VIA MEDICA

REVIEW ARTICLE

Folia Morphol.
Vol. 83, No. 4, pp. 771–778
DOI: 10.5603/fm.99720

ISSN 0015–5659
eISSN 1644–3284
journals.viamedica.pl

The complete anatomy of the iliolumbar artery: a meta-analysis with clinical implications

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[Received: 5 February 2023 March 2024; Accepted: 22 April 2024; Early publication date: 10 May 2024]

Background: *The arterial anatomy of the pelvic region is highly variable, and variations in the anatomy of the ILA may often be observed in its point of origin. The main objective of the present meta-analysis was to provide the most up-to-date and evidence-based data regarding the complete anatomy of the iliolumbar artery (ILA. It is hoped that our results may aid in reducing possible complications associated with various procedures performed in the pelvis.*
Materials and methods: *To perform this meta-analysis, major online medical databases — PubMed, Scopus, Embase, Web of Science, Cochrane Library, and Google Scholar — were searched through to find all studies considering the anatomy of the ILA.*
Results: *The pooled prevalence of the ILA originating from the Internal Iliac Artery, in the overall analysis, was found to be 93.62% (95% CI: 82.96–99.63%). Mean diameter of the ILA was found to be 2.67 mm (standard error = 0.19; lower limit = 2.29; upper limit = 3.05). Mean length of the ILA was established at 12.50 mm (standard error = 1.64; lower limit = 9.28; upper limit = 15.73).*
Conclusions: *The anatomy of the ILA was found to be quite constant, in contrast to what has been discussed in the literature. The said artery originated most frequently from the internal iliac artery (93.62%). Most frequently, this artery originated from the internal iliac artery (observed in approximately 93.62% of cases). Notably, the results of our current meta-analysis indicate that the average distance between the ILA's point of origin, the lower margin of the L5 vertebra, and the bifurcation site of the common iliac artery were 43.20 mm and 28.58 mm, respectively.* (Folia Morphol 2024; 83, 4: 771–778)

Keywords: iliolumbar artery, pelvis, anatomy, internal iliac artery, endovascular

INTRODUCTION

The iliolumbar artery (ILA) commonly arises from the internal iliac artery and travels laterally on the surface towards the sacroiliac joint and lumbosacral joint, which is the junction between the lumbar spine and the sacrum. As it courses posteriorly and inferiorly, the ILA runs on the psoas major muscle, traveling towards the posterior abdominal wall. Additionally, the ILA can be found deep to the external iliac artery, coursing on the superior medial portion of the iliac

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fossa. It is also one of the vessels that pass between the obturator nerve and the lumbosacral plexus [29].

As the ILA travels posteriorly, it branches into what is known as the lumbar branch. This branch supplies the psoas major muscle and the quadratum lumborum muscle. The lumbar branch also gives rise to a minor artery, called the spinal branch, which courses between the intervertebral foramen, a space between the fifth lumbar vertebra and the first sacral vertebra, to supply the cauda equina as it travels superiorly [21].

The iliac branch of the ILA, or the largest nutrient pedicle of the ilium, or the artery of Haller [23], travels laterally and inferiorly into the iliac fossa to supply the iliac bone and the iliacus. Moreover, this branch forms anastomoses with branches of the obturator artery, deep circumflex iliac artery, and lateral circumflex femoral artery. These anastomoses are important for the blood supply of the gluteal and abdominal wall muscles [18].

The arterial anatomy of the pelvic region is highly variable [15, 28, 32, 35], and variations in the anatomy of the ILA may often be observed in its point of origin. It is most commonly seen arising from the internal iliac artery, but some variations have been reported. In some cases, the ILA originates from the common iliac artery or the external iliac artery. Furthermore, there have been descriptions of the artery originating from different points on the internal iliac artery itself [16]. Gender-related variations have also been noted, with some females having the ILA arising from the gluteal artery instead of the internal iliac artery [7].

The clinical significance of the ILA is evident in various contexts, such as surgical procedures and interventional radiology. In surgical procedures, knowledge of variations in the anatomy of the ILA is crucial to minimize the risk of injury and bleeding during lumbar spine surgery, pelvic tumour resection, and iliac crest bone grafting [11]. Moreover, understanding the anatomy of this vessel is also beneficial in interventional radiology procedures like embolization of the ILA, which is performed to control bleeding following pelvic fractures and tumours [5]. Therefore, the main objective of the present meta-analysis was to provide the most up-to-date and evidence-based data regarding the complete anatomy of the ILA. It is hoped that our results may aid in reducing possible complications associated with various procedures performed in the pelvis.

