

Successful Kidney Transplantation from a Living Donor with Double Inferior Vena Cava and Three Renal Veins: Case Report and Literature Review

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Case Report

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Abstract

Background: Vascular anomalies in living kidney donors pose technical challenges. Double inferior vena cava (D-IVC) occurs in 0.2%–0.7%, and multiple renal veins in 3%–14%. Their combination is exceptionally rare.

Case Report: We report successful living donor transplantation from a 49-year-old male with D-IVC and three left renal veins, donated to his daughter with End-stage renal disease (ESRD). Preoperative Computed tomography angiography (CTA) suggested a prominent gonadal vein; intraoperatively, D-IVC was confirmed. Three short, distant veins could not be merged; each was individually anastomosed to the external iliac vein. Cold ischemia was 20 minutes. Both recovered uneventfully with excellent graft function.

Literature Review: We synthesized 15 high-quality publications (2020–2025) on epidemiology, surgical strategies, and outcomes. CTA with 3D reconstruction is the gold standard (sensitivity 98%). Options include vein grafts or individual anastomoses. One-year graft survival (94.2% vs. 95.1%) and donor outcomes are comparable to conventional anatomy.

Conclusions: D-IVC with triple renal veins is not an absolute contraindication. With meticulous imaging and tailored techniques, excellent outcomes are achievable.

Highlights

1. Double inferior vena cava (D-IVC) concurrent with three renal veins (TRV) are rare but not absolute contraindications to living donor renal transplantation.
2. Preoperative CTA with 3D reconstruction is essential for identifying these anomalies (sensitivity 98%).
3. Key CTA clues for D-IVC: bilateral para-aortic venous structures; left IVC diameter 60%–80% of right IVC.
4. For short or distant multiple renal veins, individual anastomosis directly to the external iliac vein is a feasible alternative to vein grafts.
5. Cold ischemia time should be minimized (ideally <30 minutes) when performing multiple venous anastomoses.
6. Postoperative Doppler ultrasound within 24 hours is critical to confirm venous patency.

1. Introduction

Living donor renal transplantation (LDRT) offers superior graft survival and shorter waiting times over deceased donation or dialysis^[1]. However, vascular variations—such as double inferior vena cava (D-IVC) and multiple renal veins—increase surgical complexity^[2].

D-IVC results from incomplete regression of the embryonic left supracardinal vein, with a prevalence of 0.2%–3.0%^[3]. Triple renal veins (TRV)—three distinct venous trunks draining into the vena cava—occurs in 0.8%–9.7% of donors, mainly on the right^[4]. Their coexistence is extremely rare, with only sporadic case reports^[5–7].

We present a successful LDRT case with D-IVC and three renal veins (TRV) accompanied by a literature review (2020–2025) covering epidemiology, preoperative assessment, surgical management and outcomes. This case report has been reported in line with the SCARE checklist^[8].

2. Case Presentation

2.1 Donor Characteristics

A 49-year-old male volunteered as a living related donor for his daughter with ESRD. Preoperative labs, renal function, and blood pressure were normal. Split glomerular filtration rate (GFR) was 37.3 mL/min (left) and 43.6 mL/min (right).

2.2 Preoperative Imaging

CTA revealed a prominent venous structure (~ 14.2 mm) parallel to the left gonadal vein, joining the left renal vein at 90° before connecting to the right-sided IVC (Fig. 1). Initially interpreted as a dilated gonadal vein, D-IVC was not definitively diagnosed preoperatively. Left laparoscopic donor nephrectomy was planned.

2.3 Donor Surgery

Retroperitoneoscopic left nephrectomy identified a large (~ 15 mm) venous structure along the left aorta, consistent with a duplicated IVC. The left kidney had a single artery but three separate renal veins (superior, middle, inferior) draining into the left IVC (Fig. 2). Meticulous dissection preserved the duplicate IVC; lumbar and adrenal veins were ligated. The kidney was extracted and flushed.

2.4 Back-Table and Recipient Surgery

The recipient (ESRD on hemodialysis) underwent left iliac fossa Gibson incision, exposing external iliac vessels.

