Original Article

Anatomoclinical Mapping of the Inferior Epigastric Artery with Relevance in Invasive Procedures of the Anterior Abdominal Wall

Mapeamento Anatomoclínico da Artéria Epigástrica Inferior com Relevância em Procedimentos Invasivos da Parede Abdominal Anterior

Márcio Cesário da Cunha Sobrinho[1]*, Andrea de Martino Luppi[1], Paula Hanada Ono[1], Marcelo André Domingues[1]

1. Universidade Federal de Uberlândia, Uberlândia, Minas Gerais, Brasil

Corresponding Author/Autor Correspondente:
Márcio Cesário da Cunha Sobrinho [marciocesariocunha@gmail.com]
Avenida Terezina, 2251, Umuarama, Uberlândia, Minas Gerais, Brasil

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ABSTRACT

Introduction: Injuries to the inferior epigastric artery (IEA) have been reported following surgical incisions in the lower abdominal wall, abdominal paracentesis, and placement of trocars in laparoscopic access sites, resulting in the formation of hematomas in the abdominal wall. This study aimed to determine its course in relation to anatomical landmarks and suggest safe areas for performing invasive procedures.

Methods: The abdominal and pelvic computed tomography images of 50 patients were analyzed. The distance between the superior and inferior epigastric vessels and the midline was determined at two levels and then correlated with each other and with the patient's age and sex.

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Results: Computed tomography successfully mapped the epigastric vessels, demonstrating that they are usually located between 4 and 8 cm from the midline.
Conclusion: Staying away from this area will establish the safe entry zone of the anterior abdominal wall.

Keywords: Abdominal Wall; Epigastric Arteries/anatomy & histology; Epigastric Arteries/surgery

RESUMO

Introdução: Lesões da artéria epigástrica inferior (AEI) são complicações conhecidas de incisões cirúrgicas na parede abdominal inferior, paracentes e colocação de trocateres em laparoscopia, frequentemente resultando em hematomas da parede abdominal. O nosso objetivo foi mapear o trajeto da AEI em relação a marcos anatómicos e identificar zonas seguras para procedimentos invasivos.
Métodos: Foram analisadas tomografias computorizadas (TC) de abdomen e pelvis de 50 pacientes. A distância entre os vasos epigástricos superior e inferior e a linha média foi medida em dois níveis e correlacionada com idade e sexo.
Resultados: A TC identificou de forma consistente os vasos epigástricos, localizados entre 4 e 8 cm lateralmente à linha média.
Conclusão: Esses pontos anatómicos devem ser considerados sempre que houver necessidade de fazer uma incisão na parede abdominal para evitar danos acidentais, não apenas durante laparoscopia ou procedimentos cirúrgicos abertos, mas também durante procedimentos guiados por imagem, como biópsia e paracentese.

Palavras-chave: Artérias Epigástricas/anatomia e histologia; Artérias Epigástricas/cirurgia; Parede Abdominal

INTRODUCTION

The inferior epigastric artery (IEA) is an important blood vessel that supplies the anterior abdominal wall. It originates from the external iliac artery above the inguinal ligament and runs superficially through the transverse fascia, penetrating the rectus abdominis muscle in its lower third.[1-9]

IEA injuries have been reported after surgical incisions in the abdominal wall in procedures such as paracentesis, placement of trocars for laparoscopic access, and enterostomies. This results in the formation of hematomas on the abdominal wall that can expand considerably due to the lack of resistance of the adjacent tissue.[5,10]

During laparoscopy, the bleeding can manifest as internal dripping, seen through the cannula inside the abdominal cavity, and as external blood exudation. This type of injury may initially go unnoticed due to temporary tamponade, both by the cannula and the pneumoperitoneum, and later present as a hematoma or pseudoaneurysm.[5,11-14]

