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Variability of the obturator artery and its surgical implications in a South Indian population

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SUMMARY

The obturator artery (OBA) is an artery of numerous variations and also of surgical significance. Although it is usually a branch of the internal iliac artery, it may also originate from the external iliac system. This study was aimed at studying the variations of the OBA in its origin, the gender and the side differences in South Indian population. Relation of the OBA of external iliac origin to the femoral ring was also noted in view of its clinical significance. The study was done on 116 pelvic halves obtained from 58 cadavers. The OBA revealed considerable variations in its origin, course and relation to the femoral ring. It took origin from the external iliac artery and its branch, the inferior epigastric artery in 39.7%, inclusive of its dual origin from the external and internal iliac systems. Bilateral origin of the OBA from the external iliac system was noted in 22.4%. It was found to be placed lateral to the femoral ring in 78.2% and it was medial in 21.7% of the specimens. The origin of OBA from the external iliac system of common occurrence has to be viewed with appropriate caution while performing surgical procedures in this region.

Key words: Obturator artery – Anatomical variations – Surgical practice

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INTRODUCTION

The retro pubic space has a well-defined vascular anatomy which must be known to the operating surgeon in order to avoid hemorrhagic complications (Negura et al., 1993). A sound knowledge of this anatomy is pivotal for successful performance of endoscopic total extra peritoneal inguinal hernioplasty (Lau and Lee, 2003). The obturator artery (OBA) is one of the branches of the anterior division of the internal iliac artery. It passes forward and downward on the lateral wall of the pelvis to the upper part of the obturator foramen, through which it emerges from the pelvic cavity to supply the lower limb. Apart from the other branches, it gives off a pubic branch, just before it leaves the pelvic cavity. The pubic branch ascends upon the back of the pubis, communicating with the corresponding vessel of the opposite side, and with the inferior epigastric artery (Gray, 1901). The OBA deserves a detailed study since it has marked variations in its origin and course with surgical relevance.

The OBA that takes origin from the external iliac artery and its branches is actually the enlargement of the anastomosis between the pubic branches of the OBA and that of the inferior epigastric artery. It might completely replace the OBA. If the enlarged pubic branch of the inferior epigastric artery joins the normal OBA it is known as accessory OBA (Moore, 2006).

Gilroy et al. (1997) in their study on 105 specimens found that 70 to 82% of pelvic halves and 83 to 90% of whole pelves have obturator artery,

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vein or both in variant positions. Different studies in other population groups have shown varied origins of OBA namely common iliac or anterior division of internal iliac, inferior epigastric, superior gluteal, inferior gluteal/ internal pudendal trunk, inferior gluteal, internal pudendal and external iliac arteries OBA (Poynter, 1922; Piersol, 1930; Pick et al., 1942; Braithwaite, 1952; Grant, 1957; Roberts et al., 1967; Jakubowicz et al., 1996). The OBA originating from external iliac system is of surgical significance due to its close relation to the femoral ring and the pubic ramus. Surgery for strangulated femoral hernia which requires widening of the femoral ring or any orthopedic intervention in this region, namely ilioinguinal approach or surgery for fracture of pubic ramus, involves the risk of injury to the vessel crossing the pubic ramus (Rusu et al., 2010). The presence of the dual origin of the OBA (i.e., from both the external iliac and internal iliac artery), with extensive anastomoses between them is known as *corona mortis* or 'crown of death' [which includes venous anastomoses also], because of the profuse bleeding that can occur when either of the vessels is severed (*Skandalakis* et al., 2004).

A detailed description of OBA is not available from South Indian population. Hence this study was conducted with the objective of assessing the variability of the OBA in South Indian population and their applications in clinical practice.

MATERIALS AND METHODS

The study was conducted using one hundred and sixteen specimens. Each specimen was a bisected pelvic half of an embalmed adult cadaver. Detailed dissection was done by the authors after the preliminary dissection by preclinical medical students. The cadavers with scars or surgical wounds in the groin or upper thigh were not included in the study due to the possible damage to the normal anatomy. The specimens were obtained from 58 adult cadavers composed of 34 males and 24 females in the age group of 50 to 85 years. The pelvis was first separated by transection at the level of the L4-L5 articulation, and both the hip joints were disarticulated. The pelvis was bisected longitudinally in the midline passing through the pubic symphyses and midline of the vertebrae.

