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Gross and histological studies on the epididymis of large white Yorkshire pig (*Sus scrofa*)

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Abstract
The gross study was conducted on the 30 Large White Yorkshire pig aged between seven months to around one and half year. It was composed of three different parts: head, body and tail. It was attached to the dorsal extremity of the testis by a fibrous band. The upper extremity of the testis was occupied by the head of epididymis whereas lower extremity was slightly thicker and connected to the tail of epididymis. Histologically, the epididymis was covered by the thick fibrous capsule called as the tunica albuginea. It was comprised predominantly of collagen fibres with few reticular and elastic fibres with blood vessels. The epididymal duct was highly convoluted and lined by the pseudostratified columnar ciliated epithelium. The pseudostratified epithelium of epididymal duct had 3 types of cells, viz. principal cells, basal cells and apical cells.

Keywords: Pig, epididymis, gross, histological, epididymal duct

1. Introduction
Piggery is the sector that directly plays an important role in the socioeconomic status of the poor rural people, more particularly in the tribal population of the country as it acts as an insurance coverage for the downtrodden and socially weaker section of the society. The testes are the most essential and primary organs of the male reproductive system. The epididymis is a vigorous and cylindrical organ which is closely attached to the testicles. It not only controls the maturation of spermatozoa but also their exit from the male reproductive system and it serves as a storage reservoir for spermatozoa. The knowledge of gross structure and histology of epididymis is important for understanding normal physiology, histo-pathology, surgical anatomy and breeding aspects. This sphere always attracts the researchers for adding new information by their research which results to enrich and update the knowledge.

2. Materials and Methods
The 30 pairs of epididymis were used for the gross anatomical studies. The epididymis were procured from apparently healthy animals from the local abattoir house, Bikaner. The samples were cleaned and the adhering connective tissue and fats were removed and placed in the surgical plate in their normal position. The measurement for various physical parameters like width of head epididymis, thickness of head epididyms, width of middle epididymis, thickness of middle epididymis, width of tail epididymis, thickness of tail epididymis and circumference of head, middle and tail epididymis were carried out.

2.1 Width of head epididymis: It was recorded at the widest portion of the caput and recorded in cm.

2.2 Thickness of head epididymis: Thickness was recorded at the maximum height of the expanded portion of caput and measured in cm.

2.3 Width of middle epididymis: It was measured as a distance between the lateral and medial walls of the corpus epididymis in the middle of its length. It was calculated in cm.

2.4 Thickness of middle epididymis: It was recorded as the distance between the anterior and posterior walls of the epididymis in the middle of the corpus. It was calculated in cm.

2.5 Width of tail epididymis: It was measured as a distance between the lateral and medial surfaces of cauda epididymis and recorded in cm.

2.6 Thickness of tail epididymis: It was measured as the distance between anterior and posterior margins of the cauda epididymis. It was calculated in cm.

2.7 Circumference of head, middle and tail epididymis: The circumference was recorded with the help of the non-stretchable thread with the help of the scale. It was measured in cm.

After gross examination, small pieces of tissues (4-6 mm thickness) were collected from the 12 pairs (12 right and 12 left) of epididymis for the histological study. From the each epididymis, tissues were obtained from the 3 fixed anatomical regions to explore the regional differences, if any. Tissues were immediately fixed in 10% formal saline for 48 hrs., Bouin's fluid for 12 hrs. and Zenker's fluid for 18 hrs. After fixation, the tissues were washed in running tap water for 6-10 hrs. The tissues were dehydrated in various ascending grades of alcohol. After proper dehydration, tissues were embedded in paraffin wax of melting point of 58-60 ºC. The tissues were sectioned serially at 5 µm thickness. Then the sections were mounted on albuminized slides and dried. Finally the sections were stained with the following routine histological stains to demonstrate different components of the epididymis.

Statistical Analysis was done with the help of the T test.

