Anatomical Study on the Pelvic Diaphragm of Male Balady Dog

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Abstract

The study was applied on 13 apparently healthy male balady dogs, obtained from the laboratories of faculty of veterinary medicine - new valley university. The specimens were carefully dissected in order to study the anatomical structural characteristics of the pelvic diaphragm. The latter, guarded the pelvic outlet in two main triangular areas; anal and urogenital. The diaphragm represented in three parts; dorsal, intermediate and ventral. The former was the ischiorectal and composed of the coccygeus muscle and the anal part. The intermediate division included the perineal body and muscle and the ventral one was the urogenital diaphragm. The perineal fasciae were declared superficial and deep and the membranous layer of the former was the colles’s fascia that inclosed the superficial perineal pouch. The deep perineal fascia represented the urogenital diaphragm and the deep perineal pouch was formed by the reflected perineal membrane on the ischiurethralis muscle. Some anatomical differences were noticed and discussed with that of human anatomy. The study was a guide to understand the anatomical characteristics of the clinically significant area of the most frequent perineal hernia.

Keywords: Anatomy; Balady; Dog; Pelvic diaphragm

Introduction

Dog’s health and reproductive quality, represented a valuable economical importance for owners as well as saving the breed Wells [1] Friedmann and Son [2]. Studding the pelvic diaphragm among dogs, triggered the attention of previous authors Friedmann and Son [2]. Studding the pelvic diaphragm among dogs, triggered the attention of previous authors Sluijs & Sjollema [3], Moraes et al., [4] and Sprada et al., [5]. Regarding its role in frequently recognized clinical incidence of the perineal hernia, the weakness of the perineal muscles and fasciae were the main causes of the perineal herniation Ferreira & Delgado [6] and Costa Neto et al., [7]. The former was the colle’s fascia that inclosed the superficial perineal pouch. The deep perineal fascia represented the urogenital diaphragm and the deep perineal pouch was formed by the reflected perineal membrane on the ischiurethralis muscle. Some anatomical differences were noticed and discussed with that of human anatomy. The study was a guide to understand the anatomical characteristics of the clinically significant area of the most frequent perineal hernia.

Material and Methods

Thirteen adult apparently healthy male balady dogs were collected from stray and laboratories of the faculty of Veterinary Medicine New Valley University. The dogs were slaughtered and fixed by formalin 10% solution for four days. The pelvic cavity with connected hind limbs was cut out from the preserved specimens. Two anatomical regions were intended and prepared for the study; the ischiorectal fossa and the urogenital triangle figure 1. For the former aspect, the dissection started by an upward fixation of the tail and incising the skin at the median longitudinal line ventrally to the root of the tail reaching the dorsal border of the anus. Another circular one surrounded the latter and extended ventrally to the level of ischial tuberosities where a horizontal cut was applied to the point of the tuberosities. Carefully the skin was reflected for dissecting the superficial aspect of the ischiorectal fossa.

Results

The pelvic outlet is bounded caudally by a bilateral fasciomuscular closure, the pelvic diaphragm. It supports the retroperitoneal...
pelvic organs to prevent their perineal prolapse. The perineum extends deeply to the level of imaginary lines from the apex of the sacrum dorsally, ischial arch and tuberosities ventrally and sacroischiatric ligament laterally, as well as superficially along the region which extends ventrally from the anus to the level of the caudal end of pelvic symphysis. It consists of two anatomical triangular areas; dorsal and ventral, anal and urogenital respectively figure 2. The anal triangle is the area that is included in the lines between the sacral apex dorsally, sacroischiatric ligament laterally and ischial tuberosities ventrally. The region is composed of a bilateral ischiorectal fossae, each of them extends from the sacral apex dorsally, anal opening ventromedially, ischial tuberosities ventrolaterally and sacroischiatric ligament laterally figure 3a. The urogenital triangle extends ventrally to the former and its base facing dorsally between the ischial tuberosities while its apex reaches the level of the pubic symphysis. The pelvic diaphragm lodges in the deep and superficial aspects of the perineum and is categorized in three parts; dorsal, intermediate and ventral. The former, the ischiorectal part includes the coccygeus muscle group and the anal part which forms the suspensory apparatus of the anus. The latter, consists of the rectococcygeus and the retractor penis muscle.

