures were revealed, seen clearly and labeled in two corresponding photographs of cross-sections and CT scans of the sheep head. The various dimensions of the nasal, cranial and tympanic cavities were recorded.

Key words: head, sheep, cross sectional anatomy, computed tomography.

INTRODUCTION

Sheep farming as a component of the livestock industry is extensively practiced in developed countries specifically for its products of meat and wool. In the laboratory, sheep have also been used as models for variety of research enquires including nutrition, reproduction and dis-

ease processes. In fact, the world of biotechnology reverberated at the birth of the first ever cloned animal Dolly the sheep in Scotland, in 1997.

Computed tomography (CT) currently plays a prominent role in the diagnosis and evaluation of many human diseases. It was not initially used in veterinary medicine because of its limited accessibility and high costs. However accessibility has improved, which has increased the need of expertise in the use of this technique in animals.

Computed tomography (CT) imaging of the head is performed increasingly in dogs^{2,3,4,5}, horse^{6,7,8,9,10}, llama¹¹ and goat¹² but to our knowledge, there is no any earlier study has been reported on the use of CT in sheep.

The knowledge of normal anatomy of the sheep head on CT images is necessary to provide accurate interpretation of these images and to describe abnormalities that may be present. The aim of this study was to provide an atlas of normal cross-sectional anatomy of the sheep head using CT images and transverse gross anatomic sections.

MATERIALS AND METHODS

Normal five heads of sheep (*Ovis aries*) were used in this study. The sheep were adult and of different ages (2-4 years) and sexes (three

females and two males). The sheep were killed and the heads were sectioned at the level of atlantoaxial joint. The heads were obtained immediately after slaughtering, cooled and imaged within 12 hours to minimize post-mortem changes.

The computerized tomographic scans were carried out using TOSHIBA 600 HQ (third-generation equip TCT). The acquisition parameters were as follows: kVp, 125; field of view, 80 mA; algorithm, standard. The heads were positioned with the image plane perpendicular to the sagittal plane of the head. Transverse 10-mm contiguous slices of the head were made beginning from the level of the central incisors (center of Rima oris) to the level of the occipital condyles. For documentation, the images were printed as hard copies and stored digitally.

After CT images were obtained, the heads were frozen then sectioned using an electric band saw, with the slabs cut transversely perpendicular to a long axis extending from the center of Rima oris to just below the center of Foramen magnum (Figure 1) to correspond with the CT images. All sections were cleaned, photographed and kept for the future studies.

The CT images were labeled by comparison with the anatomical cross sections. Labeling was adopted according to the *Nomina Anatomica Veterinaria*^{13, 14}. Some structures present in the

anatomical sections could not be seen on the corresponding CT images and vice versa. CT image artifacts were noted.

By using the horizontal and vertical scales in the CT sheets, the dimensions of the nasal, cranial and tympanic cavities were recorded.

RESULTS

The head length- measured from the level of the center of Rima oris to the level of the center of Foramen magnum- ranged between 21 and 23 cm (Fig. 1).

The results of the present study consisted of 20 CT images and 18 cross-sections through the heads of sheep.

Important anatomical structures were revealed, seen clearly and labeled in two corresponding photographs of cross-sections and CT scans of the sheep head. These sections were shown in a rostral to caudal progression from the level of the center of Rima oris to the level of the occipital condyles (Figs. 2-21).

Not all structures were labeled in every slice; contra-lateral structures of symmetrical tissues weren't labeled if their identification seemed obvious.

The results revealed that the vomeronasal organ

extended as far caudad as the level of the second premolar tooth, at about 7 cm caudal to the center of Rima oris (Fig. 7B).

The nasolacrimal duct courses rostrad in the lateral wall of the nasal cavity, immediately lateral to the basal lamella of the ventral nasal concha (Figs. 4, 6, 10, 11).

The ventral border of the nasal septum lost its attachment to the floor of the nasal cavity at the level of the first molar tooth, at about 10 cm caudal to the center of Rima oris. So beyond this level, the two halves of the nasal cavity communicated together below the ventral border of the nasal septum (Figs. 10 B, 11, 12, 13).

The dorsal nasal concha consisted only of a basal lamella, in its rostral portion as far caudad as the level of the third premolar, at about 8 cm caudal to the center of Rima oris. Beyond this level it presented a dorsal conchal sinus as far caudad as the level of the caudal end of the third molar tooth, at about 13 cm caudal to the center of Rima oris (Figs. 9B, 10B, 11B, 12B, 13B).

The ventral nasal concha (Figs. 7, 8, 9, 10) presented a dorsal spiral lamella that enclosed a recess and a ventral spiral lamella that enclosed a bulla (Fig. 8B). The caudal portion of the basal lamella of the ventral nasal concha divided into two basal lamellae opposite to the second and third molar tooth at about 11-12 cm caudal to the center of Rima oris (Figs. 11, 12).

The middle nasal concha extended as far rostrad as the level of the second molar tooth, at about 11 cm caudal to the center of the Rima oris (Fig. 12). The palatine sinus extended from the level of the second premolar tooth, at about 7 cm. caudal to the center of Rima oris (Fig. 7B) to the level of the first molar tooth, at about 10 cm. caudal to the center of Rima oris (Fig. 10B). It communicated with the maxillary sinus above the infraorbital canal (Figs. 9, 10).

