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GROSS ANATOMICAL STUDY OF THE MALE ACCESSORY GENITAL GLANDS IN THE ADULT RABBIT WITH SPECIAL REFERENCES ON THEIR VASCULARIZATION.

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ABSTRACT

The gross anatomy of the male accessory genital glands of the healthy adult rabbit and their vascularization were investigated using thirty five male specimens. The morphological study was carried on six male rabbits and showed that the male genital glands constituted of: the ampulla of ductus deferens, the vesicular gland, the prostate gland and the bulbo-urethral gland. These regions were defined through shape and relation to adjacent organs. The vascularization of the male genital glands in rabbit was applied on twenty nine adult ones. The arterial supply was oriented by the urogenital artery or the prostatic artery from internal pudendal artery and the ventral branch as well as the caudal branch of vesicular gland from the umbilical artery. The venous drainage was achieved by internal pudendal vein which drained into the caudal vena cava.

Key word: Rabbit, Gross anatomy, Vascularization. Pudendal Artery

INTRODUCTION

The European common rabbit ***(oryctologus cuniculus)*** belongs to the family ***Leporidae*** which contains a large number of closely related species formely included under the single genus ***Lepus*** but distributed among nine genera with living representatives and a large number of extinct ones according to **Horne (1948**).

According to Norman (2014), Rabbits are excellent cheap animals but highly nutritional food source. They produce lean meat (white meat, high in protein, low in fat, highly palatable, low in cholesterol) and their carcass are only 20% bone. Rabbits are important and high economic value, the domestic laboratory animal used in many medical researches. Rabbits are easy to rear, make considerably less noise

than chicken and geese and have ability to adapt to environmental changes. .

Davies (2003) and Lebas (1997), Rabbits are true herbivorous animal which are super-efficient convert fodder to food. The whole point of meat production is to convert plant proteins of little or no use to people as food into high value animal protein that produce 6 times more meat per food and water intake. The aim of our work is demonstrating the anatomy of the male genital organs of adult rabbit in relation to vascularization.

MATERIAL AND METHODS

The present work was totally conducted on thirty five healthy adult male rabbits. Our first study included the description and the morphology of the adult male genital organs. The second study determined vascularization of the arterial supply and venous drainage. The average weight of the adult male rabbit was 3.5-4kg.ranging from 6-7 months.

Gross anatomical study

Six adult male rabbits (***Oryctologus Cuniculus***) were used in this work. Before exsanguination, rabbits anesthetized by I/P injection of thiopental sodium 3ml 2.5% solution for 20-40second and prolonged inhalation anesthesia using chloroform for 2-5 minutes. Each specimen was exsanguinated through the common carotid artery and the jugular vein then left to bleed for 15 minutes. The cadavers preserved in a suitable container with 10% formalin solution for 3-5 days. The morphometric study, the values of both length and width of the organs and the vessels were measured by aid of Vernier digital Caliber (Fig. A) and a magnifying lens (Fig. B).

1. The angio-architectural study

A research study was completed on twenty nine adult male healthy rabbits. Before exsanguination, the animals were injected by heparin (Cal heparin, 5000I.U) in the ear vein and left 30 minutes to prevent blood clotting. Each specimen was exsanguinated through the common carotid artery and the jugular vein and then left to bleed for 15 minutes. Immediately following euthanasia, the sternum and the ribs were removed to expose the heart for injecting twenty four specimens with latex by using red and blue Rottring ink and other five specimens injected by color red and blue epoxy for arteries and veins.

1. Gum milk latex injection technique

Twenty four specimens were injected with colored gum milk latex, twelve out of the specimens for the arteries and the rest of the examined cases for the veins. The vessels of injection were cannulated and thoroughly washed by warm normal saline solution Nacl 0.9% containing amount of heparin (heparin calcium 5000 I.U.) to remove the clots and the blood remaining in the vessels. According to the technique of ***Rajtova (2011),*** the injected specimens were preserved in 10% formalin solution for 3-5 days. The specimens were dissected for exposing the arterial distribution and the venous pattern.

