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RESEARCH ARTICLE

Macro-anatomic, cross-sectional anatomic, and computerized tomographic examination of anal region in dogs

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Köpeklerde regio analis'in makro anatomik, kesitsel anatomik ve bilgisayarlı tomografik incelemesi

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Öz

Amaç: Bu çalışmanın amacı köpeklerde regio analis'i oluşturan anatomik yapıları farklı anatomik inceleme yöntemleri ile inceleyerek bölgeye üç farklı (diseksiyon, kesit anatomisi, bilgisayarlı tomografi) açıdan yaklaşım sergilemektir. Hernia perinealis, anal kese yangı ve fistülleri, prolapsus recti v.b klinik vakalara yeni yaklaşımlar sergilemek açısından çalışmamız önem arzetmektedir.

Gereç ve Yöntem: Çalışma 12 köpek kadavrası üzerinde gerçekleştirildi. Regio perinealis'in karşılaştırmalı diseksiyon çalışması 3 erkek ve 3 dişi köpek kadavrasında yapıldı. Kesit anatomisi çalışması ise 3 adet erkek ve 3 adet dişi kadavrasında icra edildi. Bir adet erkek köpek kadavramızdan regio perinealis'in bilgisayarlı tomografik görüntüleri temin edilerek çalışmamız kapsamında elde edilen görüntülere eklendi.

Bulgular: Çalışmamız kapsamında regio analis üç anatomik başlık altında incelendi. Literatürde genelde şekil ve çizim ile gösterilen diaphragma pelvis ve oluşumuna katılan anatomik yapılar diseksiyon, kesit anatomisi ve bilgisayarlı tomografi yöntemleri ile tespit edildi. Kesit anatomisi ve bilgisayarlı tomografi yöntemleri aracılığı ile sagittal, transversal ve horizantal kesitler ile üç boyutlu anatomik bilgi karşılaştırmalı olarak tespit edildi. Ayrıca regio analis'in yapısını oluşturan kasların origo, insertio, kalınlık ve genişlik gibi değerleri ölçülerek köpeğin yaşı ile yapılan ölçümler arasında bir ilişki kurulmuştur.

Öneri: Özellikle hernia perinealis, prolapsus recti, urethrotomi, anal keselerin yangısı ve fistülleri gibi patolojik ve klinik vakalara sergilenecek yaklaşımlarda teşhis ve tedavi yöntemlerinin geliştirilmesinde bu çalışmanın katkısı oldukça önem arzetmektedir.

Anahtar kelimeler: Regio perinealis, regio analis, hernia perinealis, diaphragma pelvis, köpek.

Abstract

Aim: The aim of the study is to examine the anatomical structures of anal region in dogs via different anatomical examination methods and to present an approach to the region in terms of three perspectives. Our study is important for presenting new approaches for the clinical cases such as perineal hernia, anal sac inflammation and fistulae, rectal prolapse etc.

Materials and Methods: The study was conducted on 12 dog cadavers. Comparative dissection study was conducted on perineal region of 3 male and 3 female dog cadavers. A cross-sectional anatomical study was performed in 3 male and 3 female cadavers. From 1 male dog cadaver, computerized tomographic images of perineal region were obtained and added to the images obtained within the scope of the present study.

Results: In the study, anal region was examined under three anatomical titles. Pelvic diaphragm and its anatomical structures, which are shown via figures and drawings in the literature, were determined using dissection, cross-sectional anatomy, and computerized tomography methods. Three-dimensional anatomical data obtained by sagittal, transversal and horizontal sections was comparatively determined via cross-sectional anatomy and computerized tomography methods. In addition, the values of the muscles of the anal region such as origin, insertion, thickness and width were measured and a correlation was found between the age of the dog and the measurements.

Conclusion: The contribution of this study is important for development of diagnostic and treatment methods in approaches to be exhibited especially towards pathological and clinical cases such as perineal hernia, rectal prolapse, urethrotomy, anal sac inflammation and fistulae.

Keywords: Regio perinealis, regio analis, hernia perinealis, diaphragma pelvis, dog.

Introduction

Perineal region is examined under the titles of two sub regions. -Anal region, -Urogenital region (Habel 1966, Rolf 1995, Budras et al. 2009, NAV 2017). In order to define anal region exactly and to provide more reliable information about the region, it is required to examine the region by separating it into two important anatomical structures; -pelvic diaphragm, -ischiorectal fossa (Habel 1966, Rolf 1995, Budras et al. 2009, Dyce et al. 2018). Pelvic diaphragm is a structure composed of levator ani and coccygeal muscles and also internal fascia of pelvic diaphragm and external fascia of pelvic diaphragm in contact with these muscles. (Habel 1966, Miller 1979, Nickel et al. 1979, Alpak 1992, Miller 1993, Rolf 1995, Schaller 2007, Budras et al. 2009, Dyce et al. 2018). As a result of the abnormalities and loss of function in the anatomical functions of the muscles and fasciae that form the structure of the pelvic diaphragm, pathologies such as perineal hernia, rectal prolapse etc. may develop (Habel 1966, Miller 1979, Rolf 1995, König et Liebich 2015, Dyce et al. 2018). Coccygeal muscle is a muscle that originates from ischiadic spine (Çalışlar 1976, Miller 1993, Rolf 1995, Budras et al. 2009, König et Liebich 2015, Dyce et al. 2018). Coccygeal muscle is a thicker and shorter muscle than levator ani muscle that is another muscle involving in the formation of pelvic diaphragm (Miller 1993). When coccygeal muscle stretches, it pulls the tail to its contraction side (Budras et al. 2009, König et Liebich 2015). When it is contracted bilaterally, it pulls the tail to the ventral (Pasquini et al. 2003, Budras et al. 2009). Levator ani muscle is in the medial of coccygeal muscle and has a wide origin from the medial surface of ischiadic spine and corpus ossis ilii (Dyce et al. 2018).

Ischiorectal fossa in dogs is a tube-shaped depression in the lateral of coccygeal and levator ani muscles and anal canal (Rolf 1995). Depth of ischiorectal fossa is densely filled with the body fat (Habel 1966, Çalışlar 1976, Miller 1979, Alpak 1992, Rolf 1995, Pasquini et al. 2003, Budras et al. 2009). External anal sphincter muscle is a striated muscle that takes the anal canal under control by surrounding it (Miller 1979, Budras et al. 2009). In dogs, paranal sinuses (anal sac) are located between the external anal sphincter muscle, which a striated muscle, and the internal anal sphincter muscle that is the continuation of the circular smooth muscle layer of the rectum (Budras et al. 2009). Paranal sinuses (anal sacs) varying from oval to circular shape according to its content inside are located on both lateral sides of the anus (Miller 1979, Rolf 1995, Budras et al. 2009, König et Liebich 2015, Dyce et al. 2018). In dogs, the pathologies arising from the obstruction of ducts of paranal sinuses are quite common. For instance, pain and abscess, fistulae and constipation cases of anal sacs are considerably frequent (Çalışlar 1976, Miller 1979, Rolf 1995, Dursun 2008b, König et Liebich 2015, Dyce et al. 2018). Rectococcygeal muscle is a muscle that dissolves and inserts by continuing approximately to ventral of the 3rd tail vertebra as a single muscle upon combination of the muscular fibers from the right and left halves of the rectum at the tail ventral (Miller 1979). The aim of this study is to examine the anal region of the dogs via macroscopic, cross-sectional and computerized tomography methods and to perform some morphometric measurements.

