Journal of Morphological Sciences
J Morphol Sci
Brazilian Society of Anatomy

Original Article
J Morphol Sci 2022;39:42-46

CT Angiographic Correlation of the Aberrant Obturator Artery

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Disclose and conflicts of interest: none to be declared by all authors

ABSTRACT

Introduction: the aberrant obturator artery is a variation where the obturator artery arises from the external iliac artery or inferior epigastric artery. This study aims to investigate the incidence of the aberrant obturator artery by cadaveric dissection and CT Angiogram in Indian population.

Methods and Methods: the cadaveric study was conducted on 78 prosected hemipelves, 54 male and 24 female. The obturator artery was dissected to see the source of the vessel on all cadavers. All variations from normal were photographed and documented. On account of the important clinical and surgical implications of the aberrant obturator artery, a retrospective study of 62 CT angiograms; 42 male and 20 female (124 pelvic sides) were studied by a radiologist. Maximum Intensity Projection [MIP] and 3D volume rendered imaging was also done routinely for all CT angiography studies. The source of obturator artery was documented.

Results: Out of the 78 hemipelves, 69% had the source from internal iliac artery, 14% from the inferior epigastric artery, 1% from the external iliac artery and 16% from both the inferior epigastric artery and internal iliac artery. Out of the 124 pelvic sides in CT angiogram, 82% had the source from internal iliac artery, 5% from the inferior epigastric artery, 11% from the external iliac artery, 1% from both the inferior epigastric artery and internal iliac artery and 1% from the profunda femoris artery (medial circumflex). The total incidence of the aberrant obturator artery in this study was 15%.

Conclusion: the aberrant obturator artery arising either from inferior epigastric or external iliac artery was present in 15% of cadaveric specimens and 16% of CT angiograms, which forms an important component of the 'corona mortis'.

Keywords: External iliac artery; Internal iliac artery; Obturator artery; Corona mortis.

Introduction

The obturator artery is a paired medium sized parietal branch of the internal iliac artery. It arises from the anterior division of the internal iliac artery and runs antero-inferiorly on the lateral pelvic wall towards the obturator foramen. It is accompanied by the obturator nerve above and the vein below. Before it leaves the pelvis through the obturator canal, it gives off a pubic branch, muscular branches, and a nutrient artery to the ilium. The pubic branch before it leaves the pelvis, ascends on the pelvic surface of the pubis to anastomose with the pubic branch of the inferior epigastric artery, a branch of the external iliac artery[1]. If the obturator artery arises from the external iliac artery or inferior epigastric artery, it is known as aberrant obturator artery[2]. The incidence of the aberrant obturator artery is given as 20% in most of the standard textbooks. However an extensive literature search in Pubmed and other database revealed inconsistencies in the percentages of the aberrant obturator artery[3]. The author has reported 12% in a pilot study done on 40 hemipelves in South Indian population[4]. Till date, there is no radiological study on Indian population regarding the incidence of aberrant obturator artery. This present study aims to investigate the incidence of the aberrant obturator artery by cadaveric dissection on more samples and CT Angiogram in Indian population.

Materials and methods

Approval for this study was obtained from the Institutional Review Board of our institution. The cadaveric study was conducted on 78 prosected hemipelves, 54 male and 24 female, available in our department. These were obtained from cadavers, fixed with formalin, donated to the department of Anatomy for teaching and research. The lateral pelvic wall was cleaned of all connective tissue meticulously to look for the obturator canal. The obturator artery was dissected to see the source of the vessel on all cadavers. All variations from normal were photographed and documented.

On account of the important clinical and surgical implications of the aberrant obturator artery, a retrospective study of 62 CT angiograms; 42 male and 20 female (124 pelvic sides) were studied by a radiologist. These were patients who underwent CT angiography for peripheral arterial disease. Patients with aorto-iliac diseases were excluded from this group because of the possibility of collaterals in such cases. CT angiograms

DOI: 10.51929/jms.39.42.2022
ISSN 2177-0298

were performed in 16 slice Siemens CT scanner and 64 slice GE 750HD CT scanner. Thin sections of 0.625 [GE] or 0.75mm [Siemens] sections were acquired volumetrically and multiplanar reconstruction were done. Maximum Intensity Projection [MIP] and 3D volume rendered imaging was also done routinely for all CT angiography studies. The source of obturator artery was documented.