1. Eboxy injection technique

Five specimens of adult male rabbits preserved for the injection as that used for the preceding technique then they were injected by Eboxy (E151 N20) to prepare vascular pattern by help of the procedure that reported by ***Schummer (1951).*** After hardening of the specimens (1-2 weeks) in room temperature, the specimens were dissected carefully for the configuration and the arborization of the arterial supply and the venous drainage of the adult male rabbits. The specimens were photographed using Olympus digital camera SP-600UZ 12 mega pixel.

RESULTS

The vesicular glands

As shown in Figs.(5,6) , they are two bilateral round lobes cranial to the pro-prostate gland and slightly covered by the latter gland and the prostate one. The length of the vesicular glands ranges 0.4-0.6 cm. (Table 2). The cranial end of the gland is the broadest part which slopes caudally where it covers the glandular or ampullated part of the ductus deferens. The narrowest of each vesicular gland opens separately at the urethral crest on the apex of colliculus seminalis by the ejaculatory duct.

The prostate gland (Figs.4,5,6), it is complex gland that consist of three lobes; the pro-prostate, the prostate and the para- prostate.

The pro-prostate (Fig.5) is the largest compartment of the prostate group which measure about 1-1.5 cm.in length (Table2) and situated in between the vesicular gland cranially and the prostate gland caudally. The dorso-lateral part of the pro-prostate gland slightly rises forming a concaving dorsal surface of the gland. The pro-prostate is situated dorsal to the pelvic urethra where it opens separately on the dorso-lateral aspect of the colliculus seminalis beside ampulla of ductus deferens**.**

The prostate gland (Figs.5,6) is rectangle in shape measure about 0.8-1cm. in length (Table 2) and situated behind the pro-prostate on the dorsal wall of the pelvic urethra and cranial to the bulbo-urethral glands.

The para-prostates (Figs.4,5) are two in number and finger like elevation between the pro-prostate and prostate dorso-lateral the ampulla of ductus deferens. It measures about 0.4-0.6 cm. in length.

The bulbo-urethral glands (Fig.6) are paired, flat and smooth cubic in shape measure about 0.3-0.4 cm. in length (Table 2), situated on the caudal border of the prostate and imbedded on the doso-lateral wall of the penile urethra in relation to the root of penis.

Fig.(1):A photograph showing the male genital organs and the urinary bladder.(Dorsal view)

Fig.(2): A photograph showing the male genital organs and urinary bladder. (Lateral view)

Fig.(3): A photograph showing the accessory genital glands. (Dorsal view)

Fig.(4): A photograph showing the accessory genital glands and the testis. (Dorsal view)

Legend of figures (1-4)
Morphology

a: Urinary bladder.

b: Testis.

c: Head of epididymis.

d: Tail of epididymis.

e: Ductus deferens.

f: Ampulla of ductus deferens.

g: Scrotum.

h: External cremaster muscle.

n2: Body (corpus) of penis.

p.p.: Prepuital gland.

pre: Prepuce.

p.l.: Pars libera.

i: Vesicular gland.
p1: Pro-prostate.
p2: Prostate.
P3: Para-prostate.
m: Urethra.
m1: Urethral groove.
c.g: Cowper's gland.
n1: Bulb of penis
r: Ischial arch.
O: Crura of penis.
R. &L.: Right & Left.
s: Spermatic cord.

1. Arterial supply

The arterial supply of the male accessory genital glands in the adult rabbit comprises: internal iliac trunk which gives of the umbilical artery and internal pudendal artery.

2. Iliaca Interna

The internal iliac artery (Fig.9/8) is short, stout vessels right and left; the diameter is about 0.25 mm. (Table3) and 0.3cm. in length. It erupted from the medial aspect of common iliac trunk at the level of body of the 7th lumbar vertebrae and gives off the main two branches; the umbilical and the internal pudendal arteries.