MATERIALS AND METHODS

Search strategy

To perform this meta-analysis, major online medical databases — PubMed, Scopus, Embase, Web of Science, Cochrane Library, and Google Scholar — were searched through to find all studies considering the anatomy of the ILA. The overall search process was conducted in 3 stages. In the first step, the following search terms were used in all databases: (iliolumbar artery) OR (arteria iliolumbalis). Neither the date, language, type of article, nor text availability conditions were applied. (2) Furthermore, the mentioned databases were searched through once again using another set of search phrases: (a) (iliolumbar artery [Title/Abstract]) AND (anatomy [Title/Abstract]); (b) (iliolumbar artery [Title/Abstract]) AND (topography [Title/Abstract]); (c) (iliolumbar artery [Title/Abstract]) AND (morphology [Title/Abstract]); (d) (iliolumbar artery [Title/Abstract]) AND (variations [Title/Abstract]); (e) (iliolumbar artery [Title/Abstract]) AND (type [Title/Abstract]). Additionally, each phrase has been checked for dependence of results on grammatical variations of a given phrase and adjusted to each database. (3) Lastly, a manual search was also performed throughout the references of the initially gathered studies. Furthermore, the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines were followed during the study. To ensure the highest quality of findings the Critical Appraisal Tool for Anatomical Meta-Analyses (CATAM) and the Anatomical Quality Assessment (AQUA) tools were used to evaluate submitted studies [6, 9].

Eligibility assessment

A total of 1583 articles were initially evaluated by two independent researchers. Initially, a total of 1362 records were removed due to being irrelevant to the studied topic or being duplicates of the previously qualified studies. Articles such as case reports, case series, conference reports, reviews, letters to the editor, and studies that provided incomplete or irrelevant data were also excluded. The inclusion criteria involved original studies with extractable numerical data on the origin, diameter, length, or any other data that referred to the overall anatomy, morphology, topography, or variabilities of the ILA. Finally, a total of 14 studies were included in the present meta-analysis [1, 3, 4, 13, 16–18, 20, 26, 27, 29–31, 33]. The flow chart that presents the study inclusion process is shown in Figure 1. The characteristics of submitted studies can be found in Table 1.

Data extraction

Data from qualified articles were extracted by two independent researchers. Qualitative data, such as methodology, year of publication, and country of origin were assessed. Quantitative data about the ILA, such as prevalence of each origin, length, diameter, and its topographical location were extracted. Studies containing mean results, but without standard deviation or interquartile range or unclear or unspecified variations were excluded. Any discrepancies between the studies identified by the two researchers were resolved by contacting the authors of the original studies wherever possible or by consensus with a third reviewer.

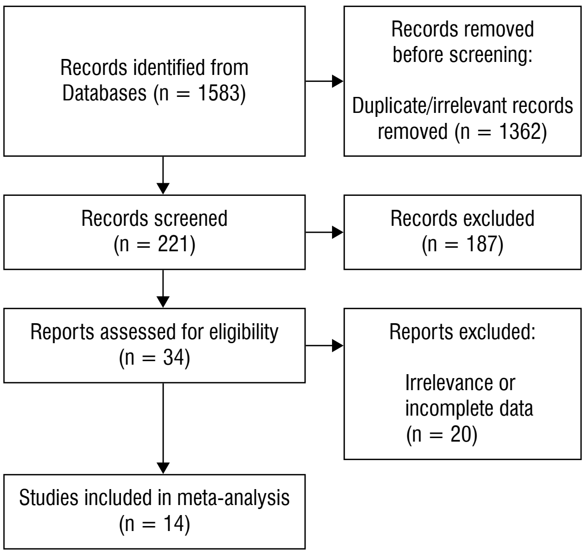

Figure 1. Flow diagram presenting process of collecting data included in this meta-analysis.