The internal iliac artery was identified and was traced distally to note the origin of the OBA. The course of the OBA was followed until it enters the obturator foramen. The external iliac artery and inferior epigastric artery were also exposed to reveal the origin of OBA from the external iliac system and its relation to the femoral ring was also noted. Throughout the dissection, utmost care was taken to preserve the vessels in place, to avoid any possible topographic alteration.

RESULTS

The various origins of the OBA observed in the study are summarized in Table 1. The OBA was found to arise from the internal iliac system in 60.3% of specimens. Some of the origins are shown in figures 1 to 3. The origin of the OBA from the external iliac system was noted in 39.7%. Among these, in 3.4% of specimens it arose from the external iliac artery trunk (Fig. 4)

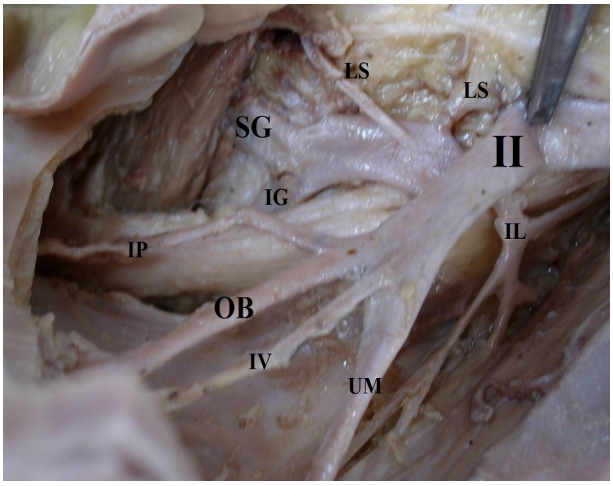

Fig. 1. Left half of a male pelvis showing the origin of OBA from the anterior division of the internal iliac artery. II-Internal iliac artery; IL-Iliolumbar artery; LS-Lateral sacral artery; SG- Superior gluteal artery; IG-inferior gluteal artery; IP-Internal pudendal artery; OB-Obturator artery; IV-Inferior vesical artery; UM-Umbilical artery.

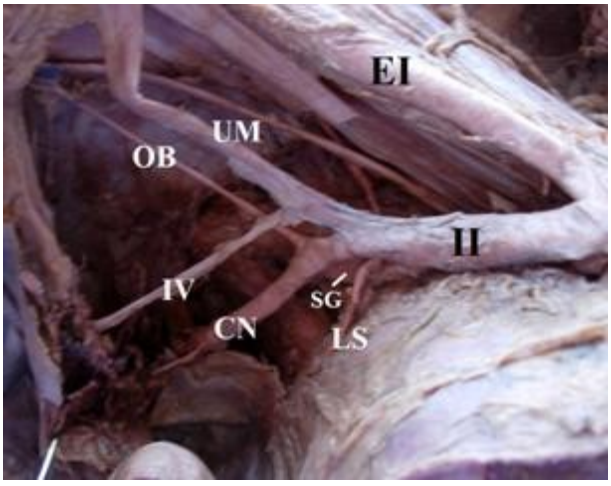

Fig. 2. Right half of a male pelvis showing the origin of OBA from the common trunk of the internal pudendal artery and the inferior gluteal artery. EI- External iliac artery; II- Internal iliac artery; LS- Lateral sacral artery; SG- Superior gluteal artery; OB- Obturator artery; IV-Inferior vesical artery; UM-Umbilical artery; CN-Common trunk of internal pudendal and inferior gluteal artery.

and in the remaining, it arose from the inferior epigastric artery (Fig. 5). The male cadavers showed a slightly higher incidence of origin from external iliac system than the female cadavers.

The OBA of dual origin with anastomoses at the obturator foramen was noted in 5.2% (6/116). The internal iliac origin was from the superior gluteal artery in one specimen, from posterior division of the internal iliac artery in another specimen, and from the anterior division of the internal iliac artery in the remaining four specimens. In all of them the external iliac origin was from the inferior epigastric artery.

In 90% of the specimens, the superior pubic ramus was crossed by venous structures that varied in number and size and coursed from the obturator foramen to the inguinal region to drain into the external iliac vein.