3. Umbilicalis

The umbilical artery (Fig.9,10) is a long strong vessel that detaches from originated trunk and its width is 0.1mm. (Table3).It is directed obliquely caudo-ventrally in relation to the descending colon and divided into two branches; cranial and caudal vesical arteries (Fig.10).

4. Vesicalis cranialis

the cranial vesical artery (fig.2.21) is small twig which distributed into the urinary bladder by 3-4 fine radicles.

5. Vesicalis caudalis

The caudal vesical artery (Fig.10) is long fine vessel, measures about 2.5-3cm. in length that arises directly from the root trunk where it passes caudo-laterally on the urinary bladder. During its course, it detaches several branches; R. ductus deferentis, R. ampulla of ductus deferentis (Fig.9/7&17), R.Vesicalis caudalis and R. vesicalis ventralis (Fig.13).

R. ductus deferentis

The branch of ductus deferens (Fig.10) is long coiled vessel and emanates from caudal vesical artery. It passes parallel to corresponding organ suspended in meso-ductus deferens and gives 3-4 fine arterioles.

R. ampulla of ductus deferentis

The branch of the ampulla of the ductus deferens (Fig.13/17) is short corrugated vessels about 1.6cm. in length where it is released from the

parent trunk and directed obliquely caudo-laterally to supply the corresponding organs by 2-3 fine collateral vessels.

R. Vesicalis caudalis

The caudal branch of the vesicular gland (Fig.10/18) is long thin vessel which emits from the caudal vesical artery and passes cranially till reach to supply the caudal border of this gland by 2-4 fine branches.

R. Vesicalis ventralis

The ventral branch of vesicular gland (Fig.13/9) is long weak vessel about 1.8cm. in length. It erupted from the caudo-medial wall of the main trunk and directed into cranio-ventral wall of the current organ to supply it by 2-3 fine arterioles.

6. Pudenda interna

The internal pudendal artery (Fig.15) is the direct continuation of internal iliac artery. It is a long stout vessel about 0.2mm. in diameter (Table3) and about 5.6cm. in length. It proceeds caudo-laterally along the dorso-medial wall of the pelvic cavity where it biforicates into the urogenital artery and the penile artery.

A.Urogenitalis

The urogenital artery (Fig.15, 16) is short stout vessel, measures about 1.5cm. in length where it emanates from the ventral aspect of the parent trunk. It directs obliquely caudo-ventrally till reaches the second sacral vertebrae where it gives off two branches; the cranial and the caudal prostatic arteries.

A. prostatica cranialis

The cranial prostatic artery (Fig.16/12) is fine short branch which originates from the cranial aspect of the parent trunk. It passes obliquely craino-ventrally till reach to the pro-prostate and ramifies into 2-3 fine arteries to supply it.

R. prostatica caudalis

The caudal prostatic artery (Fig.16/11) is considered the continuation of the urogenital trunk, measures about 3-4cm. in length. It passes obliquely caudo-ventrally till reaches to the corpus spongiosum penis where it continues its course as the caudal prostatic ramus which in turn divided into ramus bulbi penis and ramus bulbo-urethralis.

Fig.(1): A photograph showing the main arterial supply of the male genital organs.

Fig.(2): A photograph showing the origin and distribution of the testicular and umbilical arteries.

Fig(3): A photograph showing the origin of internal pudendal artery.

Fig.(4): A photograph showing the distribution of the caudal vesicular artery.

Fig.(5): A photograph showing the arterial blood supply of the prostate gland.

