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Case Report

Laparoscopic Donor Nephrectomy and Ligation of Duplicate Inferior Vena Cava: A Case Report and Review of Literature

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Abstract

Introduction: Laparoscopic donor nephrectomy can be technically challenging in the presence of anomalous vasculature. We report the case of a 24 year old female with a duplicated inferior vena cava (IVC) who successfully underwent laparoscopic donor nephrectomy and division of the left duplicated inferior vena cava in order to lengthen the renal vein with no long term adverse consequences for the donor. The pertaining literature is reviewed.

Methods: Publications reporting the presence of a duplicated IVC during laparoscopic or open nephrectomy from January 1991 to July 2014 were identified from a Medline and Embase search. Due to a dearth in the number of reports, publications on nephrectomy carried out for renal malignancy were also included and analysed separately

Results: There were seven case reports describing eleven patients undergoing donor nephrectomy in the presence of a duplicate IVC. There were only two previous instances where the duplicate segment of the IVC was sacrificed and both were during open donor nephrectomy. One of these cases resulted in ipsilateral lower limb oedema

Conclusion: Our results suggest that the laparoscopic donor nephrectomy can be safely performed in the presence of a duplicate IVC. The duplicate segment may be sacrificed in an attempt to lengthen the renal vein and facilitate dissection but this may result in oedema of the ipsilateral lower limb.

Introduction

The length of the donor renal artery and vein is crucial in a renal transplant and shorter vessels are generally recognised to make the procedure more difficult [1,2]. During donor nephrectomy every effort is made to maximise the length of the vessels retrieved but this can be limited during live donor surgery due to proximity to the aorta and inferior vena cava (IVC). Rarely, the length of the vessels that can be retrieved may be impeded by anomalous vasculature.

Duplication of IVC is a relatively rare anatomical variant and has a reported incidence of 0.3 to 0.4% [1] and can present unique challenges during the course of a donor nephrectomy as it reduces the length of the renal vein to be retrieved. We present the case of a patient who underwent a laparoscopic left donor nephrectomy along with division of the duplicate IVC (D-IVC) and review the pertaining literature to ascertain the feasibility of performing laparoscopic donor nephrectomy in such cases.

Methods

Publications reporting the presence of a D-IVC during either laparoscopic or open nephrectomy from January 1991 to July 2014 were identified from a Medline and Embase database search. Original articles and reviews published in English were collated. Search terms included 'double, doubled, duplication, IVC', 'vena-cava' and 'duplicate' (Figure 1). References of relevant articles were reviewed to identify further publications.

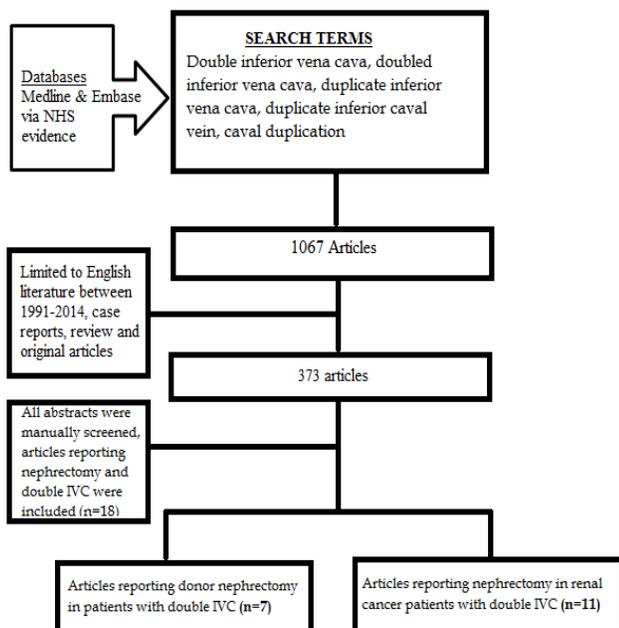


Figure 1. Flow chart of the literature search.

Inclusions and exclusions

All English language publications on duplicate IVC were eligible for inclusion. Studies including patients undergoing both laparoscopic or open donor nephrectomy were included. Due to the paucity of the number of reports, publications on nephrectomy carried out for renal malignancy were also included and analysed separately to determine the consequences of division of the duplicate IVC segment.

Case Presentation

A 24 year old generally fit and well female, presented herself as a kidney donor. Previous medical history included only a tonsillectomy and examination findings were unremarkable.

Computerised tomographic (CT) angiogram showed a single left renal artery, 6mm in diameter, and a single left renal vein passing anterior to the aorta in the usual position. It was however joined inferiorly by a much larger vessel measuring 1 cm in diameter about 5 mm lateral to the crossing point of the left border of the aorta, which was draining the left lower limb and therefore was a D-IVC. During its subsequent course it curved medially to drain into the main IVC (Figure 2). The right side had two renal arteries and therefore it was decided to perform a left donor nephrectomy.

