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Research Article

Comparative Study on the Arterial Supply of the Accessory Genital Glands in Adult Male Domestic Rabbit (*Oryctolagus cuniculus*) and Wild Fox (*Vulpes vulpes*)

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ABSTRACT

The arterial supply of the accessory genital glands was demonstrated on ten adult apparently healthy male rabbits and five male foxes where was oriented by; the umbilical and the internal pudendal arteries of the internal iliac trunk in both animals in addition to the urogenital artery of the internal pudendal artery in rabbits. In rabbits, the ampulla ductus deferens is supplied by the corresponding branch of the caudal vesical artery that ramified from the umbilical vessel. The seminal vesicular gland is received its arterial blood ventrally by the succeeding branch of the caudal vesical artery which arborized from the umbilical trunk and dorsally by the dorsal vesicular branch of the cranial prostatic artery which derived from the urogenital vessel. The two parts of the prostate (proprostate and prostate) are contributed by cranial, middle and caudal prostatic arteries of the urogenital trunk. In foxes, the prostate gland is supplied by the prostatic artery that detached from the umbilical trunk and bifurcated into cranial and caudal prostatic branches. The bulbourethral glands in rabbits are distributed ventrolaterally by right and left; cranial bulbourethral branches of the caudal prostatic arteries that emanated from the urogenital artery while in the foxes they are contributed by dorsal bulbourethral arteries of the internal pudendal artery.

Key words: Rabbit, Fox, Accessory glands, Arterial supply, Anatomy

INTRODUCTION

The arterial supply of organs in the pelvic cavity was studied by many authors in both animals and human (Fatu *et al*., 2006). The distribution of the internal iliac and the internal duodenal arteries were the most demonstrated in all available literatures (Stefanov, 2004 and Holub *et al*., 2005).

The morphological approaches relevant to vascular architecture were considered to be useful for both surgical interventions and training in anatomy (Erdogan, 2011), the origin and distribution of the umbilical, urogenital and internal pudendal arteries were described by (Orsi *et al*., 1979) in rabbits, this study demonstrated the umbilical artery. In adult male rabbits, the umbilical artery gives origin to the cranial vesicular artery and a caudal branch that supply the pelvic urogenital organs and the rectum with six branches in both male and females (Orsi *et al*., 1979).

The internal pudendal artery is the direct continuation of the internal iliac artery and gives some visceral branches that irrigate the penis, bulbourethral gland and rectum in males while it supplies the vagina, clitoris and rectum in females (Orsi *et al*., 1979). The present study was designed in a view of the availability of a limited number of studies to the accessory genital glands in the male rabbits. Therefore, the aim of our investigation is providing an accurate, anatomical descriptive bases of the arterial supply of the accessory genital glands in male domestic rabbit that showed a model for human about the prostatic arteries during surgical excision for the treatment of the prostatic lesions in human been as benign prostatic hyperplasia, prostatic neoplasm.

MATERIALS AND METHODS

A survey study was performed on ten adult healthy male domestic rabbit and five adult healthy male foxes. Each specimen was exsanguinated through the common carotid arteries and the jagular veins then left to bleed for 15 minutes. The thoracic muscles and the sternum were carefully removed to expose the heart for injection of latex neoprene, according to the technique of (Neumayer,

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1932) the specimens were injected by gum milk latex colored with red Rottring ink through the descending aorta canulation by using a Nelaton catheter of size 8F to 10F (Ma Medical company). The injected specimens are preserved in 10% formalin solution for duration ranged between 8-10 days. The specimens were dissected for exposing the arterial distribution. The specimens were photographed using Olympus digital camera SP-600UZ 12 mega pixel. The nomenclature used in this study was that given by the Nomina Anatomica veterinaria (Frewein and Habel, 2012).

RESULTS

The arterial supply of the accessory genital glands in the rabbit and the fox is mainly achieved by the umbilical artery and internal pudendal artery of the internal iliac trunk in addition to the urogenital artery of the internal pudendal artery in the rabbit.