The maxillary sinus (Figs. 9B, 10, 11, 12, 13, 14) extended from the level of the fourth premolar, at about 9 cm caudal to the center of rima oris, to the level of the temporal process of the zygomatic bone, at about 14 cm caudal to the center of Rima oris.

The frontal sinuses extended from the level of the third molar, at about 13 cm caudal to the level of the center of Rima oris, to just caudal to the level of the supraorbital process, at about 16 cm caudal to the center of the Rima oris.

The right and left frontal sinuses (Figs. 13A, 14A) were separated by a complete median partition The septum sinuum frontaliu (Figs. 14A, 15). The frontal sinuses on each side were divided by complete Septa sinuum frontaliu into a Sinus frontalis lateralis (Figs. 15, 16) and a Sinus frontalis medialis (Figs. 15, 16B). Incomplete Laminae intrasinuales project into the frontal sinuses.

The maximum height of the frontal sinuses measured about 0.5, 1.25, 1.25 and 0.75 cm at 13cm, 14 cm, 15 cm and 16 cm caudal to the center of Rima oris respectively.

The maximum width of the frontal sinuses - on one side of the head- measured about 3.3, 3.5, 3.3 and 0.75 cm at 13cm, 14 cm, 15 cm and 16 cm caudal to the center of Rima oris respectively.

The rostral (frontal) pole of the cerebral hemisphere (Fig. 15) was located in a transverse plane with the supraorbital process, at about 15 cm caudal to the center of Rima oris and about 3 cm behind the caudal border of the last molar tooth.

The caudal (occipital) pole of the cerebral hemisphere was located in a transverse plane with the paracondylar process of the occipital bone; at about 2 cm caudal to the temporomandibular joint.

The tympanic cavity (Fig. 19) measured about 1.5 cm in height and about one cm in width. It was located in a level with the external acoustic meatus, at about one cm behind the temporomandibular joint and about 4 cm caudal to the supraorbital process.

The hypophysis cerebri (Fig. 17) was located in between the paired cavernous sinuses in a transverse plane with the root of the supraorbital pro-

cess, at about 4 cm behind the last molar and about 17 cm behind the center of Rima oris.

The rostral colliculi of the Corpora quadrigemina (Fig. 18B) were located in a transverse plane with the temporomandibular joint, at about 5 cm behind the last molar tooth.

The maximum height of the cranial cavity measured about 2.3, 2.8, 5, 3.8 and 4.3 at 15 cm, 16 cm, 17-19 cm, 20 cm and 21 cm caudal to the center of Rima oris respectively. The sudden increase in height at 17- 19 cm caudal to center of Rima oris was caused by the Sella turcica.

The maximum width of the cranial cavity measured about 4, 5, 5.5, 5.2, 2.2 and 2 cm at 16 cm, 17 cm, 18 cm, 19 cm, 20 cm and 21 cm caudal to the center of Rima oris respectively.

The maximum height of the nasal cavity measured about 2.4, 3.6, 4.3, 4.7, 4.9, 5, 6.8, 6, 6, 6.2, 6.4 cm at 3cm, 4 cm, 5 cm, 6 cm, 7 cm, 8 cm, 9 cm, 10 cm, 11 cm, 12 cm and 13 cm caudal to the center of Rima oris respectively.

The maximum width of the nasal cavity measured about 2, 1.7, 3.3, 2.7, 3.1, 3.8, 5, 4.3, 4.4, 5.1, 5.2 cm at 3cm, 4 cm, 5 cm, 6 cm, 7 cm, 8 cm, 9 cm, 10 cm, 11 cm, 12 cm and 13 cm caudal to the center of Rima oris respectively.

The maximum height of the nasopharynx meas-

ured about 3, 2.5 and 2.5cm at 14 cm, 15 cm and 16 cm caudal to the center of Rima oris respectively.

The maximum width of the nasopharynx measured about 1.3 cm at 14 cm - 16 cm caudal to the center of Rima oris .

Figure legends:

Fig. 1: A photograph of adult sheep skull with a probe representing its long axis on which the CT scans and cross sections were perpendicular.

Fig. 2: CT image (A) and cross section (B) at 2 cm caudal to the center of Rima oris. 1- Septum nasi, 2- Plica alaris, 3-Nares, 4- Labium superius, 5- Labium inferius, 6- Rima oris, 7- Processus nasalis ossis incisivi, 8- Pars incisiva corporis mandibulae, 9- Vestibulum nasi, 10- Vomer, 11- Cartilago nasi lateralis dorsalis, 12- Apex linguae.

Fig. 3: CT image (A) and cross section (B) at 3 cm caudal to the center of Rima oris. 1- Pars mobilis septi nasi, 2- Plica alaris, 3- Cartilago nasi lateralis dorsalis, 4- Labium superius, 5- Labium inferius, 6- Rima oris, 7- Processus nasalis ossis incisivi, 8- Pars incisiva corporis mandibulae, 9- Vestibulum nasi, 10- Vomer, 11- Nares 12- Apex linguae, 13- Cavum oris proprium, 14- Organum vomeronasale.

Fig. 4: CT image (A) and cross section (B) at 4

cm caudal to the center of Rima oris. 1- Septum nasi, 2- Plica alaris, 3- Plica recta, 4- Labium superius, 5- Labium inferius, 6- Rima oris, 7- Processus nasalis ossis incisivi, 8- Pars incisiva corporis mandibulae, 9- Meatus nasi communis, 10- Vomer, 11- Os nasale, 12- Apex linguae, 13- Cavum oris proprium, 14- Organum vomeronasale, 15- Ductus nasolacrimalis.

