

The morphology of the penis in porcupine (*Hystrix cristata*)

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ABSTRACT: In this study, histological and macroanatomical structures of porcupine penis were examined on 3 adult male porcupines. The non-erectile position of porcupine penis was directed to caudal. There was an obvious collum penis. Glans penis with a black colour was easily distinguished from corpus penis which had a white color. There were cornified papillae covering on both the glans penis and corpus penis. Two small nail symmetrical structures were noted in connective tissue just behind of glans penis, and under the urethra of the corpus penis were distinguished. Histological examinations indicated that these structures histologically fulfilled completely to the name as the nail contained an inner and an outer layer, namely, connective tissue and keratin, respectively. Histological evaluations also showed that it is suitable to categorize the porcupines penis as vascular type. In conclusion, the anatomy of porcupine penis was initially examined in the present study. Our findings will make an important contribution to the knowledge of similar subjects.

Keywords: *Hystrix cristata*; porcupine; penis

The rodents (*Rodentia*), which are the widest order of placental mammals, comprise of more than half of the mammals known at the present day. The porcupine, which is the subject of this study, is from Hystricidae family, which constitutes a small group of the order *Rodentia* (Weichert, 1970; Kuru, 1987; Demirsoy, 1992).

There was relatively more information on the anatomy of the penis of both domestic (Nickel et al., 1981; Dursun, 1996) and laboratory animals (Green, 1963; Cook, 1965; McLaughlin and Chiasson, 1979; Vilmann and Vilmann, 1983; Popesko et al., 1990; Dinc et al., 1996). However, our literature survey showed that there was no reported information on the anatomy of the penis of porcupines.

This investigation was, therefore, focused on the anatomy of the penis in porcupines for the first time to extend the knowledge in this field.

MATERIAL AND METHODS

Histological and macroanatomical structure of porcupine penis was examined on 3 adult male porcupines. The erection of the penis was provided by

an electro ejaculator. For this purpose, a rectal probe (100 mm in length, and 7 mm in diameter) was inserted to the rectum, then electrical stimulation was applied for intervals of 3 to 5 seconds, and alternated with rest periods of similar duration. During each stimulation, the current increased until penis was erect; this took between 1–2 minutes. Then the erected penis was photographed. The penises were trimmed and fixed in 10% neutral formalin solution, routinely decalcified in 5% nitric acid solution, and embedded in paraffin. Serial 5 µm sagittal and vertical sections were stained with hematoxylin and eosin (H & E), van Gieson's Collagen Fiber stain (vGH), and Masson Trichrome Connective tissue stain (MTC) (Luna, 1968).

RESULTS

Macroanatomic findings (Figures 1 and 2)

The penis was located at the regio urogenitalis, and was directed caudally. Its average length and diameter was 5 cm and 1 cm, respectively. There was an obvious collum penis after glans penis, which



Figure 1. **1** – Grossly, lateral appearance of non-erectile penis: b = glans penis, c = collum penis, d = corpus penis. **2** – Erectile penis: a = cornified papillae, e = penis nail

was black in colour. There was corpus penis, that was white in color and that has average 4 cm length after collum penis. Raphe preputii was observed on urethral surface of corpus penis. There were cornified papillae on the dorsal surface of both corpus penis and glans penis. Cornified papillae were more present intensely at the glans penis. Two small nails in the penis structures, measuring approximately 2–3 mm length 1–2 mm width at the right and left sides, were buried in connective tissue cushions under urethra, immediately after glans penis when the penis was at a non-erectile position. It was determined that in the erectile penis, there are caverns around the connective tissue where nails that are

buried, and are filled with blood upon erection, and cause these nails exit from their places.

Histological findings (Figures 3, 4 and 5)

There was an os penis in the shape of a grooved catheter immediately under of lamina interna of preputium located at the dorsal section of the corpus penis, at the transversal section of the penis. The outer section of the os penis is formed by compact bone, and the interior section is formed by spongy bone. Chondrocytes received blue staining during MTC dying, and this proved that the os penis at the glans penis was cartilaginous in structure (alinin blue positive).