3. Results and Discussion

3.1 Gross Studies

The attached border was posterior border which had the epididymis closely attached to testis (Fig. 1). These observations were in total agreement with the reports of Robert (1971) [20] in boar, Getty (1977) [10] in horse, dog and ruminant, Dyce *et al.* (2002) [8] in boar, Yaseen (2009) [28] in Marwari goat and Singh (2013) [25] in Marwari sheep. The upper end of the testis was occupied by the head of epididymis whereas lower end slightly thicker and connected to the tail of epididymis. These observations were in accordance with the findings of Sisson and Grossman (1953) [26] in domestic animals, Babu (2012) [4] in pig, Zayed *et al.* (2012) [29] in one humped camel, Pasha *et al* (2013) [17] in one humped camel, Pathak *et al.* (2014) [18] in Gaddi goat, Raji and Ajala (2015) [19] in West African dwarf buck goat, Adhikary *et al.* (2016) [1] in bull and Hanumant (2016) [11] in goat.

The tail of the epididymis was very large, directed upward and had blunt conical projections at the ventral extremity of the testis. These observations were in total agreement with the reports of Babu (2012) [4] in pig and Kalita *et al.* (2015) [12] in Mizo local pigs.

The average thickness of right epididymis in head, middle and tail portions were 1.77±10 cm, 0.39±0.13 cm and 2.35±0.26 cm respectively while average thickness of left epididymis in head, middle and tail portions were 1.92±0.49 cm, 0.41±1.50 cm and 2.35±0.35 cm, respectively. The average width of right epididymis in head, middle and tail portions were 2.47±0.27 cm, 1.02±0.21 cm and 2.60±0.36 cm respectively while the average width of left epididymis in head, middle and tail portions were 2.54±0.26 cm, 1.05±0.23 cm and 2.68±0.59 cm, respectively. The average circumference of right epididymis in head, middle and tail portions were 8.38±0.21 cm, 2.82±0.26 cm and 9.40±0.30 cm, respectively while the average circumference of left epididymis in head, middle and tail portions were 8.44±0.24 cm, 3.04±0.25 cm and 9.79±0.30 cm, respectively. The values of width, thickness and circumference of left epididymis were non-significantly higher ($p>.05$) than right one in current study. These findings were in total agreement with the reports of Bhattacharyya *et al.* (2010) [5] in sheep. Khan *et al*. (2015) [13] described that the statistically no significant difference in the right and left epididymis parameters of the male goat. Pathak *et al.* (2014) [18] mentioned that the mean width and thickness of the right head epididymis was greater than the left one, which were recorded as 2.77 cm, 1.89 cm, 2.73 cm and 1.80 cm in Gaddi goat. The mean width of the left middle epididymis was lesser than the right one, which was recorded as 0.83 cm and 0.96 cm, respectively and the mean thickness of the left middle epididymis was equal to right one, which was recorded 0.24 cm and 0.24 cm, respectively. The width of the left tail epididymis was lesser than the right one, which was recorded as 1.82 cm and 1.85 cm. The thickness of the left tail epididymis was greater than the right one, which was recorded as 1.89 cm and 1.87 cm, respectively in Gaddi goat.

3.2 Histological Studies

The epididymis was covered by the thick fibrous capsule called as the tunica albuginea (Fig.2). This observation was similar as the findings of Dellmann and Eurell (1998) [7] in domestic animals and Sarma *et al.* (2012) [22] in Assam goat. The tunica albuginea comprised predominantly of collagen fibres with few reticular and elastic fibres (Fig. 3). Reticular fibres were found around the blood vessels in the loose connective tissue. The smooth muscles were found between the connective tissue fibres and surrounded each tubule. These findings were similar with the reports of Alkafafy *et al.* (2011) [2] in camel, Sarma *et al.* (2012) [22] in Assam goat and Shukla *et al* (2015) [24] in Chamurthi horses. However, Trautmann and Fiebiger (1957) [27] mentioned that the muscular tunica albuginea was present in horse. On contratry, Kumar and Chaurasia (2008) [15] stated that the epididymis was enveloped within dense fibrous capsule was composed of collagen and reticular fibres in buffalo calves.

The epididymal duct at the caput region revealed an irregular contour that varied from triangular to stellate shaped lumina contained no or few spermatozoa. These findings were similar as the observations of Alkafafy *et al.* (2011) [2] in camel. However, Zayed *et al.* (2012) [29] mentioned that the lamina propria of the epididymal duct contained a layer of interlaced elastic fibers in one- humped camel.