Fig. 5: CT image (A) and cross section (B) at 5

cm caudal to the center of Rima oris. 1- Septum nasi, 2- Meatus nasi dorsalis, 3- Concha nasalis ventralis, 4- Maxilla, 5- Concha nasalis dorsalis, 6- Labium inferius, 7- Palatum durum, 8- Corpus mandibulae, 9- Meatus nasi communis, 10- Vomer, 11- Os nasale, 12- Lingua, 13- Cavum oris proprium, 14- Organum vomeronasale, 15- Foramen mentale.

Fig. 6: CT image (A) and cross section (B) at 6

cm caudal to the center of Rima oris. 1- Septum nasi, 2- Meatus nasi dorsalis, 3- Concha nasalis ventralis, 4- Maxilla, 5- Concha nasalis dorsalis, 6- Ductus nasolacrimalis, 7- Palatum durum, 8- Corpus mandibulae, 9- Meatus nasi communis, 10- Vomer, 11- Os nasale, 12- Lingua, 13- Organum vomeronasale, 14- Papillae buccales, 15- N. hypoglossus, 16- Canalis mandibulae.

Fig. 7: CT image (A) and cross section (B) at the

level of the second premolar tooth (7 cm caudal to the center of Rima oris). 1-

Septum nasi, 2- Meatus nasi dorsalis, 3- Meatus nasi medius, 4- Meatus nasi ventralis, 5- Concha nasalis dorsalis, 6- Concha nasalis ventralis, 7- Palatum durum, 8- Pars molaris corporis mandibulae, 9- Mucatus nasi communis, 10- Vomer, 11- Os nasale, 12- Corpus linguae, 13- Cavum oris proprium, 14- Organum vomeronasale, 15- Vestibulum oris, 16- Dentis premolaris superior II (P2), 17- Dentis premolaris inferior II (P2), 18- Sinus palatinus, 19- Maxilla, 20- Canalis mandibulae.

Fig. 8: CT image (A) and cross section (B) at the

level of the third premolar tooth (8 cm caudal to the center of Rima oris). 1- Septum nasi, 2- Meatus nasi dorsalis, 3- Meatus nasi medius, 4- Meatus nasi ventralis, 5- Concha nasalis dorsalis, 6- Concha nasalis ventralis, 7- Palatum durum, 8- Pars molaris corporis mandibulae, 9- Meatus nasi communis, 10- Vomer, 11- Os nasale, 12- Corpus linguae, 13- Cavum oris proprium, 14- Bulla conchalis ventralis 15- Vestibulum oris, 16- Dentis premolaris superior III (P3), 17- Dentis premolaris inferior III (P3), 18- Sinus palatinus, 19- Maxilla, 20- Canalis mandibulae.

Fig. 9: CT image (A) and cross section (B) at the

level of the fourth premolar tooth (9 cm caudal to the center of Rima oris). 1- Septum nasi, 2- Meatus nasi dorsalis, 3- Meatus nasi medius, 4- Meatus nasi ventralis, 5- Sinus conchae dorsalis, 6- Concha nas-

alis ventralis, 7- Palatum durum, 8- Pars molaris corpus mandibulae, 9- Meatus nasi communis, 10- Vomer, 11- Sinus palatinus 12- Corpus linguae, 13- Cavum oris proprium, 14- Dentis premolaris superior IV (P4), 15- Dentis premolaris inferior IV (P4), 16- Vestibulum oris, 17- Sinus maxillaries.

Fig. 10: CT image (A) and cross section (B) at

the level of the first molar tooth (10 cm caudal to the center of Rima oris). 1- Septum nasi, 2- Meatus nasi dorsalis , 3- Meatus nasi medius, 4- Meatus nasi ventralis, 5- Sinus conchae dorsalis, 6-Concha nasalis ventralis, 7- Palatum durum, 8- processus palatinus maxillae, 9- Meatus nasi communis, 10- Vomer, 11- Sinus palatinus, 12- Corpus linguae, 13- Cavum oris proprium, 14- Dentis molaris superior I (M1), 15- Dentis molaris inferior I (M1), 16- Vestibulum oris, 17- Pars molaris corpus mandibulae, 18- Sinus maxillaris, 19- Maxilla, 20- Canalis infraorbitalis, 21- Ductus nasolacrimalis.

linguae, 13- Cavum oris proprium, 14- Vestibulum oris, 15- Canalis infraorbitalis, 16- Pars molaris corporis mandibulae, 17- Meatus nasi communis, 18- Ductus nasolacrimalis, 19- Os hyoideum, 20- Sinus palatinus.

Fig. 12: CT image (A) and cross section (B) at

the level of the rostral portion of the third molar tooth (12 cm caudal to the center of Rima oris). 1- Septum nasi, 2- Meatus nasi dorsalis, 3- Meatus nasi medius, 4- Meatus nasi ventralis, 5- Sinus conchae dorsalis, 6- Concha nasalis ventralis (with divided basal lamella), 7- Palatum durum, 8- Processus alveolaris maxillae, 9- Dentis molaris superior III (M3), 10- Dentis molaris inferior III (M3) 11- Sinus maxillaris, , 12- Corpus linguae, 13- Vomer, 14- Vestibulum oris, 15- Infraorbital canal, 16- Pars molaris corporis mandibulae, 17- Meatus nasi communis, 18- Sinus infraorbitalis, 19- Sinus palatinus, 20- Canalis mandibulae, 21- Concha nasalis medius.

