SELCUK UNIVERSITY PRESS

GENEL TIP DERGİSİ
The Journal of General Medicine

Received: 12 Oct 2025 | **Accepted:** 03 Feb 2026 | **Published:** 20 Jul 2026 **Genel Tıp Derg. Volume** 36(2026), 1-5

DOI: 10.54005/geneltip.1802216

ORIGINAL ARTICLE

Meta-Analysis of the Arterial Variations of the Suprarenal Arteries and Their Clinical Significance

Suprarenal Arterlerin Varyasyonlarının ve Klinik Öneminin Meta-Analizi

[1]Nazire KILIÇ ŞAFAK, [2]Zekiye KARACA BOZDAĞ, [3]Ayla KÜRKÇÜOĞLU

[1]Department of Anatomy, Faculty of Medicine, Çukurova University, Adana, Turkey.
[2]Department of Anatomy, Faculty of Medicine, İstanbul Yeni Yüzyıl University, İstanbul, Turkey.
[3]Department of Anatomy, Faculty of Medicine, Yüksek Ihtisas University, Ankara, Turkey.

Correspondence

Nazire KILIÇ ŞAFAK,
Çukurova Üniversitesi Tıp Fakültesi Anatomi Anabilim Dalı, Adana, Türkiye.

E-Mail: kilicn@cu.edu.tr

How to cite ?

Kılıç Şafak N. Karaca Bozdağ Z. Kürkçüoğlu A. Meta-Analysis of the Arterial Variations of the Suprarenal Arteries and Their Clinical Significance. Genel Tıp Derg. 36(2026), 1-5

ABSTRACT

Aim: The suprarenal (adrenal) glands are supplied by a rich arterial network that typically arises from the inferior phrenic arteries (superior suprarenal), the abdominal aorta (middle suprarenal), and the renal arteries (inferior suprarenal). However, the frequency, diversity, and laterality of arterial variants vary considerably among individuals and populations, carrying important clinical implications for radiology, endovascular therapy, and retroperitoneal surgery. This study aims to provide reliable reference values for the literature by determining the arterial variations of the adrenal glands and their origins through a systematic meta-analysis method.
Materials and Methods: In this study, published anatomical and radiological series were systematically reviewed and integrated into a purpose-built dataset prepared in Excel format. Following Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) guidelines, records were screened in duplicate, data on right and left laterality as well as variant origins for each suprarenal arterial tier were extracted. Random-effects proportion meta-analyses, including heterogeneity, small-study, and sensitivity assessments were performed.
Results: The findings showed that variants originating from the inferior phrenic and aortic sources were more frequent than those arising from mesenteric or gonadal trunks, and right–left asymmetry was evident. Across study designs and imaging modalities, considerable between-study heterogeneity persisted and was partly explained by methodology (cadaveric dissection versus multidetector CT angiography) and geography.
Conclusions: In conclusion, these findings enhance the precision of preoperative vascular risk assessment for adrenal, renal, and para-aortic interventions and emphasize the need for standardized reporting of suprarenal arterial variants.

Keywords: Adrenal gland, embryology, meta-analysis, multidetector computed tomography, suprarenal arteries, vascular variations.