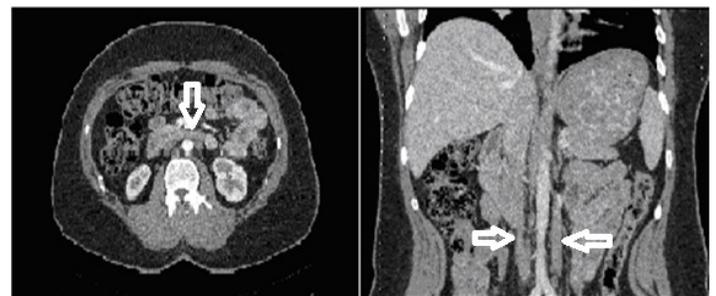


Figure 2. Spiral CT angiogram demonstrating the D-IVC.

The patient underwent a total laparoscopic left nephrectomy *via* two 10 mm and a 5 mm port. The left colon was mobilised and the perinephric fat and ureter were dissected using a Harmonic scalpel. After dissecting the renal vessels, the length of the renal vein was not thought to be adequate and therefore it was decided to divide the duplicate IVC where it was draining into the renal vein. It was initially test clamped for a period of five minutes during which no signs of venous congestion were evident and thereafter it was divided using a linear stapler cutter (Ethicon Echelon flex®) inferior to the renal vein. This allowed an additional 2 centimetres to be added to the length of the renal vein and also facilitated the subsequent dissection of the renal artery. After complete mobilisation of the kidney, the renal artery was divided at the usual position where it was arising from the aorta using a linear stapler cutter (Ethicon Echelon flex®) followed by the renal vein which was divided further proximally towards the aorta. The kidney

was retrieved *via* a 6 cm Pfannenstiel incision using an endo-catch device.

The patient made an uneventful postoperative recovery and was discharged on the third postoperative day. During follow up, two weeks after surgery, she was found to have a bluish discoloration and oedema of the left leg. A venous duplex scan did not demonstrate any evidence of venous obstruction. The symptoms resolved spontaneously in 4 to 6 weeks and she has been asymptomatic one year following the procedure.

Results of literature review

There were seven case reports presenting eleven patients undergoing donor nephrectomy in the presence of a D-IVC (Table 1) [3-9]. Four of these were performed *via* a hand-assisted laparoscopic approach [3,5,6,8] and only one was totally laparoscopic. There were only two instances where the duplicate segment of the IVC was sacrificed and this was during open donor nephrectomy [4,9]. One of the cases where D-IVC was resected resulted in ipsilateral lower limb oedema [9]. A breakdown of the publications is presented in Figure 1.

We further looked into publications of resection of renal cell tumours in patients with D-IVC (Table 2). There were eleven case reports [10-20], two of which described *en-bloc* resection of the ipsilateral D-IVC and none of them reported any complications [11,15].

Discussion

Laparoscopic donor nephrectomy can be technically challenging in the presence of anomalous vasculature. The purpose of this article was to review the literature to assess the possibility of performing a laparoscopic donor nephrectomy in the presence of a duplicate IVC and also highlight the feasibility of laparoscopically dividing the duplicate segment of IVC in order to lengthen the renal vein.

A review of the literature revealed that laparoscopic donor nephrectomy in the presence of a duplicate IVC has been reported in five cases in the past (Table 1). Another two case reports presented six cases where open donor nephrectomy was performed in the presence of duplicate IVCs (Table 1) and the duplicate segment of IVC was divided in two of these. One of the cases where the duplicate IVC was resected resulted in transient pelvic and left thigh swelling which recovered spontaneously with no long-term sequelae [9], whereas the other did not report to have any complications. In order to further determine the result of division of a duplicate IVC segment, cases describing nephrectomy for renal malignancy were also reviewed. Two further case reports were thus identified where resection of D-IVC was necessitated due to the invasion of the duplicated segment by tumour thrombus and none of them reported any postoperative lower limb oedema [11,15] (Table 2).

To our knowledge, we are reporting the first case where a D-IVC has been divided during laparoscopic donor nephrectomy. Our patient developed mild oedema of the ipsilateral lower limb which appears to be similar to that reported by Davari *et al* [9]. This was transient with no long term consequences and it is plausible that the symptoms resolved due to development of venous collaterals. Interestingly the other three cases where the D-IVC segment was resected did not develop any complications. In the report by Nakatani *et al.* only a partial resection of the duplicate segment seems to have been carried out [4], whereas in the other two instances it was resected for malignancy [11,15] and it is likely that venous collaterals were already present due to the tumour obstructing the duplicate IVC segment.

The embryonic development of the IVC occurs during the 6th and 7th week of gestation and it arises from series of complex anastomoses and regression between the three paired post-cardinal, subcardinal and supracardinal veins which sequentially form in the developing embryo [21,22]. Failure of any of these steps to proceed can result in a spectrum of anomalies, including duplication, which results from failure of the left supracardinal vein to regress [23]. In this condition the left lower limb is drained by an ipsilateral vein running on left side of the aorta which drains into the main IVC via the left renal vein. The two IVCs often have intercommunicating collaterals [24,25].