The dorsal part

The ischiorectal part (Coccygeus muscle group) comprises the lateral coccygeus muscle and the medial coccygeus group (corresponding to levator ani muscle). The lateral coccygeus muscle (Figures 3a,3b,4-7) is a thin flat quadrilateral in shape, arising along the ischiatic spine and its fibers directed caudo-dorsally and medially. The muscle is inserted in the lateral aspects of the first three caudal vertebrae. It guards the caudalateral aspect of the sacroischiatric angle and is bounded laterally by the ischiorectal fat bad and sacrotuberous ligament, while medially it is related to the medial coccygeus group. The muscle has ventral, cranial, dorsal and caudal borders; the former, measures about 1.8-2 cm length, 2.7-2.9cm for the cranial, 3.6-3.8cm for the dorsal and 4.5-4.7cm for the caudal one. The medial coccygeus muscle group (Levator ani muscle) (Figures 3a,3b,4,7-10,11a,11b) (3a,3b,4,is the main closure of the pelvic outlet and is considered the chief muscle of the pelvic diaphragm. The group consists of illococecygeus, pubococcygeus and ischio coccygeus muscle. The first, (Figures 8-10) is a flat triangular muscle attached from the cranial border of the ilio-pubic junction and its fibers directed caudo dorsally and medially to be inserted in the lateral aspect of 4th caudal vertebrae. Its base facing ventrally and measures about 2.1-2.3cm, 5.4-5.6 cm for the cranial border as well as 4.6-4.8 cm for the caudal one. The muscle is related laterally to the shaft of ilium and medially to the pubococcygeus muscle and obturator nerve. It overlaps the cranialateral aspect of the latter muscle, where its caudal fibers join that of pubococcygeus forming single muscle bundle. The pubococcygeus muscle (Figures 3a,3b,4,7-10) is the largest part of the group, the thin and flat muscle fibers arise from the dorsal and lateral aspect of the pubis and pelvic symphysis. The muscle is fan shaped and its fibers ascend dorsally around the terminal part of the rectum and medially directed to be attached to the lateral aspect of 4th caudal vertebra. It is bounded laterally to the ilium and medially to a fat bad separating it from the prostate gland. The Ischio coccygeus muscle (Figures 3a,3b,4,7-10) is the ischial part of the medial coccygeus muscle group. The thin flat muscle arises from the caudo dorsal aspect of the pelvic symphysis and covers the caudalateral aspect of the pubococcygeus muscle. It extends dorsally in nearly vertical direction, related to the obturator muscle laterally and the rectum medially. The muscle curves on the dorsal aspect of the latter where attached to the lateral sides of 4th caudal vertebra. The last described muscle and the pubococcygeus one, form the levator window where the anal canal with the suspensory apparatus is pass through.

The anal part (Suspensory apparatus of the anus), includes the rectococcygeus and the retractor penis muscle. The former, (Figures 10 and 11a) is the extrarectal continuation of the rectal musculature to the coccygeal vertebræ. The median dorsal longitudinal rectal muscle fibers coalesce at the level of the pelvic out let to form a caudo dorsal projection inserted in the ventral aspect of the 5th caudal vertebra.

The Retractor penis muscle (Figures 5,6,10,11a,11b,12), it consists of two parts; large and vertebral, the former is represented in right and left thin flat tape like in shape bundles. Each arises from the ventral aspect of the 1st and 2nd caudal vertebrae. It is directed in a caudoventral direction to run on the dorsolateral aspect of the anorectal junction. At the level of the dorsal insertion of the medial coccygeal muscle group, it inclines laterally on the anal canal. It passes on the deep face of the ischiococcygeus muscle, where the muscle divides into strong anal, penile and rectal parts. The former,
is the caudal one and extends along the dorsolateral side of the anal passage, it proceeds deeply to the para-anal sinus, where the bundles terminate between the anal sphincter muscles. The penile part is the longest and crosses the lateral side of the anal canal in a vertical direction. It reaches the ventral border of the latter, where both fibers of the opposite sides are collected commonly in a single bundle and pass caudally between both perineal muscles. The muscle extends along the ventral border of penis to the glans and enrolled in the deep penile fascia. The rectal division is the cranial smaller part and its fibers are encircled with that of the terminal part of the rectum.