Fig. 13: CT image (A) and cross section (B) at

the level of the third molar tooth, close to its caudal border (13 cm caudal to the center of Rima oris). 1- Lamina perpendicularis ossis ethmoidale, 2- Os frontale, 3- Os pterygoideum, 4- Dentis molaris superior III (M3), 5- Os zygomaticum, 6- Palatum molle, 7- Isthmus faucium, 8- Labyrinthus ethmoidalis, 9- Sinus frontalis, 10- Ramus mandibulae, 11- Choana, 12- Sinus maxillaris, 13- Sinus conchae dorsalis, 14- Mea-

Fig. 11: CT image (A) and cross section (B) at the level of the second molar tooth (11 cm caudal to the center of Rima oris). 1- Septum nasi, 2- Meatus nasi dorsalis , 3- Meatus nasi medius, 4- Meatus nasi ventralis, 5- Sinus conchae dorsalis, 6-Concha nasalis ventralis, 7- Palatum durum, 8- Processus alveolaris maxillae, 9- Dentis molaris superior II (M2), 10- Dentis molaris inferior II (M2), 11- Sinus maxillaris, 12- Corpus



tus nasi dorsalis, 15- Ductus nasolacrimalis.

Fig. 14: CT image (A) and cross section (B) at a level just rostral to the cribriform plate (14 cm caudal to the center of Rima oris). 1- Lamina perpendicularis ossis ethmoidale, 2- Cellulae ethmoidalis et Meatus ethmoidales, 3- Nasopharynx, 4- Os frontale, 5- Oropharynx, 6- Palatum molle, 7- Sinus frontales (divided by the complete Septa sinuum frontalem and into which project the incomplete Laminae intrasinuales), 8- Sinus maxillaris, 9- Hamulus pterygoideus, 10- Cartilago epiglottica, 11- M. masseter, 12- Bulbus oculi, 13- Os pterygoideum, 14- Ramus mandibulae, 15- Processus temporalis ossis zygomatici, 16- Septum sinuum frontalem (a complete median partition between right and left frontal sinuses), 17- Septum Pharyngis, 18- Lamina perpendicularis ossis palatini.

Fig. 15: CT image (A) and cross section (B) at a level close to the rostral border of the supraorbital process (15 cm caudal to the center of Rima oris). 1- Os frontale, 2- Sinus frontalis (lateralis et medialis), 3- Septum sinuum frontalem (a complete median partition between right and left frontal sinuses), 4- Bulbus oculi, 5- Processus coronoidaeus, 6- Musculi oculi, 7- Septum pharyngis, 8- Canalis opticus, 9- Os presphenoidale, 10- Crista galli, 11- Arcus zygomaticus, 12- Polus frontalis hemispherii cerebri 13- Nasopharynx, 14- Palatum

molle, 15- Ramus mandibulae, 16- Processus zygomaticus ossis frontale, 17- M. masseter, 18- Lamina perpendicularis ossis palatini, 19- Os pterygoideum, 20- Cavum laryngis, 21- Laryngopharynx, 22- Hamulus pterygoideus, 23- Os hyoideum.

Fig. 16: CT image (A) and cross section (B) at a level close to the caudal border of the supraorbital process (16 cm. caudal to the center of Rima oris). 1- Os frontale, 2- Sinus frontalis (lateralis et medialis), 3- Hemisphere cerebri, 4- Bulbus oculi, 5- Processus zygomaticus ossis frontale, 6- Os hyoideum, 7- Arcus zygomaticus, 8- Processus pterygoideus ossis basisphenoidale, 9- Os presphenoidale, 10- Os basisphenoidale, 11- Ramus mandibulae, 12- M. pterygoideus lateralis, 13- Nasopharynx, 14- Palatum molle 15- M. masseter, 16- Processus coronoidaeus.

Fig. 17: CT image (A) and cross section (B) at the level of the coronoid process of the mandible (17 cm caudal to the center of the Rima oris). 1- Os frontale, 2- Cerebrum, 3- Processus zygomaticus ossis frontale, 4- Arcus zygomaticus, 5- Processus coronoidaeus, 6- Sinus cavernosus (enclosing Ramus mirabile epidurale rostrale) 7- Hypophys cerebri 8- Os basisphenoidale, 9- Stylohyoideum, 10- Ramus mandibulae, 11- M. masseter, 12- Pars squamosa ossis temporale, 13- Cavum laryngis, 14- V. lingualis, 15- Epiglottis.