Legands of figures (1-5)

Arterial supply of the adult male genital organs in rabbit

1.A. Abdominalis aortae.
2.A. Iliaca communis.
3.A. Testicularis dextrae.
4.A. Testicularis sinistra.
5.Ramus Epididymalis caudalis.
6.Ramus Epididymalis cranialis.
7.A. Ductus deferentis.
8.A. Iliaca interna.
9.A. pudenda interna.
10.A. umbilicalis.
11.A. prostatica (A. Urogenitalia).
12.A. prostatica cranialis.
13.A. prostatica caudalis.
B. V. Testicularis sinistra.
P. V. Pudendal interna.
M. V. Iliaca communis.
A. Vena cava caudalis.

1. A. Penis.
2.A. dorsalis penis.
3. A. profunda penis.
4.A. ductus deferentis ampullae.
5.A. Vesicalis caudalis.
6. Ramus vesicularis ventralis.
7. Ramus vesicularis caudalis.
8.A. vesicalis cranialis.
9.Ramus epididymalis media
10. Plexus pampiniformis.
11. Ramus prostatica caudalis.
1.Urinary bladder.
2.Testis.
3.Head of epididymis.
1.Ductus deferens.
2.Ampulla of ductus deferentis.
1.Vesicular gland.
1. Pro-prostate.
2. Prostate.
.l. Pars Libera.
.k. Left kidney.
1. Bulb of penis.
2. Body of penis.

Vv. Pudenda interna

The internal pudendal veins (Fig.6/P) are the two terminal branches of the caudal vena cava. Each one is long, strong vessel and measure about 0.4mm. in diameter. It drains from the parent vessels on a level with the beginning of the sacrum. It passes caudo-laterally and detaches the prostatic and the penile veins.

V. prostatica

The prostatic vein (Fig.7/N) is short, stout vessel drained from the internal pudendal vein and directed caudo-ventral to reach the prostate gland where it drains the cranial and the caudal prostatic veins.

V. prostatica cranialis:

The cranial prostatic vein (Fig.7/O) is short vessel drained from the prostatic vein and it ramified and drained the cranial part of the prostate gland (pro-prostate).

V. prostatica caudalis:

The caudal prostatic vein (Fig. 7/ w) is similar to proceeding one and drained to the lateral border of the prostate gland a here it distributed.

V. Umblicalis:

The umbilical vein (Figs.10,11/Z) is strong and short vessel that drained into the internal iliac vein. It is directed obliquely caudo-ventrally and detaches the caudal vesical vein.

V. vesicalis caudalis:

The caudal vesical vein (Figs.10,11/R) is long, convoluted vessel that drained into the parent vein where it passes caudo-laterally on the urinary bladder. During its course, it drains the ductus deferntis.

V. ductus deferentis

The ductus deferntis vein (Figs.1,2/l) is relatively long branches distributed along whole length of the ductus deferens. It drains into the caudal vesical vein.

Fig(1): A photograph showing the main venous drainage of the male genital organs.

Fig.(2): A photograph showing the venous drainage of the vesicular gland

Fig.(3): A photograph showing the origin of the internal pudendal vein.

Fig.(4): A photograph showing the venous drainage of the prostate gland.

Legend of figures (1-4)

Venous drainage of the male genital organs in the adult rabbit:

1.Vena cava caudalis.

2.V. Testicularis sinistra.

3.V. Testicularis dextra.

4.V.ilio-lumalis.

5.V. lumbo-testicularis.

6.V.renalis sinistra.

7.Pampiniform plexus.

8.V. umblicalis.

9.V. Ductus deferentis.

1.V. epididymalis caudalis.

2.V. iliaca interna.

3.V.iliaca communis.

4.V. prostatica.

5.V.prostatica cranialis.

6.V.pudenda interna.

7.V. penis.

8.V. vesicalis caudalis.

9.R. vesicalis ventralis.

10.R. vaginalis tunica

11.R. muscularis

W. V. prostatica caudalis.

X. V. epididymalis cranialis.

Y. Common trunk of T and U.

Z. V.Umblicalis.

a. urinary bladder.

b. Testis.

c. Head of epididymis

d. Tail of epididymis.

f. Ampulla of the ductus deferentis.

i. vesicular gland.