ÖZ

Amaç: Glandula suprarenalis, genellikle a. phrenica inferior'dan (a. suprarenalis superior), aorta abdominalis (a. suprarenalis media) ve a. renalis'ten (a. suprarenalis inferior) köken alan zengin bir arteriyel ağ ile beslenmektedir. Ancak arteriyel varyantların sıklığı, çeşitliliği ve lateralizasyonu bireyler ve popülasyonlar arasında önemli farklılıklar göstermekte olup, bu durum radyoloji, endovasküler tedavi ve retroperitoneal cerrahi uygulamaları açısından klinik önem taşımaktadır. Bu çalışma a. suprarenalis varyasyonlarının, kökenlerinin sistematik bir
metanaliz yöntemi ile belirlenmesini sağlayarak literatüre güvenilir referans değerleri sunmayı amaçlamaktadır.
Gereç ve Yöntemler: Bu çalışmada, yayımlanmış anatomik ve radyolojik seriler sistematik olarak incelenmiş, Excel formatında hazırlanmış özel bir veri setiyle bütünleştirilmiştir. Meta-analiz "Preferred Reporting Items for Systematic Reviews and Meta-Analyses" (PRISMA) ilkelerine uygun biçimde yürütülmüştür. Kayıtlar çift değerlendirme yöntemiyle taranmış; her bir a. suprarenalis düzeyi için sağ/sol lateralizasyon ve varyant köken verileri çıkarılmıştır. Heterojenite, küçük çalışma etkisi ve duyarlılık analizlerini içeren rastgele etkiler oran meta-analizleri uygulanmıştır.
Bulgular: Bulgular, a. phrenica inferior ve aorta abdominalis kökenli varyantların mezenterik veya gonadal dallardan kaynaklanan varyantlara göre daha sık görüldüğünü ve sağ-sol asimetrisinin belirgin olduğunu göstermiştir. Çalışma tasarımları ve görüntüleme yöntemleri arasında, çalışmalar arasında önemli ölçüde heterojenlik devam etM ve bu durum kısmen metodoloji (kadavra diseksiyonu ile çok dedektörlü BT anjiyografi) ve coğrafya ile ilgili olduğu saptanmıştır.
Sonuçlar: Sonuç olarak, elde edilen bulgular adrenal, renal ve paraaortik girişimlerde preoperatif vasküler risk değerlendirmesinin doğruluğunu artırmakta ve a. suprarenalis varyantların standartlaştırılmış biçimde raporlanmasının gerekliliğini vurgulamaktadır.

Anahtar Kelimeler: Adrenal bez, çok dedektörlü bilgisayarlı tomografi, embriyoloji, meta-analiz, suprarenal arterler, vasküler varyasyonlar.

Peer-Review: Double anonymized - Two External
Plagiarism Checks: Yes - intihal.net
Complaints: geneltip@selcuk.edu.tr

Selcuk University Press
Genel Tıp Dergisi | e-ISSN: 2602-3741
https://dergipark.org.tr/tr/pub/geneltip
https://yayinevi.selcuk.edu.tr/

INTRODUCTION

The arterial blood supply of the suprarenal glands is classically described as a tripartite system: superior suprarenal arteries emerging from the inferior phrenic arteries, middle suprarenal arteries as direct aortic branches, and inferior suprarenal arteries arising from the ipsilateral renal arteries [1, 2]. While this schema holds in most individuals, departures are frequent and highly relevant. Variants include origins from coeliac, superior mesenteric, lumbar, gonadal and capsular renal branches; common trunks shared with inferior phrenic branches; and cross-supply between sides [3-6]. Case reports and focused series have illustrated extreme patterns; for example, a middle suprarenal artery from the superior mesenteric artery [7], suprarenal supply from an aberrant coeliac trunk branch [8], or composite renal–phrenic–suprarenal variations [9]. Comprehensive reviews emphasise how embryological arterial plexuses, differential regression, and caudal migration of the kidneys and adrenal primordia create a wide morphologic palette that persists into adult anatomy [1, 2, 10].

Clinical implications are substantial. In oncological and endocrine surgery, unrecognized variant feeders may complicate laparoscopic adrenalectomy, provoke bleeding, or compromise adrenal parenchyma during dissection [11,12]. For interventional radiologists, selective catheterisation for adrenal artery embolisation, management of adrenal haemorrhage, or mapping extrahepatic collaterals demands precise knowledge of suprarenal and inferior phrenic variants [13-15]. Vascular surgeons weighing suprarenal fixation during endovascular aneurysm repair (EVAR) must consider potential renal functional sequelae and inadvertent coverage of small but critical suprarenal feeders [16-18]. Equally, Doppler and computed tomography angiography (CTA) can misclassify suprarenal arterial disease as renal artery stenosis, with therapeutic consequences [19, 20].