The sulcus urethralis was located under the os penis. In longitudinal sections, it was detected that the urethra under the sulcus urethralis became wider when entering into the glans penis. The urethra mucosa, having stratified transitional epithelium, was transformed into stratified squamous epithelium during this widening. Pars spongiosa of the urethra was detected immediately under urethra epithelium, and corpus spongiosum penis was present under it. After this region, corpus cavernosum penis was considerably rich in erectile tissue (caverns), covered by endothelial cell layer and engorged with erythrocytes. The caverns were surrounded by smooth muscle and elastic threads. The corpus cavernosum part of penis wrapping the corpus spongiosum penis as a wide layer, and was encircled by the epidermis of the penis. The epidermis of the penis was encircled by lamina interna of the preputium. In the longitudinal sections, a connective tissue region which

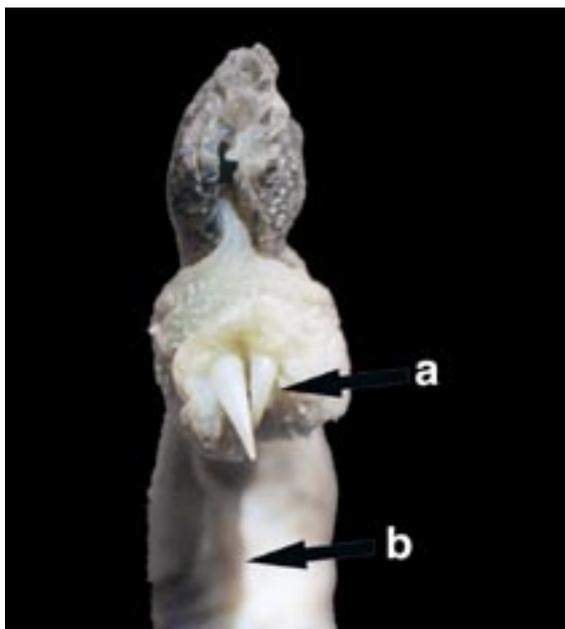


Figure 2. Grossly, ventral appearance of erectile penis: a = penis nails, b = raphe preputii

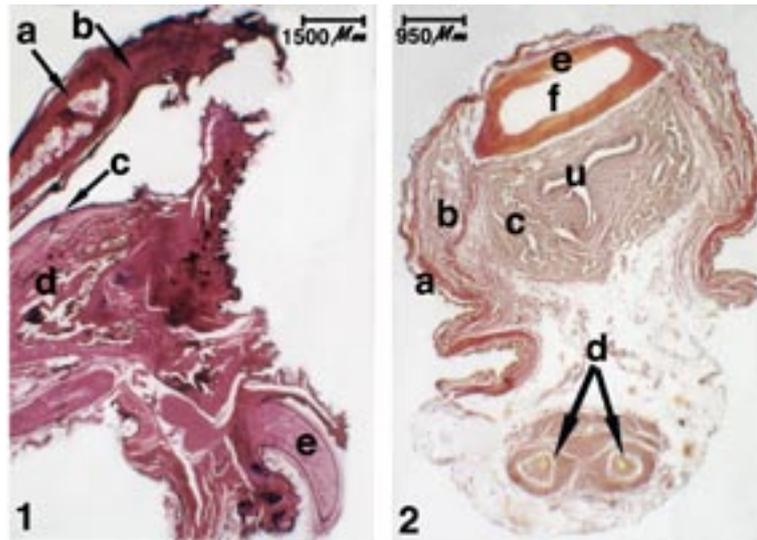


Figure 3. **1** – Histologically, longitudinal section of the penis (H & E): a = os penis – bony structure at the corpus, b = os penis – cartilaginous structure at the glans, c = widening of urethra and transition of it's epithelium from the stratified transitionale to stratified squamous, d = corpus cavernosum penis, e = location of the nail in the penis. **2** – Transversal section of penis (vGH): a = lamina interna of preputium, b = corpus cavernosum penis, c = corpus spongiosum penis, d = arteries of penis, e = compact bone structure of outer section of os penis, f = spongy bone structure of interior section of os penis, g = sulcus urethralis, u = urethral lumen