Among the 58 cadavers studied, 15 (26.5%) had similar origins of OBA on both sides. 33 whole pelves showed the origin of OBA from external iliac system (including the specimens with dual origin). It was found to be bilateral in 13 and unilateral in 20 whole pelves (12 pelves were right sided and left sided in 8 pelves). Among these specimens, the gender differences were noted as mentioned in Table 2.

The OBA arising from the external iliac system (including the specimens with dual origin), had its course lateral to the femoral ring in 78.2% (Fig. 6). It was found to be medial to the femoral ring – i.e., along the margin of lacunar ligament in

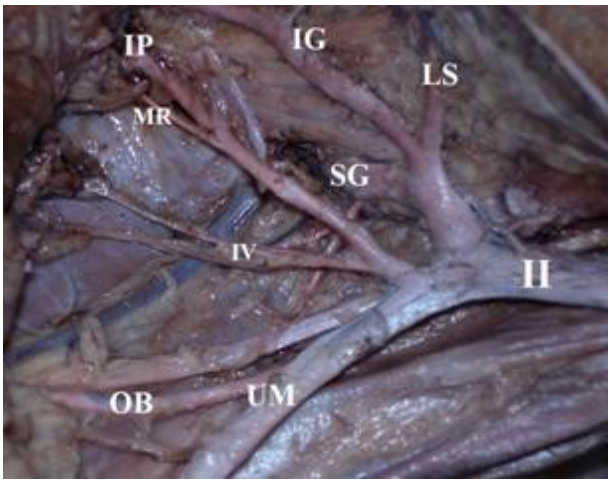

Fig. 3. Left half of a male pelvis showing the origin of OBA from the umbilical artery. II-Internal iliac artery; IL-Iliolumbar artery; LS- Lateral sacral artery; SG-Superior gluteal artery; IG- inferior gluteal artery; IP-Internal pudendal artery; OB- Obturator artery; IV-Inferior vesical artery; UM-Umbilical artery; MR- Middle rectal artery.

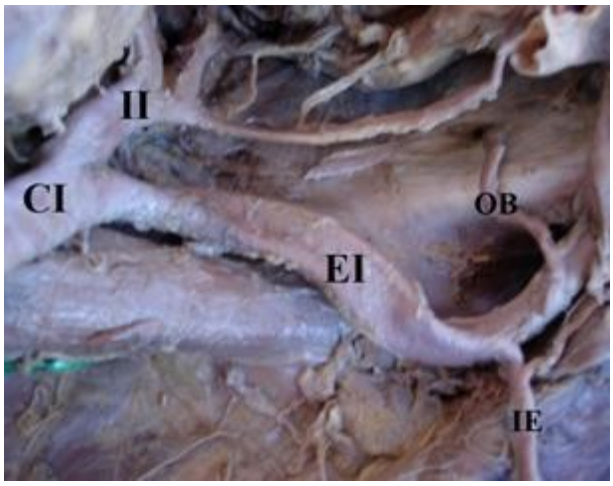

Fig. 4. Right half of a male pelvis showing the OBA arising from the external iliac artery. CI- Common iliac artery; II- Internal iliac artery; EI- External iliac artery; IE- Inferior epigastric artery; OB- Obturator artery.

Fig. 5. Right half of a male pelvis showing the OBA arising from the inferior epigastric artery. II- Internal iliac artery; EI- External iliac artery; IE- Inferior epigastric artery; OB- Obturator artery; LL- Lacunar ligament.

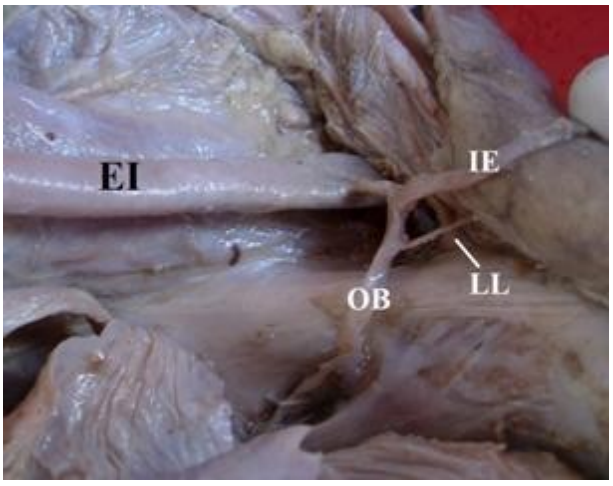

Fig. 6. Left half of a male pelvis showing the lateral relation of OBA to the femoral ring. EI- External iliac artery; IE- Inferior epigastric artery; OB- Obturator artery; LL- Lacunar ligament.