A.Iliaca interna

In rabbit and fox: The two internal iliac arteries (Figs. A.1,2,3,4,5/6) and (Figs. B.1,2,3,4,/5) are stout vessels right and left; those measure about 0.35 cm that they represented as the medial branches of the common iliac trunk (Figs. A.1,2,3,4/3) and (Figs. B.1,2,3,4/2) where each branch of the internal iliac artery divided into the umbilical and the internal pudendal arteries; just after originated from the parent trunk.

A.Umbilicalis

In rabbit: The umbilical artery (Figs. A.1,2,3,5/7) is along thin vessel which originates from the ventromedial wall of the internal iliac artery to pass caudoventrally obliquely lateral to the caudal part of the descending colon. During its course it gives off the cranial (Figs. A.1,2/8) and the caudal vesicular arteries (Figs. A.1/9).

In fox: The umbilical artery (Figs. B.1,2,3,4/6) is a short cylindrical vessel which measures about 1.4cm. It arises from the dorsomedial aspect of the internal iliac artery (Figs. B.1,2,3,4,/5) then directs obliquely caudoventrally till reach on a level with the junction between the terminal part of the urinary bladder neck and the commencement of the prostate gland where it terminated by the caudal vesicular (ramified into ductus deferens branch (Figs. B.4/8) and uretric branch (Figs. B.4/9) and the prostatic arteries.

In rabbit

A.Vesicalis caudalis: The caudal vesicular artery (Figs. A.1/9) is a long thin vessel, measures about 2.4 cm in its length. It emanates from the caudomedial aspect of the umbilical artery where it passes obliquely caudoventrally till reach the ventral aspect of the seminal vesicle gland. Along its course it detaches R. ductus deferentis (Figs. A.1/10), R.vesicalis caudalis, R.ampulla ductus deferentis (Figs. A.1,2,3,4,5/11) and R. vesicularis ventralis (Figs. A.1,3/12).

R.Ampulla ductus deferentis: The ampulla ductus deferens branch (Figs. A. 1,2,3,4,5/11) is a short vessel, measures about 1.5 cm. It arises from the caudal aspect of the caudal vesicular artery. It directs obliquely caudolaterally in a zigzag manner to the corresponding organ where it ramified into 2-3 fine branches.

R.vesicularis ventralis: The ventral branch of the seminal vesicle (Figs. A. 1,3/12) is a long thin vessel that measures about 1.5 cm. it detaches from the caudomedial wall of the caudal vesicular vessel till reach to the cranioventral wall of the current organ where it ramified by 2-3 fine branches.

In fox

A.prostatica: The prostatic artery (Figs. B.1,2,3,4/10)is short thin vessel that measures about 0.5 cm where it erupts from the caudomedial wall of the umbilical artery. It passes caudoventral oblique till reach the vicinity of the corresponding organ where it bifurcated into the cranial and the caudal prostatic branches.

R.prostatica cranialis: The cranial prostatic branch (Figs. B.4 /11) is a long thin branch that measures about 1.2cm in its length. It emanates from the craniomedial aspect of the prostatic artery then directs obliquely cranioventrally to supply the cranial third of the corresponding gland by 2-3 fine twigs.

R.prostatica caudalis: The caudal prostatic branch (Figs. B.4 /12) is a long stout cylindrical branch that measures about 2.4 cm and represents the direct continuation of the prostatic artery. During its course it detaches 4-6 collateral rami that distribute the consistency among the caudal thirds of the prostate gland and the pelvic urethra.

In rabbit

Aa.pudenda interna: The internal pudendal arteries (Figs. A.1,2,3,4,5/13) are right and left, they considered the direct continuation of the internal iliac arteries. The internal pudendal artery (visceral branch of the internal iliac artery due to supply the all pelvic visceral organs) is a long pudendal type stout vessel that measures about 5.2 cm where it passes caudodorsally along the dorsomedial aspect of the pelvic cavity till bifurcated into ventral perineal (Figs. A.1,2,3,4,5/25) and penile arteries (Figs. A.1,2,3,4,5/24). Along its course it detaches Rr.muscularis dorsales (Figs.A.1/23) and A.urogenitalis (Figs. A.1,2,3, 4,5/15).

