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Original Research Article

Anatomical study of the origin of obturator artery in Indian cadavers

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ABSTRACT

Background and Aim: Obturator artery (OA) originates from the anterior division of the internal iliac artery (IIA) and gives various branches to the pelvic cavity, medial compartment of the thigh, and hip joint. Studies in literature illustrate variable origin from the posterior division of the IIA, external iliac artery (EIA), or the branches of both the IIA and EIA. Understanding the pelvic vascular anatomy pertaining to the OA is crucial in averting the risk of its injury in pelvic surgeries. Present study reports on the variant anatomy of the origin of the OA in the Indian population.

Materials and Methods: The study included 61 specimens from 25 formalin-embalmed cadavers (male-19, female-6) and 11 hemipelvis (male-9, female-2) utilized for undergraduate teaching in the Department of Anatomy. After dissecting the peritoneum and mobilizing the pelvic organs, the origin of OA was examined for variations.

Result: The OA originated from the IIA in 83.61%. It was a branch from the anterior division of the IIA in 65.58% and the posterior division in 18.03%. OA was also given off at the site of the bifurcation of IIA into anterior and posterior divisions in 3.28%, from EIA in 4.92%, from an inferior epigastric artery (IEA) in 8.2%, and from the inferior gluteal artery and umbilical artery in 1.64% each.

Conclusion: This study recognizes the variant anatomy of the origin of the OA. Anticipating these variations will be valuable in pelvic surgeries and laparoscopic procedures such as herniorrhaphy to avoid any untoward traumatic haemorrhage.

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1. Introduction

Obturator artery (OA) commences from the anterior division of the internal iliac artery (IIA) and supplies various branches to the pelvic cavity, medial compartment of the thigh, and hip joint.¹ OA traverses along the lateral pelvic wall and enters the obturator canal, accompanied by the obturator nerve and vein. During its pelvic course, the OA is related to the obturator nerve superiorly and the obturator vein inferiorly. It gives off a pubic branch before entering the obturator canal which passes over the superior pubic ramus and anastomoses with the pubic

branch of the inferior epigastric artery (IEA).¹ The OA divides into the anterior and posterior branches as it emerges from the obturator canal. These branches encircle the obturator foramen between the obturator externus muscle and obturator membrane, and terminate by anastomosing with each other. The posterior branch of the OA provides the acetabular branch to supply the hip joint.¹

Studies in literature illustrate that the OA might arise from the posterior division of the IIA (IIA-PD), external iliac artery (EIA), IEA and the femoral artery.²⁻⁶ It can also arise from the branches of the IIA such as superior gluteal, inferior gluteal and internal pudendal arteries.⁷ The origin of the OA is thus highly inconsistent and widely researched

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because of its clinical significance in pelvic surgeries. Unsuccessful obturator nerve block during transurethral electroresection of urinary bladder tumor might result in injury to the OA and cause life-threatening hemorrhage as reported by Akata et al.⁸ Superior pubic rami fracture may also lead to severe hemorrhage due to the injury of blood vessels crossing it.² The understanding of the pelvic vascular anatomy would be crucial in avoiding the risk of injury in endoscopic procedures and pelvic surgeries such as fixation of pubic fractures and inguinal hernia repair.² Hence the present study focuses on the variations in the origin of the OA in cadavers from India.

2. Materials and Methods

Present study included 61 specimens (fixed in 10% formalin), from 25 cadavers (Male-19, Female-6) and 11 hemi-pelves (male-9, female-2) of Indian origin, that were approved for undergraduate teaching and research, from the year 2015 to 2019 in the Department of Anatomy. The specimens which were damaged due to flawed dissection or any vascular surgeries were excluded from the study. The study sample thus obtained had a total of 47 male (Right-23, Left-24) and 14 female (Right-7, Left-7) specimens. As per the Cunninghams manual of Practical anatomy, the pelvic organs were mobilized and the peritoneum of the pelvis was meticulously dissected. After identifying the EIA and IIA, the anterior and posterior divisions of the IIA and their branches were dissected methodically.⁹ The OA was traced from its origin to its termination into the anterior and posterior branches. The observations on the origin of OA, its relation to the obturator vein and nerve were recorded. Descriptive statistics was applied and the differences between gender and sides were analyzed using SPSS version 20.

3. Results

Out of the 61 specimens, variations in the origin of the OA were observed in 48% of the whole pelvis (25 cadavers) and 36% of the hemi-pelves (11 specimens). Bilateral variation was observed in five specimens (20%) among the 25 cadavers examined. Comparisons between sides and gender are specified in Figure 1 and Figure 2 respectively. There was no statistically significant variations in the prevalence pertaining to the gender (p-value -0.729) and sides (p-value -0.466) of the pelvis.