Table 1. Origins of the obturator artery. R:L - Right side: Left side ; IIA - internal iliac artery; EIA - external iliac artery; Cn. trunk for IG & IP - common trunk for inferior gluteal artery and internal pudendal artery

ORIGIN	MALE (n = 68)		FEMALE (n = 48)		TOTAL (n = 116)	
	No. (R: L)	%	No. (R: L)	%	No. (R: L)	%
IIA SYSTEM						
Anterior division	17 (10:7)	25	12 (7:5)	25	29 (17:12)	25
Cn. trunk for IG & IP	7 (4:3)	10.3	5 (2:3)	10.4	12 (6:6)	10.3
Inferior gluteal artery	3 (1:2)	4.4	4 (2:2)	8.3	7 (3:4)	6.0
Superior gluteal artery	4 (2:2)	5.9	2 (1:1)	4.2	6 (3:3)	5.2
Posterior division	6 (4:2)	8.8	3 (2:1)	6.3	9 (6:3)	7.8
Umbilical artery	3 (1:2)	4.4	4 (2:2)	8.4	7 (3:4)	6
TOTAL	40 (22:18)	58.8	30 (16:14)	62.5	70 (38:32)	60.3
EIA SYSTEM						
Main stem of EIA	4 (3:1)	5.9	-	-	4 (3:1)	3.5
Inferior epigastric artery	20 (9:11)	29.4	16 (9:7)	33.3	36 (18:18)	31
TOTAL	24 (12:12)	35.3	16 (9:7)	33.3	40 (21:19)	34.5
Dual origin from IIA & EIA systems	4 (1:3)	5.9	2 (1:1)	4.2	6 (2:4)	5.2

Table 2. Bilateral and unilateral origins of obturator artery from external iliac system

Specimens	Bilateral	Unilateral	
		Right	Left
Male (34 whole pelves)	8 (23.5%)	5(14.7%)	7 (20.6%)
Female (24 whole pelves)	5 (20.8%)	5 (20.8%)	3 (12.5%)
Total (58 whole pelves)	13 (22.4%)	10 (17.2%)	1 (17.2%)
		20 (34.4%)	

Table 3. Relation of the obturator artery of external iliac origin to the femoral ring

	Lateral to the ring	Medial to the ring
Male (28 specimens)	21 (75%)	7 (25%)
Female (18 specimens)	15(83.3%)	3 (16.7%)
Total (46 specimens)	36 (78.2%)	10 (21.7%)

Table 4. Comparison studies of according to the classification based on the number of origins of the OBA. IIA- Internal iliac artery; EIA –External iliac artery

		Braithwaite (1952) %	Roberts et al. (1967) %	Biswas et al. (2010)	Sanudo et al. (2011) %	Metaanalysis by Sanudo et al. (2011) %	Our study %
SINGLE ORIGIN		93.5	100	100	96.55		94.7
Type a	Anterior trunk of IIA	59.9	53.2	44.6	52.68	35.5	47.3
Type b	Inf.epigastric artery	19.5	25.3	23.2	29.02	22.5	31
Type c	Posterior trunk of IIA	13.5	16.5	28.5	8.48	12.1	13.0
Type d	IIA above the division	-	3.7	-	8.04	16.7	-
Type e	EIA	1.1	1.3	3.5	1.79	1.7	3.5
Type f	Femoral artery	-	-	-	-	-	-
DOUBLE ORIGIN		6.5	-	-	3.02	-	5.2
TRIPLE ORIGIN		-	-	-	0.43	-	-

21.7% (Fig. 5). The gender differences are as shown in Table 3.

DISCUSSION

The OBA has been documented to be arising from all the possible neighboring arteries, namely common iliac, external iliac, from any branch of internal iliac in either sex. To avoid confusion, the latest classification was proposed by Sanudo et al. (2011), and it is based on the number of origins of OBA. Various studies are compared based on this classification as shown in Table 4. To enable comparison, the origins from the umbilical artery, the inferior gluteal artery, the common trunk for the inferior gluteal artery and the internal pudendal artery are included under the anterior trunk, and the origin from the superior gluteal artery is included under the posterior trunk.