Recent studies have shown that the injury rate of these blood vessels during laparoscopic procedures is approximately 0.2%–2%. These injuries result in significant morbidity and mortality, requiring immediate surgical repair.[15] A systematic review of laparoscopic major vascular injuries in gynecologic surgery for benign indications demonstrates inferior epigastric vessels were the most commonly injured vessel, comprising 48% of all injuries. The majority of injuries occurred during abdominal entry, and the remainder occurred during surgical dissection. Most injuries were recognized intraoperatively, and approximately half required laparotomy for repair.[6]

Furthermore, there are reports of injuries to the inferior epigastric artery that progressed to hemorrhagic shock in robotic surgeries, demonstrating the importance of knowing the anatomical variations of these vessels.[13]

Several authors have reported that imaging exams can provide more details on the vascularization of the abdominal wall than basic anatomy books, therefore avoiding possible complications during surgery.[1,3,4,11] Preservation and anatomical knowledge of arteries during invasive procedures are critical to reduce complications during and after the operation.

This study aims to locate the course of IEA concerning anatomical landmarks and suggest safe areas to perform invasive procedures on the abdominal wall, such as the placement of trocars in laparoscopy, laparotomies, enterostomies, and paracentesis.

METHOD

The study was developed after being approved by the Research Ethics Committee of the Federal University of Uberlândia. It consists of a retrospective analysis involving the evaluation of fifty computed tomography angiograms of the abdominal aorta and iliac arteries from the last five years, performed as part of the propaedeutic of abdominal disorders. The exams were acquired from the Clinical Hospital of the Federal University of Uberlândia in the state of Minas Gerais, Brazil.

The patients were distributed into two groups: 25 females and 25 males, with a mean age of 60.6 ± 13.98 years for men and 59.96 ± 11.48 years for women. Their ages ranged between 29 and 78 years, with a difference of p=0.87 between sexes, showing a higher age among male patients.

Among the associated abdominal conditions, abdominal aortic aneurysm (25%) and descending aortic dissection (10%) were the most common. Approximately 18% of the exams did not show any pathological correlation.

For this study, patients were randomly selected. Those who had some degree of deformation in the abdominal wall or disorders that could interfere with the assessment of the inferior epigastric artery were excluded.

The arterial phase of computed tomography (CT) angiograms that included the chest, abdomen, and pelvis was studied. The epigastric vessels' location was determined at two reference points: the umbilical scar and the mid-inguinal point (halfway between the anterior superior iliac spine and the symphysis pubis). These anatomical references were based on studies with cadavers that aimed to define surface relations to propose guidelines for safer trocar placement.[1-3,10,12]

The distances between the IEA and the midline were bilaterally measured on the same multiplanar reconstruction (MPR) section. In each case, maximum intensity projection (MIP) generated and reformatted thin axial images.

The analyzed data, such as age, were expressed as mean ± standard deviation, and the average distance of the epigastric vessels from the midline was summarized as mean ± standard deviation in 95% confidence intervals. Furthermore, Pearson's correlation coefficient was used to determine the correlation between general patient information and measured data. All tests were two-tailed, and a p<0.05 value was considered statistically significant. Statistical calculations were performed using SPSS 26.0 software (IBM SPSS Statistics 26.0).

RESULTS

The inferior epigastric artery (IEA) was absent in 4% of patients. In such cases, the IEA was exclusively observed unilaterally in both men and women without any significant predominance on either side.

Table 1 shows the inferior epigastric vessels' location in relation to the midline. The data reveals that at the level of the mid-inguinal point, the mean distance of the IEA was 5.37 cm to the right and 5.17 cm to the left. At the level of the umbilical scar, the mean distance from the IEA to the right was 4.73 cm and 4.87 cm to the left.

In only 2% of cases, the left inferior epigastric artery ended below the umbilical scar.

The arteries demonstrated an average external caliber of 2.87 mm on the right and 2.81 mm on the left, with a difference between sides (p = 0.54) and a greater variation in caliber on the left.

The blue line represents the location of the inferior epigastric arteries in Fig. 1. The dashed line indicates the distance of the vessels from the midline based on the upper and lower 95% confidence intervals at each level. The starting point of the figure is defined as the average distance between the epigastric arteries and the midline at the level of the pubic symphysis, being 7.32 cm on the right and 7.23 cm on the left. Invasive operations through the abdominal wall should avoid these areas.