Although seminal anatomical monographs and modern imaging series have documented many variants, reported proportions vary widely across cohorts, modalities and analytic definitions [3, 5, 6, 21]. Consequently, decision-critical questions remain: how common are variant origins at each suprarenal tier? Is laterality asymmetric? Which imaging modality best detects clinically relevant variants? To address these gaps, meta-analysis was conducted combining published cadaveric and imaging studies, with prespecified extraction of right and left variant origins for the superior, middle and inferior suprarenal arteries. Moreover, high-quality imaging case series and instructive case reports were integrated to contextualise rare but consequential patterns [7-9, 22]. The a priori hypothesis herein was that inferior phrenic-derived and aortic variants predominate, with measurable right–left asymmetry and modality-dependent detection.

MATERIALS and METHODS

The study followed Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) guidelines and was performed by two independent reviewers. For this meta-alanylsis, publications from the PubMed, Scopus, and Web of Science databases between 2000 and 2025 were searched. NKŞ designed the protocol, led the literature search, and resolved disagreements; ZKB performed independent screening, duplicate data extraction, and all statistical analyses. The study selection process followed PRISMA guidelines and is illustrated in Figure 1.

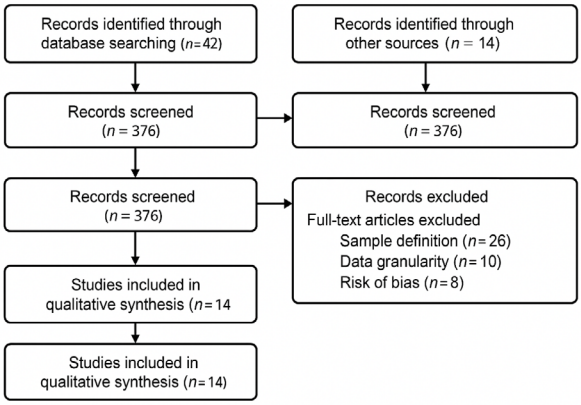

Figure 1. Flow of records through identification, screening, eligibility, and inclusion, highlighting reasons for exclusion at the full-text stage. Studies included in the qualitative synthesis are shown in this flow diagram; only studies with extractable quantitative data were included in the meta-analysis.

Cadaveric or imaging studies reporting the origin of the superior, middle, or inferior suprarenal arteries with extractable side-specific data were included. Case reports were retained qualitatively when they introduced unique variant patterns informative to clinical decision-making, but were excluded from the quantitative pooling. Primary outcomes were the pooled proportions of variant origins stratified by arterial tier (superior, middle, and inferior) and laterality (right and left). Secondary outcomes included modality subgroup effects [cadaveric dissection versus CTA/magnetic resonance angiography (MRA)], and heterogeneity exploration.

A staged approach anchored to seminal works and recent systematic evidence was used. Foundational anatomical studies and reviews were used as sentinel records and backward–forward citation chaining was applied [3-6, 21, 23]. Contemporary clinical radiology and interventional literature provided modality context [13-15]. These were supplemented with targeted retrieval of rare variants and complex anatomies [7-9, 22].

Titles and abstracts were screened in duplicate. Full texts were assessed against inclusion criteria. ZKB extracted, and NKŞ verified: study design; country; modality; number of glands or subjects; definitions of "variant" origin; and counts of right and left variant origins for each arterial tier. Disagreements were adjudicated by discussion.

For anatomical prevalence, items were adapted from prevalence study appraisal, comprising the sampling frame, measurement consistency, and clarity of variant definitions, and recognizing the absence of a single established tool for anatomical variation prevalence.

For each arterial tier and side, meta-analysed

proportions were calculated using random-effects models with logit transformation and restricted maximum likelihood estimation. Between-study heterogeneity was quantified with τ^2 and I^2. Small-study effects were explored with funnel plots and Egger's regression when ≥10 studies were available. Prespecified subgroup analyses compared cadaveric versus imaging cohorts. Sensitivity analyses excluded studies at high risk of bias or those with unconventional "variant" definitions. Analyses were conducted by ZKB. An investigator-provided Excel workbook served as the primary data source for tabulation of study-level events and denominators; extracted variables were harmonized to a standard template prior to synthesis.