Results

Four patterns of obturator artery were found: those that originated from 1. the internal iliac artery (normal) 2. the inferior epigastric artery (aberrant) 3. the external iliac artery (aberrant) and 4. from both the internal iliac artery and inferior epigastric artery. Out of the 78 hemipelves, 69% had the source from internal iliac artery, 14% from the inferior epigastric artery (Figure 1), 1% from the external iliac artery and 16% from both the inferior epigastric artery and internal iliac artery. (Table 1) (Figure 2).

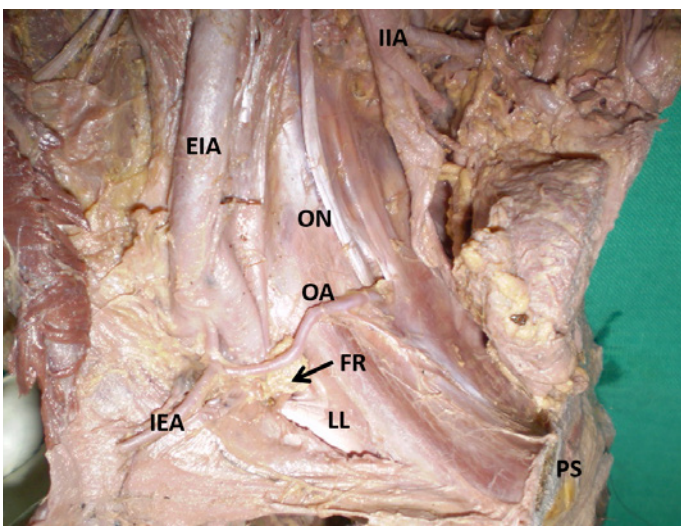

Figure 1. Right hemipelvis showing the aberrant obturator artery from the inferior epigastric artery, coursing over the femoral ring (PS- pubic symphysis; EIA – external iliac artery ; IIA – internal iliac artery ; OA – obturator artery ; ON – obturator nerve ; IEA – inferior epigastric artery ; LL – lacunar ligament ; FR – femoral ring).

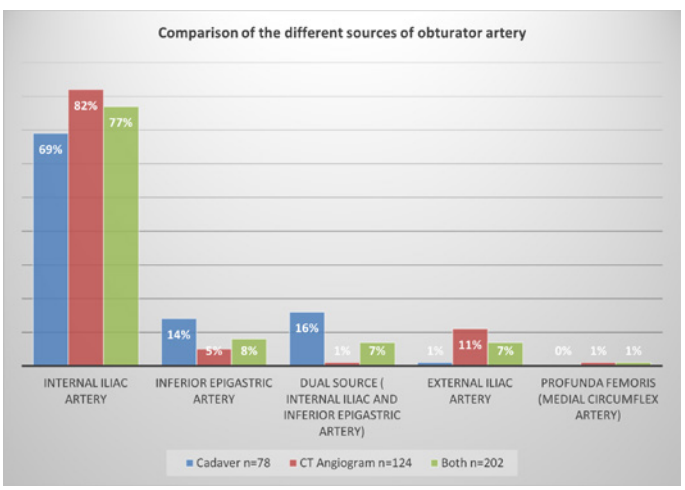

Figure 2. Bar diagram showing the comparison of various sources of Obturator artery.