The OA originated from the IIA in 51 (83.61%) specimens. The non-IIA sites for the OA origin (16.39%) were the site of bifurcation of IIA into anterior and posterior divisions (3.28%), from the EIA (4.92%), IEA (8.2%), umbilical artery (1.64%), and inferior gluteal artery (1.64%). In case of IIA origin, the anterior division (AD) was the more frequent source of origin than the posterior division (PD). In the cases of non-IIA sites of origin, IEA

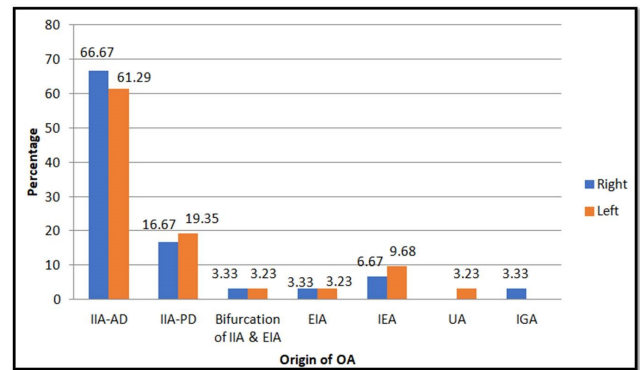


Fig. 1: Comparison of the origin of the obturator artery on the right and left sides

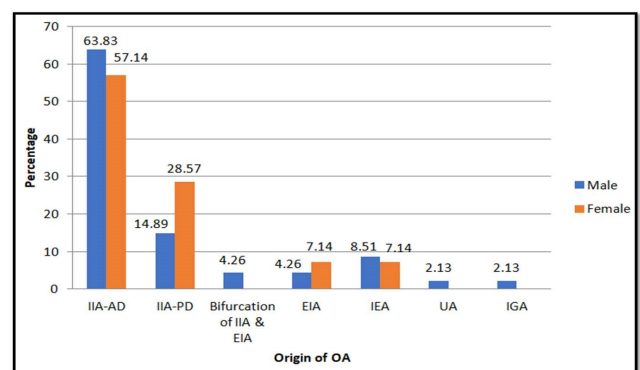


Fig. 2: Comparison of the origin of the obturator artery in male and female cadavers

was the most common source.

The anterior division of the IIA (IIA-AD) gave rise to the OA in 65.58% (38 specimens). In 36 specimens, the OA was a direct branch of the IIA-AD and in two specimens from the other branches (IGA and UA) of the IIA-AD. In Figure 3, UA was seen arising from IIA-AD, giving origin to OA and superior vesical artery and further continuing as the obliterated umbilical artery. In 18.03% (11 specimens) where the OA originated from the IIA-PD, it was found to have a common stem of origin with the superior gluteal artery. The origin of OA from IIA-PD was more frequent on the left side (19.35%) than on the right side (16.67%) and was also found to be more frequent in females (28.57%) than in males (14.89%). From IEA, the origin of OA was mostly left-sided compared to that on the right (Figure 4). Accessory OA was not encountered in the study. After giving off the pubic branch, OA proceeded through the obturator canal and terminated by dividing into anterior and posterior branches (Figure 5).