The presence of inter-iliac collaterals probably renders the division or resection of the duplicate segment safer. The authors tried to identify any collateral intra-operatively by clamping the duplicate IVC for about five minutes prior to resection and since the duplicate IVC did not engorge it was thought to be safe to divide. In the current report, inter-iliac collateral were not evident on the preoperative CT angiogram. Other radiological techniques such as duplex ultrasound scan, or magnetic resonance angiography [26] may be helpful, although plain venography of the inferior vena cava has been reported to supersede these in detecting inter-iliac collateral [15,16,27,28].

There have been case reports describing thrombi developing within D-IVCs, although it is not clear if these were due to the duplicate segment itself [24]. The results of our review did not reveal any thrombotic complications developing as a result of donor nephrectomy being performed in the presence of D-IVC and additional thromboprophylaxis was not used in any of the cases.

Conclusion

Duplicate IVC is not a common condition and the paucity of publications on donor nephrectomy in the presence of D-IVC reflects this. The limited available literature suggests that the presence of a duplicate IVC is not an absolute contraindication for performing a laparoscopic left donor nephrectomy. Whenever this anomaly is suspected, preoperative duplex

Table 1. Cases of duplicate inferior vena cava in patients undergoing donor nephrectomy.

Author	Age (years), sex	Image Modality	Type of donor surgery	IVC Resected	Postoperative complications	Period of follow-up
Kennealey, PT. et al (2009) [3]	49, Female	CT angiogram	Left, hand-assisted nephrectomy	No	None	NR
Nakatani, T. et al (2004) [4]	40, Male 49, Female 44, Female 67, Female	CT angiogram venogram	Open left nephrectomy (2) Open right nephrectomy (2)	Yes (1) No (3)	None None None	NR
Wu, CT. et al (2004)[5]	35, Female	CT angiogram	Left, hand-assisted nephrectomy	No	None	Nine months
Fronek, JPJ. et al (2006)[6]	44, Male	CT angiogram	Left, hand-assisted retroperitoneal nephrectomy	No	None	Four months
Christakis, P.G. et al (2012) [7]	32, Male	CT angiogram	Left laparoscopic	No	Scrotal oedema	Six weeks
Sakai, H. et al (2012) [8]	61, Female	CT angiogram	Left, hand-assisted retroperitoneal nephrectomy	No	None	Six months
Davari, HZ. et al (2007) [9]	NR	None	Open left nephrectomy (two cases)	Yes No	Transient pelvic and left thigh oedema	NR

IVC= inferior vena cava, CT = computed tomography, NR= not reported

ultrasonography or magnetic resonance venography may be sought in order to demonstrate the presence of venous collaterals which could reduce the chances of postoperative limb oedema. Wherever possible the duplicate segment of the IVC should be preserved, although in circumstances where it is felt that the length of the procured renal vein will not be adequate for the implantation procedure, the duplicate segment of the IVC may be divided. This carries a risk of transient oedema of the ipsilateral lower limb and the patient should be forewarned of this. There have been no reports of deep vein thromboses in patients undergoing donor nephrectomy in the presence of a

duplicate IVC.

Conflict of interest

All authors declare no conflicts of interest

Table 2. Cases of duplicate inferior vena cava in patients undergoing nephrectomy for malignancy.

Author	Age (Year), sex	Approach for nephrectomy	Image Modality	IVC Resected	IVC tumour thrombus	Follow up	Postoperative complication
Yang, B. et al (2012)[10]	21 Female	Laparoscopic left nephrectomy	CT scan FDG-PET/CT	No	No	3 months	None
Habuchi, T. et al (1993) [11]	77 Male	Open left nephrectomy	CT scan ^{99m} TcMAA Cavography	Yes	Yes	23 months	None
Kumar, S. et al (2008) [12]	62 Female	Open left nephrectomy	USS CECT 3D MRI	No	Yes	4 months	Small bowel ileus
Jiang, Y. et al (2011) [13]	16 Male	Laparoscopic partial right nephrectomy	CT scan Venogram	No	No	4 months	None
Ito, K. et al (2007) [14]	59 Male	Laparoscopic left nephrectomy	3D CT scan	No	No	NR	None
Abbasi, A. et al (2012) [15]	NR	Open right nephrectomy	CT scan Venogram	Yes	Yes	NR	None
Wang, L. et al (2012) [18]	76 Female	LESS left nephrectomy	CT scan	No	No	3 months	None
Wang, L. et al (2012) [17]	63 Male	Laparoscopic left nephrectomy	CT scan	No	No	NR	None
Wang, L. et al (2011) [19]	53 Male	LESS right nephrectomy	CT scan	No	No	6 months	None
Wang, L. et al (2012) [16]	49 Male	Laparoscopic (converted to open left nephrectomy)	CT scan	No	Yes	NR	None
De Melo, FPF et al (2001)[20]	71 Male	Open right nephrectomy	USS CT scan MRI	No	No	NR	None

IVC=inferior vena cava, NA= not applicable, NR= not reported, PEComas=perivascular epithelioid cell differentiation, FDG-PET CT=flurodeoxyglucose positron emission tomography computed tomography, RCC=renal cell carcinoma, ^{99m}TcMAA=technetium 99m macroaggregated albumin, USS= ultrasound scan, CECT 3D= contrast enhanced CT scan three dimensional, MRI= magnetic resonance imaging, LESS= laparoEndoscopic single site

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