P1. Proprostate.

P2. Para prostate.

c.g. cowpers' gland.

m. Male urethra.

n1. Bulb of the penis.

n2. Corpus (body) of the penis.

Pre. Prepuce.

Pl. pars libera.

8. A. Abdominalis aortae.

9. A. iliaca communis.

10. A.Testicularis dextra.

11. A.Testicularis sinistra.

DISCUSSION

I- Gross anatomical study

In consent with the description of **Dyce et al., (2002), Sisson and Grossman (1975), Nickel et al., Elhagri (1967) in dog, Foote and Holtzi (1978) in rabbit and Jacob and Jennings (1901) in cat**, we noted that **the ductus deferens** was the continuation of the tail of the epididymis at the caudal pole of the testis that proceeded caudally to open into the colliculus seminalis. It was undulating tube which emerged and gradually straightened toward its termination at the dorsal surface of the neck of the bladder and cranio-dorsally on the prostate gland.

In the present study, the distal end of the ductus deferens was diluted to form enlarged ampullated part that situated between the vesicular gland and the dorsal wall of the neck of the bladder which agreed with **Laura et al., (2015) in hamster, Dyce et al., (2002), Elhagri(1967) in dog and Horne (1948) in rabbit**. On the other hand, **Sisson and Grossman (1975) and Nickel et al., (1973) in dog** described that the ductus deferens was not very prominent. While the latter authors with **Elhagri (1967) in cat** added that the ampulla of ductus deferens was absent.

Our investigation on **the vesicular glands** which were two bi-lateral round lobes similar to the observation of **Laura et al., (2015) in hamster, Guinea pig, mouse and rat and Foote and Holtzi (1978) in rabbit.** However, **Dyce et al., (2002), Sisson and Grossman (1975), Nickel et al., (1973) and Elhagri(1967) in dog and cat** asserted that the vesicular glands were absent.

Our results confirmed that the vesicular glands located cranial to pro-prostate and slightly covered by the latter and the prostate glands. The

cranial end of the gland was the broadest part and covered the glandular part of the ductus deferens. The narrowest of each gland open separately at the urethral crest on the apex of colliculus seminalis by ejaculatory duct.

Our findings regarding **the prostate gland**, it was complex that consisted of three lobes; the pro-prostate, the prostate and the para-prostate. This result was further confirmed by **Laura et al., (2015) in rabbit and hamster and Dimitrov (2013, 2011) in rabbit. In contrast to the observation given by Dyce et al., (2002), Sisson and Grossman (1975), Nickel et al., (1973) and Elhagri(1967) in dog and** cat who mentioned that the prostate gland consisted of two parts; one of them was very large compact mass and the other one was small disseminating part. While, **Laura et al., (2015), Dimitrov(2013, 2011)** in rodents, observed that the prostate gland was divided into four lobes; the anterior prostate, the prostate, the dorsal prostate and the lateral prostate.

In our applied study, the **pro-prostate gland** was large and situated in between the vesicular gland cranially and the prostate gland caudally similar to the results of **Foote and Holtzi(1978) and Horne (1948) in rabbit**. In the current work, the **prostate gland** was rectangle in shape in contrast to the observation of **Dyce et al.,(2002), Sisson and Grossman (1975), Nickel et al.,(1973), Elhagri(1967) in dog and cat**, they detected that the prostate gland was bilobed and globular or spherical in form.

In agreement with the observation of **Foote and Holtzi(1978) in rabbit**, the prostate gland situated behind the pro-prostate on the dorsal wall of the pelvic urethra and cranial to the bulbo-urethral glands. This statement disagreed with **Thurid et al., (2007), Sisson and Grossman (1975), Elhagri(1967)in dog** who suggested that the prostate gland

was completely surround the urethra and located at or near cranial border to pubis,. However, **Dyce et al., (2002) and Nickel et al., (1973) in cat** explained that the prostate gland was covering the urethra dorso-laterally, the ventral wall of the prostate was free and the body of the prostate did not include pelvic urethra on its ventral aspect but disseminate part was extended from wall of pelvic urethra to the level bulbo-urethral glands.