Table 1. Source of obturator artery in cadaver and CT angiogram (percentage)

S.N°	Source of obturator artery	Cadaver n=78 (in %)	CT Angiogram n=124 (in %)	Both cadaver and CT Angiogram n=202 (in %)
1	Internal iliac artery (IIA)	69	82	77
2	Inferior epigastric artery (IEA)	14	5	8
3	External iliac artery	1	11	7
4	Dual source from IIA and IEA	16	1	7
5	Profunda femoris artery (medial circumflex)	0	1	1

Out of the 124 pelvic sides in CT angiogram, 82% had the source from internal iliac artery, 5% from the inferior epigastric artery (Figure 3), 11% from the external iliac artery (Figure 4), 1% from both the inferior epigastric artery and internal iliac artery

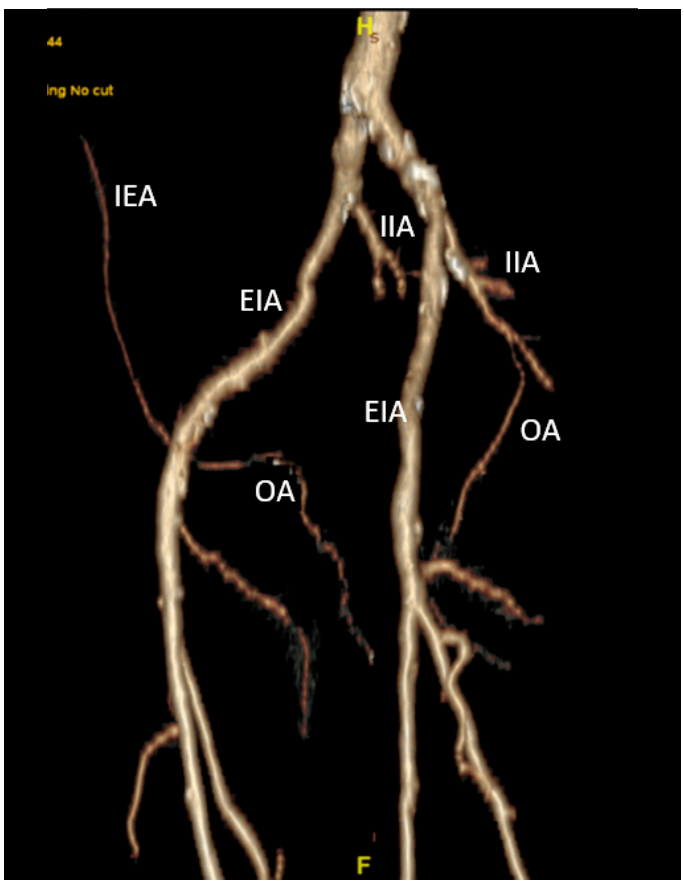

Figure 3. Volume rendered 3D reconstruction demonstrate right obturator artery (OA) arising from the inferior epigastric artery(IEA) and normal origin of left obturatory artery(OA) from left internal iliac artery(IIA). EIA -external iliac artery.