In fox: The internal pudendal arteries (Figs. B. 1,2,3,4/13) are represented the direct continuation of the internal iliac artery where it measures about 6.2 cm. It passes caudodorsally in the pelvic cavity till terminated as a deep penile artery (Figs. B.1,4/18) at the vicinity of the penile crus. Along its course it gives off muscular (Figs.B.1/14), ventral perineal (Figs.B.1/15), urethral (Figs. B.1,2,3, 4/16), dorsal bulbourethral (Figss.B.1,2,3/17) and dorsal penile arteries (Figs. B.1,2,3,4/19).

In rabbit

A.urogenitalis or A.prostatica: The urogenital artery or the prostatic artery (Figs .A. 1,2,3,4,5/15) is a thin short vessel that measures about 0.8 cm where it arises from the ventral aspect of the internal pudendal artery on a level with the body of the second sacral vertebra. It passes caudoventral oblique till reach the cranioventral wall of the bulbourethral glands. During its course it gives off A. prostatica cranialis, A. prostatica caudalis.

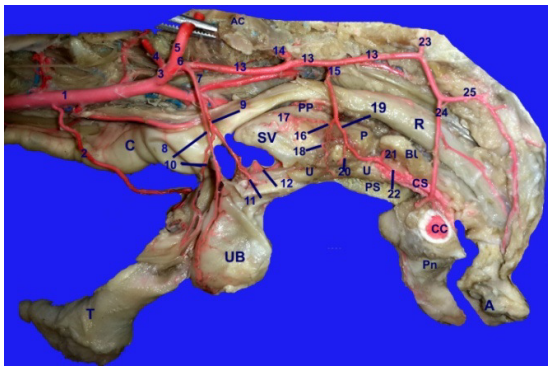

Fig. A (1): A photograph showing the left lateral view of the pelvic cavity arterial supply in male rabbit.

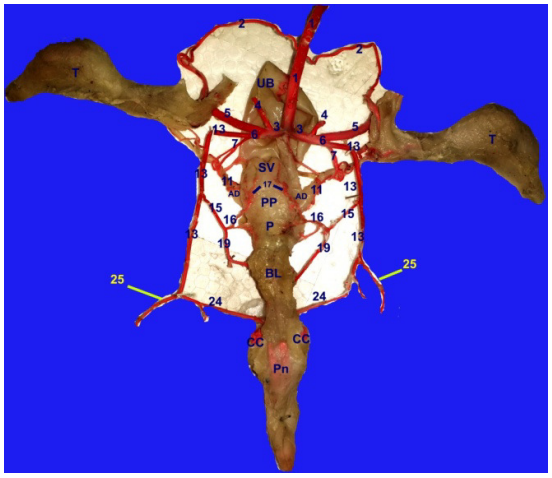

Fig. A (2): A photograph showing the dorsal view of the accessory genital glands arterial supply male rabbit.

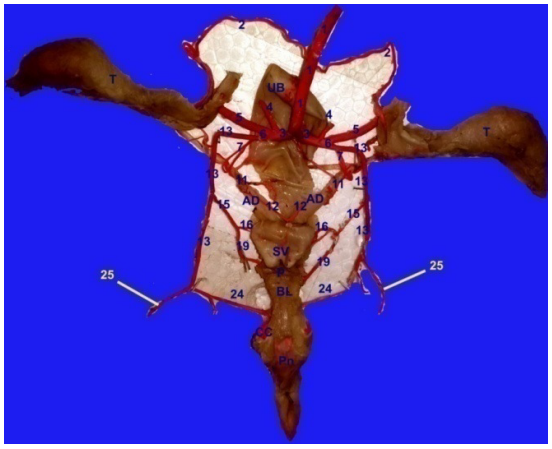

Fig. A (3): A photograph showing the dorsal view of the accessory genital glands arterial supply with reflected seminal vesicle in male rabbit.