Material and Methods

In the present study, the cadavers were supplied from animal shelter under Environmental Protection and Control Department of Konya Metropolitan Municipality. Before their physical death took place, they had been obtained and taken to laboratory of Anatomy Department of Faculty of Veterinary Science of Selçuk University. 3 male and 3 female dog cadavers were supplied for the dissection studies of perineal region, and 3 male and 3 female dog cadavers were supplied for the cross-sectional anatomy of perineal region and all of them were brought to our laboratory. In one of the male cadavers for cross-sectional anatomy, the computerized tomography images were obtained. We abstained from supplying small-bodied dogs in order to perform an accurate study between the age groups. Approval letter about supply of dog cadavers from animal shelter under Environmental Protection and Control Department of Konya Metropolitan Municipality and accordingly committee approval (dated 31.05.2017 and numbered 2017/54) from Ethics Committee of Faculty of Veterinary Science of Selçuk University were obtained for dissection, cross-sectional anatomy and computerized tomography of perineal region.

Macro-anatomic and cross-sectional anatomy study

In the dissections performed on the dog cadavers; the widths of the origin, insertion and the midpoint of the muscle and the thickness of the muscle were measured by a caliper (bts 200 mm) and an estimation was tried to be done regarding the differences depending on age and sex. Horizontal and transversal sections were also applied for perineal region besides the macro-anatomic study performed via dissection. Among male and female cadavers, 2 were subjected to transversal cross-sectional study and one male and one female dogs were subjected to horizontal cross-sectional anatomy study. Transversal and horizontal sections were taken with 1 cm.-1.5 cm intervals.

Computerized tomography

The tomography device at clinic of Selçuk University Faculty of Medicine was used for the computerized tomography imaging of perineal region of 1 male dog. The images obtained from the cadaver were taken with a thickness of 0.5 mm and recorded in DICOM format.

Results

Anal region

Three important anatomical structures were determined in anal region, one of the two sub- regions of perineal region. These structures are pelvic diaphragm, ischiorectal fossa, other muscles of the anal region, and anal canal. Table.1 shows physical characteristics of the dog cadavers used in the study.

Coccygeal muscle

This muscle is located just in lateral side of levator ani muscle. It was detected that after coccygeal muscle, originating from the medial surface of ischiadic spine, progressed a short distance in caudo-dorsal direction and continued and inserted at the ventral of transverse process of 1st-3rd tail vertebrae of 1st and 2nd male dogs, 1st-4th tail vertebrae in the 3rd male dog, and 1st-4th tail vertebrae in 3 female dogs. When the origin of coccygeal muscle was carefully examined, it was observed that it originated from the medial surface of ischiadic spine with a tendinous origin in the medial of sacrotuberous ligament and internal pudendal artery and inserted by combining with the tail fascia in the region corresponding to the ventral of transverse process of the tail vertebrae. During defecation, levator ani and rectococcygeal muscles work coordinately and contribute to taking the right position for removing the feces.

It was detected that the vessels and nerve package that was important for perineal region (internal pudendal artery, internal pudendal vein and pudendal nerve) was located close to the location where coccygeal muscle originated from ischiadic spine. It was determined that the muscle reached its widest shape at its origin and insertion points, it was a triangular-shaped muscle, and it inserted by continuing towards the ventral of the tail vertebrae and adhering to the fascia in the ventral of the tail vertebrae. However, when the whole muscle was reached together with its origin and insertion, its shape was a trapezoid. (Figure 1.A, 1.B, 1.C).

Table 1. Physical Characteristics of the dog cadavers

	Breed	Age	Height (cm)	Weight (kg)
1st male	Pariah dog- mongrel	8-10	86	23
2nd male	Pariah dog- mongrel	6-8	94	25
3rd male	Pariah dog- mongrel	1-3	80	17
1st female	Pariah dog- mongrel	5-7	107	22
2nd female	Pariah dog- mongrel	1-3	92	15
3rd female	Pariah dog- mongrel	3-5	105	24

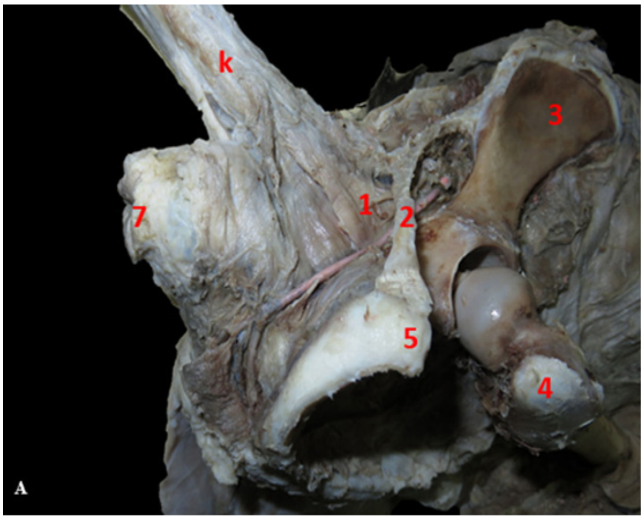

Figure 1. A. Male piece coccygeal muscle. 1: Coccygeal muscle, 2: Sacrotuberous ligament, 3:Wing of ilium, 4:Greater trochanter, 5: Ischial tuberosity, 7: Anus, k: Cauda.

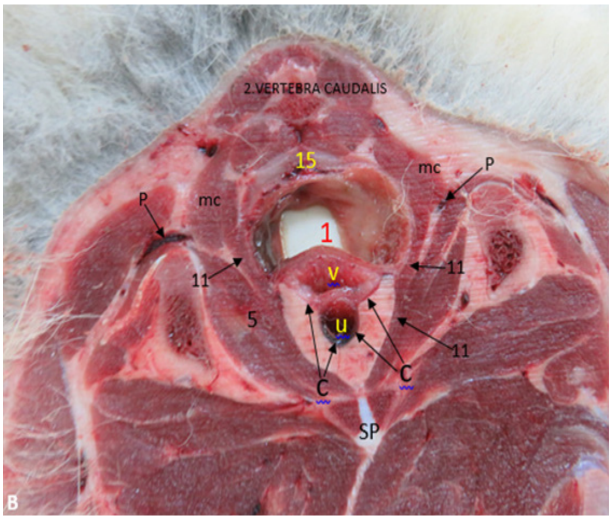

Figure 1. B. Coccygeal muscle. Female transversal 3nd section. 1: Rectum, 5: Internal obturator muscle, P: Internal pudendal artery, internal pudendal vein, pudendal nerve, 11: Levator ani muscle, u: Urethra, c: Urethral sphincter muscle, SP: Pelvic symphysis, 15: Rectococcygeal muscle, v: Vagina.