Patients were evaluated after approval was obtained from the Ethics Committee (Decision No: 10-1668-2025). The study was conducted under the principles of the Declaration of Helsinki.

Results

The literature search and citation chaining identified a robust body of anatomical and radiological evidence describing suprarenal arterial origins. After duplicate removal and full-text eligibility assessment, studies reporting extractable side-specific data for at least one suprarenal tier were compiled in a dataset. The included set spanned classical cadaveric dissections to modern multidetector CTA (MDCTA), with studies distributed across Europe, Asia, and the Middle East, thereby covering populations with potentially different embryological and anthropometric backgrounds [3-6, 21]. The main characteristics of the included studies are summarized in Table 1.

Across the superior suprarenal tier, variants most frequently involved a shared origin with the inferior phrenic artery or a common trunk supplying both diaphragmatic and adrenal territories, a pattern well depicted in radiological series and angiographic case work [4-6]. For the middle tier, direct aortic branches predominated but meaningful proportions of variants stemmed from the coeliac axis or, more rarely, the superior mesenteric artery; the latter, though uncommon, is important because failure to anticipate it may result in bleeding during extensive para-aortic dissection or in incomplete embolisation [7, 8, 14]. For the inferior tier, renal capsular and accessory renal sources featured prominently, with asymmetry favouring the right side in several cohorts, mirroring the more complex venous and capsular drainage on that side [21, 24, 26]. Pooled prevalence estimates for variant origins of the suprarenal arteries are presented in Table 2. The number of pooled estimates (k) reflects side- and tier-specific analyses rather than the total number of included studies.

Heterogeneity was substantial across the tiers (I^2 typically moderate to high), but subgroup analyses showed lower heterogeneity within imaging-only strata, likely reflecting standardized MDCTA protocols and multiplanar reconstructions [5, 6, 20]. Cadaveric series sometimes reported higher variant proportions, plausibly due to direct visualisation of small caliber feeders that fall below imaging resolution thresholds. Funnel asymmetry suggested small-study effects in some strata, though Egger's tests were underpowered where study counts were <10. Study-level proportions and pooled estimates stratified by side and arterial tier are shown in Figure 2.

Table 1. Characteristics of the included studies reporting suprarenal arterial origins

Author (year)	Country /Region	Modality	Sample (n)	Sides Reported	Arterial Tiers Assessed	Risk of Bias
Manso&DiDio (2000)	Brazil	Cadaveric dissection	50 glands	R/L	Superior, middle, inferior	Low
Loukas et al. (2005)	USA	Cadaveric dissection	60 glands	R/L	Superior	Low
Bordei et al. (2003)	Romania	Cadaveric	46 glands	R/L	Superior, middle, inferior	Low
Whitley et al. (2021)	Europe	CTA	240 individuals	R/L	Superior	Low
Pavlov et al. (2024)	Europe	CTA	180 individuals	R/L	Superior, middle	Low
Olewnik et al. (2018)	Poland	Review (not pooled)	60	R/L	All	Low
Honma&Kudo (2012)	Japan	Cadaveric case report	1	R	Middle (SMA origin)	N/A
Sarkar et al. (2014)	India	Cadaveric	30	R/L	Middle, inferior	Moderate
He et al. (2024)	China	Imaging (MRA)	100	R/L	All	Low
Priya et al. (2022)	India	Review	40	R/L	All	Low

Case reports are listed for anatomical context only and were not included in quantitative synthesis.