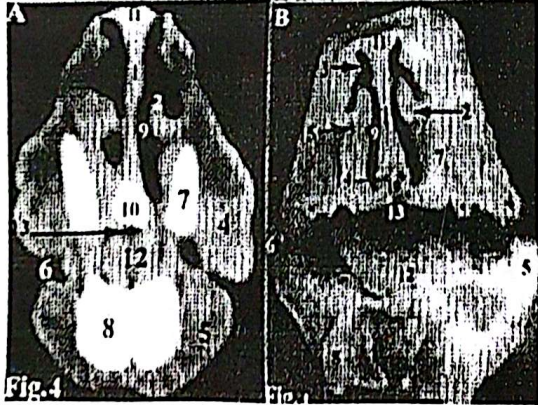
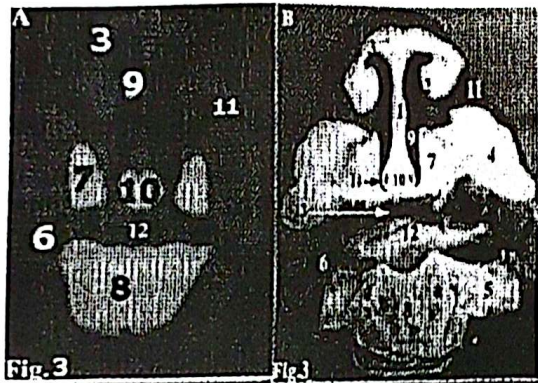
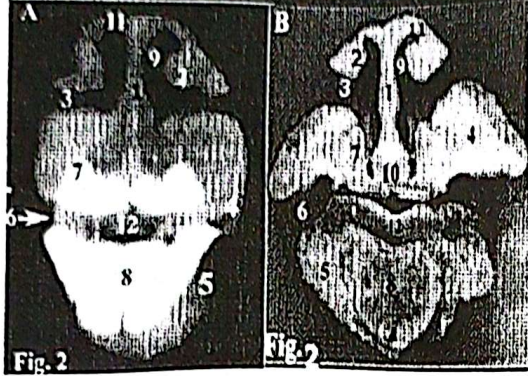
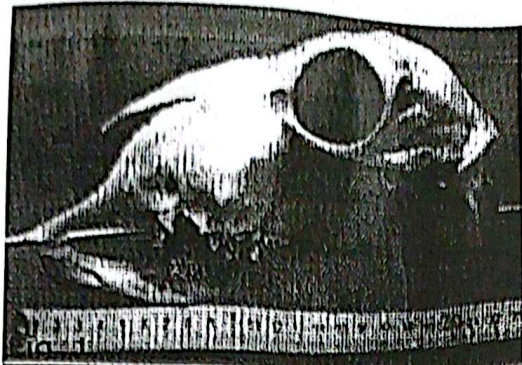
Fig. 18: CT image (A) and cross section (B) at the level of the tempromandibular joint (18 cm caudal to the center of the Rima oris). 1- Os frontale, 2- Hemispherium cerebri, 3- M. temporalis, 4- Processus zygomaticus ossis temporale, 5- Processus coronoideus, 6- Processus condylaris, 7- Cavum laryngis, 8- Articulatio tempromandibularis, 9- Stylohyoideum, 10- Alae ossis basisphenoidale, 11- M. masseter, 12- Os basisphenoidale, 13- Processus cornualis ossis frontale, 14- Pars squamosa ossis temporale, 15- Sinus cavernosus, 16- Colliculus rostralis tectum mesencephali (Corpora quadrigemna), 17- Lymphnodi retropharyngei medilales, 18- Crura cerebri, 19- Aditus oesophagi, 20- Ramus mandibulae, 21- Substantia alba, 22- Substantia grisea.

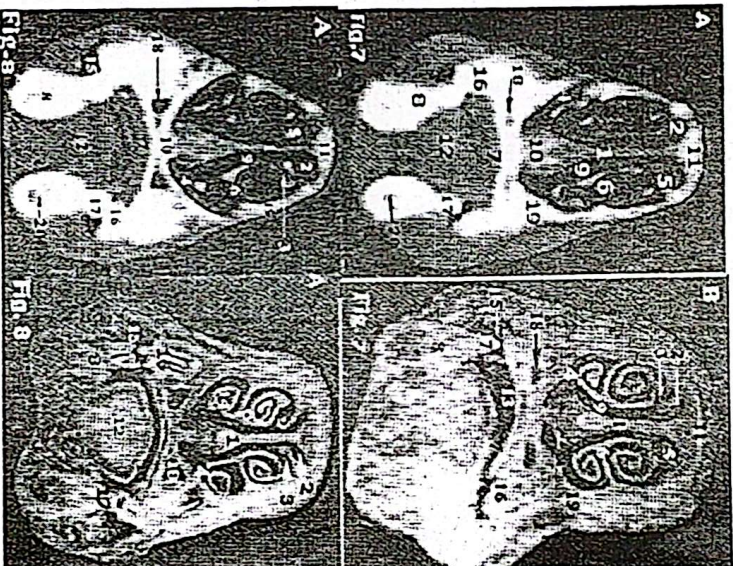
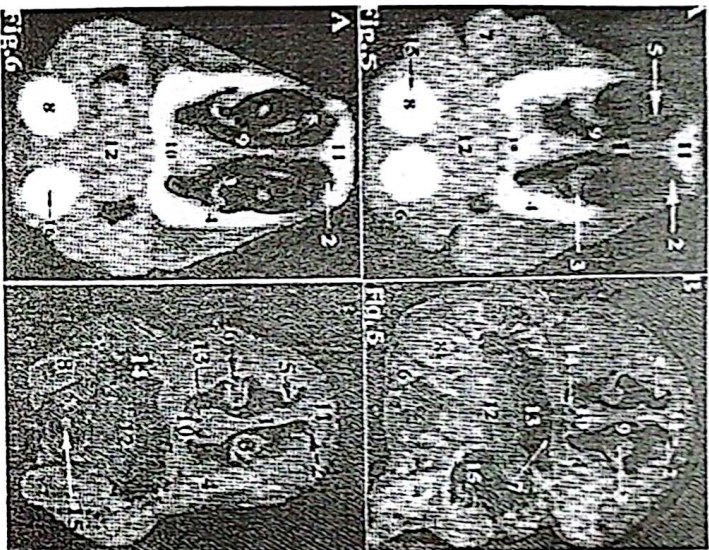
Fig. 19: CT image (A) and cross section (B) at the level of the external acoustic meatus (19 cm caudal to the center of the Rima oris). 1- Os parietale, 2- Hemispherium cerebri, 3- Cerebellum, 4- Pars basilaris ossis occipitalis, 5- Pars lateralis ossis occipitalis, 6- Processus paracondylaris, 7- Fossa condylaris dorsalis, 8- Trachea, 9- Condylus occipitalis, 10- Esophagus.