In our study, the origin of OBA from the internal iliac system was 60.3% only, which is less than the findings of various other studies, although it correlates with the findings of some authors (Gray, 1901; Schaeffer, 1953) as shown in Table 5.

The origin of OBA from the posterior trunk of IIA as noted in these studies has a clinical advantage. In cases of obstruction of the anterior division of the internal iliac artery due to any cause (either iatrogenic for obstetric indications or as a part of disease process), there will be sparing of OBA and its branches, especially the branch to the head of femur. The parietal branches of OBA are important collaterals in aorto-iliac and femoral arterial occlusive diseases. Therefore this may be considered for a possible bypass grafting in cases of ischemic necrosis of the head of the femur following decreased blood flow through OBA, connecting the posterior division to the distal end of the obstruction. Moreover, the increased length of the OBA, owing to the origin from the posterior division of the internal iliac, may have an additional advantage while grafting (Kumar and Rath, 2007).

Table 5. Comparison of origins of the obturator artery from internal iliac and external iliac system

Authors	Origin from the II system (%)	Origin from the EI system (%)
Gray (1901)	66.7	33.3
Piersol (1930)	70	30
Pick (1941)	71	29
Braithwaite (1952)	73	27
Schaeffer (1953)	63	37
Roberts (1967)	73.5	26.5
Bergman (2006)	71.6	28.4
Rusu (2009)	68.8	31.2
Mahato (2009)	78	22
Biswas (2010)	71.3	28.7
Sanudo (2011)	69.2	30.8
Our study	60.3	39.7

The origins of OBA from the femoral artery, the internal pudendal artery and from the main stem of the internal iliac artery had been earlier noted in some studies (Braithwaite, 1952; Roberts and Krishingner, 1967; Bergman et al., 2006). However, these origins were not found in our study.

In this study, the origin of OBA from the external iliac system (including the dual origin) was 39.7%, and is the highest among all the available studies (Table 5). Among the 58 whole pelves, 33 had the origin of OBA from the external iliac system. This indicates that 56.9% of cadavers had origin from external iliac system.

The origin of OBA from the inferior epigastric artery was observed in 14% to 33% in different studies (*Skandalakis* et al., 2004; Grant, 1957; Pai et al., 2009), and in our study it was found in 36.2% of specimens (including the dual origin also). Kawai et al. (2008) noted such origin of OBA in 10.5%, while they also noted the origin of inferior epigastric artery from the OBA in 0.4%. No such observation was made in our study. During normal development, the inferior epigastric artery is established at an earlier stage than the OBA as a channel for blood supply. The difference of blood flow resulting from this time lag is one of the reasons why the inferior epigastric artery from the OBA is very rare in comparison to the OBA from the inferior epigastric artery (Pai et al., 2009).

In our study, the OBA was found to originate as a direct branch of the external iliac artery in 3.4%. This is higher than the findings of earlier studies of 1.1-1.3% (Braithwaite, 1952; Roberts and Krishingner, 1967; Bergman et al., 2006), but less than the finding of Mahato (2009), who noted such an origin in 10%. In such cases, when the internal iliac artery is obstructed due to any cause, the OBA and its branches will be spared, especially the branch to the head of the femur (Pai et al., 2009).

The OBA of dual origin, which indicates its formation by the union of two trunks from both the internal and external iliac systems, was noted in 5.2% in our study and a corresponding venous communication was observed in the majority of the specimens. This is described as *corona mortis*. *Corona mortis*, literally meaning “crown of death”, has been reported at an incidence rang-

ing from 8 to 83% (Darmanis et al., 2007; Okcu et al., 2004). This anastomosis frequently poses as a surgical problem for orthopedic surgeons operating around the superior pubic ramus, because of the failure to ligate them as they retract back into the obturator canal after being injured (Nabil et al., 2008). The problem is twofold, because when either of the vessels is injured, the patient bleeds profusely from both the ends. This may lead to extraperitoneal hemorrhage and death (Sarikcioglu et al., 2003).

Despite the high prevalence of these large retro pubic vessels in the operating room, surgeons should exercise caution, but not alter their surgical approach, for fear of excessive hemorrhage (Darmanis et al., 2007). Tracing along this vessel can easily identify the obturator foramen, which is an anatomic landmark that indicates an adequate inferior dissection of the pre-peritoneal space (Lau and Lee, 2003).