Back-table inspection showed three short veins (< 1 cm each) with orifices about 1.5 cm apart and on different planes—precluding merging. We performed individual anastomoses: renal artery end-to-side to external iliac artery (6 – 0 Prolene); all three veins anastomosed to a single venotomy on the external iliac vein using triangulation (7 – 0 Prolene). Cold ischemia was 20 minutes. Reperfusion produced a pink kidney and immediate urine output.

2.5 Postoperative Outcome

Donor: Uneventful recovered and discharged on day 10 with creatinine 0.9 mg/dL. **Recipient:** Immediate graft function; creatinine fell from 8.5 to 1.2 mg/dL by day 5. Doppler at day 1 showed patent anastomoses. Discharged day 14 (creatinine 1.1); at 3 months, creatinine 0.9 mg/dL, eGFR 72 mL/min/1.73m².

3. Comprehensive Literature Review

3.1 Anatomy and Prevalence

D-IVC is classified as Type I (complete duplication, two symmetric cavae from iliac to renal level, left draining into left renal vein then to right IVC) or Type II (left IVC ends at renal level)^[9, 10]. In donors, Type I predominates. TRV (three separate hilar trunks) occurs in 9.7% on the right vs. <5% on the left^[11]; veins are classified as superior, middle, inferior. Inadvertent ligation risks segmental congestio^[12].

Concurrent D-IVC and TRV is exceedingly rare, with only a few prior reports^[1, 13–15]. complex drainage patterns and shorter veins (mean 2–3 cm) complicate reconstruction^[15, 16].

3.2 Preoperative Assessment

CTA with multiplanar/3D reconstruction is the gold standard (sensitivity 98%)^[12]. Key signs: bilateral para-aortic veins, left IVC 60%–80% of right diameter^[3]; for TRV, document number, diameter (> 3 mm), and drainage sites^[13].

A meta-analysis (Costa e Silva et al., 2024; n = 46,664) found CTA identified 95% of multiple renal vein variations, Magnetic resonance venography (MRV) or Doppler can supplement^[3]. Interdisciplinary planning is recommended^[7].

3.3 Donor Nephrectomy

Retroperitoneoscopic approach is preferred for left-sided D-IVC^[6]. Critical steps: avoid injury to duplicated IVC, preserve the longest vein (≥ 2 cm if possible), ligate accessory lumbar/gonadal veins^[3].

In four D-IVC donors, Agarwal et al. reported mean operative time 230 min and warm ischemia 136 s^[6]. For TRV, if one vein is dominant (> 5 mm), smaller ones may be ligated; if all ≥ 3 mm, reconstruction is needed^[10]. However, if all three veins are ≥ 3 mm, venous reconstruction is necessary to prevent segmental infarction.

3.4 Recipient Anastomosis

For short veins (< 1 cm), extension options include autologous renal vein grafts (from native kidney)^[5] or deceased donor vein grafts^[1]. ISakai et al. used an autologous graft to extend by 3 cm^[5].

Hayashi et al. used a Y-shaped saphenous graft to unify three veins in three cases without congestion^[10]. Popov et al. (n = 250 anomalous transplants) found no significant difference in anastomosis time versus conventional (p = 0.32)^[14]. Postoperative Doppler within 24 h is advised to check patency and flow^[7].

3.5 Outcomes

Donor

Outcomes are similar to normal anatomy. Hennawyl et al. reported 9-month follow-up with normal eGFR (85 mL/min/1.73m²)^[7]. Pal et al. reported no IVC syndrome or chronic pain in four D-IVC donors, mean stay 4.5 days^[6]. Main risk is bleeding (~ 5%), mitigated by CTA planning^[3].

Recipient: Graft survival is comparable: 1-year survival 94.2% (anomalous) vs. 95.1% (normal)^[14]. Delayed graft function (DGF) is more common in TRV (12% vs. 6%) due to prolonged clamping^[10]. risk factors include vein grafts, multiple anastomoses, cold ischemia > 6 h^[5]. Long-term complications: venous stenosis (3%–5%) and thrombosis (< 2%)^[13]; Doppler surveillance in the first year can detect stenosis for balloon angioplasty^[9].