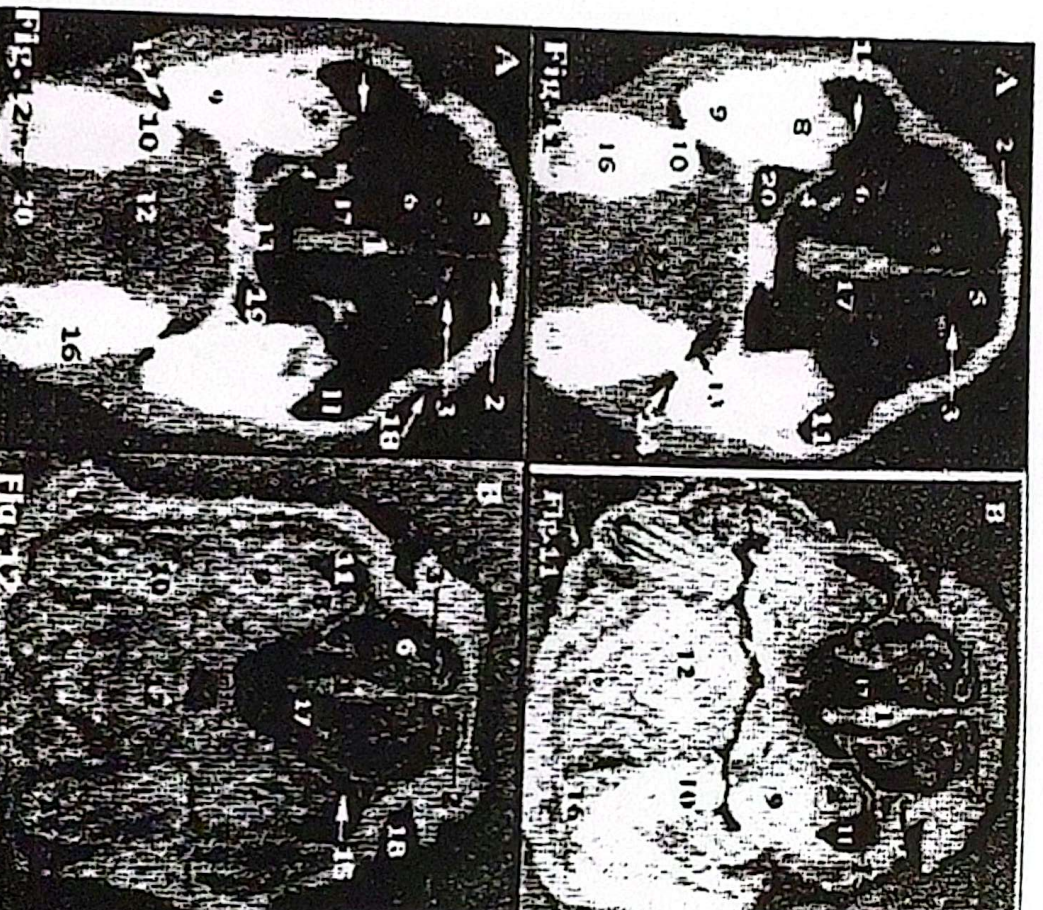
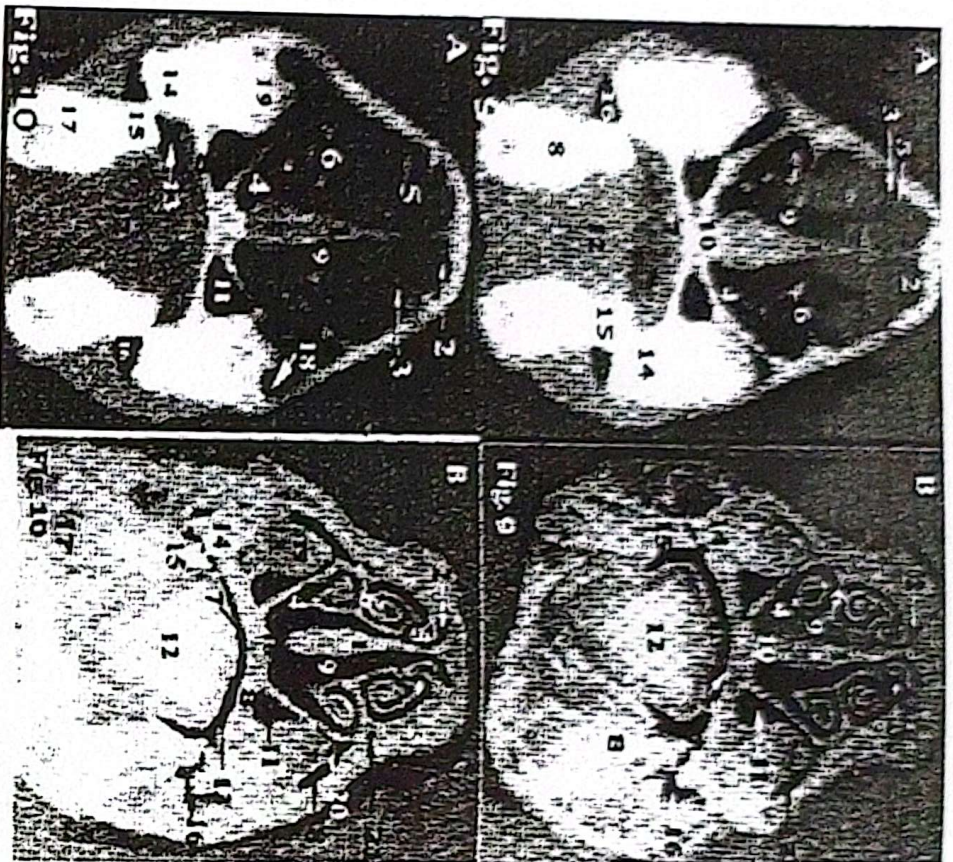
tale, 5-falx cerebri, 6-Tentorium cerebelli (enclosing Sinus transversus durae matris, 7-Meatus acusticus externus, 8 - Meatus temporalis, 9- Auricula, 10 -Cavum tympani, 11- Stylohyoideum, 12- Trachea, 13- Mm. longus capitis and rectus capitis ventralis.