A.prostatica cranialis: The cranial prostatic artery (Figs. A.1,2,3,4,5/16) is weak short branch which detaches from the cranial aspect of the urogenital artery. It passes obliquely cranioventrally till the dorsal wall of the seminal vesicle gland. A long its course it gives off R. vesicularis dorsalis and R. prostatica media.

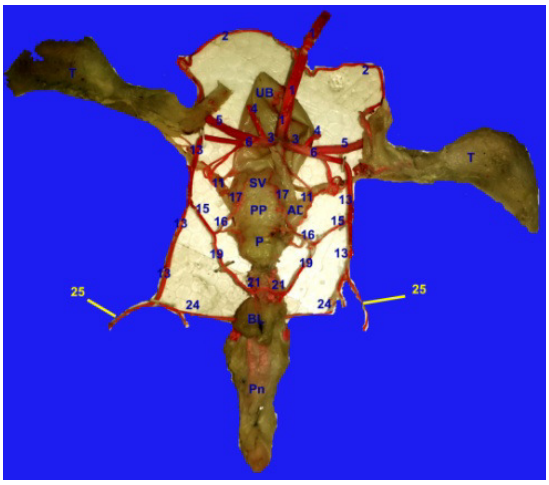

Fig. A (4): A photograph showing the dorsal view of the accessory genital glands arterial supply with reflected bulbourethral glands in male rabbit.

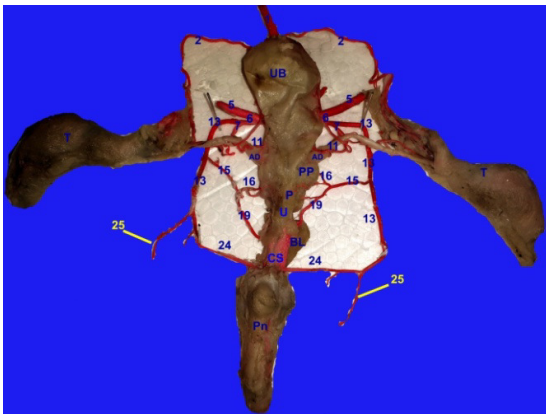

Fig. A (5): A photograph showing the ventral view of the accessory genital glands arterial supply in male rabbit.

Arterial supply of the accessory genital glands of the rabbit

C.	Colon	P.	Prostate
R.	Rectum	BL.	Glandula Bulbourethralis
AC.	Acetabulum	CS.	Corpus spongiosum penis
SV.	Glandula vesicularis	CC.	Corpus cavernosum penis
T.	Testis	Pn.	Penis
UB.	Urinary Bladder	A.	Anus
U.	Urethra	PS.	Pelvis symphysialis
PP.	Proprostata	AD.	Ampulla ductus deferentis

1.	Aorta abdominalis	14.	A.obturatoria
2.	A.testicularis	15.	A.urogenitalis
3.	A.Iliaca communis	16.	A.prostatica cranialis
4.	A.Iliolumbalis	17.	R.vesicularis dorsalis
5.	A.Iliaca externa	18.	R.prostatica media
6.	A.Iliaca interna	19.	A.prostatica caudalis
7.	A.Umbilicalis	20.	R.prostatica caudalis
8.	A.vesicalis cranialis	21.	R.bulbourethralis cranialis
9.	A.vesicalis caudalis	22.	R.bulbi penis
10.	R.ductus deferentis	23.	R.muscularis
11.	R.ampulla ductus deferentis	24.	A.penis
12.	R.vesicularis ventralis	25.	A.perinealis ventralis.
13.	A.pudenda interna		

