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THE COMMON ILIAC ARTERY IN THE GROUND SQUIRREL (*Citellus citellus*)

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The common iliac arteries (a. iliaca communis dextra et a. iliaca communis sinistra) are the terminal branches of the abdominal aorta.

The paired external iliac artery (a. iliaca externa dextra et a. iliaca externa sinistra) is a stronger branch of the paired common iliac artery. Before they leave the abdominal cavity and continue as the femoral arteries (a. femoralis dextra et a. femoralis sinistra) each external iliac artery forms the following branches:

1. The internal pudendal artery (a. pudenda interna) which, with its branches, supplies the tensor fasciae latae and quadriceps muscles (a. circumflexa femoris lateralis), cranial region of the urinary bladder, cranial end of the uterine horn in females, the deferent duct and tail of the epididymis in males (a. umbilicalis) the rectum, the external anal sphincter and perineum (a. rectalis caudalis) with blood.

2. The obturator artery (a. obturatoria), which supplies both of the obturator muscles, as well as the proximal end of the adductor muscle.

3. The pudendoepigastric trunk (truncus pudendoepigastricus) is a short vessel, which with its branches (a. pudenda externa, a. epigastrica caudalis et a. urethrogenitalis) supplies the caudal end of the rectus abdominis muscle, tip of the penis, preputium, superficial inguinal lymph nodes, scrotum in males and inguinal mamma in females, transversus and internus abdominis muscles, neck of the urinary bladder, urethra, vagina and vulva in females and accessory glands in males.

4. Paired internal iliac arteries (a. iliaca interna dextra et a. iliaca interna sinistra) are thinner branches than the external iliac arteries. The internal iliac artery with its branches supplies the cranial and caudal parts of the gluteal muscles (a. glutea cranialis et a. glutea caudalis), as well as the muscles of the lateral side of the tail (a. caudalis lateralis).

Key words: ground squirrel, paired common iliac artery, paired external iliac artery, paried internal iliac artery

INTRODUCTION

The ground squirrel (*Citellus citellus*) is a rodent, very active through most of the day except during the hours of most intesive sunlight. In Serbia and

Macedonia it is one of the most troublesome pests to homeowners and gardeners. Throught the colder areas of their range, ground squirrels hibernate during the winter months, decreasing the normal body temperature and metabolic rate to very low levels. During this time they stay within the burrow, seldom venturing out (Blanton, 1996). Altered body temperature during hibernation was described by Strijkstra (1999), Zhou *et al*. (2001) and Hut *et al*. (2001). The hibernation effect on the memory in the European ground squirrel was reported by Millesi *et al*. (2001), as well as changed responsiveness of aortic tissue and persistent circadian rhythmicity in hibernating ground squirrels (Deelman *et al*., 1998). The effects of TSH-releasing hormone on neurons of the brain were studied in hibernating and active ground squirrel (Belousov and Belousova, 1993). So were studied the fine structure of photoreceptor cells of the ground squirrel (Hollenberg and Berstein, 2005), the follicular development in European ground squirrels in different phases of the annul cycle (Millesi *et al*., 2008). Brown adipose tissue has been widely investigated (Cinti *et al*., 1997; Kochan *et al*., 1999; Konishi *et al*., 2000; Murakami *et al*., 2001).

The arterial system of experimental animals has been studied by many authors. This includes the circulatory system of the rat (Hebel and Stromberg, 1976; Popesko *et al*., 1990), the morphology and arteries of the heart in the mole rat (Blagojević, 1981; Blagojević *et al*., 1995), the portal system in the mole rat (Blagojević and Nikolić, 1989) and ground squirrel (Nikolić *et al*., 2003), the subclavian artery and its branches in the ground squirrel (Nikolić *et al*., 2004), vascularization, innervation, morphology and topography of the organs in the pectoral cavity in the ground squirrel (Blagojević, 2010), the circulatory system in the golden hamster (Lelievre, 1963) and morphology of the femoral artery in the pregnant guinea-pig (Jovanović *et al*., 1999). As part of a continual study on the morphology and topography of the cardiovascular system in the ground squirrel, the morphology and topography of the common iliac artery are described here. Our results correspond with the pattern of this artery in other experimental animals such as the rat (*Rattus norvegicus*) and mole rat (*Spalax leucodon*).