Statistical analysis

To perform the meta-analyses, STATISTICA version 13.1 software (StatSoft Inc., Tulsa, OK, USA), MetaXL version 5.3 software (EpiGear International Pty Ltd., Wilston, Queensland, Australia) and Comprehensive Meta-analysis version 4.0 software (Biostat, Inc., Englewood, NJ, USA) were used. A random effects model was used in all analyses. The Chi-square test and the I-squared statistic were used to assess the heterogeneity among the studies [10, 12]. A p-value and confidence intervals were used to determine statistical significance between studies. A p-value lower than 0.05 was considered statistically significant. In the event of overlapping confidence intervals, differences were considered statistically insignificant. I-squared statistics were interpreted as follows: values of 0–40% were considered as "might not be important", values of 30–60% were considered as "might indicate moderate heterogeneity", values of 50–90% were considered as "may indicate substantial heterogeneity", and values of 75–100% were considered as "may indicate substantial heterogeneity".

RESULTS

The pooled prevalence of the ILA originating from the Internal Iliac Artery, in the overall analysis, was

Table 1. Characteristics of studies included in this meta-analysis.

First author	Year	Continent	Country	Type of study
Al Talalwah, W.	2014	Asia	Saudi Arabia	Cadaveric study
Baqué, P.	2005	Europe	France	Cadaveric study
Bleich, AT.	2007	North America	USA	Cadaveric study
Chen, RS.	1998	Asia	China	Cadaveric study
Teli, CG.	2013	Asia	India	Cadaveric study
Kacra, BK.	2011	Asia	Turkey	Cadaveric study
Kiray, A.	2010	Asia	Turkey	Cadaveric study
Koç, T.	2016	Asia	Turkey	Cadaveric study
Mamatha, H.	2012	Asia	India	Cadaveric study
Naguib, NNN.	2008	Europe	Germany	Radiological study
Nguyen, B.	2022	Asia	Vietnam	Cadaveric study
Rusu, MC	2009	Europe	Romania	Cadaveric + radiological study
Sankaranarayanan, G.	2018	Asia	India	Cadaveric study
Yiming, A.	2002	Europe	France	Cadaveric study

Table 2. Statistical results of this meta-analysis regarding the origin of the ILA.

Category	N	Pooled prevalence	LCI	HCI	Q	I^2
Origin of the ILA (overall)						
Internal iliac artery	831	93.62%	82.96%	99.63%	216.43	94.92
Common iliac artery	831	5.22%	0.00%	16.16%	244.83	95.51
External iliac artery	831	0.53%	0.13%	1.16%	1.87	0.00
Superior gluteal artery	831	0.53%	0.13%	1.15%	1.31	0.00
Inferior gluteal artery	831	0.50%	0.12%	1.12%	2.76	0.00
Sciatic artery	831	0.42%	0.07%	1.00%	0.83	0.00
Origin of the ILA (Asia)						
Internal iliac artery	521	96.79%	95.09%	98.15%	5.41	0.00
Common iliac artery	521	2.04%	0.98%	3.45%	5.08	0.00
Superior gluteal artery	521	0.65%	0.11%	1.56%	0.29	0.00
Inferior gluteal artery	521	0.60%	0.08%	1.48%	2.18	0.00
Sciatic artery	521	0.46%	0.03%	1.28%	0.18	0.00
External iliac artery	521	0.46%	0.03%	1.28%	0.18	0.00
Origin of the ILA (Europe)						
Internal iliac artery	204	91.63%	74.98%	100.00%	33.46	91.03
Common iliac artery	204	8.37%	0.00%	25.02%	33.46	91.03
Absence of the ILA						
Overall absence	903	1.25%	0.25%	2.88%	29.12	55.36

HCI — higher confidence interval; ILA — iliolumbar artery; LCI — lower confidence interval. Q — Cochran's Q.

Table 3. Statistical results of this meta-analysis regarding the diameter and the length of the Iliolumbar Artery (ILA).

Category	Mean	Standard error	Variance	Lower limit	Upper limit	Z-value	p-value
ILA diameter [mm]	2.67	0.19	0.04	2.29	3.05	13.77	0.00
ILA length [mm]	12.50	1.64	2.70	9.28	15.73	7.61	0.00

found to be 93.62% (95% CI: 82.96–99.63%). In the Asian population, the pooled prevalence of the ILA originating from the internal iliac artery was found to be 96.79% (95% CI: 95.09–98.15%), whereas in the European population it was found to be 91.63% (95% CI: 74.98–100.00%). There were no statistically significant differences between those groups regarding the origin of the ILA from the internal iliac artery ($p > 0.05$).