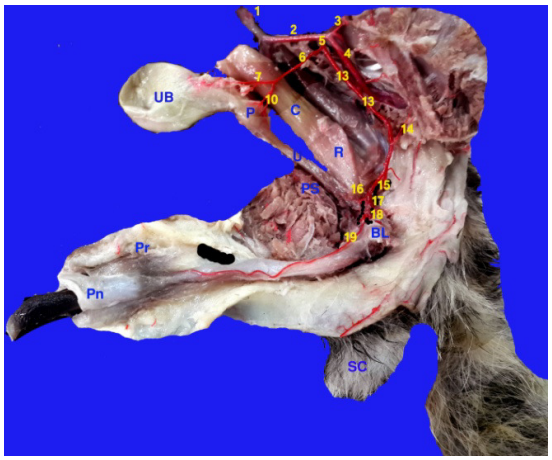

Fig. B (1): A photograph showing the left lateral view of the pelvic cavity arterial supply in the male fox.

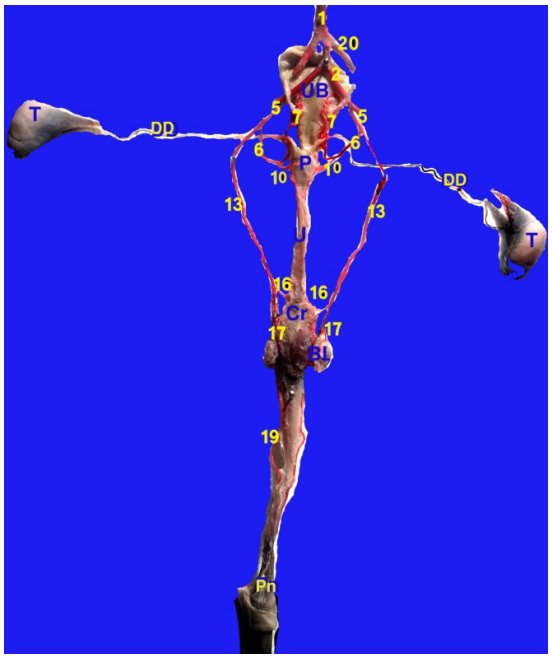

Fig. B (2): A photograph showing dorsal view of the accessory genital glands arterial supply in male fox.

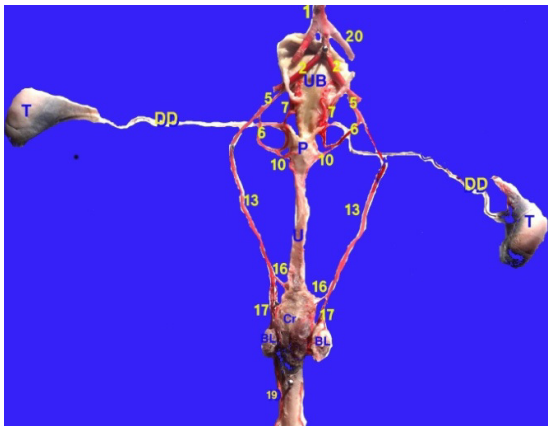

Fig. B (3): A photograph showing dorsal view of the accessory genital glands arterial supply in male fox.

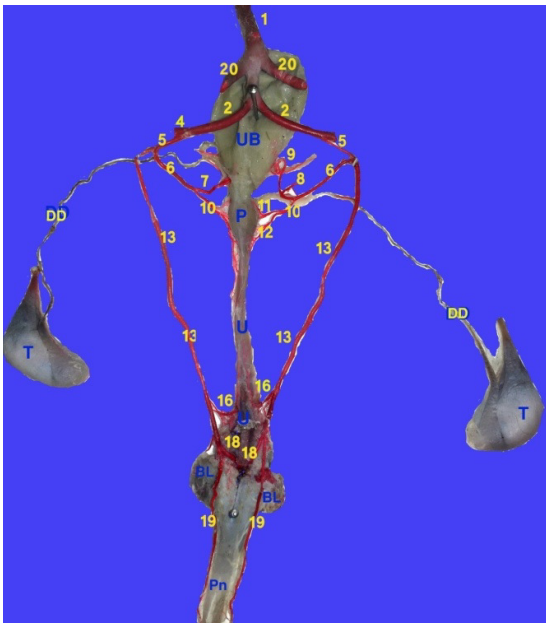

Fig. B (4): A photograph showing ventral view of the accessory genital glands arterial supply in male fox.