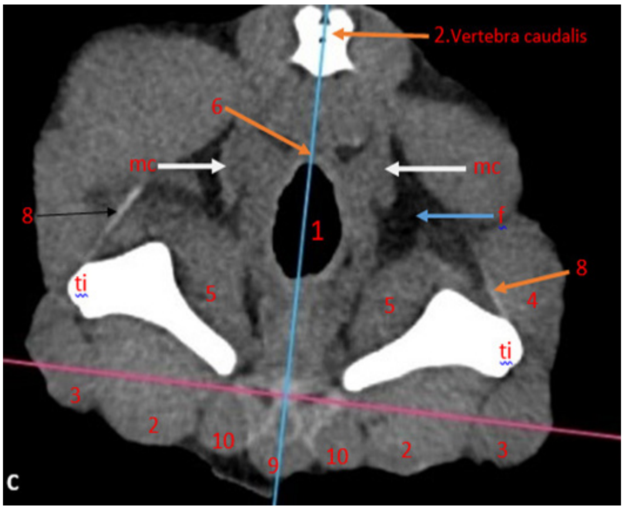

Figure 1. C. Male piece coccygeal muscle CT transversal section mc: Coccygeal muscle, 1: Rectum, 2: Semimembranosus muscle, 3: Semitendinosus muscle, 4: Biceps femoris muscle, 5: Internal obturator muscle, 6: Rectococcygeal muscle, 8: Sacrotuberous ligament, 9: Bulbospongiosus muscle, 10: Ischiocavernosus muscle, ti: Ischial tuberosity, f: Ischiorectal fossa.

Origin width, insertion width, width of the midpoint of coccygeal muscle, and the thickness of the m.coccygeus are shown Table 2. When Table 2 is examined; as a result, based on the coccygeal measurements in 3 male and 3 female dog cadavers, it was detected that the width of insertion decreased while the thickness of coccygeal muscle increased depending on the age.

Table 3 shows cranial edge length of coccygeal muscle between ischiadic spine and the first tail vertebrae and its caudal edge length between ischiadic spine and the last tail vertebrae.

When Table 3 is examined; Based on the dissection of three male and three female dogs, it was detected that the youngest dogs had longer caudal length of coccygeal muscle than the older dogs.

Levator ani muscle

It was determined that levator ani muscle, located just in the medial of coccygeal muscle, was a wider and thinner muscle than coccygeal muscle. It was detected that levator ani muscle had a wide origin originating from the medio-ventral of corpus ossis ilii and the medial surface of ischiadic spine and continuing to the cranial origin of pelvic symphysis and it was located in the medial of sacrotuberous ligament and internal pudendal artery. The muscle continued towards caudo-dorsal from its origin and inserted at the ventral of transverse processes of 1st-4th tail vertebrae of 1st and 2nd male dogs, 1st-3rd tail vertebrae in the 3rd male dog, and 1st-4th tail vertebrae in 1st, 2nd, and 3rd female dogs. The muscle inserted by combining with caudal fascia under the tail at insertion rate. Due to the spreading of the origin of levator ani muscle over a wide pelvic band, it hanged and surrounded the pelvic structures in its medial, surrounded and encircled by the muscle, and especially rectum, towards the tail vertebrae. Levator ani muscle is a bipartite muscle. Both parts have a triangle shape. The larger part in the cranial is called

Table 2. Origin width, insertion width, width of the midpoint of coccygeal muscle, and the thickness of the muscle

Coccygeal muscle	Width of origin (mm)	Width of insertion (mm)	Width of the midpoint (mm)	Thickness (mm)
1st male	40.5	39.1	23	8.50
2nd male	41.08	40.67	25.99	9.72
3rd male	30.42	54.36	28.32	3.06
1st female	28.86	43.89	30.81	8.24
2nd female	28.84	50.39	35.18	6.30
3rd female	27.52	48.54	30.07	7.55

Table 3. Cranial and caudal edge lengths of coccygeal muscle

Coccygeal muscle	1st Male	2nd Male	3rd Male
cranial length (mm)	29.45	31.09	26.97
caudal length (mm)	48.75	52.41	54.03
Coccygeal muscle	1st female	2nd female	3rd female
cranial length (mm)	19.64	18.73	25.83
caudal length (mm)	34.41	49.82	46.48

as iliocaudal muscle (-coccygeal). The smaller part that is at a more caudal side than iliocaudal muscle is called as pubocaudal muscle (-coccygeal). Iliocaudal muscle is the part of levator ani muscle originating from the medial surface of ischiadic spine and corpus ossis ilii. Pubocaudal muscle is the small part of levator ani muscle and is its part originating from the medial border of os pubis, in other words, from pubic symphysis.

Insertion of the said two muscles affects all of the tail vertebrae via the tail fascia but not as a combination directly with the bone at a specific point (Figure 2.D, 2.E, 2.F). Table 4 and Table 5 shows origin and insertion width and muscle thickness of iliocaudal and pubocaudal muscles. When Table 4 and Table 5 are examined; accordingly, it was observed that the origin width and insertion width of levator ani muscle, and the thickness values of both parts of the muscle increased depending on the increasing age.

It was determined that in both sexes, levator ani muscle was a wider and thinner muscle than coccygeal muscle.

Pelvic diaphragm

Caudal pelvic aperture is laterally surrounded by coccygeal muscle, levator ani muscle, and the fascia of these muscles from the external environment. This structure that laterally separates pelvic cavity from the external environment is called as pelvic diaphragm. Coccygeal muscle, levator ani muscle, and the specialized fasciae surrounding these muscles shape a diaphragm in the anal region. It was determined that internal fascia of pelvic diaphragm was combined with the fascia that externally surrounded the anal region and urogenital region by continuing to the ventral side after it covered the medial surfaces of coccygeal and levator ani muscles.

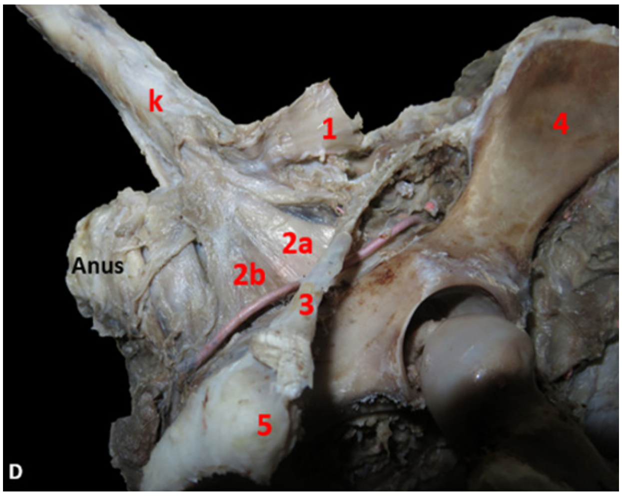

Figure.2. D. Male piece levator ani muscle. 1: Coccygeal muscle, 2a: Iliocaudal muscle, 2b: Pubocaudal muscle, 3: Sacrotuberous ligament, 4: Wing of ilium, 5: Ischial tuberosity, k: Cauda.