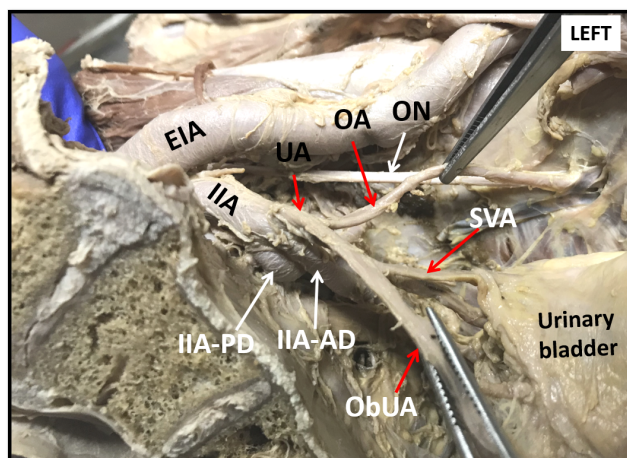


Fig. 3: Obturator and superior vesical arteries arising from umbilical artery

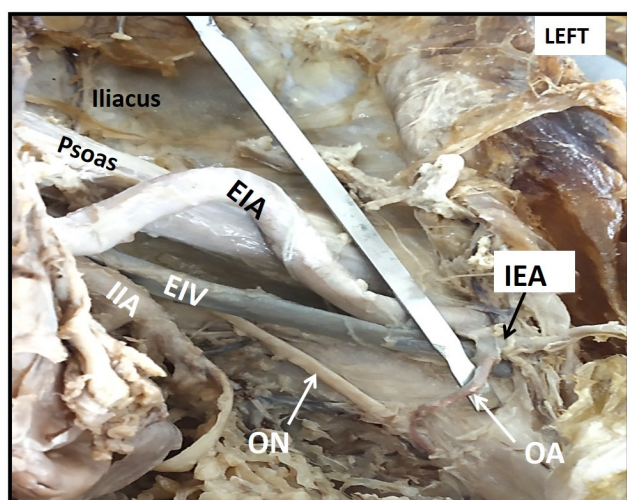


Fig. 4: Obturator artery arising from the inferior epigastric artery

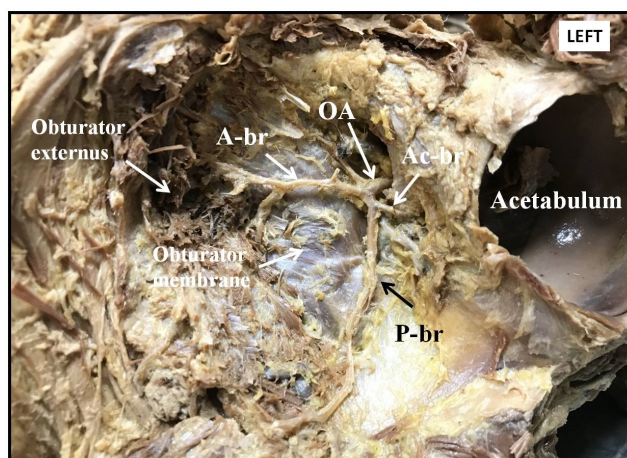


Fig. 5: Termination of obturator artery

4. Discussion

OA has been studied widely due to the various clinically significant situations such as a) pubic branches of OA crossing the superior pubic rami b) corona mortis – communication between IIA and EIA crossing the superior pubic rami c) accessory OA.^{2,10} Variant OA was observed in 38% and 33% of the population from the United States and China respectively.¹⁰ An Indian study by Rajive and Pillay reported variations of the OA in 46% of the 50 half-pelves examined.³

OA arising from the IIA-AD is the most common point of origin followed by IEA.¹¹ In a Korean study, the OA was a branch of the IIA in 91.7% of pelvic halves.¹² In a study by Pai et al., OA originated from IIA in 77% of 98 specimens.¹³ Braithwaite reported that the OA was a branch of the IIA-AD in 41.4% followed by IEA in 19.5%.⁷ Incidence of origin of the OA from the EIA varies greatly with different studies. It was 1.1% in a study by Braithwaite whereas 25% by Missankov et al.^{7,14} Jakubowicz and Czerniawska-Grzesinska found the OA to originate from the EIA in 1.3% of the specimens and an Indian study reported 8.33%.^{15,16} In contrast, EIA gave origin to the OA in 4.92% of cases in the present study. The OA originated from the common trunk or at the point of its bifurcation into anterior and posterior divisions in 3.28% in the present study which is comparable to 3.33% reported by Maneesha et al.⁴

Al-Talalwah et al. reported the variant origin of the artery from the IIA-AD and IIA-PD as 45% and 25%, respectively.² Tajra et al observed that the OA was a branch of the IIA-AD in 59.09%, and the IIA-PD in 18.18%.¹⁷ The present study varied widely with the study from the East India region where the OA was from the IIA-AD in 44.6% and from the IIA-PD in 12.5% whereas it was similar to the study by Pavan et al., where the incidence was 72% and 18% respectively.^{5,18} Mamatha et al. observed the OA to originate from the IIA-PD in 14%.¹⁹ The finding of IIA-AD being the most common source of the OA in the aforementioned studies is consistent with that of our findings. A comparison of various studies on the origin of the OA is specified in Table 1.

The incidence of the OA arising from the IEA varies widely in different studies. It was reported as 23.2% by Biswas et al., 13.63% by Tajra et al., 22% by Rajive and Pillay, and 6% by Pavan et al.^{3,5,17,18} Jakubowicz and Czerniawska-Grzesinska found the OA to originate from the IEA in 2.6% of the specimen.¹⁵ Incidence of 8.2% in the present study correlates with 8.3% reported by Lee et al.¹² One-fourth to one-third of the hemi-pelves and 50% of whole pelvis had a variant origin of the OA from IEA in a report by Gilroy et al.¹⁰ Variant origin of OA from IEA is of surgical significance in cases of femoral hernia repair. The variant OA arising from the IEA could be related to the lateral border, medial border, or middle of the femoral ring, and in cases of femoral hernia, it was usually related to its