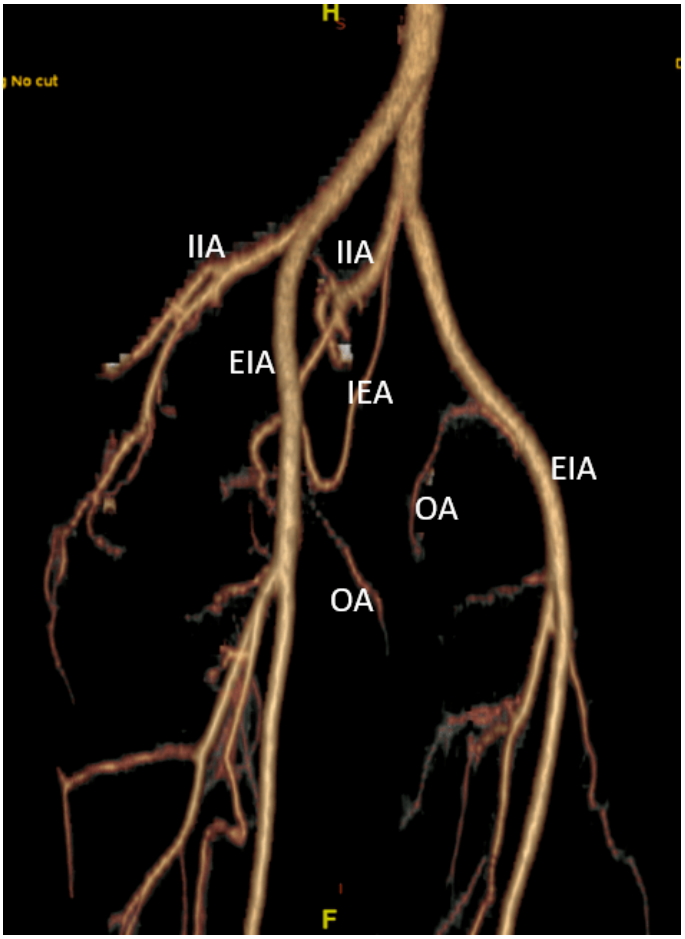

Figure 4. Volume rendered 3D reconstruction demonstrate bilateral obturator arteries (OA) arising from corresponding external iliac arteries (EIA). IEA – inferior epigastric artery, IIA – internal iliac artery.

and 1% from the profunda femoris artery (medial circumflex) (Table 1) (Figure 1). The total incidence of the aberrant obturator artery in this study was 15%.

Discussion

Probably no artery in the human body of proportionate size has so voluminous a literature as the obturator artery. It has been the subject of repeated research, revealing inconsistencies in the percentages of the aberrant obturator artery (Table 2). It was Haller who first observed and noted the origin of obturator artery as a branch from the inferior epigastric artery in the year 1745. Later this was followed by observations of this aberrant obturator artery by Monroe (1805), Barclay (1806) and Cooper (1807). They stressed the important relation of this aberrant vessel coursing close to the free edge of the lacunar ligament (Gimbernat's) and it's surgical importance to femoral hernia repair as found in the standard textbooks of anatomy[3].

The obturator artery develops from the embryonic 'rete pelvicum' by an unusual selection of channels from a primary capillary plexus. The most appropriate channels enlarge whilst others retract and disappear, thereby establishing the final arterial pattern[5,6]. This unusual selection of channel, if it arises as a common

Table 2. Percentage of AOA in various studies.

Author	Number of cadavers examined	Percentage of AOA
Quain	400	31.9
Cloquet	500	31.4
Hoffman	63	32.5
Pfitzner	307	37.6
Hasselbach	64	42.2
Krusche	63	21.2
Dwight	500	25.8
Jastschinski	404	24
Levi	100	25.2
Pick	320	27
Braithwaite	80	19.5
Lipshutz	93	25

trunk for both the inferior epigastric artery and obturator artery from the external iliac artery, it gives rise to the common variation called the aberrant obturator artery occurring in 20-30%[1] of individuals. Some authors opine that the aberrant obturator artery is the enlarged communication between the pubic branches of the obturator artery and the inferior epigastric artery.

The introduction of high-technology non-invasive imaging procedures like CT angiography and MR angiography have allowed radiologists to study the arterial variations in more detail[7]. Though digital subtraction angiography is considered as the gold standard for evaluating vascular structures, its invasive nature significantly limits its role[8]. Hence non-invasive vascular imaging like CT angiography or MR angiography is essential to provide accurate anatomical knowledge on the arterial variations before any surgical or interventional radiology procedures[9]. Since CT angiography has demonstrated diagnostic superiority over conventional arteriography in several applications, and is less invasive and less expensive[10], we chose to evaluate the source of obturator artery retrospectively from CT angiograms performed on patients for peripheral arterial diseases. Patients who had aorto-iliac disease were excluded because of the development of collateral vessels[11].