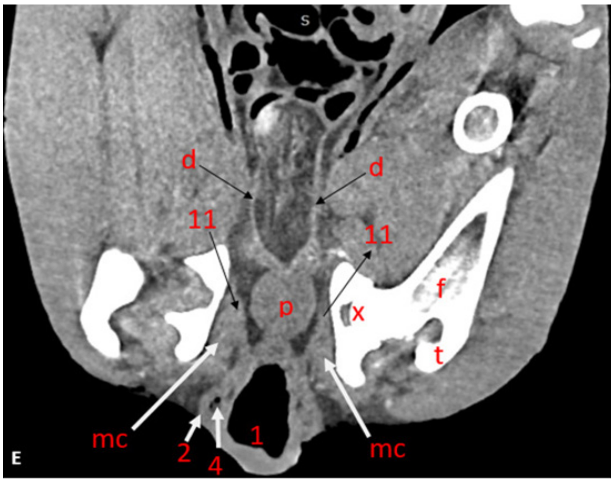

Figure.2. E. Dorsoventral view to the horizontal CT section of anal region. mc: Coccygeal muscle, 1: Anal canal, 2: External anal sphincter muscle, 4: Paranal sinuses, 11: Levator ani muscle, x: Head of femur, f: Femur, t: Greater trochanter, p: Prostata, d: Ductus deferens.

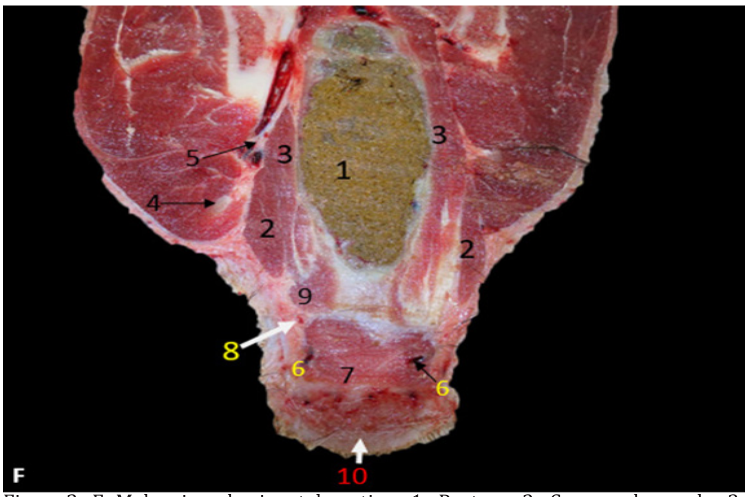

Figure.2. F. Male piece horizontal section. 1: Rectum, 2: Coccygeal muscle, 3: Levator ani muscle, 4: Sacrotuberous ligament, 5: Sciatic nerve, 6: Paranal sinus, 7: External anal sphincter muscle, 8: Caudal rectal artery, 9: Internal obturator muscle, 10: Circumanal glands.

It was detected that external fascia of pelvic diaphragm continued to the ventral by covering the lateral walls of coccygeal and levator ani muscles and combined with the deep fascia of bulbospongiosus and ischiocavernosus muscles.

These fasciae surrounded coccygeal muscle and levator ani muscle and coordinated the effect of these two muscles on the urogenital and digestive system organs. (Figure 3.H, 3.J, 3.K).

Other structures in anal region

Rectococcygeal muscle

It was observed that muscle, due to its shape, had a triangular shape that extended to the ventral of the tail vertebrae in the dorsal of external anal sphincter muscle. The muscle is shaped by the combination of external longitudinal muscle fibers of the rectum caudo-dorsally with the first six caudal vertebrae from the rectum to the tail on its vertebral surface.

Table 4. Origin and insertion width and muscle thickness of iliocaudal muscle

iliocaudal muscle	Width of origin (mm)	Width of insertion (mm)	Thickness (mm)
1st male	41.6	32.34	6.14
2nd male	44.21	36.61	6.62
3rd male	26.51	28.17	1.90
1st female	40.36	32.34	4.46
2nd female	32.45	34.59	2.39
3rd female	25.31	29.51	3.55

Table 5. Origin and insertion width and muscle thickness of Pubocaudal muscle

Pubocaudal muscle	Width of origin (mm)	Width of insertion (mm)	Thickness (mm)
1st male	15.28	25.45	6.55
2nd male	13.84	29.35	6.65
3rd male	8.39	11.82	1.92
1st female	36.22	19.13	4.52
2nd female	12.81	10.76	3.56
3rd female	21.04	18.63	3.65

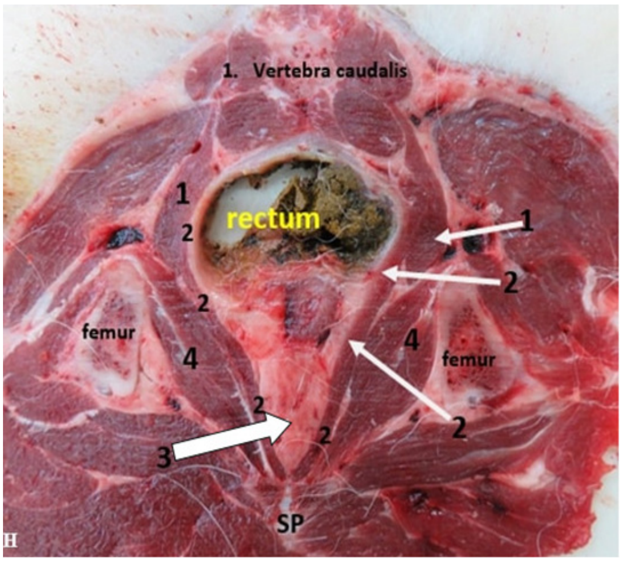

Figure.3. H. Male piece, formation of pelvic diaphragm, the view of cross-sectional anatomy. 1: Coccygeal muscle, 2: Levator ani muscle, 3: Prostata, SP: Pelvic symphysis, 4: Internal obturator muscle.