It was lined with pseudostratified columnar ciliated epithelium similar as Dellmann and Eurell (1998) [7] in domestic animals, Kishore (2006) [14] in sheep, Mrigesh *et al.* (2008) [16] in Neelgai, Archana *et al.* (2009) [3] in Gaddi goat, Yaseen (2009) [28] in Marwari goat, Sarma *et al.* (2012) [22] in Assam goat, Zayed *et al.* (2012) [29] in one humped camel, Singh (2013) [25] in Marwari sheep and Shukla *et al.* (2015) [24] in Chamurthi horses. On contrary, Sharma *et al* (2014) [23] in goat described that the epididymal duct was lined with columnar epithelium. In present study, the pseudostratified epithelium of epididymal tubule was composed of 3 cell types, i.e. principal cells, basal cells and apical cell (Fig. 4). These observations were in accordance to the reports of Kumar and Chaurasia (2008) [15] in buffalo calves and Sarma *et al.* (2012) [22] in goat. Whereas, Sanchez *et al.* (1998) [21] observed five different cell types in epididymis of cat and these were principal cells, basal cells, narrow cells, apical cells and migratory cells; Yaseen (2009) [28] reported 4 cell types, which were principal cells, basal cells, narrow cells and apical cell in Marwari goat. Epididymal tubules displayed

numerous intraepithelial glands in the middle segment of the duct as same as the reported by Zayed *et al.* (2012) [29] in one humped camel. However, Gaykee *et al.* (2008) [9] in horse and Alkafafy *et al.* (2011) [2] in camel noted out that the pseudostratified epithelium of epididymal tubule had principal tall columnar cells and short basal cells in horse.

The apical parts of tall columnar cells were stained lighter due to the presence of stereocilia (Fig.4). These findings were also reported by Bilaspuri and Kaur (1992) [6] in goat, Dellmann and Eurell (1998) [7] in domestic animals and Mrigesh *et al.* (2008) [16] in Neelgai.

Vacuolation was seen in the apical part of the cytoplasm of the principal cells (Fig.5). Similar finding was in total agreement with the report of Sarma *et al.* (2012) [22] in Assam goat.

Fig 1: Photograph showing Testis (T) of Large White Yorkshire pig attached with Epididymis (E).

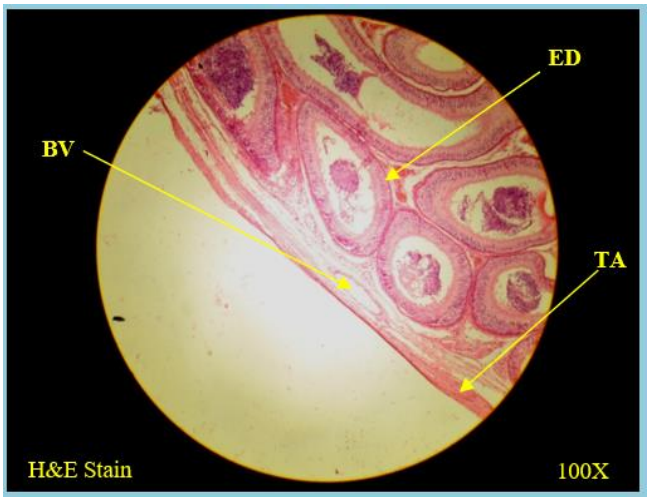

Fig 2: Cross section of epididymis showing Blood vessels (BV), Epididymal duct (ED) and Tunica albuginea (TA).