In a study of variations of the parietal branches of the obturator artery, Braithwaite found that the incidence of aberrant obturator artery from inferior epigastric artery was 19.5% and the dual origin was 6.5%[12]. However other studies have shown a higher incidence of 20 to 30% of aberrant obturator[3,13] and a very low incidence (1%) of dual source[3,13,14]. In contrast, the present cadaveric study has shown a low incidence of aberrant obturator artery arising either from inferior epigastric or external iliac artery

and a very high incidence of dual source (16%). Adachi (1928) pointed out that an obturator artery with two roots probably occurs more frequently than previous findings have indicated, this discrepancy being due to the difficulty of recognizing one of the roots when of very small size. In such instances, the larger root, which generally arises from the inferior epigastric artery, would probably be regarded as an obturator artery arising by a single stem[15] which could be the probable reason for the low incidence in the previous studies.

Radiological studies using CT angiography and MR angiography to study the source of obturator artery has revealed an incidence of 26% of the aberrant obturator artery[7]. In a study of the angiographic anatomy of the male pelvic arteries, Bilhim *et al*., found that two-thirds of obturator artery arose from the internal iliac artery and one-third arose from the inferior epigastric artery[16]. They described the angiographic anatomy of the aberrant obturator artery as following a trajectory first inward then vertically downward to the upper border of the obturator foramen, when compared to the normal obturator artery that follows a straight trajectory and passes forward and downward along the rim of the pelvis and exits the pelvis through the upper border of the obturator foramen[16]. This description of the aberrant obturator artery was kept in mind when studying the CT angiograms in our study. In the present radiological study an incidence of 16% of the aberrant obturator artery from the inferior epigastric artery and external iliac artery was noted. The source of obturator artery of dual origin is very low in radiological study (1%) when compared to the cadaveric study (16%). This stresses the importance of cadaveric studies on arterial variations. Although a common trunk for inferior epigastric artery, obturator artery and profunda femoris artery from the external iliac artery has been reported in literature[17,18], to our knowledge this is the first time profunda femoris (medial circumflex artery) is reported as the source for obturator artery.

The aberrant obturator artery has important clinical and surgical implications. It forms an important component of 'Corona Mortis' which is defined as the vascular connection between the obturator and external iliac systems over the superior pubic ramus. A venous communication is more common (52–96%) than an arterial one. The aberrant obturator artery is referred by clinicians as 'corona mortis of Hesselbach' which is present in 8–43% of cases[19]. Since it is well hidden by overlying lymphatic tissue confluent with that of the femoral canal it can be inadvertently injured during surgeries in the retro-pubic region. It is susceptible to injuries during dissection of the Bogros space and stapling of the mesh onto Cooper's ligament in laproscopic herniorraphy or endoscopic total extraperitoneal inguinal hernioplasty[20]. In gynaecological procedures such as the Burch urethropexy, paravaginal defect repairs, and midurethral or pubovaginal slings, lymphatics and preperitoneal fatty tissue often obscure the anatomy of the superior pubic ramus, preventing direct visualization of the vessels found in this region. Laceration of the corona mortis can result in catastrophic bleeding because these vessels connect high-volume systems and may retract into the obturator canal[21]. Successful hemostasis of an injured corona mortis vessel has been described using coil embolization[22]. Angiography followed by embolization is an effective method of controlling arterial hemorrhage associated with pelvic fractures. Usually occlusion of the internal iliac artery and its branches stops the hemorrhage. This procedure fails to halt the hemorrhage in cases of aberrant obturator artery, which has a source from the external iliac artery (inferior epigastric)[23].

Conclusion

The aberrant obturator artery arising either from inferior epigastric or external iliac artery was present in 15% of cadaveric specimens and 16% of CT angiograms in Indian population, which forms an important component of the 'corona mortis'. Surgeons operating in that area should be careful not to injure the vessel as it can cause troublesome haemorrhage. It should be kept in mind as probable source of bleeding in intractable haemorrhage in pelvic trauma cases.

Acknowledgements

The authors sincerely thank those who donated their bodies to science so that anatomical research and teaching could be performed. Results from such research can potentially increase scientific knowledge and can improve patient care. Therefore, these donors and their families deserve our highest respect.

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Received: November 29, 2021
Accepted: December 15, 2021

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