4. Discussion

This case confirms that D-IVC with TRV is not a contraindication to LDRT. Success depends on preoperative diagnosis, surgical skill, and planning.

4.1 Preoperative Diagnosis and Imaging

Our D-IVC was visible on CTA but misread as a gonadal vein. Radiologists and surgeons should recognize key clues: (1) a left-sided para-aortic vein from the left common iliac, (2) ascending to renal level, joining the left renal vein and crossing anterior to the aorta to the right IVC, and (3) identical contrast enhancement. Familiarity with these signs enables preoperative planning^[15].

4.2 Technical Challenges

Donor

The duplicate IVC altered anatomy; retroperitoneoscopic access allowed safe dissection and ligation while preserving the left IVC^[6]. The use of a retroperitoneoscopic approach provided direct access to the renal hilum and may have facilitated this dissection.

Recipient

Three short, distant veins on different planes precluded merging. Individual anastomoses to a single venotomy ensured adequate outflow, preventing congestion/thrombosis. The 20-minute cold ischemia was vital to the excellent outcome.

4.3 Comparison with Published Cases

Most prior cases used vein grafts or Y-shaped reconstructions (**Table 1**). Our case uniquely shows that direct individual anastomoses are feasible when merging is impossible.

4.4 Expanding the Donor Pool

Vascular anomalies should not automatically exclude willing healthy donors. Technical innovation can overcome these challenges, safely expanding the living donor pool^[16], offering more patients with ESRD the best chance for a cure.

4.5 Limitations

As a single case report, long-term follow-up beyond 3 months is lacking. However, the short-term success and consistency with published cases support feasibility.

5. Conclusion

LDRT from donors with D-IVC and three renal veins is technically demanding but feasible with meticulous preoperative imaging (CTA with 3D reconstruction) and tailored surgical strategies (extension grafts, Y-shaped anastomoses, or individual anastomoses). Donor and recipient outcomes are favorable, and these anomalies are not contraindications to LDRT. Future work should focus on standardized classification and long-term outcomes in larger cohorts.

Abbreviations

D-IVC
Double Inferior Vena Cava
ESRD
End-Stage Renal Disease
CTA
Computed Tomography Angiography
LDRT
Living Donor Renal Transplantation
TRV
Triple Renal Veins
GFR
Glomerular Filtration Rate
eGFR
estimated Glomerular Filtration Rate
MRV
Magnetic Resonance Venography
DGF

Declarations

Ethics approval and consent to participate: Not applicable

Consent for publication: Written informed consent for publication of this case report, including any potentially identifiable clinical details, was obtained from the patient. A copy of the signed consent form is available for review by the editorial office upon request.

Availability of data and materials: All data generated or analysed during this study are included in this published article, and its supplementary information files.

Competing Interests: The authors declare that they have no competing interests.

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References

1. Whooley J, Ferede A, Smyth G, Little D. Venous anomalies in renal transplantation: an accessory left-sided IVC in a live kidney donor. *BMJ Case Rep.* 2019;12. 10.1136/bcr-2019-232695.
2. Ji B, Tian X, Jing G, Zhang C, Cao G, Wu X et al. (2026). Living donor kidney transplantation in a donor with double inferior vena cava anomaly: A case report. *Chin J Organ Transplant (In Chinese).* 2022;43:431–433. 10.3760/cma.j.cn421203-20220405-00062