Arterial supply of the accessory genital glands of the fox

C.	Colon	P.	Prostate
R.	Rectum	BL.	Glandula Bulbourethralis
PS.	Pelvis symphysialis	Pr.	Preputium
SV.	Glandula vesicularis	Sc.	Scrotum
T.	Testis	Pn.	Penis
UB.	Urinary Bladder	Cr.	Crus penis
U.	Urethra	DD.	ductus deferentis

1.	Aorta abdominalis	11.	R.prostatica cranialis
2.	A.Iliaca communis	12.	R.prostatica caudalis
3.	A.Iliolumbalis	13.	A.pudenda interna
4.	A.Iliaca externa	14.	R.muscularis
5.	A.Iliaca interna	15.	A.perinealis ventralis.
6.	A.Umbilicalis	16.	R.urethralis
7.	A.vesicalis caudalis	17.	A.bulbourethralis dorsalis
8.	R.ductus deferentis	18.	A.Profunda penis
9.	R. ductus deferentis	19.	A.penis dorsalis
10.	A.prostatica	20.	A.Renalis

R.vesicualris dorsalis: The dorsal branch of the seminal vesicle (Figs. A.1,2,4/17) is a short vessel that emanates from the cranial aspect of the cranial prostatic artery. It directs cranioventral oblique till ramified by 3-4 fine arterioles that supplying the caudodorsal wall of the corresponding organ and the current aspect of the pro-prostate.

R.prostatica media: The middle prostatic branch (Figs. A.1/18) arises from the caudoventral wall of the cranial prostatic artery where it passes ventrally on the lateral wall of the prostate till reach the ventral wall of the prostatic urethra. Along its course it gives off 3-4 fine urethral branches that supplying the corresponding organ.

A.prostatica caudalis: The caudal prostatic artery (Figs.A.1,2,3,4,5/19) is represented the direct continuation of the urogenital artery in 50% of the examined cases and considered a branch detaches from the penile artery in the

30% of specimens and in 20% of specimens arises from the internal pudendal artery. It is a long vessel that measures about 2.3 cm where it passes obliquely caudoventrally till reach to the origin of the corpus spongiosus penis. Along its course it gives off R. prostatica caudalis (Figs.A.1/20), and bifurcates into R. bulbourethralis cranialis (Figs. A.1,4/21) and R.bulbi penis (Figs. A.1/22).

R.bulbourethralis cranialis: The cranial bulbourethral branch (Figs. A.1,4/21) is detached from the caudomedial wall of the caudal prostatic artery. It directs obliquely caudoventrally to insinuate between the caudal border of the prostate and the cranioventrolateral wall of the bulbourethral gland. During its course it supplies the corresponding parts by 2-3 fine branches that anastomosed with others of another side.

In fox

A.bulbourethralis dorsalis: The dorsal bulbourethral artery (Figs. B.1,2,3/17) is a short stout vessel that measures about 0.6 cm that emerges from the caudoventral aspect of the prostatic artery. It directs obliquely caudolaterally in a zigzag manner till reach the dorsal surface of the bulbourethral gland where it terminated by 2-3 fine twigs.