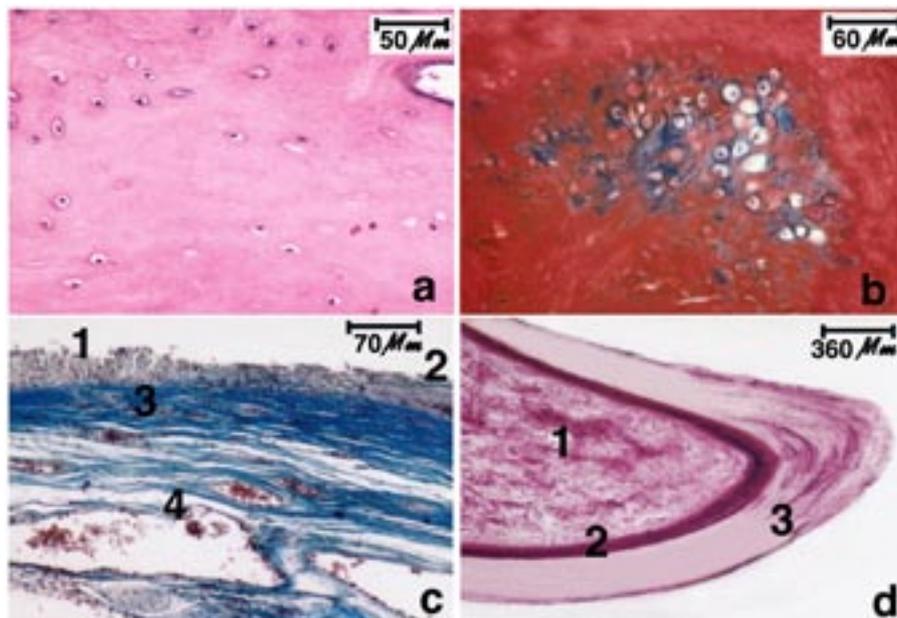


Figure 4. **a** – Osteocytes in the corpus penis (H & E). **b** – Chondrocytes in the glans penis (alcian blue positive) (MTC). **c** – Longitudinal section of urethra (MTC): 1 = stratified transitionale epithelium at the urethral mucosa, 2 = stratified squamous epithelium at the urethral mucosa, 3 = pars spongiosa of urethra, 4 = corpus spongiosum penis. **d** – Longitudinal section of the nail (H & E): 1 = including connective tissue, 2 = squamous epithelium, 3 = keratinized layer

was rich in smooth muscle and collagen threads under corpus cavernosum penis was noted. Nails in the penis buried in this connective tissue were clear in longitudinal sections. The internal side of the nails in the penis consisted of an inner layer

rich in collagen, and outer layer consisting of a keratinized layer.

Penis arteries observed on transversal sections of penis were at the urethral surface of the corpus penis.