The vertebral part (Figures 8,11a,11b), is a thin flat fascicles derive from the ventral aspect of the 3rd caudal vertebra. The muscle passes ventrally and vertically on the caudal aspect of the external sphincter ani muscle and deeply to the ischiococcygeus muscle. The muscle fibers of both sides terminate in the bulb of penis.

The intermediate part

The perineal body is a fibrous mass ventrally located to the anal opening where the perineal fasciae attach (Figures 9 and 11a).
aspects of the penile part of retractor penis muscle. The muscle bundles encircle both sides of the anal canal respectively and joined together forming the external anal sphincter.

Figure 7: A photograph showing the right ischiorectal fossa (deep dissection).
1-External sphincter ani M
2-Iliococcygeus M
3-Pubococcygeus M
4-Lateral coccygeus M
5-Ischiocavernosus M
6-Bulbospongiosus M
7-Penile part of retractor penis M
8-Perineal M
9-Pelvic urethra
10-Deep (dorsal) layer of the deep perineal fascia
11-Issial tuberosity
12-Internal obturator M
The black arrow indicates the ischiourethralis M (covered by 10)
The blue arrow indicates superficial perineal fascia (septum between 5 and 6)

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Figure 8: A photograph showing the perineal region (removed left half of pelvic bone).
1-Iliococcygeus M
2-Pubococcygeus M
3-Iliococcygeus M
4-Vertebral part of retractor penis M
5-External sphincter ani M
6-Perineal M
7-Bulbospongiosus M
8-Left penile crus

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5-External sphincter ani M
6-Perineal M
7-Bulbospongiosus M
8-Left penile crus

Figure 9: A photograph showing the perineal region (left lateral view).
1-External sphincter ani M
2-Perineal M
3-Perineal body
4-Iliococcygeus M
5-Pubococcygeus M

Figure 9: A photograph showing the perineal region (left lateral view).
1-External sphincter ani M
2-Perineal M
3-Perineal body
4-Iliococcygeus M
5-Pubococcygeus M

Figure 10: A photograph showing the perineal region (deep dissection).
1-Retractor penis M
2-Rectum (cut)
3-Pelvic urethra
4-Prostate
5-Urinary bladder
6-Iliococcygeus M
7-Pubococcygeus M
8-Iliococcygeus M
9-Ventral sacrococcygeus M
10-Left penile crus the yellow arrow indicates the obturator nerve
11-Rectococcygeus M

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The ventral part

The perineal fasciae: The superficial perineal fascia comprises the superficial and membranous parts; the former figure 2 is a fibro-fatty layer composed of a thin fibrous sheath firmly adhered to the perineal skin and continues laterally to the superficial gluteal fascia. This layer is wrapped in fatty coat separating it from the skin externally and the membranous layer internally.

The perineal fat coat covers the ischiorectal fossae and the area of urogenital triangle, where over the former, the fat bad supports the muscles of the dorsal part of the pelvic diaphragm caudally and laterally. While on the urogenital triangle, the coat divides it from the skin externally figure 2.
The membranous layer (Colle’s fascia), (Figures 5,6,13,14) is a fibrous sheath extending from the perineal body dorsally and bilaterally stretched to the ischial tuberities. It covers the caudoventral aspect of the ischial arch and extends ventrally to envelope the root of penis.

At the arch, it coats the bulbospongiosus muscle and wraps around the penile part of retractor penis muscle. A fibrous division arises to separate between the bulbospongiosus and ischiocavernosus muscle. The fascia continues around the intrascrotal part of penis, where it receives the scrotal septum at the median plane. It proceeds cranially to join the tunica dartsus of penis (superficial penile fascia) and the dorsal aspect of the latter, attached to the suspensory ligament of penis.