MATERIAL AND METHODS

The investigation was perfomed on 20 adult ground squirrels, of both sexes. After bleeding out, various contrast agents were injected into the abdominal aorta. The most often used contrast medium was gelatin stained with minium, painting tempera or micropack-barium. For roentgenograms minium and gelatin were used or minium in linseed oil.

RESULTS AND DISCUSSION

The common iliac arteries (*a. iliaca communis dextra et a. iliaca communis sinistra*, Figure 1_2,1_2', 2_3', 2_3') are the terminal branches of the abdominal aorta (Figure 1_1) in the ground squirrel, as well as in the mole rat (Blagojević, 1981) and

rat (Hebel and Stromberg, 1976). It length is from 5 to 6 mm. Each of the common iliac arteries gives off the external and internal iliac arteries.

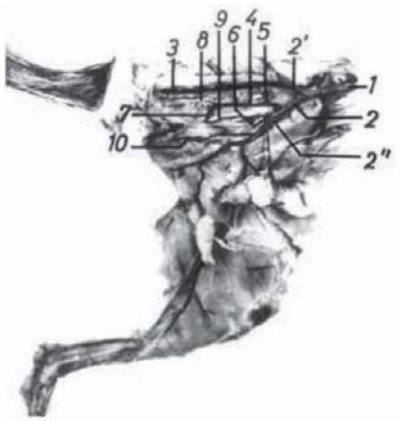

Figure 1. Topographical position of the common iliac artery and its branches
1- *aorta abdominalis,* 2- *a. iliaca communis sinistra,* 2'- *a. iliaca communis dextra,* 2"- *a. iliaca externa sinistra,* 3- *a. sacralis media,* 4- *a. iliaca interna,* 5- *a. glutea cranialis,* 6- *a. circumflexa femoris lateralis,* 7- *a. glutea caudalis,* 8- *a. caudalis lateralis,* 9- *a. pudenda interna,* 10- *a. obturatoria*

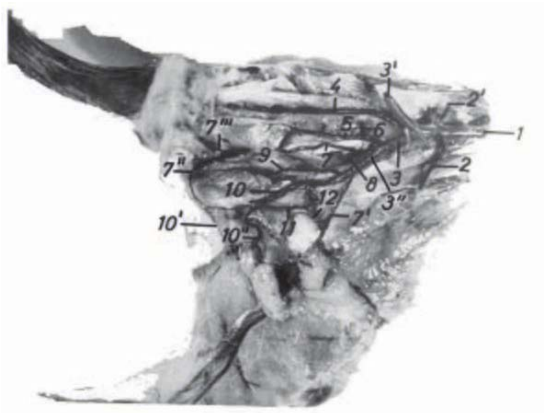

Figure 2. Topographical position of the common iliac artery and its branches
1- *aorta abdominalis,* 2- *a. circumflexa ilium profunda sinistra,* 2'- *a.circumflexa ilium profunda dextra,* 3- *a. iliaca communis sinistra,* 3'- *a. iliaca communis dextra,* 3''- *a. iliaca externa sinistra,* 4- *a sacralis media,* 5- *a. iliaca interna, 6- a. glutea cranialis,* 7- *a. pudenda interna,* 7'- *a. umbilicalis,* 7''- *a. dorsalis penis caudalis,* 7'''- *a. rectalis caudalis,* 8- *a. circumflexa femoris lateralis,* 9- *a. obturatoria,* 10- *a. pudenda externa,* 10'- *a. dorsalis penis cranialis,* 10''- *branch for ln. inguinalis superficialis,* 11- *a. epigastrica caudalis,* 12- *a. vesicalis caudalis*