Nevertheless, in the general and Asian population, ILA was found to originate from 5 other arteries: (1) common iliac artery; (2) external iliac artery; (3) superior gluteal artery; (4) inferior gluteal artery; (5) sciatic artery. In the European population, besides ILA originating from internal iliac artery, only ILA originating from common iliac artery has been found. Common iliac artery was found to be the most common alternative origin of the ILA in all of the analysed subgroups. The pooled prevalences of ILA originating from common iliac artery were 5.22% (95% CI: 0.00–16.16%), 2.04% (95% CI: 0.98–3.45%), and 8.37% (95% CI: 0.00–25.05%) for the general, Asian and European population respectively. All of the results mentioned before and more detailed ones regarding the origin of the ILA are presented in Table 2.

Mean diameter of the ILA was found to be 2.67 mm (standard error = 0.19; lower limit = 2.29; upper limit = 3.05). Mean length of the ILA was established at 12.50 mm (standard error = 1.64; lower limit = = 9.28; upper limit = 15.73). Detailed statistics regarding the diameter and length of the ILA are gathered in Table 3.

Distance between ILA origin and lower margin of L5 was found to be 43.20 mm (standard error = 1.33; lower limit = 40.59; upper limit = 45.81). Distance between ILA origin and common iliac artery bifurcation was set to be 28.58 mm (standard error = 6.10; lower limit = 16.61; upper limit = 40.54).

Table 4. Statistical results of this meta-analysis regarding the topographical location of the iliolumbar artery (ILA).

Category	Mean	Standard error	Variance	Lower limit	Upper limit	Z-value	p-value
Distance between ILA origin and Lower Margin of L5 [mm]	43.20	1.33	1.78	40.59	45.81	32.38	0.00
Distance between ILA origin and Common Iliac Artery Bifurcation [mm]	28.58	6.10	37.27	16.61	40.54	4.68	0.00

Detailed statistics regarding those distances can be found in Table 4.

DISCUSSION

The ILA is described as a branch of the posterior division of the internal iliac artery. It travels superolaterally, turning sharply backward relative to its origin, to the iliac fossa. Later, it divides into an iliac branch, which mainly supplies the iliacus muscle and ilium, and a lumbar branch, which supplies the psoas major and quadratus lumborum muscles. The vessel is also an essential contributor to the complex collateral circulation in the pelvis, frequently forming anastomoses with the lumbar arteries [19]. However, numerous studies have demonstrated the variability in the anatomy of the ILA, especially regarding its origin and overall prevalence. The majority of the papers present the origin of the ILA to be from the internal iliac artery or the posterior trunk of the internal iliac artery, with a frequency ranging from 19.0% to 96.3% [4, 16, 29]. However, a vast number of different origins have also been demonstrated, including origins from the gluteal arteries, the bifurcation point of the internal iliac artery, the sciatic artery, the lateral sacral artery, and the obturator artery, amongst others [4, 7, 29]. In a study conducted by Al Talalwah et al. [29], the most common origin of the ILA was from the posterior trunk of the internal iliac artery (77.9%); however, they reported that the said vessel also originated from the superior gluteal artery (0.7%), inferior gluteal artery (0.3%), and sciatic artery (0.3%). Interestingly, they reported the ILA to be absent in relatively many specimens (n = 14). The absence of the ILA was also described in the study conducted by Koc et al. [17], where four ILAs were absent, and their branches originated from other nearby arteries. The results of the present meta-analysis show that the ILA was absent in 1.25%.

Valchkevich and Borel [7] stated that the ILA also forms common trunks with nearby arteries, such as the lateral sacral artery (3.3%) and the obturator artery (3.3%). However, it is important to note that the aforementioned study was conducted on only 15 cadavers. In the study conducted by Kiray et al. [16], it was demonstrated that the ILA may have a relatively superior origin, where it arises from the common iliac artery. The authors of the said study stated that this origin was found in 4.8% of the specimens examined. The results of the present meta-analysis demonstrated that the origin of the ILA is predominately from the internal iliac artery (93.62%). However, the said vessel also originated from the common iliac artery, as well as the gluteal arteries (Tab. 2).

Various studies have also analysed the morphometric properties of the ILA. Kiray et al. [16] stated that the length of the ILA was 13.2 mm; however, Chen et al. [4] presented a relatively shorter length of 9.2 mm. Additionally, the diameter of the ILA has ranged between 1.21 mm and 4.6 mm in the available literature. The results of the present meta-analysis, which took into account all of the available data in the literature, demonstrate that the mean diameter and length of the ILA are 2.67 mm and 12.50 mm, respectively.