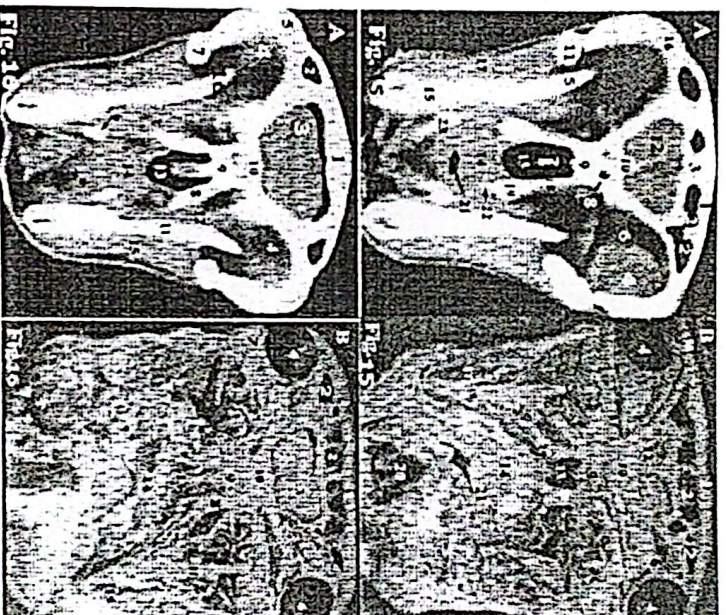
Fig. 20: CT image at a level with the paracondylar process close to its rostral border (20 cm caudal to the center of the Rima oris). 1- Squama occipitalis, 2- Cerebellum, 3- Polus caudalis hemispherii cerebri, 4- Pars basilaris ossis occipitalis, 5- Pars lateralis ossis occipitalis, 6- Processus paracondylaris, 7- Fossa condylaris dorsalis, 8- Trachea, 9- Condylus occipitalis, 10- Esophagus.

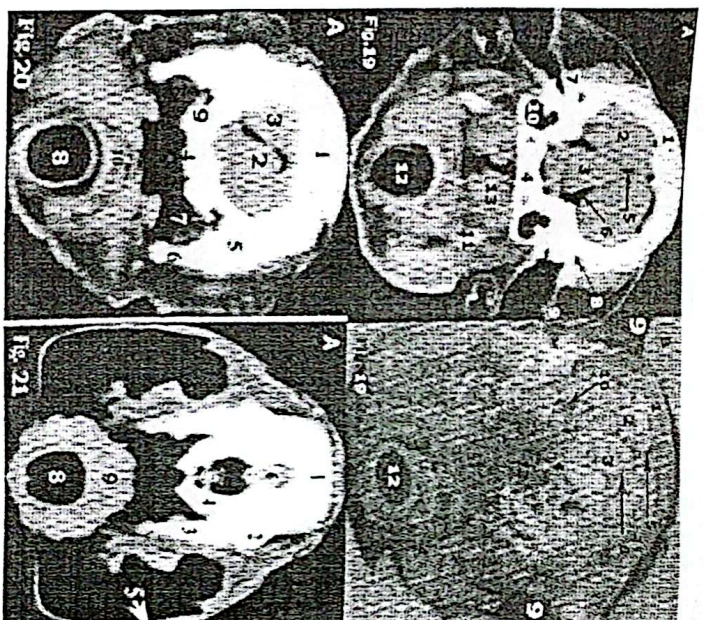
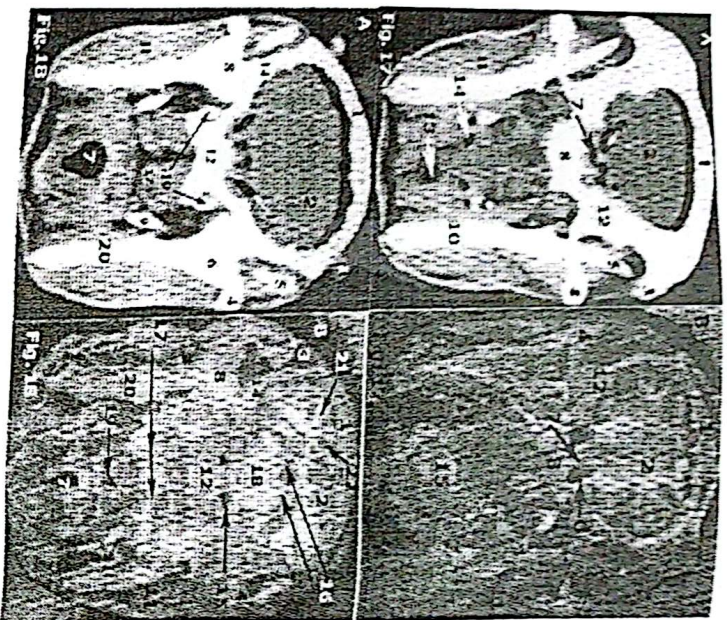
Fig. 21: CT image at a level with the occipital condyles (21 cm caudal to the center of the Rima oris). 1- Squama occipitalis, 2- Pars lateralis ossis occipitalis, 3- Processus paracondylaris, 4- Condylus occipitalis, 5- Auricula, 6- Cerebellum, 7- Medulla oblongata, 8- Trachea, 9- Esophagus, 10-Cisterna cerebellomedullaris.