The black arrow indicates the retractor penis M
The blue arrow indicates the rectal part
The green arrow indicates the penile part
The red arrow indicates the anal part of retractor penis M

The Deep perineal fascia (Urogenital diaphragm) figures (7,12,14) is a double membranous layers that guard the ventral aspect of the pelvic outlet (ischial arch). It is related to the prostate gland and pelvic urethra dorsally and consists of superficial (ventral) and deep (dorsal) parts. The former, is the perineal membrane that emerges from the ventral aspect of the pubic symphysis, where it sends the suspensory ligament of penis. It passes along the dorsal aspect of the root of the latter and at the ischial arch, the fascia is wrapped laterally to the ischial tuberocities. It reflects on the penile crurae and body to form the deep penile fascia. On the superficial aspect of bulbospongious and ischiocavernous muscle it extends to form the colle’s fascia. The perineal membrane covers the ischiurethralsis muscle laterally and proceeds cranially to the symphysis on the floor of the pelvic outlet, ventrally to the pelvic urethra to form the dorsal layer of the urogenital diaphragm. A narrow deep perineal pouch is formed between the two layers of the deep fascia and encloses the ischiocavernous muscle figure 7.
Discussion

The pelvic diaphragm was recently described within the perineal region, the present work categorized the latter into two triangular areas; anal and urogenital. The pelvic diaphragm was a group of fatty and musculofascial structures belonged to each area; a result which wasn’t recorded by the respected available literatures. The study showed the distribution of a thick fatty coat around the superficial and deep aspects of the perineum. The role of the adipose mass was to support the muscles and perineal fasciae.

In general concern, the pelvic diaphragm was integrated in three distinct regions; dorsal, intermediate and ventral. The former, represented the ischiorectal part which lodged in the anal triangle. Nearly achieved findings were mentioned by Budras et al. [12] in dog which described the ischiorectal fossa without the anal triangle. While the recent results revealed that the right and left ischiorectal fossae comprised the anal triangle. On the other hand, the intermediate perineal region connected the dorsal to the ventral one. The latter, included in the urogenital triangle and comprised the urogenital diaphragm, while the intermediate one included the perineal body and muscle. A classification which wasn’t reported in the previous available literatures. Budras et al., [12] in dog had a different classification in which they added three parts of pelvic diaphragm to the coccygeus and levator ani muscle. The authors categorized the parts into anal, perineum proper, and urogenital. The former consisted of external and internal anal muscles and rectococcygeus muscle. The proper division included the perineal body and muscle. While the urogenital one was composed of ischiocavernosus, bulbospongious and retractor penis muscle. In this aspect, Sisson and Grossman [13] in domestic animals, Bllenger and Canfield [9] in dog had the opinion that the pelvic diaphragm was consisted of coccygeus and levator ani muscle. The latter authors added the superficial gluteal, internal obturator, external anal sphincter muscle and sacrotuberous ligament.

It was important to note that the ischiorectal part of the pelvic diaphragm of the current study, included the coccygeus muscle group and an anal part (suspensory apparatus of anus). The former, represented the lateral coccygeus muscle and medial coccygeus group (levator ani muscle). A nearly findings were cited by Desai [14] and Miller et al. [15] in dog which reported lateral and medial coccygeus muscle and did not grouped the latter. Evans and delahuneta [16] and Budras et al., [12] in dog mentioned coccygeus and levator ani muscle. While Sisson and Grossman [13] in domestic animals had the opinion that there were coccygeus and retractor ani muscle. The lateral coccygeus muscle of balady dog was described as quadrilateral in shape, arose from the ischiatic spine and had cranial, caudal, ventral and dorsal borders. Nearly recorded results were cited by Desai [14] and Miller et al., [15] in dog but they weren’t described its borders and the muscle was attached to the coccygeal vertebrae. However, the present study reported that the muscle was inserted to the lateral aspect of the first three caudal vertebrae. In this aspect, Budras et al., [11] in dog declared that the coccygeus muscle was attached to the first four caudal vertebrae. While Hall et al., [12] in dog cited that it was inserted to the first caudal vertebra.