DISCUSSION

The results applied in our investigations reported that the arterial vascularization of the male accessory genital organs in rabbits is highly vascularized in comparison to the corresponding ones in foxes; the former species they are rich with umbilical, internal pudendal and urogenital arteries on the other hand, the other species are only supplied with umbilical and internal pudendal vessels. Where in our studied rabbits, these statements come in contact with (Orsi *et al*., 1979) in rabbits as well as (Nickel *et al*., 1981 and Constantinescu, 2004) in domestic animals where the latter authors cited that the major arterial supplies to the organs in the pelvic cavity are the internal iliac, the internal pudendal arteries and the umbilical and the prostatic arteries stemming from the former two arteries. On the other hand, (Getty, 1975 and Ghoshal, 1975) In domestic animals, (El-Gaafary *et al*., 1980) in donkey, (Chandra *et al*., 1984) in buffalos stated that these genital organs were supplied by the internal pudendal artery.

Concerning to the origin of the internal pudendal artery, the present study revealed that it is conducted with the umbilical artery and considered the direct continuation of the internal iliac artery, these statements were in disagreement with that stated by (Getty, 1975), Willkens and (Munster, 1976), (Nickel *et al*., 1976) in all species of domestic animals and (Swilim, 1979, El- Gaafary *et al*., 1980 and Tolba *et al*., 2006) in the donkey where they assessed that it is constituted with the caudal gluteal artery as the two terminal branches of the internal iliac artery.

Regarding to the course and distribution pattern of the internal pudendal artery our study described that this vessel is a long pudendal type. This was observed as represented by (Swilim, 1979, El- Gaafary, *et al*., 1980 and Tolba *et al*., 2006) in the donkey and (Getty, 1975 and Nickel *et al*., 1976) in equines and carnivores while the latter authors mentioned that the current vessel was of a short pudendal type.

In the current study, the origin of the umbilical artery is the first long thin branch of the internal iliac artery. These results similar to that mentioned by (Nickel *et al*., 1976) in bovines, swines and carnivores and (Erdogan, 2011) in tom-cat. On the other hand the corresponding artery was detached from the internal pudendal artery (Getty, 1975, Ghoshal, 1975 and Nickel *et al*., 1976) in horse and (Tolba *et al*., 2006) in donkey.

In the present study, in the rabbit, the umbilical artery gives off the cranial and the caudal vesicular arteries. The caudal vesicular artery detaches branches to the ductus deferens, the ampulla ductus deferens, caudal vesicular branch and ventral branch of the seminal vesicle. These statements are similar to that observed by (Orsi *et al*., 1979) in rabbits. While in the fox the corresponding artery is detached the caudal vesicular and prostatic arteries where the caudal vesicular artery was ramified into ductus deferens and ureteric branches .On the other hand (Getty, 1975 and Nickel *et al*., 1976) in horse, ox and pig and (Tolba *et al*., 2006) in donkey said that the branches of the umbilical artery were cranial vesicular, ductus deferens and uretric arteries. However, (Swilim, 1979, El- Gaafary *et al*., 1980) in donkey and (Erdogan, 2011) in tom- cat referred that the existence of the cranial vesicular artery as a branch of the umbilical artery but they denied the prescence of the other branches.

In viewing of the present findings, in the rabbit, the ampulla ductus deferens and ductus deferens branches are short corrugated vessels which arise from the caudal vesicular artery to supply the corresponding organ by 2-3 fine arterioles. On the other hand (Tolba *et al*., 2006) in donkey and (Getty, 1975, Willkens, 1976 and Nickel *et al*., 1976) in bovines, equines, swines investigated that the current artery is a branch of the umbilical artery.

However, the latter authors attributed its origin to the internal pudendal artery in the dog and the ram. Moreover, Miller (1993) and (Erdogan, 2011) in tom- cat demonstrated that the artery of the ductus deferens was detached from the prostatic artery.

In our investigations, the arterial supply of rabbit seminal vesicle is achieved by two branches; the ventral and the dorsal. The ventral one is detached from the caudal vesicular of the umbilical artery of the internal iliac artery, this branch is ignored in the most of the available literatures while the dorsal branch of the seminal vesicle which arose from the cranial prostatic artery of the urogenital artery where described simulating to that reported by (Clegg, 1955) in man (Tolba *et al*., 2006) in donkey.