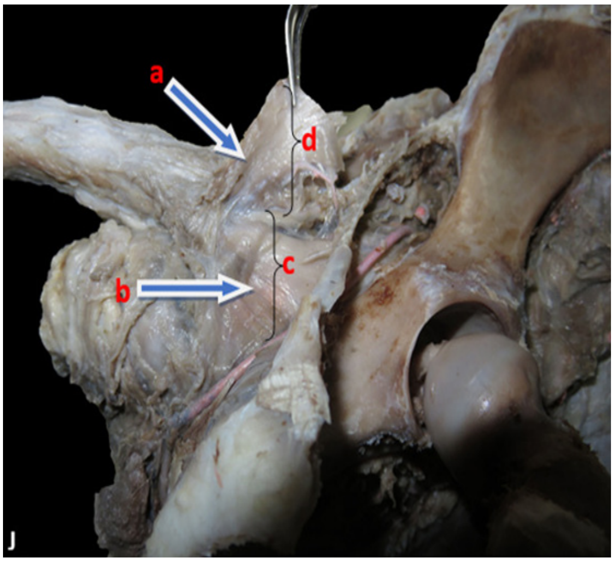

Figure.3. J. Male piece, formation of pelvic diaphragm. a: Coccygeal muscle, b: Levator ani muscle, c: External fascia of pelvic diaphragm, d: Internal fascia of pelvic diaphragm

Figure.3. K. Male piece pelvic diaphragm CT transversal section. mc: Coccygeal muscle, 1: Rectum, 2: External anal sphincter muscle, 3: İschium, 11: Levator ani muscle, SP: Pelvic symphysis, C: 2. caudal vertebra.

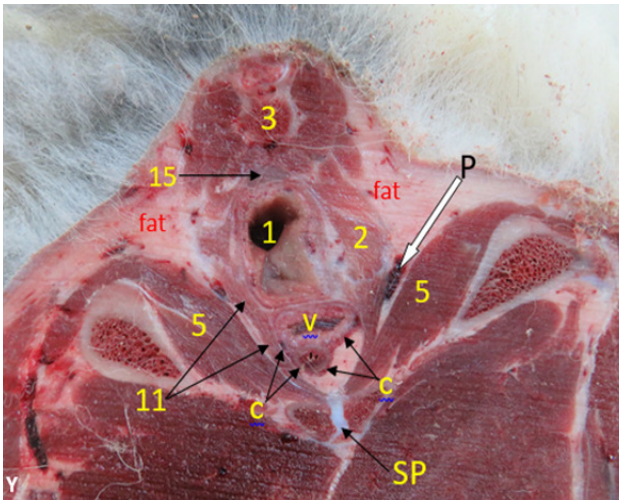

Figure.4. Y. Female transversal 2nd section. Rectococcygeal muscle. 1: Rectum, 2: External anal sphincter muscle, 3: 3.caudal vertebra. 5: Internal obturator muscle, 8: Sacrotuberous ligament, P: Internal pudendal artery, internal pudendal vein, pudendal nerve, 11: Levator ani muscle, u: Urethra, c: Urethral sphincter muscle, SP: Pelvic symphysis, 15: Rectococcygeal muscle, v: Vagina.

After rectococcygeal muscle was combined with the fascia in the tail ventral at the 1st-4th tail vertebrae: the muscle inserted by continuing to the ventral of the 4th-6th tail vertebrae (Figure 4.X, 4.Y). It was determined that rectococcygeal muscle provided the motion impulse of the intestinal content towards the anus via the tail movement during defecation. Table 6 shows measured values of rectococcygeal muscle. When Table 6 is examined; in male and female pieces, it was observed in the measurements performed with rectococcygeal muscle that there was no significant difference that was shaped depending on the age.

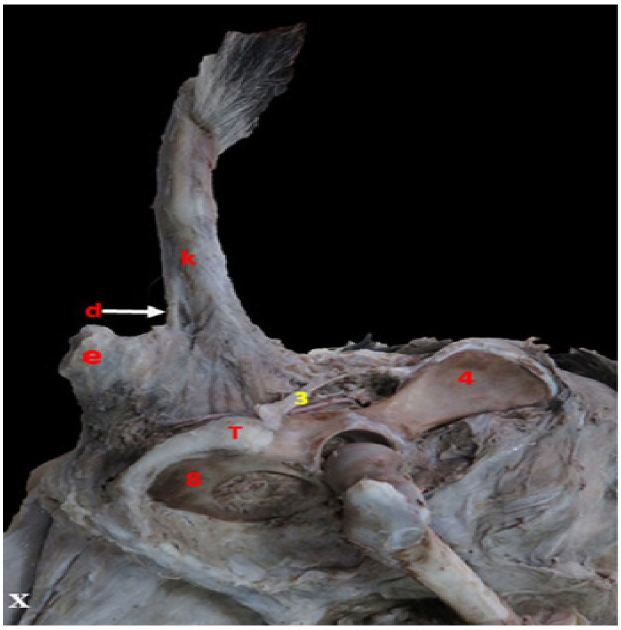

Figure.4. X. Male piece rectococcygeal muscle. d: Rectococcygeal muscle, e: Anus, k: Tail, T: Ischial tuberosity, 3: Sacrotuberous ligament, 4: Wing of ilium, 8: İschium.

External anal sphincter muscle

Around the anus, external anal sphincter muscle peripherally surrounding it like a ring was observed. After the muscle surrounded the anus, the muscle fibers were crossed before combining with bulbospongiosus muscle. Although it was reported that external anal sphincter muscle was a striated muscle, it had no direct contact with the skeleton. It was observed that external anal sphincter muscle was in a fascial connection with the ventral surface of the tail. Via the removal of this fascial connection, it was observed that external anal sphincter muscle, anus, anal canal and paranal sinus structures were free against all kinds of external effects. It is considered that the said fascial connection was effective in defecation and in positioning the anal canal.

In most of our dissections, it was detected that external anal sphincter muscle surrounded the anal canal and extended to the ventral of 3rd tail vertebra. It was observed that levator ani muscle and external anal sphincter muscle had a close relationship with the fascial bonding on the right-left sides of the anus bilaterally and they made a border with this fascial bonding. External anal sphincter muscle is divided into three sections according to the routes of muscular fibers: -cutaneous part, - superficial part, -deep part (Figure 5.L, 5.M, 5N). Table 7 shows; lateral width of external anal sphincter muscle and the width of its section corresponding to the tail ventral of the muscle. When Table 7 is examined; It was also detected that the width of the muscle increased in direct proportion to age both in female and male pieces. Besides, it was observed that the dorsal width of the muscle in the tail ventral in both sexes was larger than the lateral width.