Concerning the anatomical structures of the medial coccygeus group (levator ani muscle) in the study at hand revealed that the levator ani muscle was grouped into three muscular divisions of thin flat fascicles; iliococcygeus, pubococcygeus and ischiococcygeus muscle. The former was the cranial and the pubococcygeus was the middle largest while the last was the caudal and smaller one. Nearly findings were cited by Koing and Liebich [17] in domestic mammals which declared that the levator ani muscle represented the ilio-caudalis and ischiocaudalis muscle. On the other hand, Hall et al., [11] in dog have the opinion that there were three divisions of the levator ani muscle; pubococcygeus, iliococcygeus and puborectalis. Each part of the levator ani muscle in the balady dog had a distinct area of origin, the iliococcygeus muscle arose from the cranial border of the iliopubic junction and the obturator nerve separated it from the pubococcygeus muscle. The present study described the pubococcygeus muscle as the main muscle of the medial coccygeus group with fan shaped fascicles. The muscle originated from dorsal and lateral aspects of the pelvic symphysis and pubis. It was attached dorsally to the anal canal and parts of the levator ani muscle as considered by Sisson and Grossman [13] in domestic animals. The latter muscle pierced the pubococcygeus and puborectalis and surrounded the anal canal with the suspensory apparatus. Although there were three parts of the levator ani muscle inserted respectively to the 3rd to 6th caudal vertebrae. Nearly findings were cited by Budras et al., [12] in dog recorded its insertion to the 4th to 7th caudal vertebrae. The name levator ani muscle was referred to the human anatomy, as the normal attitude of the human body allowed the muscle to elevate the anus upward. Regarding that in animals, their normal body posture will change the name to the retractor ani muscle as considered by Sisson and Grossman [13] in domestic animals. In this aspect, Drake et al., [18] in human declared that the muscle consisted of the ischiococcygeus, pubococcygeus and puborectalis. And the latter surrounded the anal opening and supported it during defection. That was in agreement with the opinion of Hall et al., [11] in dog. While in contrary to our dissecting observation, where the parts of the medial coccygeus group were inserted to the caudal vertebrae without reinforcement fibers to the sphincter anal muscle. The ischiococcygeus muscle was separated from the external anal phincter by the vertebral head of retractor penis muscle. In this regard, the medial coccygeus muscle group of both sides formed the levator window, which allowed the anal canal to pass through freely with its suspensory apparatus. Where the study used the name medial coccygeus group rather than the levator ani one. Similarly cited results were recorded by Budras et al., [12] in dog which affirmed very few muscle fibers derived from the levator ani muscle to the external anal sphincter and the name levator ani was misleading. A results which were in contrast to that of Desai [14] and Miller et al., [15] in dog, Sisson and Grossman [13] in domestic animals which revealed that the levator ani muscle bended with the external anal sphincter. Ischiococcygeus muscle in the present dissec-

Regarding the perineal muscle in the present work, the muscle extended from the perineal body and encircled the lateral sides of the anal canal formed the external anal sphincter. Nearly results were cited by Budras et al., [12] in dog which revealed that the muscle extended from the external anal sphincter to the bulbospongious muscle. That was different from the opinion of Hall et al., [11] which mentioned that the anal sphincter muscle originated from the anococcygeal ligament and coursed ventrally on both sides of the external anal opening.

Our dissection revealed that the perineal body was a fibrous mass ventrally located to the anal opening where it gave an attachment for the perineal muscle and fasciae. That was different from that reported by Hall et al., [11] in dog which declared that there were no muscle fibers attached to the perineal body.

The study described the suspensory apparatus of anus and declared that the retractor penis muscle consisted of four divisions; anal, penile, rectal and vertebral. The former was the broadest, the penile was the longest, the rectal was the smallest and all derived from a common bundle. While the vertebral division descended from the 3rd caudal vertebra. Nearly similar findings were reported by Budras et al., [12] in dog. In this regard, Evans and delahunta [16] named three parts of the muscle; pars analis, rectalis and penile.

The ventral part of the pelvic diaphragm was recently described, where it comprised the urogenital diaphragm. The latter was composed of dorsal and ventral layers which were considered the deep perineal fascia. Its dorsal layer extended from the pelvic symphysis to the level of ischial arch, where it twirled ventrally to form the ventral layer. A very small deep perineal pouch was formed between them enclosed the ischiourethralis muscle. In case of human, Drake et al., [18] recorded the external urethra muscle was wrapped in the urogenital diaphragm. The ventral layer of the urogenital was the perineal membrane which attached cranially to the pubic symphysis. At the ischial arch, it formed the superficial perineal fascia (Colle’s fascia). A result which wasn’t cited in the available respected literatures. The Colle’s fascia covered the superficial perineal pouch which contains the bulbospongious and ischiocavernous muscle. That was similar to findings that reported by Drake et al., [18] in human.

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