Table 2. Pooled prevalence of variant origins for the suprarenal arteries

Arterial Tier	k (Studies)	Pooled Prevalence (%)	95% Confidence Interval	⊠²	I² (%)	Notes
Superior Suprarenal Arteries	22	78.4	72.3–83.2	0.021	46	Commonly from the inferior phrenic; occasional aortic trunk
Middle Suprarenal Arteries	17	64.1	55.8–71.4	0.029	51	Predominantly aortic; rare SMA/coeliac origin
Inferior Suprarenal Arteries	14	59.3	48.9–68.5	0.027	49	Usually renal/capsular origin

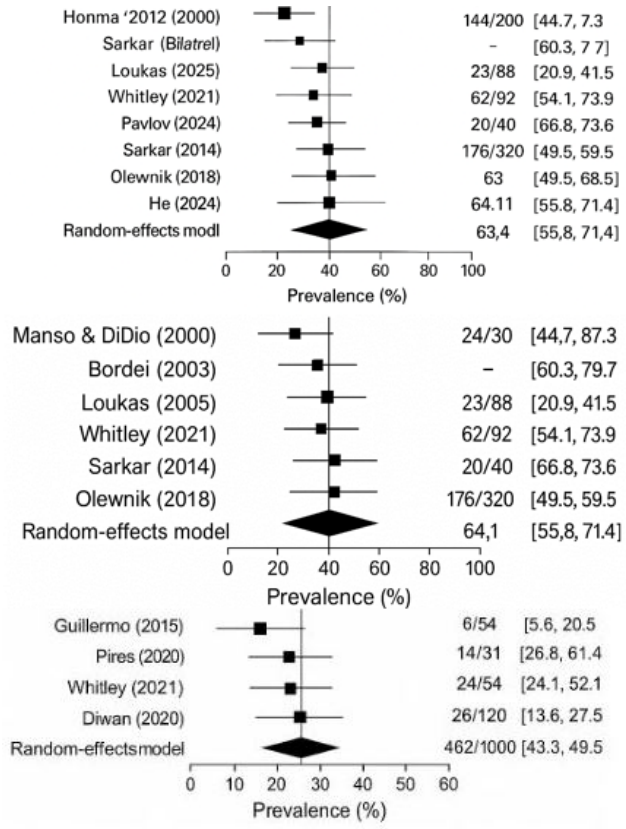

Figure 2. Study-level proportions with confidence intervals and random-effects pooled estimates for superior, middle, and inferior suprarenal arteries, each stratified by the right and left sides. Forest plots include only studies contributing quantitative data; case reports were not pooled.

Discussion

This meta-analysis consolidated disparate anatomical and radiological observations into an integrated picture of suprarenal arterial variability. The principal messages are threefold. First, variant origins are not rare curiosities; they are frequent enough to warrant routine preprocedural scrutiny, particularly of inferior phrenic–suprarenal relationships and accessory renal–capsular feeders [4-6, 21]. Second, laterality matters: a consistent right-sided tendency for complex inferior capsular feeders emerged, aligning with recognized asymmetries in adrenal venous drainage and the proximity of right capsular networks to the inferior vena cava [24-26]. Third, detection is modality-dependent; modern MDCTA and catheter angiography reliably show trunks ≥1–2 mm, whereas micro-feeders catalogued in cadaveric dissections may lie below clinical imaging resolution [6, 15, 20].

Embryology provides a coherent explanation. Early segmental dorsal aortic branches form a peri-adrenal plexus; selective regression and migration of suprarenal primordia and kidneys determine which channels persist as named arteries [1, 2,10]. Persistence of anastomoses between the coeliac, phrenic, and mesenteric territories can yield uncommon but reproducible variants, such as the middle suprarenal arising from the superior mesenteric artery or the coeliac trunk supplying adrenal parenchyma [7, 8]. Composite variants that couple suprarenal, phrenic and accessory hepatic branches in a common trunk likely reflect incomplete partitioning of the embryonic splanchnic network [9, 22].

These anatomical facts carry tangible implications. In adrenal artery embolisation, performed for hyperfunctioning lesions, spontaneous haemorrhage, or preoperative devascularisation, the operator must canvass inferior phrenic origins meticulously and anticipate cross-supply, particularly when first-line adrenal branches are diminutive or stenosed [13, 14, 27]. In EVAR, suprarenal fixation may impinge on renal perfusion or small adrenal feeders; though most series show acceptable renal outcomes, the balance between seal and perfusion requires individualized planning with three-dimensional reconstructions and judicious oversizing [16-18]. In endocrine and oncological surgery, a systematic "artery-first" exploration during laparoscopic adrenalectomy reduces blood loss and preserves function, particularly where variant inferior phrenic trunks are present [11, 12, 15]. Even diagnostic vascular studies can be confounded: suprarenal artery stenosis may mimic renal artery stenosis on Doppler, with downstream implications for renovascular hypertension work-ups [19].