We suggested that the **para-prostates** were two in number and finger like elevation between the pro-prostate and the prostate dorso-lateral the ampulla of the ampulla of ductus deferens. This statement noted by **Foote and Holtzi(1978) and Horne(1948) in rabbi*t.***

Regarding **the bulbo-urethral glands** was paired, flat and smooth cubic in shape. Such finding was approved as those given by **Laura et al, (2015), Dimitrov (2011), Foote and Holtzi(1978) in rabbit and Dyce et al., (2002) in dog and cat.** However, **Sisson and Grossman (1975) and Elhagri (1967) in dog** stated that the bulbo-uethral glands were absent while **the authors in cat** reported that the latter glands were small at size of pea.

In our work, the bulbo-urethral glands situated on the caudal border of the prostate and imbedded on the dorso-lateral wall of the penile urethra in relation to the root of the penis. A similar pattern was described by **Dyce et al., (2002), Nickel et al.,(1973)** in dog and cat**, Sisson and Grossman (1975) and Elhagri(1967) in cat , Foote and Holtzi (1978) and Horne(1948) in rabbit**.

II-Arterial supply

The results applied in these investigations recorded that the arterial pattern of the pelvis was internal iliac trunk which gave off two main

branches; the umbilical artery and internal pudendal artery. The former one divided into the cranial and the caudal vesical arteries which split into several branches; R. ductus deferentis, R. ampulla of ductus deferentis, R.Vesicalis caudalis and R. vesicalis ventralis. This statement in accordance to **Orsi et al., (1979**) in rabbit which gave nearly similar results.

Our examination offered that the internal pudendal artery was the direct continuation of internal iliac artery and gave off two main branches; the urogenital artery (prostatic artery) and the penile artery. These results were further confirmed by **Erdogan (2**011) in tom **cat, Thurid et al.,(2007) in dog, Aysun (2006), Ozgel(2003), Mohamed(2001) and Orsi et al.,(1979**) in rabbit.

Concerning, the urogenital artery (prostatic artery) which gave off two branches; the cranial and caudal prostatic arteries simulated by the observation of **Erdogan (2011**) in tom cat, **Orsi et al.,(1979**) in rabbit. Moreover, **Thurid et al.,(2007)** in dog cited that the prostatic artery gave several branches supplied the rectum, the ductus deferens, the caudal portion of bladder, ureter and the pelvic part of urethra while ***Stefanov (2004) in dog*** suggested that the prostatic artery had three small vessels (cranial, middle and caudal) toward the prostate gland.

We had found that the caudal prostatic artery was considered the continuation of the urogenital trunk in contrast to **Ozgel et al.,(1979)** in rabbit had the opinion that the caudal prostatic artery was originated from the umbilical artery. Our work, we discovered that the caudal prostatic artery divided into ramus bulbi penis and ramus bulbo-urethralis

III. Venous drainage

We found that, the umbilical vein is drained into the internal iliac vein and detaches the caudal vesical vein that passes on the urinary bladder and drains the V. ductus deferentis. This data is not recorded elsewhere in the available literatures.

We have the opinion that, the prostate gland drained through a prostatic or urogenital vein that empties into the internal pudendal vein then opens into the internal iliac vein where it ends in two branches; the cranial and the caudal prostatic veins. These statements in contrast to **Thurid and Chris (2007), Zafer and Yavuz (2004),** they observed that the venous blood drained by the prostatic and urethral veins into internal iliac vein. On the other hand **Stefanov (2004)** in dog confirmed that the prostatic part of the urethra was drained by prostatic vein, the vein of urethral bulb and the ventral prostatic veins.

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