According to Rusu et al. (2010), any vessel coursing over the superior pubic branch is termed *corona mortis*, no matter whether it was a vascular anastomosis, an obturator vessel related to the external iliac system, or a terminal small vessel. Since our study was mainly aimed at the obturator artery, we grouped the arterial patterns according to this classification. We could categorise the following types, namely type I.1. in 3.4%, type I.2. in 31% and type I.3. in 5.2% of the specimens.

Gray (1901) had earlier mentioned that, the origin of OBA from the inferior epigastric artery is not commonly found on both sides of the same body. However, Bergman et al. (2006) had summarised various studies from different populations and found the incidence of bilaterality of such an origin of OBA to be 23.7%, and our study coincides with his findings.

The OBA, arising from the external iliac system, in order to reach the point of exit from the pelvis, may take one of the 3 possible routes in relation to the femoral ring. A study by Jatschinski (1891) revealed that the OBA of external iliac origin was related to the lateral border of the femoral ring in 60% of the cases, while it was found in 78.2% in our study, and was found more frequently in females than males. It was along the margin of the lacunar ligament in 17.9%, and it was common in males while it was 21.7% in our study. The artery was related across the femoral ring in 22.5% and was common in females, but no such finding was observed in our study. The differences in the findings of the two sexes in our study coincide with the earlier results. The sex differences are associated with the difference in the form of the pelves and the obturator foramen.

The surgical significance of the relation of OBA to the femoral ring is that the artery runs a greater risk of being wounded during the operation for strangulated femoral hernia. When the surgeon has to widen the neck of the sac by cutting the lacunar ligament, the artery might get cut and bleed profusely if it is related medially or across the femoral ring (Piersol, 1930).

Embryologically, the OBA arises comparatively late in development from a plexus which in turn is joined by the axial artery of the lower limb that accompanies the sciatic nerve (Sanudo et al., 1993). The definitive OBA forms as a result of an uneven growth of the anastomosis between the internal iliac artery and the external iliac artery, which is connected with the peculiarities of regional organogenesis (Petrenko, 2000). It is currently accepted that the anomalies affecting the arterial patterns of the limbs are based on an unusual selection of channels from primary capillaries. The most appropriate channel enlarges, whilst others retract and disappear, thereby establishing the final arterial pattern classified as "normal" (Fitzgerald, 1978). All gradations may be found between normal arrangement and complete replacement of the original intra-pelvic portion of the OBA by the pubic anastomosis (Piersol, 1930).

Sanudo et al. (1993) had described two cases of arterial variation in which the obturator, inferior epigastric and medial circumflex femoral arteries arose from a common trunk from the external iliac artery and advanced the ontogenetic interpretation of the anomaly. Before the medial circumflex femoral and obturator arteries appear as independent blood vessels from the 'rete femorale' and 'rete pelvicum', the blood flow destined for their territory makes an unusual choice of source channels and, instead of arising from the femoral or internal iliac artery as is usual, it arises from the inferior epigastric. The presence of a dual origin for the OBA may be interpreted as being due to the blood flow having two source channels, one from the internal iliac artery and the other from the inferior epigastric artery.

The study implies the frequent occurrence of OBA origin from external iliac system in Indian population. Such common variations indicate the necessity of the surgeons and orthopedicians to look for such vascularity to avoid undue hemorrhage and complications.

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REFERENCES

BERGMAN RA, AFIFI AK, MIYAUCHI R (2006) Illustrated Encyclopedia of human anatomical variations. Opus II: Cardiovascular System - Anatomy Atlases. (Available at URL: http://www.anatomyatlases.org/ Accessed 10 July 2009).

BISWAS S, BANDOPADHYAY M, ADHIKARI A, KUNDU P, ROY R (2010) Variation of origin of obturator artery in Eastern India population - A study. *J Anat Soc India*, 59: 168-172.

BRAITHWAITE JL (1952) Variations in origin of the parietal branches of the internal iliac artery. *J Anat*, 86: 423-430.

DARMANIS S, LEWIS A, MANSOOR A, BIRCHER M (2007) Corona mortis: an anatomical study with clinical implication in approaches to the pelvis and acetabulam. *Clin Anat*, 20: 433-439.

FITZGERALD MJT (1978) Human Embryology. Harper and Row, New York.

GRANT JCB (1957) The Anatomy of the respiratory, blood vascular and lymphatic system. Oxford University Press, London.