3. Sozzi G, Sottile DL. Para-aortic lymphadenectomy in double inferior vena cava. *Int J Gynecol Cancer*. 2026;36:102708. 10.1016/j.ijgc.2025.102708.
4. Baptista-Silva JC, Veríssimo MJ, Castro MJ, Câmara AL, Pestana JO. Anatomical study of the renal veins observed during 342 living-donor nephrectomies. *Sao Paulo Med J*. 1997;115:1456–9. 10.1590/s1516-31801997000300011.
5. Sakai H, Ide K, Ishiyama K, Onoe T, Tazawa H, Hotta R, et al. Renal vein extension using an autologous renal vein in a living donor with double inferior vena cava: a case report. *Transpl Proc*. 2012;44:1446–9. 10.1016/j.transproceed.2011.11.065.
6. Pal BC, Modi PR, Rizvi SJ, Chauhan R, Kumar S, Gandhi SP, et al. Pure retroperitoneoscopic donor nephrectomy in duplication of inferior vena cava: A series of four cases. *Urol Ann*. 2017;9:335–8. 10.4103/ua.Ua_59_17.
7. El Hennawy HM, Al Faifi AS, Al Atta E, Safar O, Shalkamy O, Elatreisy A, et al. Successful Completion of Left Laparoendoscopic Single-Site Donor Nephrectomy in a Patient with Duplicated Inferior Vena Cava: Case Report and Review of Literature. *Exp Clin Transpl*. 2023;21:272–4. 10.6002/ect.2023.0009.
8. Sohrabi C, Mathew G, Maria N, Kerwan A, Franchi T, Agha RA. The SCARE 2023 guideline: updating consensus Surgical CAse REport (SCARE) guidelines. *Int J Surg*. 2023;109:1136–40. 10.1097/js9.0000000000000373.
9. Wu YL, Yang GK, Chen Q, Tang Y, Zhang JH, Wu SJ, et al. Case Report: Imaging features of a new type double inferior vena cava malformation and review. *Front Cardiovasc Med*. 2023;10:1298071. 10.3389/fcvm.2023.1298071.
10. Miyauchi Y, Noda T, Miura N, Kikugawa T, Saika T. Venous reconstruction using a Y-shaped saphenous vein in kidney transplantation: A report of three cases. *IJU Case Rep*. 2021;4:146–9. 10.1002/iju5.12266.
11. Anwar H, Pardi A, Patel M, Raquib AR, Andrews K, Broniak C et al., *Duplicated Inferior Vena Cava: A Case Study With Clinical Implications*. *Cureus*. 2025;17:e81652. 10.7759/cureus.81652.
12. Arévalo Pérez J, Gragera Torres F, Marín Toribio A, Koren Fernández L, Hayoun C, Daimiel Naranjo I. Angio CT assessment of anatomical variants in renal vasculature: its importance in the living donor. *Insights Imaging*. 2013;4:199–211. 10.1007/s13244-012-0217-5.
13. Valenzuela Fuenzalida JJ, Vera-Tapia K, Urzúa-Márquez C, Yáñez-Castillo J, Trujillo-Riveros M, Koscina Z, et al. Anatomical Variants of the Renal Veins and Their Relationship with Morphofunctional Alterations of the Kidney: A Systematic Review and Meta-Analysis of Prevalence. *J Clin Med*. 2024;13. 10.3390/jcm13133689.
14. Popov Z, Stankov O, Stavridis S, Saidi S, Ivanovski O, Spasovski G, et al. Management of Multiple Renal Arteries and Unusual Venous Anatomy During Kidney Transplant: From a Simple Technical Problem to a Graft-Saving Procedure. *Exp Clin Transpl*. 2020;18:763–70. 10.6002/ect.2019.0314.
15. Forbes KL, Prieto L, Duarte-Caceres D. Successful Transcatheter Pulmonary Valve Replacement Via the Azygous Vein in a Patient With Interrupted Inferior Vena Cava. *JACC Case Rep*. 2025;30:105341.

16. Huseynov A, Şengul H. Effect of multi-artery renal grafts on patient outcomes in living donor kidney transplantation. *Langenbecks Arch Surg.* 2025;410:312. 10.1007/s00423-025-03880-9.

Tables

Table 1. Summary of prior D-IVC + multiple renal vein cases; data from [5-7,9] not reproduced here for brevity.

