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Anatomical study of the common iliac arteries

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Background: *The common iliac arteries (CIA) are the two terminal branches of the abdominal aorta which supply the pelvis and the lower extremities. The present study aims to examine the morphometric features of the CIA in a cadaveric sample and possible correlations between lengths.*

Materials and methods: *Seventy-six formalin fixed cadavers of Greek origin were dissected in the Department of Anatomy, School of Medicine, National and Kapodistrian University of Athens. In each cadaver dissected, the abdominal aorta and the CIA were identified and their lengths were measured. Also the torso length was measured and the height of each cadaver. All the statistical analysis was done by SPSS 15.0.*

Results: *The mean length of the left CIA was 6.12 cm (SD: ± 1.791, SE: 0.205) and that of the right one was 6.03 cm (SD: ± 1.607, SE: 0.184). The lengths of the CIA differed between the sexes, but no statistically significant difference was observed. Statistically significant differences regarding the torso lengths and body heights were found between the sexes, as well as a statistically strong correlation between the lengths of the left and right CIA in the cadavers dissected.*

Conclusions: *The knowledge of the anatomy and morphology of the CIA is of great clinical significance, given that abnormal course, length or branching pattern of these vessels are not uncommon and their clinical impact may be great. Mostly interventional radiologists and vascular surgeons should be aware of this knowledge.* (Folia Morphol 2021; 80, 4: 845–849)

Key words: anatomy, morphology, morphometry, abdominal aorta, cadaver, measurements

INTRODUCTION

The course of each common iliac artery (CIA) begins just after the termination of the aorta, usually at the level of the lower 3rd of the body of the 4th lumbar vertebra. Afterwards, each CIA follows an oblique descending trajectory outwards to the pelvic margin, where it is terminated at the level of the intervertebral disc between the sacrum and the 5th lumbar vertebra; at this point each CIA is divided into external and internal iliac artery (99% of the cases), whereas in 1% of the cases the CIAs may be totally absent and the internal and external iliac arteries arise directly from the abdominal aorta (AA) [9]. The right CIA is slightly longer than the left and in most of the cases it follows a more oblique trajectory across the L5 vertebral body. The right CIA comes laterally in relation to the inferior vena cava, the right common iliac vein (CIV) and the ipsilateral Psoas Magnus muscle, whereas the left CIA is related laterally only to the left Psoas Magnus muscle and

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medially to the ipsilateral CIV [7, 17, 18]. The two CIAs give off normally no lateral branches except from a few cases described in which the testicular arteries originated from the CIAs (< 1%) [9].

The point, at which each CIA bifurcates, varies, but in most of cases the left CIA divides in a lower level than the right CIA. Also, the length of these arteries is subject to a non-negligible variety [7, 17, 18]. Hence, aim of the present study is to find and present patterns of this variety as well as to examine the existence of statistically significant correlations between distances or sexes regarding measurements on the CIAs of a Greek population. The present paper constitutes a continuation of a previous study [14] with greater sample and a special focus on CIAs.

MATERIALS AND METHODS

Seventy-six adult cadavers of Caucasian (Greek) origin, of which 39 were males and 37 females, were dissected for educational and research purposes by the authors. The anatomical dissection took place at the Hall of Dissections of the Anatomy Department, Faculty of Medicine, National and Kapodistrian University of Athens. A 10% formalin solution was used for the embalming procedure. All the 76 cadavers derived from body donation with informed consent, written and signed by the donator himself [11]. Approval for the present research's protocol was obtained from the ethics committee of our institution. The age of the cadavers ranged between 39 and 98 years (average age 75.43 years, standard dimension [SD]: ± 11.23, standard error of mean [SE]: 1.288).

In every one cadaver, we identified and revealed the AA, as well as the right and left CIA according to the Clemente's Anatomy Dissector [1] and the length of both the right and left CIAs was measured from the level of the bifurcation of the abdominal aorta to the level at which each CIA was divided into external and internal iliac artery (Fig. 1). The torso length was also measured in all 76 cadavers of this study, from the level of the hyoid bone to the pubic symphysis, whereas the total height of the body was measured from the bregma to the medial process of the calcaneus (the bodies were in supine position). Additionally, the length between of the AA, from the origin of the coeliac artery to its bifurcation was also evaluated in order to perform correlations with the studies lengths.