GILROY AM, HERMEY DC, DIBENEDETTO LM, MARKS SC JR, PAGE DW, LEI QF (1998) Variability of the obturator vessels. *Clin Anat*, 10: 328-332.

GRAY H (1901) Anatomy Descriptive and Surgical. Courage books, Pennsylvania.

JACUBOWICZ M, CZARNIAWSKA-GRZESINSKA M (1996) Variability in origin and topography of the inferior epigastric artery and obturator arteries. *Folia Morphol*, 55: 121-126.

JASTSCHINSKI S (1891) Die typischen Verzweigungformen der Arteria Hypogastrica. *Int J Anat Physiol*, 8: 111-127.

KAWAI K, HONMA S, KOIZUMI M, KODAMA K (2008) Inferior epigastric artery arising from obturator artery as a terminal branch of the internal iliac artery and consideration of its rare occurrence. *Ann Anat*, 190: 541-548.

KUMAR D, RATH G (2007) Anomalous origin of obturator artery from the internal iliac artery. *Int J Morphol*, 25: 639-641.

LAU H, LEE F (2003) A prospective endoscopic study of retro pubic vascular anatomy in 121 patients undergoing endoscopic extra peritoneal inguinal hernioplasty. *Surg Endosc*, 17: 1376-1379.

MAHATO NK (2009) Retro-pubic vascular anomalies: A study of abnormal obturator vessels. *Eur J Anat*, 13: 121-126.

MOORE KL, AGUR AMR, ARTHUR FD II (2006) Essential clinical anatomy. Lippincott William and Wilkins, Philadelphia.

NABIL AE, JIAYONG L, ALAN HL, VISHWAS P, MUNIER MSN, CHRIS GSJ (2008) Obturator artery disruption associated with acetabular fracture: A case study and anatomy review. *Injury*, 39: 44-46.

NEGURA A, ANDREESCU G, MARDEROS GG, MARDEROS GH, MFIRGFIRIT L (1993) Hemorrhagic risks in the burch procedure. *Int Urogynecol J*, 4: 310-313.

OKCU G, EERKAN S, YERCAN HS, OZIC U (2004) The incidence and location of corona mortis: a study on 75 cadavers. *Acta Orthop Scand*, 75: 53-55.

PAI MM, KRISHNAMURTHY A, PRABHU LV, PAI MV, KUMAR SA, HADIMANI GA (2009) Variability in the origin of the obturator artery. *Clinics*, 64: 897-901.

PETRENKO VM (2000) Development of the obturator artery in human prenatal ontogenesis. *Morfologias*, 118: 51-53.

PICK JW, ANSON BJ, ASHLEY FL (1942) The origin of the obturator artery. A study of 640 body-halves. *Am J Anat*, 70: 317-343.

PIERSOL GA (1930) Human Anatomy. Lippincott, Philadelphia.

POYNTER CWM (1922) Congenital anomalies of the arteries and vein of the human body with bibliography. University Studies of the University of Nebraska, 22: 1-106.

ROBERTS WH, KRISHINGNER GL (1967) Comparative study of human internal iliac artery based on Adachi classification. *Anat Rec*, 158: 191-196.

RUSU MC, CERGAN R, MOTOC AG, FOLESCU R, POP E (2010) Anatomical considerations on the corona mortis. *Surg Radiol Anat*, 32: 17-24.

SANUDO JR, ROIG M, RODRIGUEZ A, FERREIRA B, DOMENECH JM (1993) Rare origin of the obturator artery, inferior epigatric and femoral arteries from a common trunk. *J Anat*, 183: 161-163.

SANUDO JR, MIRAPEIX R, NIEDENFUHR MR, MARANILLO E, PARKIN IG, VÁZQUEZ T (2011) Obturator artery revisited. *Int Urogynecol J*, 22:1313-1318.

SARIKCIOGLU L, MUZAFFER S, FEYYAZ A, SEMIH G (2003) Anastomotic vessels in the retro pubic region: Corona mortis. *Folia Morphologica*, 62: 179-182.

SCHAEFFER JP (1953) Morris Human Anatomy. The Blackiston Co, New York.

SKANDALAKIS JE, GENE LC, THOMAS AW, ROGER SF, ANDREW NK, LEE JS (2004) Surgical Anatomy, The embryologic and anatomic basis of modern surgery. PM Publications, Greece.