Table 6. Measured values of rectococcygeal muscle				
recto coccygeal muscle	Width in the dorsal of external anal sphincter muscle (mm)	Width of insertion (mm)	Insertion point (mm)	Width of the midpoint (mm)
1st male	7.39	3.08	4th-5th tail vertebrae	5.25
2nd male	15.18	4.09	4th-5th tail vertebrae	10.42
3rd male	8.03	2.35	5th-6th tail vertebrae.	6.92
1st female	12.58	3.45	4th-5th tail vertebrae	8.34
2nd female	8.14	2.38	4th tail vertebra	6.30
3rd female	8.87	2.77	4th -5th tail vertebrae	6.96

Table 7. Lateral width of external anal sphincter muscle and the width of its section corresponding to the tail ventral of the muscle

External anal sphincter muscle	lateral width of the muscle (mm)	dorsal width of the muscle (mm)
1st male	26.54	27.01
2nd male	24.19	24.72
3rd male	14.93	15.11
1st female	26.99	27.50
2nd female	18.25	19.15
3rd female	24.60	25.21

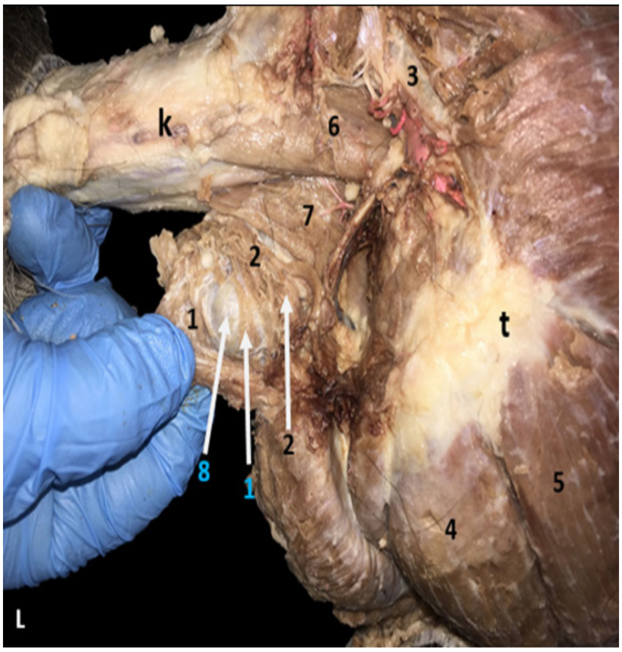

Figure.5. L. Male piece external anal sphincter muscle. 1: Deep part, 2: Fibers of superficial part, k: Cauda, t: Ischial tuberosity, 3: Sacrotuberous ligament, 4: Semimembranosus muscle, 5: Semitendinosus muscle, 6: Coccygeal muscle, 7: Levator ani muscle., 8: Paranal sinus.

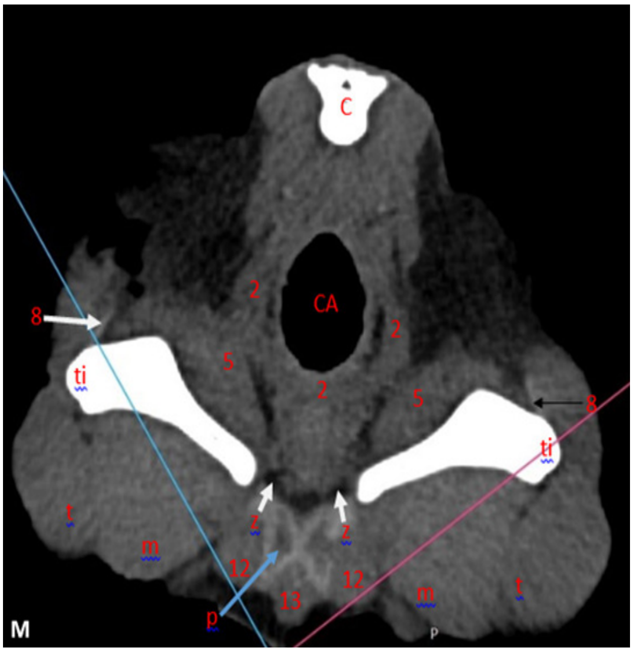

Figure.5. M. Male piece external anal sphincter muscle CT transversal image section. 2: External anal sphincter muscle, 5: Internal obturator muscle, 8: Sacrotuberous ligament, 12: Ischiocavernosus muscle, 13: Bulbospongiosus muscle, z: Dorsal vein and artery of penis, u: Urethra, CA: Anal canal, C: 3. caudal vertebra, ti: Ischial tuberosity, t: Semitendinosus muscle, m: Semimembranosus muscle, p: Bulb of penis.

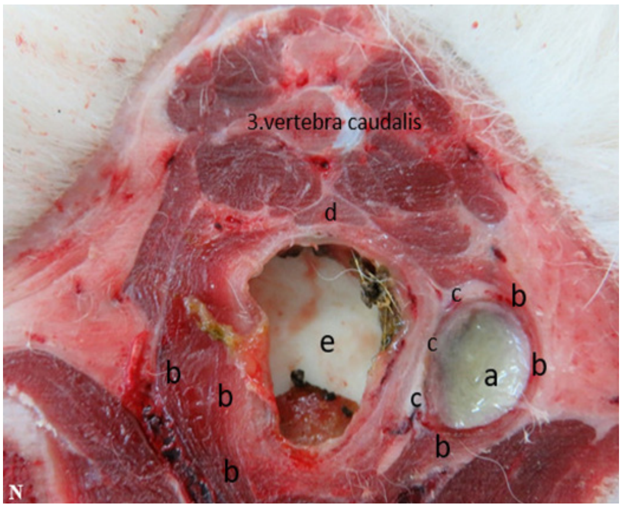

Figure.5. N. Transversal section of external anal sphincter muscle. a: Paranal sinus, b: External anal sphincter muscle, c: Internal anal sphincter muscle, d: Rectococcygeal muscle, e: Anal canal.

Internal anal sphincter muscle

When the dissection was continued to the depth of the anal sacs, a thin structure that was similar to the muscle fibers was determined. When especially the medial of the anal sacs, namely the points of connection with the anus were carefully examined, the muscle fibers became slightly more noticeable. It was in the form of an expansion of the circular muscle layer of the rectum. Anal sacs have great importance particularly to determine the location of this muscle accurately. Because paranal sinus (anal sacs) were located in a position between the external anal sphincter muscle and internal anal sphincter muscle that was surrounded by these muscles. There was an indistinct fascia between the internal anal sphincter muscle and external anal sphincter muscle and the anal sacs (Figure 5 N).

Paranal sinus

There are two anal sacs between external anal sphincter muscle and internal anal sphincter muscle. In the region of anus corresponding to 8-16 o'clock level laterally, it is possible to differentiate the anal sacs within two bulges (Figure 5.L, 5.N). It was detected that anus was opened to the cutaneous zone via the secretion ducts of paranal sinuses. Because the cutaneous zone of the anus was the last exit region of anal canal, the region was pathologically and clinically important. In terms of veterinary medicine, obstruction of the ducts and fistulae were frequently encountered.

Table 8 shows diameters of anal sacs in two different forms as cranio-caudal and dorso-ventral according to the body plane. When Table 8 is examined; based on the measurements performed in male and female dog cadavers, it was determined that diameters of paranal sinuses increased depending on the increasing age. As a result of the male and female dissections, it was observed that in general, the dorsoventral diameters of paranal sinuses were larger than the craniocaudal diameters and the anal sacs were oval-shaped. Tablo 9 shows diameters and lengths of ducts of paranal sinuses. When Table 9 is examined; with increasing age, the diameter and length of the ducts of paranal sinuses increased in dogs.