The collected measurements were subjected in statistical analysis, in order to calculate the average, maximum and minimum value, SD, and SE and finally the correlations between the discovered distances. For correlations we calculated the Pearson correlation coefficient (r) in each case and also examined the statistical significance of each resulting correlation ($p < 0.05$). All the statistical analysis was done by SPSS 15.0.

RESULTS

Both CIAs were observed in all the 76 cadavers (39 males and 37 females) without finding any anatomical variation.

The mean length of the left CIA was 6.12 cm (SD: ± 1.791, SE: 0.205), noticing a fairly wide range of values, with a minimum of 2.3 cm and a maximum of 13.9 cm (Table 1). The corresponding length in male cadavers was slightly longer, with a mean value of 6.37 cm (SD: ± 1.949, SE: 0.312) and a shorter range of values, from 4.1 cm to 13.9 cm (Table 1). On the contrary, in females the mean left CIA's length was 5.86 cm (SD: ± 1.534, SE: 0.262) and measurements ranged between 2.3 and 9.6 cm (Table 1). Nevertheless, no statistically significant difference between the two sexes was found ($p = 0.222$, $p > 0.05$).

The range of measurements on the length of the right CIA was shorter than the corresponding of the left CIA (min: 3.3 cm, max: 9.6 cm), and the mean length was 6.03 cm (SD: ± 1.607, SE: 0.184) (Table 1). The relationship of the CIA lengths observed between the sexes on the left side, was also found on the right side; the length of the right CIA was longer in male cadavers (mean: 6.10 cm, SD: ± 1.672, SE: 0.268) than in female ones (mean: 5.96 cm, SD: ± 1.555, SE: 0.256) (Table 1). Also in this category no statistically significant difference was found between males and females ($p = 0.696$, $p < 0.05$).

Additionally, no statistically significant difference was found between the lengths of the right and left CIAs ($p = 0.746$, $p < 0.05$), despite the small differences in measurements which were actually observed.

Regarding the torso length, the mean value was 62.27 cm (SD: ± 4.325, SE: 0.496) and the measurements ranged between 51.5 cm and 70.0 cm (Table 2). The torso length in males and females is presented in Table 2. Between the two sexes a statistically significant difference was found ($p < 0.001$).

The mean height of the cadavers dissected was 155.3 cm (SD: ± 10.124, SE: 1.161), with a minimum of 128.0 cm and a maximum of 174.5 cm (Table 2). Referring to the sexes, the height of men and women are shown in Table 2. Also, in this category, a sta-