Table 1. Distance of the inferior epigastric vessels from the midline.

	Right			Left		
Location	**n**	**Mean ± SD**	**CI of 95%**	**n**	**Mean ± SD**	**CI of 95%**
Mid-inguinal point	49	5.37±0.95	5.10 - 5.64	49	5.17±0.95	4.89 - 5.44
Umbilical scar	49	4.73±1.60	4.27 – 5.19	48	4.87±1.54	4.42 – 5.31

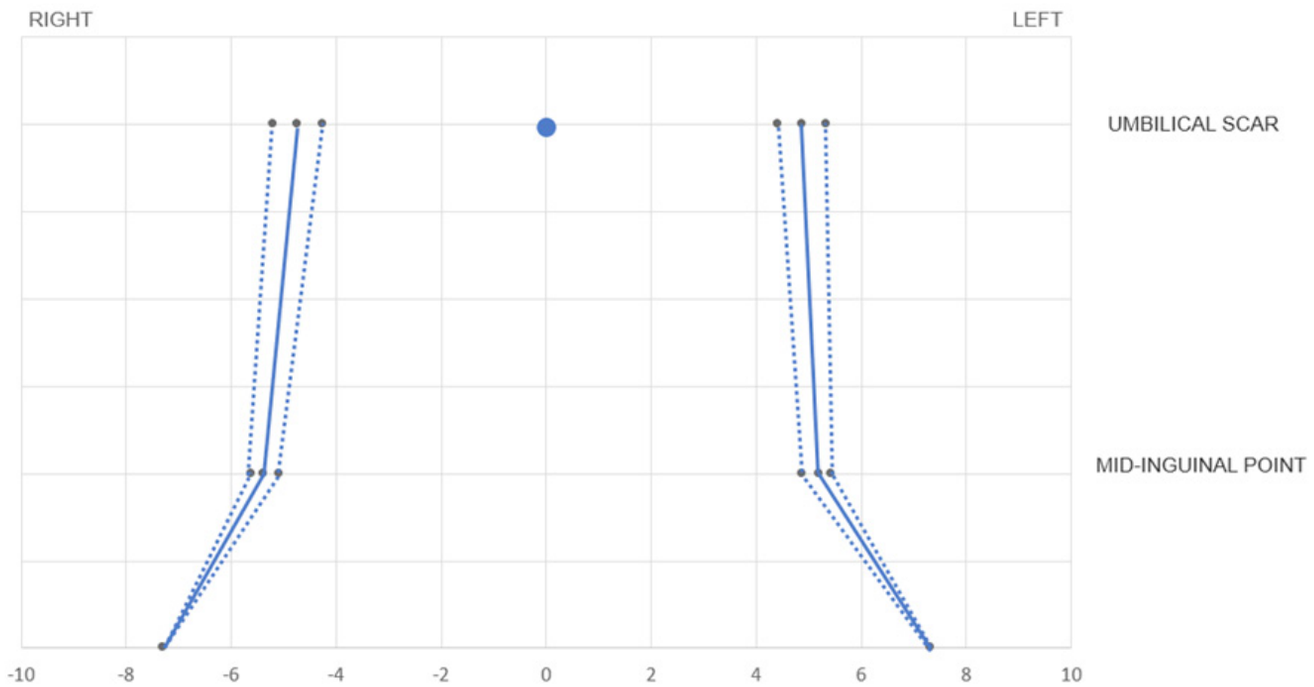

Figure 1. Distance of the inferior epigastric vessels from the midline.

The correlation between patient characteristics and the distance of the Inferior Epigastric Arteries from the midline was analyzed using Pearson's correlation coefficient. The results show that age is not related to the path of the vessels with a low correlation between the results, Pearson index of 0.07 to 0.28.

Furthermore, measurements indicate a statistically significant association with the patient's sex, with the correlation being more substantial at the level of the umbilical scar on the left. The samples, divided into two groups according to sex are presented in Tables 2 and 3, which show the location of the IEA based on the average value for both groups.