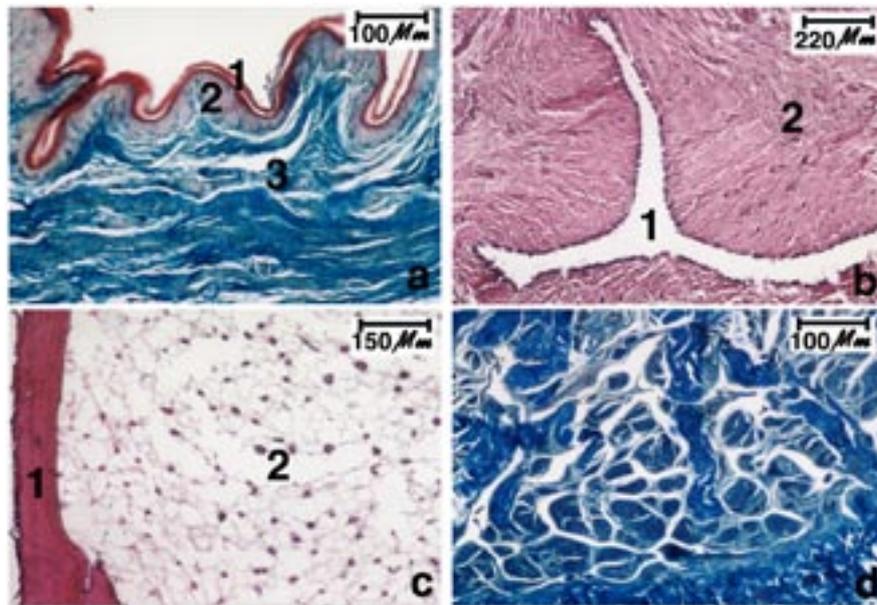


Figure 5. **a** – Outer sides of penis (MTC): 1 = lamina interna of preputium, 2 = epidermis of the penis, 3 = corpus cavernosum penis. **b** – Urethra (H & E): 1 = lumen, 2 = pars spongiosa. **c** – Os penis (H & E): 1 = compact bone, 2 = spongy bone. **d** – Erectile tissue (MTC)

DISCUSSION

Dursun (1996) reported that glans and corpus penis of the equidae and carnivores were separated from each other by an evident collum penis. This was also found by Popesko et al. (1990), indicating the same results for rabbits. Similarly as in the equidae of carnivores and rabbits, porcupines have an evident collum penis. Also, the glans penis of porcupines is black, and the corpus penis is white. This is helpful in determining the borders of both the two parts.

The penis is directed caudally in such laboratory animals as rats (Green, 1963), mice (Cook, 1965), guinea pigs and rabbits (Popesko et al., 1990). To the best of our knowledge, the cat is the only domestic animal of which the penis was directed into a caudal position (Nickel et al., 1981). According to our results, porcupines should be included in this list.

Nickel et al. (1981) in cats and Murakami (1987) in mice reported that the corpus penis was studded with small cornified papillae, which is considered as a secondary sex characteristic. These structures were also observed at the porcupines. Additionally, the fact that no other animal has nails in the penis could also be considered as another secondary sex characteristics, is rather striking.

It has been well-documented that there is an os penis in the shape of grooved catheter at the corpus penis of the carnivores, and the os penis has cartilaginous structure at the glans penis (Nickel et al., 1981). Also, the same authors noted that the os

penis of these animals is at the middle part of the cross-section of the penis. While it is reported that the os penises of the rat and the mouse are in the form of proximal and distal segments at glans penis (Vilmann, 1982; Rasmussen et al., 1986; Murakami, 1987; Yamamoto, 1987), and it is informed that the Japanese macaca has only a proximal segment (Yamamoto et al., 1990). It was determined that porcupines have an os penis in form of grooved catheter like the carnivores, and glans penis that has the cartilaginous structure of os penis. However, different from carnivores, os penis is localized at dorsal part of the transversal section of the penis.

Several reports (Banks, 1986; Tanyolac, 1993) indicated that, from interior to exterior, the normal histological structure of the penis in both domestic and laboratory animals is constituted from; lamina interna of preputium, epidermis of penis, tunica albuginea (fibrous type penis), corpus cavernosum penis, corpus spongiosum penis, sulcus urethralis and urethra. All these structures were observed in the porcupine, except for the tunica albuginea.

According to Tanyolac (1993), the urethra widens while entering glans penis and during this entrance, the stratified transitional epithelium of urethra transforms into stratified squamous epithelium. This finding was found to be completely the same for porcupines.

Banks (1986) reported that histologically, the penis has two types; tunica albuginea that was well developed in “fibrous type penis”, and tunica albuginea,

that was imperceptible and erectile tissues had too much surface area in the “vascular type penis”. The same author informed us that, according to this classification, that ruminants and boar were fibrous type; that human, equidae, and carnivores were of the vascular type. In the cross-sections, it was observed that tunica albuginea was imperceptible, and erectile tissues were well developed. According to this, histologically the penis of the porcupines was suitably considered in “vascular type penis”, which also includes humans, equidae and carnivores.

As a result, it was determined that the penis of porcupines were very similar to penises of cats, which is a domestic animal. In addition, it has common characteristics with rats, mice, guinea pigs and rabbits. Additionally, it was detected that the histological classification of the penis of the porcupine is that of a “vascular type penis”. To the best of authors’ knowledge, the nails in the penis had not been reported for any other animal species, and it may be considered that they attach to vagina of the female during copulation.

The results of the present study represent the first report on the anatomy of the penis in porcupines, and may contribute to present knowledge in this field.

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