The external iliac arteries (*a. iliaca externa dextra et a. iliaca externa* sinistra, Figure $1_{2'}$, $1_{2''}$, $2_{3''}$) are stronger branches of the common iliac arteries in the

ground squirrel, similarly to the rat (Popesko *et al*., 1990). It runs caudo-laterally, covered by the peritoneum, to the abdominal wall. Further distally it lies on the iliopsoas and the psoas minor muscles. It continues outside the abdominal wall as femoral artery. Before they leave the abdominal cavity and continue as the femoral artery each external iliac artery forms the following branches:

1. The internal pudendal artery (*a. pudenda interna*, Figure 1_9, 2_7) is the first branch of the external iliac artery in the ground squirrel, but the third branch from the common iliac artery in the the mole rat. Hebel and Stromberg (1976) described the internal pudendal as the branch of the common trunk for the internal pudendal, the lateral and medial circumflex femoral and the obturator artery. It runs in a caudal direction ventral to its satelite vein and the ischiadic nerve. At the level of the third sacral vertebrae it runs along the dorsal border of the ischiadic spine where it leaves lateral to the levator ani and coccygeal muscles. The internal pudendal gives off the following branches:

a. lateral circumflex femoral artery (*a. circumflexa femoris lateralis,* Figure 1_6, 2_8), runs lateral to the body of the ilium and supplies tensor fasciae latae and quadriceps muscles.

b. The umbilical artery (*a. umbilicalis*, figure $2_{7'}$) in the male varies in length from 5 to 10 mm. It gives off the cranial vesical artery (*a. vesicalis cranialis*) in animals of both sexes, and the deferent duct artery (*a. ductus deferentis*) in male animals whereas in females it gives off the median uterine. The cranial vesical artery runs in the direction of the cranial region of the urinary bladder throught the lateral ligament of the bladder and vascularizes its cranial part. The deferent duct artery runs together with ductus deferens, via the spermatic funicle, reaches the tail of the epididymis branching in it. Here it forms anastomoses with the internal spermatic artery. The uterine artery (*a. uterina*), enters the mesometrium at the level of the cervix uteri. Upon entering the broad ligament it diverges from the uterine horn until it approaches the cranial end of the horn, where it anastomoses with the uterine ramus of the utero-ovarian artery. The uterine artery sends branches into both sides of the uterine horn. The uterine artery is also known as the media uterine artery (*a. uterina media*). The umbilical artery in the ground squirrel is the second branch of the the internal pudendal, but in the rat (Hebel and Stromberg, 1976) it is the second branch of the common iliac artery. However, Popesko *et al*. (1990) described in the rat the artery as an arising branch from the internal iliac artery.

c. The caudal rectal artery (*a. rectalis caudalis*, Figure $2_{7'''}$) terminates the internal pudendal in the ground squirrel similarly to the mole rat (Blagojević, 1981) and rat (Hebel and Stromberg, 1976). The caudal rectal artery sends branches to the rectum, external anal sphincter and the skin of the perineum ramifying in it.

The internal pudendal in males continues toward the caudal end of the pelvis, giving off a branch to the perineum, urethra and bulbus urethrae. After, it enters the cavernous body of the penis as the caudal dorsal penile artery (*a. dorsalis penis caudalis*). In females the internal pudendal gives off an urethral branch (*ramus urethralis*) which ramifies into a dorsal and a deep branch as the artery of the clitoris (*a. clitoridis*).

2. The obturator artery (*a. obturatoria*, Figure 2_9) runs to the obturator foramen and furnishes branches to the external and internal obturator muscles. Most of the obturator branches terminate in the internal obturator muscle. The obturator artery also sends branches into the proximal end of the adductor muscle. Thus, the obturator artery in the ground squirrel is the second branch of the external iliac, but in the rat (Popesko *et al*., 1990) it the fourth branch of the internal iliac artery. However, in the mole rat (Blagojević, 1981) the obturator artery is the first branch of the internal pudendal artery.