According to the present work, in the rabbit, the origin of the prostatic artery is from the internal pudendal artery. This statement is similar to that asserted by (Nickel *et al*., 1976) in horses, (Wilkens and Munster, 1976) in carnivores, (Orsi *et al*., 1979) in rabbits, (El- Gaafary etal., 1980) in the donkey, (Smith, 1999) in dog and (Erdogan, 2011) in tom- cat. While in the fox, the current artery is derived from the umbilical artery. On the other hand, (Clegg, 1955) in man assessed that the prostate gland was supplied by the prostatic artery of a common arterial trunk (prostate-vesical).

Concerning to the distribution of the urogenital or the prostatic artery which gave off cranial and caudal prostatic arteries that supplying the corresponding gland. These results simulated the observation reported by (Getty, 1975) in swines and (Clegg, 1955) in man. In this respect Stefanov (2004) in dog, (Tolba *et al*., 2006) in donkey described that the presence of the three branches supplying the prostate gland; cranial, middle and caudal prostatic arteries. These statements are similar to our investigated study in the rabbit where the prostate gland is supplied by the cranial prostatic artery, middle prostatic branch of the cranial prostatic artery and the caudal prostatic branch of the caudal prostatic artery. On the other hand, (Swilim, 1979) and (El- Gaafary *et al*., 1980) referred to the existence of the prostatic artery as a single branch found on either side of the corresponding gland in the donkey. Moreover, (Nickel *et al*., 1981) in male mammals revealed that the prostatic artery was divided into three branches; artery of the deferent duct and prostate artery, the caudal vesical artery.

In the examined rabbits recorded that the caudal prostatic artery is represented the direct continuation of the urogenital (prostatic) trunk in 50% of the examined cases. In accordance with (Cammerate, 1923), (Flocks, 1937) and (Awataguti, 1939) in man. It is considered a branch detaches from the internal pudendal artery in the 20% of specimens which similar to that regarded by (Tolba *et al*., 2006) in donkey. On the other hand, (Ozgel *et al*., 2003) in New Zealand rabbit have the opinion that the caudal prostatic artery was originated from the umbilical artery. Further the more, (Getty, 1975), (Nickel, 1976) and (Swilim, 1979) denied the existence of this vessel.

Although the anatomical importance of the bulbourethral glands among the other accessory genital organs, yet its arterial blood supply have a little data in the most of the existed literatures so, in the current work attempted to give a detailed description of their corresponding vessels where our investigations in rabbits reported that the bulbourethral glands are received their blood supply from the cranial bulbourethral artery of the caudal prostatic vessel that detached from the prostatic trunk. These results simulated to that given by (El-Gaafary *et al*., 1980) in donkey. These statements were in contrast to the results that revealed by (Tolba *et al*., 2006) in donkey where they reported that the bulbourethral glands obtained blood supply from the cranial, middle and caudal bulbourethral arteries of the internal pudendal artery. On the other hand in the fox mentioned that the current glands were supplied by 2-3 fine twigs that emanated from the dorsal bulbourethral artery of the internal pudendal trunk. However, (Getty, 1975), Wilkens and Munster, 1976), (Ghoshal, 1975), (Nickel *et al*., 1976) and (Swilim, 1979) observed that the corresponding glands were supplied by small branches detached from the ventral perineal or the caudal urethral arteries.

Conclusion

Injection of latex neoprene (gum milk latex) through the descending aorta was sufficient method to demonstrate the arterial supply of the male accessory genital organs in rabbis and foxes. The internal puodendal artery is a long puodendal type and direct continuation of the internal iliac artery in rabbits. The origin of the prostatic artery in rabbits is emanated from the internal puodendal artery. In foxes the prostate gland is supplied by the prostatic artery that detached from the umbilical trunk and bifurcated into cranial and caudal branches.

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