Author (Year)	D-IVC Type	No. of Renal Veins	Surgical Strategy	Outcome
Sakai et al. (2012)[5]	Type I	2	Autologous vein graft	Good
Pal et al. (2017)[6]	Type I	2	Standard anastomosis	Good
Hennawy et al. (2023)[7]	Type I	2	Laparoendoscopic single-site	Good
Miyauchi et al. (2021)[9]	Type I	3	Y-shaped saphenous graft	Good
Present case	Type I	3	Individual anastomosis (3 veins to EIV)	Excellent

Figures

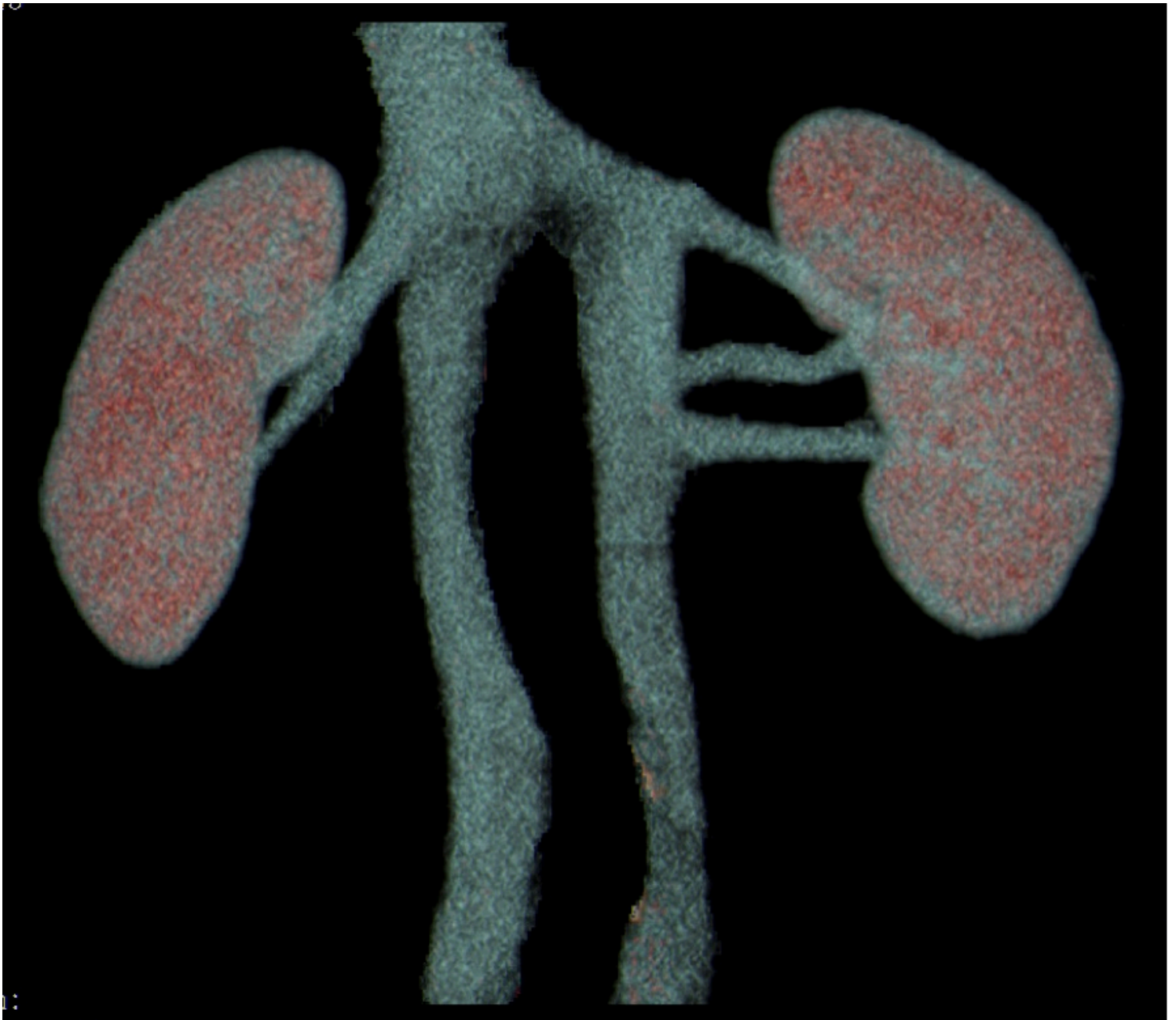


Figure 1

Preoperative CTA showing D-IVC (left IVC runs parallel to aorta, joins left renal vein, then crosses to right IVC).