3. The pudendoepigastric trunk (*Truncus pudendoepigastricus)* in the ground squirrel similarly to the rat (Popesko *et al*., 1990) is a short vessel, over 1 mm in lenght, which arises from the external iliac artery. The terminal parts of the pudendo-epigastric trunks are the following branches:

a. The external pudendal artery (*a. pudenda externa*, Figure 2_{10}) in the ground squirrel and rat (Hebel and Stromberg, 1976; Popesko *et al*., 1990) arises as the ventral terminal branch of the pudendoepigastric trunk, accompanied with its satellite vein. However, in the mole rat (Blagojević, 1981) the external pudendal arises from the common iliac artery. In males the external pudendal in its course gives off small branches which supply the caudal end of the rectus abdominis muscle. After ramifying into the above mentioned muscle the continuation of the external pudendal becomes *a. dorsalis penis cranialis* (Figure $2_{10'}$). Along its course toward the scrotum, a. dorsalis penis cranialis sends many branches into the cranial end of the penis and preputium. It also gives off small branches into the superficial inguinal lympho nodes, respective fat tissue and skin of this region. After *a. dorsalis penis cranialis* gives off these branches it runs in the direction of the scrotum as the cranial scrotal branch (*ramus scrotalis cranialis*) wich terminates in the scrotum and vacularizes it. In females the external pudendal sends branches into the rectus abdominis muscle and thereon is described as the mammaric artery (*a. mammarica*) which goes deep to the inquinal mamma. The mammaric artery also sends branches into the superficial inguinal lymphonodes, skin and fat tissue of this region. Some of these twigs run to the wall of the and vascularize it.

b. The caudal epigastric artery (*a. epigastrica caudalis*, Figure 2_{11}) runs cranioventrally between the transversus and the internal obliquus abdominis muscles ramifyng in its.

c. The urethrogenital artery (*a. urethrogenitalis*) arises from the pudendoepigastric trunk, but it may arise from the external iliac artery. In females the urethrogenital runs between the rectum and vagina and goes to the vulva. The caudal vesical artery (*a. vesicalis caudalis*, Figure 2_{12}), in females and males, is the first branch of the urethrogenital atery which reaches the urinary bladder and supplies with blood the neck of the bladder and the origin of the urethra. In the mole rat (Blagojević, 1981) the caudal vesical reaches the bladder similarly to the ground squirrel, but in the mole rat it is the first branch of the internal pudendal artery. After the urethrogenital artery gives off the gluteal caudalis artery, it terminates with branches which bring blood to the urogenital organs. Thus, smaller branches of the urethrogenital bring the blood to the caudal portion of the rectum and the urethra. Stronger branches of the urethrogenital convey blood to

the vagina and vulva. In the male the termination of the urogenital artery supplies the accessory genital glands.

The internal iliac arteries (a*. iliaca interna dextra et a. iliaca interna sinistra*, Figure 1_4, 2_5) are the terminal branches of the common iliac arteries. Each of them runs, accompanied with the ischiatic nerve and its satelite vein, to the medial side of the gluteal muscles. Here it terminates with the following branches:

1. The cranial gluteal artery (*a. glutea cranialis*, Figure 1_5, 2_6) in the ground squirrel similarly to the rat (Hebel and Stromberg, 1976) arises from the internal iliac about 2 to 3 mm from its origin. In the mole rat (Blagojević, 1981) the cranial gluteal separates the caudal gluteal artery. The cranial gluteal artery in the ground squirrel runs cranio-dorsally toward the gluteal muscle ramifynig into the cranial part of the gluteal muscles.