When it is considered that the malodorous secretion of the anal sacs varies from dog to dog, depending on the increasing age, the importance of secretion of anal sacs in determining the borders of its own region and the defecation amount has been more apparent.

Ischiorectal fossa

It is necessary to act as careful and sensitive while removing the fatty layer because the veins and nerve pack, that is quite important for perineal region, is present in this gap.

After the fatty layer is removed, a depression, i.e. A gap from the anus and ischial tuberosity towards the pelvic cavity is seen and this depression is called as ischiorectal fossa. Borders of ischiorectal fossa: -in the dorsal: caudal vertebrae and partially sacrum, -in the dorsolateral: superficial gluteal muscle, -in the lateral: sacrotuberous ligament, -in the medial: caudally external anal sphincter muscle, cranially internal

Table 8. Diameters of anal sacs in two different forms as cranio-caudal and dorso-ventral according to the body plane

Paranal sinuses	Dorso-ventral (vertical) diameter (mm)	Cranio-caudal (horizontal) diameter (mm)
1st male	19.92	18.06
2nd male	19.81	17.22
3rd male	12.26	10.82
1st female	18.82	18.66
2nd female	7.89	7.69
3rd female	23.09	19.29

Table 9. Diameters and lengths of ducts of paranal sinuses

duct of paranal sinuses	Diameter (mm)	Length (mm)
1st male	1.18	9.83
2nd male	1.12	9.67
3rd male	0.50	3.04
1st female	0.95	11.98
2nd female	0.47	2.98
3rd female	0.73	10.24

ischiadic spine (Çalışlar 1976, Miller 1979, Rolf 1995, König et Liebich 2015, Dyce et al. 2018), some others also state that the muscle originates from the medial surface of ischiadic spine (Budras et al. 2009). According to Dyce et al. (2018),

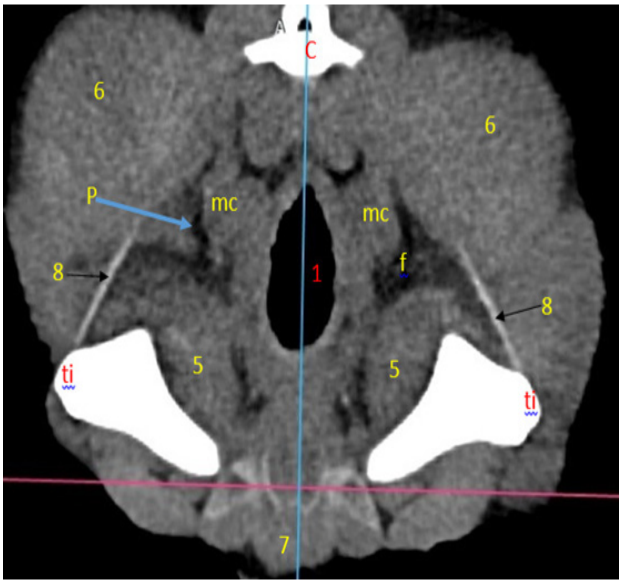

Figure 6. Ischiorectal fossa CT transversal section. mc: Coccygeal muscle, ti: Ischial tuberosity, 1: Rectum, C: 2. caudal vertebra, 5: Internal obturator muscle, f: Ischiorectal fossa, 6: Superficial gluteal muscle, 7: Bulbospongiosus muscle, 8: Sacrotuberous ligament, P: Pudendal canal.

obturator muscle in the deep, -ventrally: dorsal origin border of bulbospongiosus muscle in male dogs. Dorsal border of constrictor vulva muscle in the ventral of external anal sphincter muscle in female dogs (Figure 6).

Discussion

Numerous researchers examine anal region by dividing it into two important anatomical structures:-Pelvic diaphragm , -Ischiorectal fossa (Habel 1966, Rolf 1995, Budras et al. 2009, Dyce et al. 2018). In the present study, anal region was examined under three important anatomic sub-titles. These were: -pelvic diaphragm, -ischiorectal fossa, -other muscles of the anal region, and anal canal. While there are researchers reporting that coccygeal muscle originates from this muscle originates with a tendinous origin from ischiadic spine. In the present study, it was determined that coccygeal muscle originated from the medial surface of ischiadic spine. According to Miller (1993), the insertion of the muscle is the ventral of transverse process of 2nd-4th tail vertebrae. According to Budras et al. (2009); after it originates from ischiadic spine of coccygeal muscle, it continues towards the tail caudodorsally and inserts by adhering on the 4th-7th tail vertebrae. According to Dyce et al. (2018); coccygeal muscle inserts at the 2nd and 5th caudal vertebrae in the lateral of the tail. At the end of the study, it was detected that coccygeal muscle continued in the ventral of transverse process of 1st-4th tail vertebrae and inserted by adhering on the fascia in the ventral side of the tail. It has been reported that coccygeal muscle is a thicker and shorter muscle than levator ani muscle that is another muscle involved in the formation of pelvic diaphragm (Miller 1979, Budras et al. 2009, Dyce et al. 2018). In the study, the same finding was obtained in the measurements performed by using a caliper in male and female dog cadavers. Concerning levator ani muscle involved in the formation of pelvic diaphragm, it has been reported that it originates from ischiadic spine and inserts at the border of external anal sphincter muscle in caudal side and fascia of the tail in dorsal side (Rolf 1995). Miller (1993) has specified that levator ani muscle is located in the medial of coccygeal muscle and it has a wide origin together with the medial surface of ischiadic spine and corpus ossis İli. Regarding levator ani muscle, it was determined in this study that this muscle originated from medial surface of ischiadic spine and meidoventral of corpus ossis ilii and had a wide origin continuing to a border close to pelvic symphysis. According to König and Liebich (2015), and NAV (2017), levator ani muscle is a bipartite muscle as iliocaudal muscle and pubocaudal muscle. According to König and Liebich (2015), iliocaudal muscle is the part that originates from os ilium of levator ani muscle. Pubocaudal muscle is the part of of levator ani muscle in os pubis whose origin is along pelvic symphysis. In the present study, results similar to König and Liebich (2015) were obtained. Rolf (1995) states that it caudally ends at the border of external anal sphincter muscle and dorsally at the tail fascia, Miller (1993) specifies that levator ani muscle continues caudodorsally and inserts at the ventral of 3rd and 7th tail vertebrae, and König and Liebich (2015) state that levator ani muscle inserts by adhering to the hemal process of the tail vertebrae. In this study, regarding the insertion of levator ani muscle, it was determined that the muscle continued to the caudodorsal side and combined and inserted at the tail fascia in the ventral of transverse processes of 1st-4th tail vertebrae. In the literature, it is stated that levator ani muscle is located deeper and is thinner than coccygeal muscle (Miller 1993, König et Liebich 2015, Dyce et al. 2018). In the measurements, it was determined that levator ani muscle was a wider and thinner muscle than coccygeal muscle, which confirms the literature. In the measurements done with a caliper, for example, the thickness of coccygeal muscle was 8.50 mm. in the 1st male piece; whereas, the thickness of levator ani muscle in the same piece was measured as maximum 6.55 mm. Likewise, the thickness of coccygeal muscle was measured as 8.24 mm in the 1st female piece and the thickness of levator ani muscle was measured as maximum 4.52 mm. Regarding that levator ani muscle was a wider muscle, for example, in the 1st male piece, the origin width of coccygeal muscle was 40.5 mm and the origin width of levator ani muscle was 56.88 mm. It is stated that levator ani muscle is the depressor of the tail like coccygeal muscle (Rolf 1995, Dyce et al. 2018). It is also stated that levator ani muscle also acts to lift the anus upwards (Dursun 2008b). In addition to the findings specified on the duties of the muscle; it was detected that the origin of levator ani muscle suspended the pelvic cavity organs that were present in the medial surrounded and encircled by the muscle, and especially rectum towards the tail vertebrae because it spreaded over a wide pelvic band.