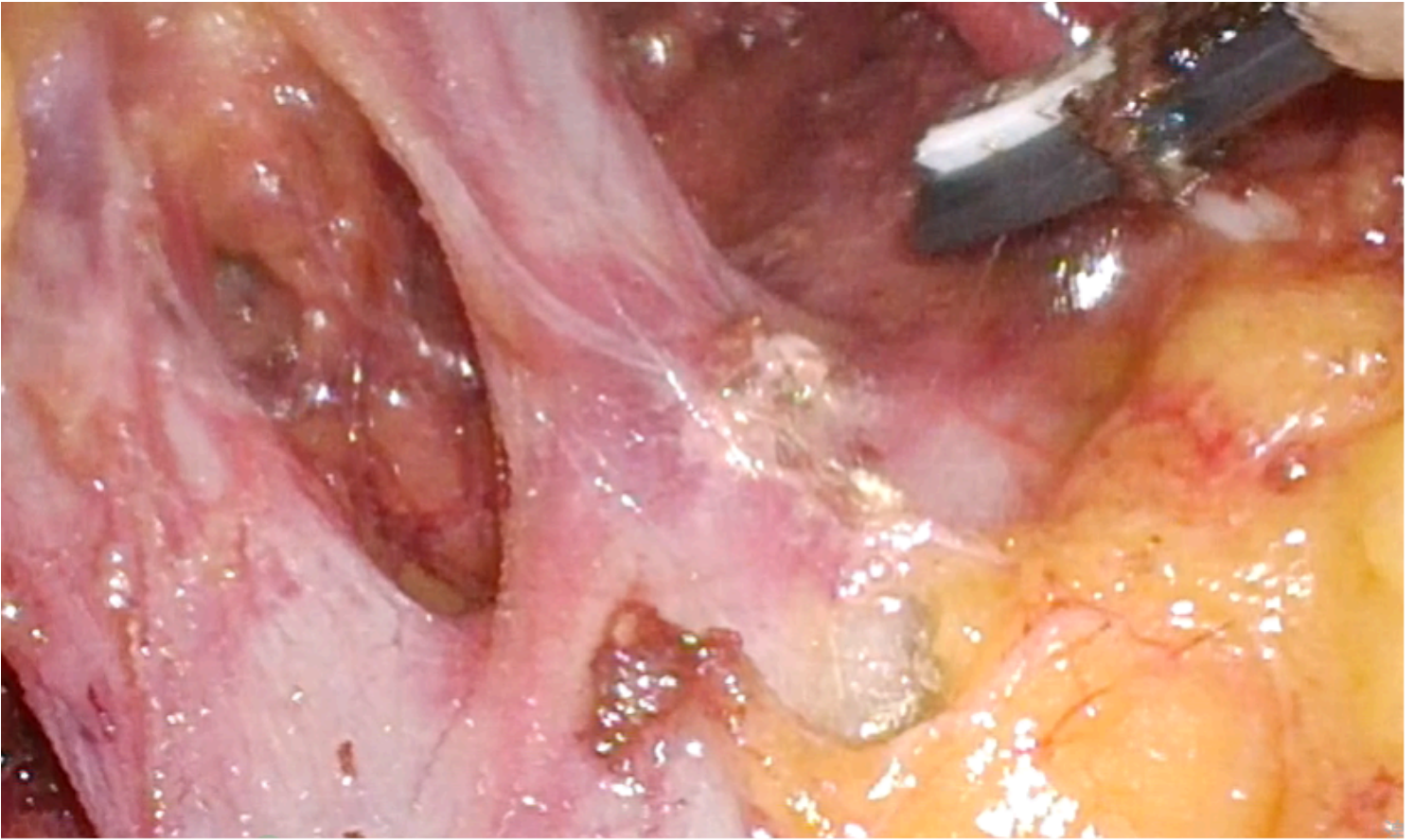


Figure 2

Intraoperative view of three left renal veins (LRV) entering the left IVC.

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