2. The caudal gluteal artery (*a. glutea caudalis*, Figure 1_7) gives off many muscular branches into the caudal part of the gluteal muscles. It also sends small branches into the proximal end of the adductor muscle. In the ground squirrel the caudal gluteal artery is the second branch of the internal iliac, in the mole rat (Blagojević, 1981) the first branch of the common iliac and in the rat (Popesko *et al*., 1990) it is the first branch of the external iliac artery.

3. The lateral caudal artery (*a. caudalis lateralis*, Figure 1_8) leaves the internal iliac about 4 mm caudal to the origin of the cranial gluteal. It runs toward the lateral side of the tail sending small branches into the skin and muscles along its lateral aspect. Other branches anastomose with the median sacral artery.

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REFERENCES

1. *Belousov B, Belousova V*, 1993, Effects of thyrotropin/releasing hormone on the activity of septal neurons in brain slices of the hibernating and active ground squirrels, *Citellus undulatus*, *J Evol Biochem Physiol*, 29, 2, 98-102.
2. *Blagojević M,* 2010, Morfologija, topografija, vaskularizacija i inervacija organa grudne duplje eksperimentalnih životinja, Doktorska disertacija, Fakultet veterinarske medicine, Beograd.
3. *Blanton*, 1996, Ground Squirrels and Prairie Dogs: a World Beneath the Ground. Chihuahuan, Desert Research Institute, Fort Davis, Texas.
4. *Blagojević Z, Nikolić Z, Vitorović D, Mrvić V,* 1995, The morphology and the arteries of the heart in the mole rat (*Spalax leucodon*), *Acta Vet Belgrade*, 45, 1, 53-60.
5. *Blagojević Z, Nikolić Z*, 1989, Extrahepatic veins of the portal system in the mole rat (*Spalax leucodon*), *Acta Vet Belgrade,* 39, 5-6, 357-64.
6. *Blagojević Z,* 1981, Srce i arterije slepog kučeta (*Spalax leucodon*), Magistarska teza, Univerzitet u Beogradu.

7. *Cinti S, Frederich RC, Zingaretti MC,* 1997, Immunohistochemical localization of leptin and uncoupling protein in white and brown adipose tissue, *Endocrinology (USA)*, 138, 2, 797-804.
8. *Deelman LA, Henning RH, Hut RA, Van der Zee EA, Epema AH*, 1998, Changed responsiveness of aortic tissue in hibernating ground squirrels, *Anesthesiology,* 89, 440-2.
9. *Hebel R, Stromberg MW*, 1976, Anatomy of the laboratory rat, The William-Wilkins Company.
10. *Hut RA, Barnes BN, Dean S*, 2001, Body temperature patterns before, during and after seminatural hibernation in the European ground squirrel, *J Comp Physiology*, *B*, 172, 1007-12.
11. *Jovanović S, Blagojević Z, Mrvić V, Nikolić Z, Jovanović A*, 1999, Pregnancy is not associated with altered morphology of the femoral artery, *Human Reprod*, 14, 7, 1885-9.
12. *Kochan Z, Karbowska J, Swierczynski J*, 1999, Effect of clofibrate on malic enzyme and leptin mRNAs level in rat brown and white adipose tissue, *Hrom Metab Research (Germany),* October, 31, 10, 538-42.
13. *Konishi M, Mikami T, Yamasaki M*, 2000, Fibroblast growth factor-16 is a growth factor for embrionic brown adipocytes, *J Biol Chem (USA)*, 275, 4, 1119-22.
14. *Lelievre J,* 1963, Vascularisation arterielle du Hamster (Schema general), These de Doctorat Veterinaire, Alfort, France.
15. *Millesi E, Strauss A, Burger T, Hoffmann I, Walzl M, 2008*, Follicular Development in European Ground Squirrels (*Spermophilus citellus*) in Different Phases of the Annual Cycle, *J Soc Reprod Fertil,* 136, 2, 205-10.
16. *Millesi E, Prossinger H, Dittami J P, Fieder M, 2001*, Hibernation Effects on Memory in European Ground Squirrels, *J Biol Rhythms*, 16, 3, 264-71.
17. *Murakami M, Kamiya Y, Morimura T,* 2001, Thyrotropin receptors in brown adipose tissue: thyrotropin stimulates type II iodthyronine deiodinase and uncoupling protein-1 in brown adipocytes, *Endocrinology (USA),* 142 , 3, 1195-201.
18. *Nikolić Z, Blagojević Z, Vitorović D, Đelić D, Nešić I*, 2003, Extrahepatic and intrahepatic veins of the portal system in the ground squirrel (*Citellus citellus*), *Acta Vet Belgrade*, 53, 1, 57-63.
19. *Nikolić Z, Blagojević Z, Drekić D, Đelić D, Mrvić-Jovičić V, Zorić Z,* 2004, The subclavian artery and its branches in the ground squirrel (*Citellus citellus*), *Acta Vet Belgrade,* 54, 2-3, 227-37.
20. Nomina Anatomica Veterinaria, 2005, 5th edition, Published by the International Committee on Veterinary Gross Anatomical Nomenclature.
21. *Popesko P, Rajtova V, Horak J,* 2000, A colour atlas of the anatomy of small laboratory animals, Volume two: Rat. Mouse. Hamster. Published by Priroda Publishing House, Bratislava.
22. *Strijkstra AM*, 1999, Periodic euthermy during hibernation in the European ground squirrel: causes and consequences, PhD Thesis, Rijksuniversiteit Groningen, The Netherland.
23. *Zhou F, Zhu X, Castellani R J, Stimmelmayr K, Perry G, Smith MA et al,* 2001, Hibernation, a model of Neuroprotection, *Am J Pathol*, 158, 2145-51.