DISCUSSION

This initial paper presents the first series of CT-based anatomically labeled sectioned images of the head of the sheep.

Knowledge of normal transverse anatomy of the head of sheep is essential to the evaluation of CT scans.

CT images of the sheep head provides complete details of the anatomical structures and correlated well with corresponding gross specimens.

CT provides good discrimination between bone and soft tissue architectures. 2, 3,4, 5, 6, 8, 9, 10, 15, 16, 17,18.

The use of CT imaging in sheep is currently limited because of its expense and less availability but with developing technology, it will soon become more readily available.

The present study should serve as an initial reference aid in CT imaging diagnosis of the sheep head disorders and in understanding the complex anatomical features of the sheep head.

In conclusion, findings of CT images of the current study are presented as a reference for normal anatomy and clinical imaging studies of the sheep head.

REFERENCES

- Olesen N and Moe L. An introduction to computed tomography (CT) in the dog. *Eur J Compan Anim Pract* 1998; 8: 29-36.
- Fike JR, LeCouteur RA, Cann CE. Anatomy of the canine brain using high resolution computed tomography. *Vet Radiol Ultrasound* 1981; 22: 236-243.
- Fike JR, LeCouteur RA, Cann CE. Anatomy of the canine orbital region. *Vet Radiol Ultrasound* 1984; 25: 32-36.
- Fecny D, Fletcher T, Hardy R. Atlas of correlative imaging anatomy of the normal dog. *Ultrasound and computed tomography*. Philadelphia: WB Saunders Co. 1991.
- George T, Smallwood JE. Anatomic atlas for computed tomography in the mesencephalic dog. *Head Neck. Vet Radiol Ultrasound* 1992; 33: 217-240.
- Barbee DD, Allen JR. Computed tomography in horse: technique. *Vet Radiol Ultrasound* 1987; 28, 144-151.
- Dick KJ. Computed tomography of the head of horses. *Magyar Allatorvosok Lapja* 1995; 50: 309-311.
- Arencibia A, Vazquez JM, Rivero M, Latorre R, Sandoval JA, Vilar JM, Ramirez JA. Computed tomography of normal craniocervical structures in two horses. *Anat Histol Embryol* 2000; 29: 295-299.
- Morrow, KL, Park RD, Spurgeon TL, Stashak TS, Arceaux B. Computed tomographic imaging of the equine head. *Vet Radiol Ultrasound* 2000; 41: 491-497.
- Probst A, Henninger W, Willmann DM. Communications of normal nasal and paranasal cavities in computed tomography of horses. *Vet Radiol Ultrasound* 2005; 46: 44-48.
- Hahncock JT, Pugh DG, Carice RE, Hammond L. Computed tomography of the llama head: Technique and normal anatomy. *Vet Radiol Ultrasound* 1995; 36: 290-296.

- Arceibia A, Vazquez JM, Ramirez JA, Sandoval JA, Ramirez G, Sosa C. Anatomy of the craniocephalic structures of the goat by imaging techniques: A computerized tomographic study. *Anat Histol Embryol* 1997; 26: 161-164.
- Schaller O. Illustrated Veterinary Anatomical Nomenclature. Stuttgart: Enke Verlag. 1992.
- Nomina Anatomica Veterinaria (NAV). Published by International Committee on Veterinary Gross Anatomical Nomenclature of the World Association of Veterinary Anatomists. Zurich and Ithaca, New York. 2005.
- Kaufman HH, G Cohen, TF Glass, Huchton JD, Pruessener JL, Ostlow FT, Andia-Wallenbaugh AM, Dujovny M. CT Atlas of the dog brain. *J Comput Assist Tomogr* 1981; 5: 529-537.
- Peterson PR, Bowman KF. Computed tomographic anatomy of the distal extremity of the horse. *Vet Radiol Ultrasound* 1988; 29: 147-156.
- Warmerdam EPL, Klein WR, Van-Herpen BP. Infectious temporomandibular joint disease in the horse: computed tomographic diagnosis and treatment of two cases. *Vet Record* 1997; 141: 172-174.
- Whitton, RC, Buckley C, Donovan T, Wales AD, Dennis R. The diagnosis of lameness associated with distal limb pathology in a horse: a comparison of radiography, computed tomography and magnetic resonance imaging. *Vet J* 1998; 155: 223-229.