Understanding the morphometric measurements of the ILA, particularly its diameter and length, holds significant importance when selecting the right-sized catheter for embolization procedures. Transcatheter embolization has been stated to be a highly effective method of treating pelvic arterial haemorrhage [25]. Moreover, the relationship between the origin of the ILA and nearby landmarks was also analysed. The results of the present meta-analysis demonstrate that the mean distance between the origin of the ILA and the lower margin of the L5 vertebra is 43.20 mm. Moreover, the distance between the origin of the ILA origin and the point of bifurcation of the common iliac artery was found to be 28.58 mm. These results may help with navigating through the vascular anatomy of the pelvic region during endovascular procedures.

The embryology of the ILA and other branches of the internal iliac artery is highly complex. During the third week of gestation, the umbilical artery establishes a connection with the dorsal branch of the abdominal aorta, known as the common iliac artery, forming a plexus. The segment of the umbilical artery proximal to this plexus gives rise to the internal iliac and superior vesical arteries. Conversely, the segment of the umbilical artery distal to this plexus transforms into the median umbilical ligament. The blood from the abdominal aorta flows into the umbilical artery through the plexus in a caudal direction, leading to the caudal migration of the said vessel. This caudal migration potentially accounts for the variations observed in the branches of the internal iliac artery, including the ILA [14, 27].

Knowledge regarding the complete anatomy of the ILA is of immense importance in various surgical procedures. The iliac crest flap is most commonly used for vascularized bone grafting; however, it has also been used for maxillary reconstructions [2]. The said flap has been pedicled on various vessels, including the ILA. Chen et al. [4] performed both free bone grafting and pedicled bone transfer using the iliac crest flap pedicled on the said vessel with satisfactory results. Additionally, in lumbar spine surgery, haemorrhage from the vessels overlying the anterior part of the lumbar spine can be a devastating complication, leading to mortality rates as high as 40% in affected patients [24]. This complication tends to occur more frequently during the exposure stage rather than the actual procedure, primarily due to the intricate and often unfamiliar anatomy of this area to many neuro- and orthopaedic surgeons [26]. Moreover, the ILA has close proximity to the sacroiliac joint, which can increase the risk of haemorrhage in cases of open-book or shearing fractures [1, 22, 33, 34]. Additionally, this vessel may sustain damage during an anterior approach to the sacroiliac joint for arthrodesis or internal fixation [8].

The present study is not without limitations. It may be burdened with potential bias, as the accuracy of the data taken from various publications limits the results of this meta-analysis. The authors were unable to perform some of the analyses due to an insufficient amount of consistent data. Although not without limitations, our meta-analysis attempts to estimate ILA anatomy based on data from the literature that meet the requirements of evidence-based anatomy.

CONCLUSIONS

The anatomy of the ILA was found to be quite constant, in contrast to what has been discussed in the literature. The said artery originated most frequently from the internal iliac artery (93.62%). Most frequently, this artery originated from the internal iliac artery (observed in approximately 93.62% of cases). Notably, the results of our current meta-analysis indicate that the average distance between the ILA's point of origin, the lower margin of the L5 vertebra, and the bifurcation site of the common iliac artery were 43.20 mm and 28.58 mm, respectively. These findings hold potential significance for navigating the complex vascular anatomy of the pelvic region during endovascular procedures. By providing these measurements, we aim to contribute to the reduction of potential complications associated with various pelvic procedures.

ARTICLE INFORMATION AND DECLARATIONS

Author contributions

Paweł Hajdyła — methodology, concept, search, extraction, statistical analysis, writing. Dawid Plutecki — methodology, search, extraction. Ameen Nasser — methodology, search, extraction. Patryk Ostrowski — writing, literature, figure. Michał Bonczar — statistical analysis, writing. Adrianna Nuga — methodology, search, extraction. Jerzy Walocha — literature, writing. Mateusz Koziej — statistical analysis, tables.

Data availability statement

The data presented in this study are available on request from the corresponding author.

Funding

The authors received no financial support for the research, authorship, and/or publication of this article. Dr. Mateusz Koziej was supported by the Foundation for Polish Science (FNP). The funders had no role in the study's design, data collection and analysis, decision to publish, or preparation of the manuscript.

Conflict of interest

The authors declare no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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