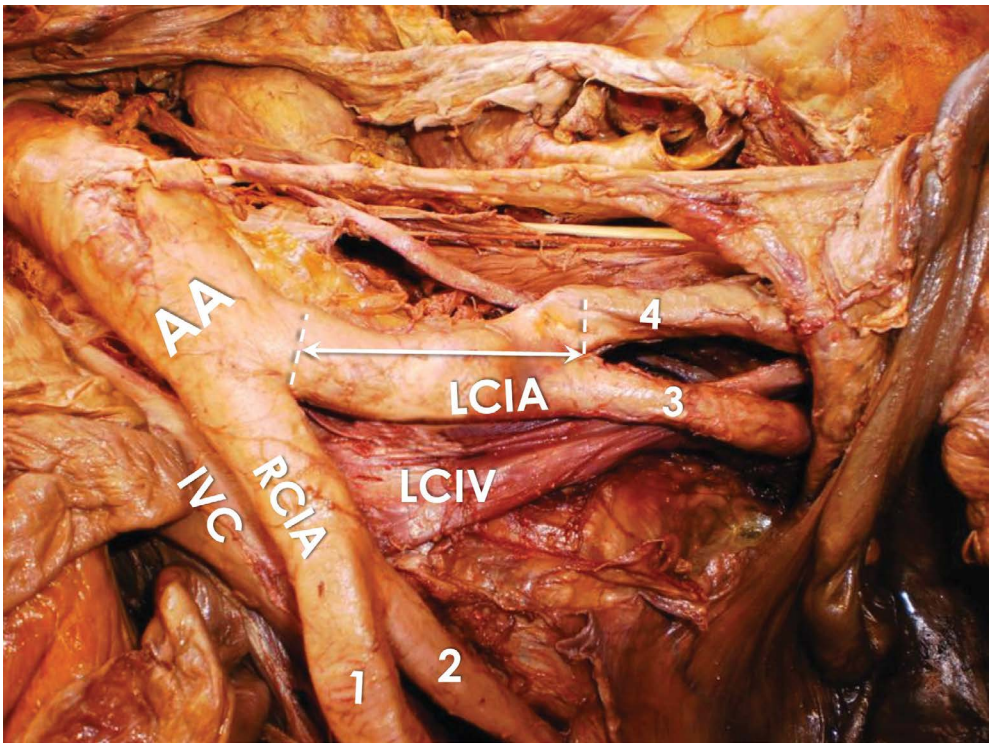

Figure 1. The length of both the right and left common iliac arteries (CIA) was measured from the level of the bifurcation of the abdominal aorta (AA) to the level at which each CIA was divided into external and internal iliac artery. The arrow points the measured length at left side – dashes are showing the level of the bifurcation of each artery; RCIA — right common iliac artery; LCIA — left common iliac artery; 1 — right external iliac artery; 2 — right internal iliac artery; 3 — left internal iliac artery; 4 — left external iliac artery; IVC — inferior vena cava; LCIV — left common iliac vein. Scale 1:1.2.

Table 1. Measurements of common iliac arteries (CIA)

CIA length (n = 76)	Mean	Minimum	Maximum	Standard deviation	Standard error
Left	6.12	2.3	13.9	± 1.791	0.205
Males (n = 39)	6.37	4.1	13.9	± 1.949	0.312
Females (n = 37)	5.86	2.3	9.6	± 1.534	0.262
Right	6.03	3.3	11.4	± 1.607	0.184
Males (n = 39)	6.10	3.4	11.4	± 1.672	0.268
Females (n = 37)	5.96	3.3	9.6	± 1.555	0.256

Table 2. Biometric features of the cadavers

Parameters (n = 76)	Mean	Minimum	Maximum	Standard deviation	Standard error
Age	75.43	39	98	± 11.23	1.288
Males (n = 39)	76.62	39	98	± 10.91	1.845
Females (n = 37)	74.27	52	92	± 10.97	1.804
Torso length [cm]	62.27	51.5	70.7	± 4.325	0.496
Males (n = 39)	64.78	59.5	70.7	± 3.249	0.520
Females (n = 37)	59.62	51.5	67	± 3.709	0.610
Height [cm]	155.3	128	174.5	± 10.124	1.161
Males (n = 39)	162.1	146	174.5	± 7.043	1.279
Females (n = 37)	148.1	128	162	± 7.571	1.245

tistically significant difference between males and females was found ($p < 0.001$).

Each of the measurements mentioned above was compared with each other and with the torso length, the height and the AA's length as well. The measured distances were also compared with each other both in the total of 76 cadavers and separately in the two sexes.

Between the lengths of the left and right CIAs resulted a strong correlation ($r = 0.668$, $p < 0.001$). Also, the length of the left CIA correlated negatively but not statistically significantly to the length of the AA ($r = –0.222$, $p = 0.54$), as well as the length of the right CIA did ($r = –0.236$, $p = 0.40$). No statistically significant correlations resulted between the torso length and the CIAs' length, or between the last and the height of the cadavers.

DISCUSSION

According to classical anatomical textbooks [7, 17, 18], the length of the left CIA is approximately 4 cm and that of the right one is 5 cm. In our previous study in a smaller sample, the recorded mean length was 5.9 ± 1.527 cm and 5.7 ± 1.427 cm in the left and right side, respectively [14]. Greater lengths were observed in the present study, with similar mean lengths (6.12 cm left and 6.10 cm right). Additionally, the lengths of both the CIAs appeared to have a wide range, especially in the left side, which was also a finding in our previous study [14]. Longer lengths were observed in the male cadavers; nevertheless, the difference was not statistically significant. The only statistically significant findings noticed, as expected, were the difference between the height and torso length among males and females. On the other hand, a strong correlation between the lengths of the left and right CIAs was found (observed also in our previous study [14]). The other correlations examined showed no statistical significance in our sample (76 adult cadavers), as well as differences in the resulting measurements. No anatomical variation was recorded.