Table 2. Location of the inferior epigastric arteries in females.

	Right			Left		
Location	**n**	**Mean ± SD**	**CI of 95%**	**n**	**Mean ± SD**	**CI of 95%**
Mid-inguinal point	24	5.63±0.95	4.60 - 5.40	25	5.22±0.90	4.63 - 5.37
Umbilical scar	24	4.61±1.61	3.32 - 4.68	25	4.50±1.52	3.37 - 4.63

Table 3. Location of the inferior epigastric arteries in males.

	Right			Left		
Location	**n**	**Mean ± SD**	**CI of 95%**	**n**	**Mean ± SD**	**CI of 95%**
Mid-inguinal point	25	5.12±0.89	4.63 - 5.37	24	5.11±1.01	4.57 - 5.43
Umbilical scar	25	4.85±1.60	3.34 - 4.66	23	5.27±1.48	4.36 - 5.64

Finally, the branching patterns of the inferior epigastric artery (IEA) were evaluated in our population. These were categorized according to the 1988 Moon and Taylor classification,[8] modified to include type 0, in which the artery is absent, and type 4, in which there are four main trunks originating from the IEA according to Rozen.[11]

In 2% of cases, the IEA was absent and was classified as type 0. In the majority (83%) of CT angiography exams, the IEA did not have branches, and therefore, it was a single branch - this was called type 1. In 13%, the IEA bifurcated at the arcuate line, and this pattern was called type 2. And finally, a trifurcated pattern or type 3 was observed, found in only 2% of cases. These patterns are relevant in surgeries that use the inferior epigastric artery pedicle and in invasive procedures of the abdominal wall, as they can damage these branches.

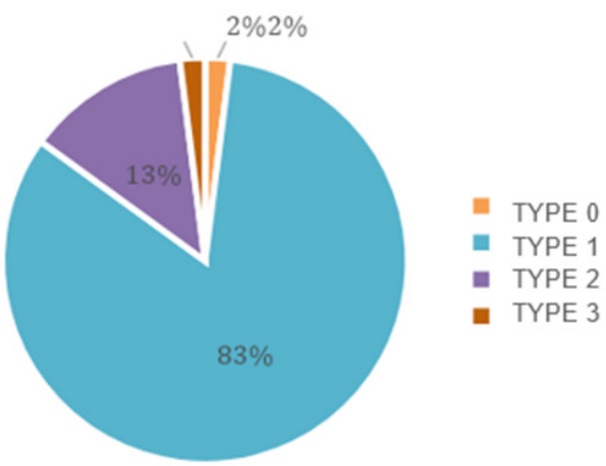

Figure 2. Type of IEA branch according to the Moon and Taylor classification.

Therefore, the use of such CT angiographic images proved to be highly accurate in delimiting the anatomical pattern of the inferior epigastric artery, with a resolution that clearly evaluated vessels as small as 3 mm in diameter and that allowed a functional view of this anatomy in vivo.

DISCUSSION

Few studies show the course and position of the IEA focused on invasive procedures of the anterior abdominal wall. A similar survey of the course of the IEA in 30 cadavers demonstrated that the mean distance of the inferior epigastric artery from the midline was 4.45 ± 1.42 cm at the level of the midpoint of the inguinal ligament and 4.49 ± 1.15 cm at the navel level.[3] In the present study, the values were 5.27 ± 1.55 at the level of the midpoint of the inguinal ligament and 4.79 ± 0.94 at the level of the umbilical scar.

When describing the anatomy of IEA, the literature is based mainly on cadaveric studies, in which many functional vascular changes can alter the anatomy. When comparing studies, we can observe a slightly lower distance value in cadavers, which can be justified by the tissue retraction performed in the fixation technique.