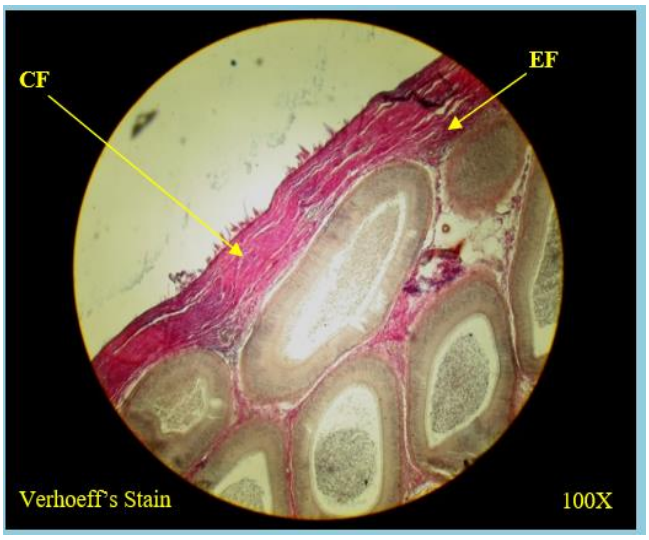

Fig 3: Cross section of epididymis showing Collagen fibres (CF) and Elastic fibres (EF).

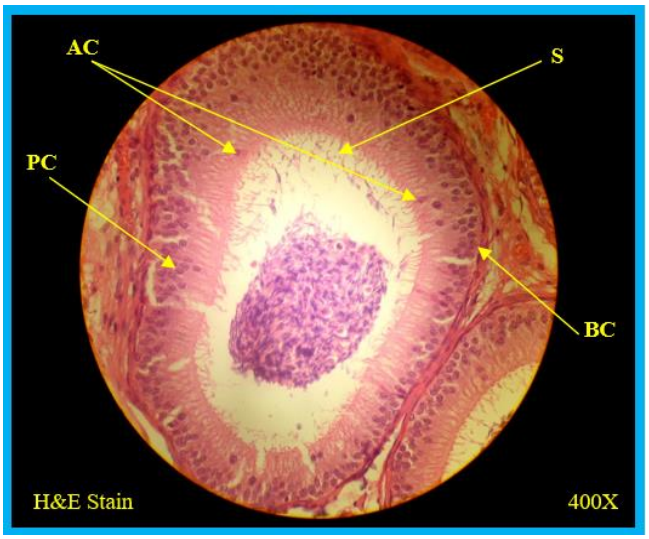

Fig 4: Cross section of epididymal duct with different cell types in epithelium of epididymis showing Apical cells (AC), Principal cells (PC), Basal cells (BC) and Stereocilia (S).

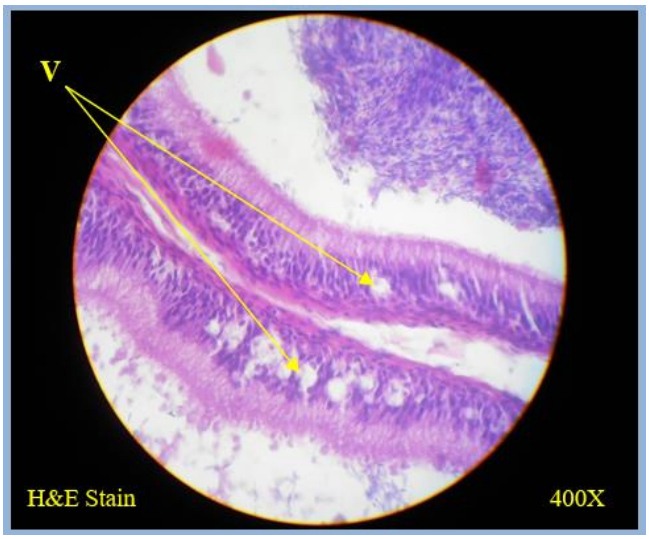

Fig 5: Cross section of epididymal duct showing Vacuolation (V).

4. Conclusion

Grossly, the attached border was posterior border which had the epididymis closely attached to testis. The upper end of the testis was occupied by the head of epididymis whereas lower end slightly thicker and connected to the tail of epididymis. The tail of the epididymis was very large, directed upward and had blunt conical projections at the ventral extremity of the testis. Histologically, the epididymis was covered by the thick fibrous capsule called as the tunica albuginea. The tunica albuginea comprised predominantly of collagen fibres with few reticular and elastic fibres. Reticular fibres were found around the blood vessels in the loose connective tissue. The smooth muscles were found between the connective tissue fibres and surrounded each tubule. The epididymal duct was lined with pseudostratified columnar ciliated epithelium.

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