According to the available literature, the course and the length of the CIAs present a significant variance with a resulting clinical impact in most cases. Fereydooni et al (2019) [5], described a rare case of a 20-year-old female patient with persistent bilateral leg swelling, caused by the compression of the left CIV that abnormally passed anterior to the contralateral CIA. Also abnormalities in dimensions and morphology in general of the CIAs seem to have a clinical significance. Hypoplastic CIAs have been referred as a rare cause of absence of femoral pulse and reduced leg supply [20, 21] and absence or atresia of the right CIA has also been noted usually prohibiting catheter's guide advance through the artery, when femoral artery endovascular approach is being proceeded [3, 10].

One more clinical impact of the anatomical variations of the CIAs is the existence of fistulae between CIAs and veins of the pelvis and the abdominal cavity. Such a fistula may occur between the right CIA and the superior mesenteric vein leading to portal hypertension [13], or between the right CIA and the ipsilateral CIV that has been reported as a rare cause of pulmonary thromboembolism [19].

Regarding to the CIAs' bifurcation, Miller and Jamroz (2017) [12] reported a case in which the right CIA passed infra the inguinal ligament and behind the Psoas Magnus muscle and did not bifurcate to give off the right internal and external iliac arteries. Moreover, Rusu et al. (2017) [15] observed that the height of bifurcation in a male patient was bilaterally asymmetrical. More specifically, the right CIA bifurcated at the level of the middle tertiary of the L5 vertebral body and the left CIA at the level of the upper border of the L5 vertebra [15].

As for the morphological oriented measurements of the CIAs, Crisp et al. (2016) [2] measured the distance between the sacral suture and the CIAs in 11 patients that underwent sacrocolpopexy. According to the findings of this study, the mean distance between the sacral suture and the right CIA was 18 mm (SD: ± 5), whereas the distance between the right internal iliac artery and the sacral suture had a mean value of 10 mm (SD: ± 5). In addition, Deswal et al. (2014) [4] dissected 25 cadavers (16 males and 9 females) and measured the length of the CIAs, their diameter as well as the angle formed between the two CIAs. The mean length of the right CIA in men was 6.09 cm (SD: 1.889) and the contralateral corresponding was 5.776 cm (SD: 2.001). In contrast to our findings, the mean length of the CIA of the female cadavers in the aforementioned study was 4.865 cm (SD: 1.323) on the right side and 4.663 cm (SD: 1.265) on the left side. However, Deswal et al. [4] found no statistically significant difference except than that between the lengths of the two CIAs in males.

Knowledge of the clinical and surgical anatomy of the CIAs is of great significance not only for the differentiation and treatment of cases as those aforemen-

tioned, but also for approaching the most common clinical entity regarding the CIAs, the aneurysms. As known, aneurisms of the CIAs occur as a result of the expansion of a massive aneurysm of the AA. However, there have been reported cases of isolated CIA's aneurysm that extended from just distal to the AA's bifurcation to the CIA's bifurcation. In such cases the surgical intervention is the treatment of choice [6, 16].

CONCLUSIONS

Although there have been numerous morphological studies for other major arteries of the human and the pelvic vessels [8, 14], the corresponding literature for the CIAs is fairly poor, to the authors knowledge, despite the applications that morphometric features of the CIAs may have, mostly in vascular surgery and interventional radiology. Presumably, future studies with a larger sample may demonstrate the statistical significance of arterial length correlations attempted in the present study.

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Conflict of interest: None declared