In other studies, using imaging methods, such as angiotomography of in vivo patients, mean distances of 5.17 ± 0.93 at the level of the middle of the inguinal ligament and 5.27 ± 1.17 cm at the level of the umbilical scar were observed in the Indian population[1]. Saber[12] describes the distance from the IEA to the midline at the level of the umbilical scar as 5.88 ± 0.14 on the right and 5.55 ± 0.13 on the left in the North American population. These facts may indicate a significant anatomical difference between populations with distinct lifestyle habits.

Regarding the branching of IEA, there is a predominance of type 1, contrasting with the previous distribution found by Moon and Taylor[8] in 1988 in Australia, where type 2, bifurcated, was the most predominant. Although population aspects can explain the difference, new studies on IEA branching patterns have shown a greater prevalence of the single branch type in the Australian population as well.[7] Studies have found a higher proportion of type 1 patterns and a lower proportion of type 2 and 3 patterns than expected in comparison to Moon and Taylor's 1988 cadaveric study.

All this data is relevant as the complexity of advanced laparoscopic procedures progressively requires the placement of many large-caliber trocars through the anterior abdominal wall. This can result in accidental injury to the abdominal wall vessels in 0.2% to 2.0% of the cases.[15] Without a doubt, the most commonly injured vessels in laparoscopic procedures are the epigastric vessels, which, given the rise in procedures outside the midline, are increasingly exposed to injuries.

Avoiding the IEA region will dramatically reduce the risk of vascular injury during invasive procedures such as trocar placement during laparoscopic surgery, enterostomy, and paracentesis. According to our data, it is clear that regardless of the abdominal level, the epigastric vessels are generally located in the area between 4 and 8 cm from the midline. Staying away from this area, whether medially or laterally,

will determine the safe entry zone into the abdominal wall without risk of injury to the epigastric vessels. These anatomical points must be considered whenever there is a need to make an incision through the abdominal wall to avoid accidental damage, not only during laparoscopy or open surgical procedures but also during image-guided procedures such as biopsy and paracentesis.

CONCLUSION

In summary, the vascular anatomy of the IEA can be a valuable alternative in managing lower abdominal wall bleeding in invasive procedures. This study provides the anatomical characteristics of IEA in the population of Minas Gerais, Brazil, as a reference and may contribute to reducing the damage caused by invasive abdominal operations.

ETHICAL DISCLOSURES

Conflicts of Interest: The authors have no conflicts of interest to declare.
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Confidentiality of Data: The authors declare that they have followed the protocols of their work center on the publication of patient data.
Protection of Human and Animal Subjects: The authors declare that the procedures followed were in accordance with the regulations of the relevant clinical research ethics committee and those of the Code of Ethics of the World Medical Association (Declaration of Helsinki as revised in 2024).
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Conflitos de Interesse: Os autores declaram a inexistência de conflitos de interesse na realização do presente trabalho.
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Confidencialidade dos Dados: Os autores declaram ter seguido os protocolos da sua instituição acerca da publicação dos dados de doentes.
Proteção de Pessoas e Animais: Os autores declaram que os procedimentos seguidos estavam de acordo com os regulamentos estabelecidos pela Comissão de Ética responsável e de acordo com a Declaração de Helsínquia revista em 2024 e da Associação Médica Mundial.
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CONTRIBUTORSHIP STATEMENT

MCCS: Bibliographical search, Study design, Data collection, Analysis and interpretation of results, Drafting of the article, Critical reviewing of the content of the article, Linguistic adaptation and technical accuracy of the translated manuscript.
AML: Study design, Analysis and interpretation of results, Critical reviewing of the content of the article.
PHO: Drafting of the article, Critical reviewing of the content of the article, Linguistic adaptation and technical accuracy of the translated manuscript.
MAD: Study design, Analysis and interpretation of results, Critical reviewing of the content of the article.
All authors approved the final version to be published.

DECLARAÇÃO DE CONTRIBUIÇÃO

MCCS: Pesquisa bibliográfica, desenho do estudo, recolha de dados, análise e interpretação dos resultados, redação do artigo, revisão crítica do conteúdo do artigo, adaptação linguística e precisão técnica do manuscrito traduzido.
AML: Desenho do estudo, análise e interpretação dos resultados, revisão crítica do conteúdo do artigo.
PHO: Redação do artigo, revisão crítica do conteúdo do artigo, adaptação linguística e precisão técnica do manuscrito traduzido.
MAD: Desenho do estudo, análise e interpretação dos resultados, revisão crítica do conteúdo do artigo.
Todos os autores aprovaram a versão final a ser publicada.