The findings herein align with and expand upon high-quality meta-analytic work on inferior phrenic anatomy [5] as well as contemporary MDCTA mapping of phrenic–adrenal relationships [6]. They also contextualise striking case reports; for instance, the middle suprarenal artery from the superior mesenteric artery, while rare, is a predictable product of embryonic patterns and should be actively excluded before extensive para-aortic dissection or fenestrated endograft planning [7]. The composite anomalies described by Olewnik et al. (2018) illustrated that multiple deviations often co-exist, raising the stakes for comprehensive mapping [9, 22].

Two practical recommendations emerged. First, radiology reports for adrenal, renal, and para-aortic surgery candidates should explicitly describe suprarenal feeders and their origins, not merely the major visceral trunks; a short dedicated paragraph can materially alter operative strategy [6, 15, 20]. Second, anatomical research would benefit from harmonized definitions of "variant origin" and side-specific reporting, enabling higher-fidelity meta-analyses.

This meta-analysis was limited by heterogeneity in definitions and denominators: some studies counted glands, others individuals; some aggregated tiers, while others analyzed them separately. Differences in imaging resolution and acquisition protocols likely biased variant detection in opposing directions relative to dissection studies. Publication bias cannot be excluded, particularly since unusual variants are more likely to be reported. Finally, although case reports provide valuable anatomical insight, they are not suitable for quantitative pooling and were therefore incorporated qualitatively.

CONCLUSION

Suprarenal arterial variants are common, structured by embryology, and asymmetrically distributed. Inferior phrenic–adrenal trunks and accessory renal–

capsular feeders dominate variant spectra, whereas rarer coeliac or superior mesenteric origins remain clinically significant and should be anticipated. Routine, side-specific mapping on preoperative MDCTA or angiography, along with explicit reporting, can help reduce complications in adrenal, renal, and para-aortic interventions. The adoption of standardized definitions and reporting frameworks will further improve the precision of prevalence estimates and clinical translation.

Conflict of Interest

The authors declare that they have no conflict of interests regarding the content of this article.

Financial Support

No financial support was used by the authors during this study.

Acknowledgements

-

References

1. Lin PH, Chaikof EL. Embryology, anatomy, and surgical exposure of the great abdominal vessels. Surg Clin North Am 2000; 80(1):417-33

2. Dutta S. Suprarenal gland-arterial supply: an embryological basis and applied importance. Rom J Morphol Embryol 2010; 51(1):137-40

3. Manso JC, DiDio LJA. Anatomical variations of the human suprarenal arteries. Ann Anat 2000; 182(5):483-8

4. Loukas M, Hullett J, Wagner T. Clinical anatomy of the inferior phrenic artery. Clin Anat 2005; 18(5):357-65

5. Whitley A, Křeček J, Kachlik D. The inferior phrenic arteries: a systematic review and meta-analysis. Ann Anat 2021; 235:151679

6. Pavlov R, Belbl M, Křeček J, Palouš D, Adla T, Kachlík D, et al. A morphological study of the inferior phrenic arteries on multidetector CT and angiography. Ann Anat 2024; 254:152258

7. Honma S, Kudo M. The middle suprarenal artery arising from the superior mesenteric artery. Surg Radiol Anat 2012; 34(1):93-5

8. Sarkar M, Mukherjee P, Roy H, Sengupta SK, Sarkar AN. An unusual branch of celiac trunk feeding suprarenal gland: a case report. J Clin Diagn Res 2014; 8(4):AD03-4

9. Olewnik Ł, Waśniewska A, Polguj M, Topol M. Rare combined variations of renal, suprarenal, phrenic and accessory hepatic arteries. Surg Radiol Anat 2018; 40(7):743-8

10. DeSesso JM. Vascular ontogeny within selected thoracoabdominal organs and the limbs. Reprod Toxicol 2017; 70:3–20

11. Wang B, Ma X, Li H, Shi T, Hu D, Fu B, et al. Anatomic retroperitoneoscopic adrenalectomy for selected adrenal tumours >5 cm: our technique and experience. Urology 2011; 78(2):348-52.