REFERENCES

1. Clemente C, Clemente C. Clemente's anatomy dissector. Lippincott Williams & Wilkins, Philadelphia, 2010: 131–160.
2. Crisp CC, Herfel CV, Pauls RN, et al. Critical anatomy relative to the sacral suture: a postoperative imaging study after robotic sacrocolpopexy. Female Pelvic Med Reconstr Surg. 2016; 22(1): 33–36, doi: 10.1097/SPV.0000000000000230, indexed in Pubmed: 26680566.
3. Dabydeen DA, Shabashov A, Shaffer K. Congenital absence of the right common iliac artery. Radiol Case Rep. 2008; 3(1): 47, doi: 10.2484/rcr.v3i1.47, indexed in Pubmed: 27303500.
4. Deswal A, Tamang BK, Bala A. Study of aortic common iliac bifurcation and its clinical significance. J Clin Diagn Res. 2014; 8(7): AC06–AC08, doi: 10.7860/JCDR/2014/8767.4559, indexed in Pubmed: 25177553.
5. Fereydooni A, Deyholos C, Nezami N, et al. Anomalous course of the left common iliac vein anterior to the right common iliac artery with resultant May-Thurner syndrome. J Vasc Surg Venous Lymphat Disord. 2019; 7(3): 450–451, doi: 10.1016/j.jvsv.2019.01.059, indexed in Pubmed: 31000065.
6. Goyal VD, Sood S, Gupta B. Isolated common iliac artery aneurysm: a rare entity. J Clin Diagn Res. 2014; 8(11): ND03–ND04, doi: 10.7860/JCDR/2014/9140.5106, indexed in Pubmed: 25584261.
7. Gray H, Carter H. Gray's Anatomy. 15th ed. Barnes & Noble, New York 2011: 536–537.
8. Hamabe A, Harino T, Ogino T, et al. Analysis of anatomical variations of intrapelvic vessels for advanced pelvic surgery. BMC Surg. 2020; 20(1): 47, doi: 10.1186/s12893-020-00711-0, indexed in Pubmed: 32178647.
9. Lippert H, Wacker F, Pabst R. Arterial Variations in Humans: Key Reference for Radiologists and Surgeons: Classifications and Frequency. Thieme; 2018.
10. Llauger J, Sabaté JM, Guardia E, et al. Congenital absence of the right common iliac artery: CT and angiographic demonstration. Eur J Radiol. 1995; 21(2): 128–130, doi: 10.1016/0720-048x(95)00701-q, indexed in Pubmed: 8850508.
11. McHanwell S, Brenner E, Chirculescu A. The legal and ethical framework governing Body Donation in Europe: a review of current practice and recommendations for good practice. Eur J Anat. 2008; 12: 1–24.
12. Miller JM, Jamroz BA. Undivided common iliac artery: unclear embryology. J Vasc Interv Radiol. 2017; 28(11): 1599, doi: 10.1016/j.jvir.2017.05.002, indexed in Pubmed: 29056192.
13. Qin J, Tang S, Jiang M, et al. Portal hypertension caused by right common iliac artery-superior mesenteric vein fistula. Jpn J Radiol. 2015; 33(5): 291–294, doi: 10.1007/s11604-015-0411-8, indexed in Pubmed: 25753263.
14. Panagouli E, Lolis E, Venieratos D. A morphometric study concerning the branching points of the main arteries in humans: relationships and correlations. Ann Anat. 2011; 193(2): 86–99, doi: 10.1016/j.aanat.2010.10.009, indexed in Pubmed: 21169000.
15. Rusu MC, Ilie AC, Brezean I. Human anatomic variations: common, external iliac, origin of the obturator, inferior epigastric and medial circumflex femoral arteries, and deep femoral artery course on the medial side of the femoral vessels. Surg Radiol Anat. 2017; 39(11): 1285–1288, doi: 10.1007/s00276-017-1863-6, indexed in Pubmed: 28451829.
16. Sandhu RS, Pipinos II. Isolated iliac artery aneurysms. Semin Vasc Surg. 2005; 18(4): 209–215, doi: 10.1053/j.semvascsurg.2005.09.007, indexed in Pubmed: 16360578.
17. Snell R. Clinical anatomy. Lippincott Williams & Wilkins, Philadelphia 2004: 63–64.
18. Standring S, Borley NR, Collins P, Crossman AR, Gatzoulis MA, Healy JC, Johnson D, Mahadevan V, Newell RLM, Wigley CB. Gray's anatomy. Theanatomical basis of clinical practice. Elsevier, Edinburgh 2008.
19. Takahashi F, Hiraiwa S, Takahashi G, et al. An autopsy case of paradoxical pulmonary thromboembolism by arteriovenous fistula from right common iliac artery to common iliac vein: a rare cause of pulmonary embolism. Am J Case Rep. 2018; 19: 1301–1305, doi: 10.12659/AJCR.910982, indexed in Pubmed: 30381754.
20. Tekgündüz KŞ, Ceviz N, Kantarcı M, et al. Rare cause of absence of femoral arterial pulse: bilateral common iliac artery hypoplasia. Pediatr Int. 2014; 56(6): 909–910, doi: 10.1111/ped.12343, indexed in Pubmed: 25521975.
21. Wallraff J, Roszel A. Hochgradige Hypoplasie der Arteria iliaca communis und der Arteria umbilicalis. Anat Anz. 1972; 132(1): 101–113.