REFERENCES

1. Epstein J, Arora A, Ellis H. Surface anatomy of the inferior epigastric artery in relation to laparoscopic injury. Clin Anat. 2004;17:400-8. doi:10.1002/ca.10192
2. Joy P, Simon B, Prithishkumar IJ, Isaac B. Topography of inferior epigastric artery relevant to laparoscopy: a CT angiographic study. Surg Radiol Anat. 2016;38:279-83. doi:10.1007/s00276-015-1513-9
3. Joy P, Prithishkumar IJ, Isaac B. Clinical anatomy of the inferior epigastric artery with special relevance to invasive procedures of the anterior abdominal wall. J Minim Access Surg. 2017;13:18-21. doi:10.4103/0972-9941.181331
4. Karunanithy N, Rose V, Lim AK, Mitchell A. CT angiography of inferior epigastric and gluteal perforating arteries before free flap breast reconstruction. Radiographics. 2011;31:1307-19. doi:10.1148/rg.315105089
5. Kian B, Teimouri A. Inferior epigastric artery pseudoaneurysm following abdominal paracentesis in a patient with chronic kidney failure: A case report and review of literature. Clin Case Rep. 2022;10:e05535. doi:10.1002/ccr3.5535
6. King N, Lin E, Yeh C, Wong J, Friedman J, Traylor J, et al. Laparoscopic Major Vascular Injuries in Gynecologic Surgery for Benign Indications: A Systematic Review. Obstet Gynecol. 2021;137:434-42. doi:10.1097/AOG.0000000000004280
7. Molina AR, Jones ME, Hazari A, Francis I, Nduka C. Correlating the deep inferior epigastric artery branching pattern with type of abdominal free flap performed in a series of 145 breast reconstruction patients. Ann R Coll Surg Engl. 2012;94:493-5. doi:10.1308/003588412X13171221592050
8. Moon HK, Taylor GI. The vascular anatomy of rectus abdominis musculocutaneous flaps based on the deep superior epigastric system. Plast Reconstr Surg. 1988;82:815-32. doi:10.1097/00006534-198811000-00014
9. Moore KL, Dalley AF, Agur AM. Clinically oriented anatomy. Philadelphia: Wolters Kluwer; 2018.
10. Pickett SD, Rodewald KJ, Billow MR, Giannios NM, Hurd WW. Avoiding major vessel injury during laparoscopic instrument insertion. Obstet Gynecol Clin North Am. 2010;37:387-97. doi:10.1016/j.ogc.2010.05.002
11. Rozen WM, Ashton MW, Grinsell D. The branching pattern of the deep inferior epigastric artery revisited in-vivo: a new classification based on CT angiography. Clin Anat. 2010;23:87-92. doi:10.1002/ca.20898
12. Saber AA, Meslemani AM, Davis R, Pimentel R. Safety zones for anterior abdominal wall entry during laparoscopy: a CT scan mapping of epigastric vessels. Ann Surg. 2004;239:182-5. doi: 10.1097/01.sla.0000109151.53296.07
13. Tran T, Mahnert N, Magrina J, Mourad J. The Road Less Traveled: Variant Inferior Epigastric Artery Injury during Robotic Surgery. J. Minim. Invasive Gynecol. 2023; 30: 132. doi.org/10.1016/j.jmig.2023.08.419.
14. Verbist J, Stillaert F, Dujardin P, Dewaele G. Pseudoaneurysm of the inferior epigastric artery. Acta Chir Belg. 1997; 97(4):196-198.
15. Wong C, Merkur H. Inferior epigastric artery: Surface anatomy, prevention and management of injury. Aust N Z J Obstet Gynaecol. 2016;56:137-41. doi:10.1111/ajo.12426