ARTERIJA ILIACA COMMUNIS U TEKUNICE (*Citellus citellus*)

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SADRŽAJ

Aa. iliacae communes (*a. iliaca communis dextra et a. iliaca communis sinistra*) su završne grane trbušne aorte.

Aa. iliacae externae (*a. iliaca externa dextra et a. iliaca externa sinistra*) su jače grane od *aa. iliacae communes*. *A. iliaca dextra* i *a. iliaca sinistra* pre nego što

napuste trbušnu duplju i nastave kao *a. femoralis dextra* i *a. femoralis sinistra* formiraju sledeće grane:

1. *A. pudenda interna*, sa svojim granama, snabdeva krvlju *m. tensor fasciae latae* i *m. quadriceps femoris* (*a. circumflexa femoris lateralis*), kranijalni deo mokraćne bešike, kranijalni kraj materičnog roga u ženki, semenovod i rep pasemenika u mužjaka *(a. umbilicalis*), *rectum, m. sphincter ani externus* i međicu (*a. rectalis caudalis*).

2. *A. obturatoria* snabdeva krvlju *m. obturator externus*, *m. obturator internus* kao i proksimalni kraj *m. adductor*-a.

3. *Truncus pudendoepigastricus* je kratak krvni sud koji sa svojim granama snabdeva krvlju kaudalni kraj *m. rectus abdominis*-a, vrh penisa, prepucijum, *lymphonodi inguinales superficiales*, mošnice u mužjaka i ingvinalni deo mlečne žlezde u ženki (*a. pudenda externa*), paran *m. transversus abdominis* i paran *m. obliquus internus abdominis*, (*a. epigastrica caudalis*), vrat mokraćne bešike, mokraćni izvodnik, vaginu i vulvu u ženki i akcesorne polne žlezde u mužjaka (*a. urethrogenitalis*).

4. *Aa. iliacae internae* (*a. iliaca interna dextra et a. iliaca interna sinistra*) su slabije grane od *aa. iliacae communes*. *Aa. iliacae internae*, svojim granama snabdevaju krvlju glutealne mišiće (*a. glutea cranialis* i *a. glutea caudalis*), kao i mišiće na lateralnoj strani repa (*a. caudalis lateralis*).