Berg describes the ischiorectal fossa in dogs as a tube-shaped depression in the lateral of coccygeal and levator ani muscles and anal canal and specifies its borders as follows; dorsal border: Sacrum and caudal vertebra, dorsolateral border: Superficial gluteal muscle, lateral border: Sacrotuberous ligament, ventrolateral border: Internal obturator muscle (Rolf 1995). In this study, another description was found for the borders of ischiorectal fossa, which are compatible with the literatüre; -dorsal: caudal vertebrae and partially sacrum, -dorsolateral: superficial gluteal muscle, -lateral: sacrotuberous ligament, -medial: depression between external anal sphincter muscle and internal obturator muscle, -ventral: dorsal origin border of bulbospongiosus muscle and the dorsal margin of constrictor vulva muscle in the ventral of external anal sphincter muscle in female dogs. Miller (1979) states that medial of ischiorectal fossa is dorsally limited with external anal sphincter muscle and ventrally limited with retractor penis muscle in male dogs and with constrictor vulva muscle in female dogs and additionally, medio-cranially located coccygeal and levator ani muscles combines with the start border of laterally located internal obturator muscle and forms an obtuse sinus. In this study, the borders specified for ischiorectal fossa and the ischiorectal fossa borders specified by Miller (1979) are compatible.

Although it was reported that external anal sphincter muscle was a striated muscle (Miller 1979, Dursun 2008b, Budras et al. 2009), it had no direct contact with the skeleton. When examining the close vicinity of the muscle, it is stated that cranial edge of external anal sphincter muscle is in close contact with the caudal edge of levator ani muscle via the fascia (Miller 1979, Dyce et al. 2018). According to Miller (1979), the muscle dorsally enlarges and is found as connected to the ventral fascia of the tail till the ventral of the 3rd tail vertebra. In this study, the fascial contact of the muscle with the levator muscle and its fascial contact with the ventral sides of the tail vertebrae were determined in male and female dog dissections. In the literature review, it was observed that the importance of this fascial connection between the external anal sphincter muscle and the ventral surfaces of the tail vertebrae was not sufficiently addressed, but it was observed that the anus and it was very effective in positioning the anal canal and the anus when the tail was moved. It is specified in the literature that external anal sphincter muscle is divided in 3 parts according to the course of its fibers (Habel 1966, Miller 1979, Alpak 1992, Rolf 1995, NAV 2017). Regarding the course of these parts; it was determined that the fibers of cutaneous part were the fibers of external anal sphincter muscle in contact with the skin because the said muscle is located immediately under the skin. Also it was found that fibers of superficial part were the fibers that were more superficial than the deep fibers and continued to the urogenital region towards the ventral. It was determined that fibers of deep part were fibers that continued to the ventral side under the superficial muscle fibers and continued deeply in the muscle. Fibers of deep part inserted by combining with bulbospongiosus muscle in the male cadavers and inserted by combining with constrictor vulva muscle in the female cadavers. Miller (1979) states that the muscle is dorsally more than 2 cm wider and ventrally reaches to 1 cm width (Miller 1979). It was detected that the dorsal width of the muscle at the tail ventral was larger than the lateral and ventral widths, which confirms the statement of Miller (1979). In the measurements, it was determined that maximum dorsal width of external anal sphincter muscle was 27.50 mm and its maximum lateral width was 26.99 mm. Thus, as reported by some researchers (Çalışlar 1976, Miller 1979, Dyce et al. 2018), it was confirmed in this study that the dorsal width of the muscle was larger. However, unlike Miller (1979), the ventral width of the muscle was more than 1 cm on average, except for small dogs.

Dorso-ventral lengths of paranal sinuses were found to be higher than the cranio-caudal diameters. Different studies have provided different values for the diameters of anal sacs. According to Dyce, its diameter in dogs is approximately 1 cm (Dyce et al. 2018). According to Berg, anal sacs vary according to the age, breed, and sex of the dogs and the diameters of these sacs vary between 0.5 cm and 3 cm (Rolf 1995). It was determined that the diameters of anal sacs increased with increasing age and varied between 1 cm and 2.5 cm on average. The values found regarding the diameters of the anal sacs are compatible with the values of Dyce et al. (2018) and Rolf (1995). Miller (1979) states that the length of the duct that discharge the content of every anal sac is approximately 5 mm and its diameter is approximately 2 mm and these ducts are opened to cutaneous zone that is the outermost region of anal canal at a close point of cutaneous zone to intermediary zone. The diameter of the duct was found as maximum 1.12 mm and minimum 0.47 mm. The length of the duct was determined as maximum 10.24 mm and minimum 2.98 mm. The measurements made in the present study are compatible with Miller (1979) who provides the above-mentioned duct values.

Rectococcygeal muscle is a double muscle and it originates from the right and left lateral half of the rectum of longitudinal muscle layer and inserts at the fascia providing the connection of external anal sphincter muscle with the tail (Miller 1979). Similar to Miller (1979), Budras et al. (2009), state that the muscle inserts at the 3rd caudal vertebra level. However, if we provide a mean value among 6 cadavers, it can be specified that rectococcygeal muscle continued till the ventral of 4th-5th tail vertebrae. (Miller) 1979 and Dyce et al. (2018) state that this muscle takes a duty of support for longitudinal smooth muscle layer of rectum. In addition to the finding of the researchers (Miller 1979, Dyce et al. 2018), it was determined that rectococcygeal muscle ensured coordination between anus, rectum and tail movements of the dog during defecation and this muscle provided motion impulse of the content of rectum towards the anus and rectum via the tail movement.

Conclusion

It is considered that the dissection, cross-sectional anatomy and computerized tomography studies applied to perineal region would guide the veterinarians, who will work in this region. The contribution of this study is important for development of diagnostic and treatment methods in approaches to be exhibited especially towards pathological and clinical cases such as perineal hernia, rectal prolapse, urethrotomy, anal sac inflammation and fistulae.

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