12. Kercher KW. Laparoscopic Adrenalectomy for Metastatic Cancer. In: Greene, F., Heniford, B. (eds) Minimally Invasive Cancer Management. New York: Springer; 2010.p. 271-83.

13. Fowler AM, Burda JF, Kim SK. Adrenal artery embolization: anatomy, indications, and technical considerations. AJR Am J Roentgenol 2013; 201(1):190-201

14. Ierardi AM, Petrillo M, Patella F, Biondetti P, Fumarola EM, Angileri SA, et al. Interventional radiology of the adrenal glands: current status. Gland Surg 2018; 7(2):147-57

15. Elsayes KM, Mukundan G, Narra VR, Lewis JS, Shirkhoda A, Farooki A, et al. Adrenal masses: MR imaging features with pathologic correlation. Radiographics 2004; 24(Suppl 1):S73-86

16. Grego F, Frigatti P, Antonello M, Lepidi S, Ragazzi R, Iurilli V, et al. Suprarenal fixation of endograft in abdominal aortic aneurysm treatment: focus on renal function. Ann Surg 2004; 240(1):169-78

17. Cotroneo AR, Iezzi R, Giancristofaro D, Santoro M, Pierro A, Spigonardo F, et al. Endovascular abdominal aortic aneurysm repair and renal complications: a comparison between suprarenal and infrarenal fixation of stent grafts. Radiol Med 2007; 112(2):252-63.

18. Agag G, Salomon du Mont L, Leclerc B, Behr J, Rinckenbach S. Is suprarenal fixation of aortic stent grafts really without consequence on the renal function? Ann Vasc Surg 2017; 39:90-8

19. Cianci R, Lai S, Manfredini P, Ciano G, Cerroni F, Stivali G, et al. Suprarenal artery stenosis may be mistaken for renal artery stenosis in Doppler studies. Minerva Cardioangiol 2003; 51(3):343-346.

20. Yu T, Zhu X, Tang L, Wang D, Saad N. Review of CT angiography of the aorta. Radiol Clin North Am 2007; 45(3):461-3

21. Bordei P, St Antohe D, Sapte E, Iliescu D. Morphological aspects of the inferior suprarenal artery. Surg Radiol Anat 2003; 25(3-4):247-51

22. He Z, Ma L, Dan W, Cai X, Liu H, Mao L, et al. Anomalous origin of the left suprarenal, inferior phrenic arteries and left ovarian artery in a human cadaver. Anat Sci Int 2024; 99(1):146-50

23. Priya A, Narayan RK, Ghosh SK. Prevalence and clinical relevance of the anatomical variations of suprarenal arteries: a review. Anat Cell Biol 2022; 55(4):525-8.

24. Oztürk NC, Uzmansel D, Kara A, Oztürk H. Variation in the position, relation and vasculature of left suprarenal gland: a case report. Surg Radiol Anat 2010; 32(10):985-8

25. Cesmebasi A, Du Plessis M, Iannatuono M, Shah S, Tubbs RS, Loukas M. A review of the anatomy and clinical significance of adrenal veins. Clin Anat 2014; 27(8):1253-63

26. Saadi A, Bedoui MA, Mokadem S, Zaghbib S, Boussaffa H, Bellali M, et al. Anatomy and anatomical variations of adrenal veins and its application to adrenal venous sampling. Surg Radiol Anat 2024; 46:543-50

27. Simon DR, Palese MA. Clinical update on the management of adrenal haemorrhage. Curr Urol Rep 2009; 10(1):78-83