Table 1: Comparison of origin of obturator artery in various studies

Origin of obturator artery	Braithwaite 1952 ⁷	Pai et al. 2009 ¹³	Biswas et al. 2010 ¹⁸	Sanudo et al. 2011 ²⁰	Sakthivelavan et al. 2013 ²¹	Rajive and Pillay 2015 ³	Tajra et al. 2016 ¹⁷	Present study n (%)
Sample size	169	98	56	238	116	50	24	61
Country	England	India	India	Spain	India	India	Brazil	India
Common trunk of IIA / at bifurcation of IIA-AD and IIA-PD	-	-	-	8.04%	-	2 (4%)	0	2 (3.28%)
IIA								
AD	41.4%	59	25 (44.6%)	52.68%	29 (25%)	27 (54%)	59.09%	38 (62.3%)
PD		7	7 (12.5%)	8.48%	9 (7.8%)	5 (10%)	18.18%	11 (18.03%)
SGA	10%	10	9 (16%)	-	6 (5.2%)	1 (2%)	-	-
IGA	4.7%	-	-	-	7 (6%)	1 (2%)	-	1 (1.64%)
IIA	3.5%	1	-	-	-	-	-	-
IPA	3.8%	-	-	-	-	1 (2%)	-	-
UA		-	-	0.43%	-	1 (2%)	-	-
EIA								
Direct branch	1.1%	-	-	1.79%	7 (6%)	-	-	1 (1.64%)
IEA	19.5%	5	2 (3.5%)	29.02%	4 (3.5%)	2 (4%)	9.09%	3 (4.92%)
Dual Origin from IIA and EIA	6.5%	14	13 (23.2%)	3.02%	36 (31%)	11 (22%)	13.63%	5 (8.2%)
Triple Origin	-	2	-	0.43%	6 (5.2%)	-	-	-
		-	-					

(IIA: Internal iliacartery; AD: Anterior division; PD: Posterior division; EIA: External iliac artery; SGA: Superior gluteal artery; IGA: Inferior glutealartery; IPA: Internal pudendal artery; UA: Umbilicalartery, IEA: Inferior epigastric artery)

lateral side.⁶

OA arising from other branches of the IIA has also been reported. Mamatha et al. described that the OA originated from the inferior vesical artery in 8% of cases.¹⁹ Sakthivelavan et al. observed the OA to originate from the IGA in 6% of cases whereas in the present study it was 1.64%.²¹ OA has been reported to take origin from internal pudendal artery in two Indian studies though that was not observed in the present study.^{3,22} Maneesha et al. observed the double origin of the OA from the IIA and the EIA in four (6.67%) of 60 adult pelvic halves examined which correlates to 6.5% reported by Braithwaite in British subjects.^{4,7} The triple origin of the OA which is very rare has been reported by Sanudo et al.²⁰ However, in the present study, similar presentations were not encountered. Tajra et al. reported that the variations of the OA were greater on the right side (27.27%) than on the left side (18.18%)¹⁷ which differs from the present study where the origin of the OA from IIA-PD from the right and left sides was 16.7% and 19.4% respectively. (Figure 1).

Embryologically, the OA is formed from the growth of uneven anastomosis of vascular channels between the IIA and EIA.²¹ Most appropriate channels enlarge and persist to form the normal anatomical arterial pattern.²³ The OA joins the axial artery at the anterior division of the IIA late in the development.²¹ Occasionally, the persistent vascular channel may join the posterior division of the IIA, resulting in a variant OA.^{23,24} Also, the vascular connections between the pubic branches of OA and IEA are reabsorbed. However, in cases where the proximal vascular channel disappears, the distal part of OA forms the variant OA, or the pubic branches of IEA and OA may persist as the variant OA.^{25,26}

5. Conclusion

Variations in the parietal branches of IIA especially the OA are of surgically important. The present study shows the OA to arise from IIA-PD in 18.03% and from non-IIA sites in 16.39%. Thus, anticipation of a variant OA will be prudent in procedures such as total extraperitoneal inguinal hernioplasty or laparoscopic herniorrhaphy, and also in other pelvic surgeries to avoid untoward traumatic haemorrhage.

6. Abbreviation

OA: Obturator artery; **IIA:** Internal iliac artery; **AD:** Anterior division; **PD:** Posterior division; **EIA:** External iliac artery; **IEA:** Inferior epigastric artery; **UA:** Umbilical artery; **IGA:** Inferior gluteal artery; **ObUA:** Obliterated umbilical artery; **SVA:** Superior vesical artery; **A-br:** Anterior branch; **P-br** - Posterior branch; **Ac-br** – Acetabular branch; **SGA:** Superior gluteal artery; **ILA:** Iliolumbar artery; **IPA:** internal pudendal artery.

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None.

8. Conflict of Interest

None.

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