Anatomical Variations of the Left Renal Vein During Laparoscopic Donor Nephrectomy

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ABSTRACT

Objectives. The aim of this study is to investigate the outcome of laparoscopic donor nephrectomy with vascular anomalies of the left renal vein.

Patients and Methods. Between August 2010 and September 2018, a total of 120 laparoscopic donor nephrectomies were performed at Kagoshima University. Among them, we experienced 7 cases of donors with anomalous left renal vein (circumaortic left renal vein n = 5, retroaortic left renal vein n = 1, left renal vein drainage into hemiazygos vein n = 1). We analyzed the following clinical outcomes: pneumoperitoneum time, estimated blood loss, warm ischemia time, length of hospital stay, and serum creatinine level of 1 month after surgery for evaluating the safety of laparoscopic donor nephrectomy.

Results. Among the 7 cases, 3 cases underwent transperitoneal approach, and 4 cases underwent retroperitoneal approach. The median pneumoperitoneum time was 168 (108–191) minutes. The median estimated blood loss was 90 (23–170) mL, and no donor required a blood transfusion. Median warm ischemia time was 4 (3–7) minutes. Length of hospital stay was 7 (6–9) days, and no readmission occurred. Median serum creatinine level of 1 month after surgery was 1.19 (0.84–1.74) mg/dL. Kidneys were transplanted successfully, and none of recipients required dialysis. Conclusions. Laparoscopic donor nephrectomy was safe for donors with an anomalous left renal vein. Preoperative recognition of anomalous left renal vein in computed tomography is important for avoiding hemorrhagic complication.

RENAL venous anomalies, mainly resulting from the embryological development, are relatively rare. However, these anomalies are potentially hazardous if the surgeon does not recognize them during renal surgery, including donor nephrectomy [1]. The left kidney is more preferred to surgeons than the right renal vein in renal transplantation because the left renal vein (LRV) is longer in length than right renal vein. Further, anomalies of renal vein are more common in LRV than that of right renal vein. It is crucial for the surgeons to recognize the running directions of the LRV to avoid unexpected hemorrhage and even death. Here we report anomalous LRV of living kidney donor and investigate the outcomes of laparoscopic donor nephrectomy with these anomalies.

PATIENTS AND METHODS

Donors With Anomalous LRV and Normal LRV

Between August 2010 and September 2018, a total of 120 laparoscopic donor nephrectomies were performed at Kagoshima University. Among them, we experienced 7 cases (5.8%) of living donor with anomalous LRV, which including 5 cases of circumaortic left renal vein (CLRV) (Fig 1A), 1 case of retroaortic left renal vein (RLRV) (Fig 1B), and 1 case of LRV drainage into the

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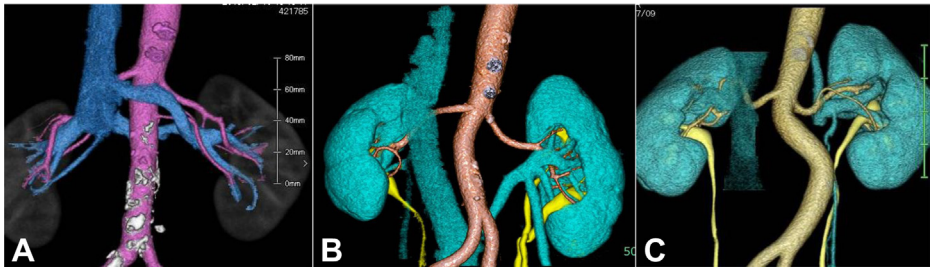

Fig 1. Computed tomography findings showed circumaortic left renal vein **(A)**, retroaortic left renal vein, Case 3 **(B)**, and left renal vein drainage into hemiazygos vein, Case 6 **(C)**.

hemiazygos vein (Fig 1C). Seven cases of donors with anomalous LRV were allocated to the anomalous LRV group. On the other hand, 113 cases of donors with normal LRV were allocated to the normal LRV group.

Surgical Procedure in Donors

Donor nephrectomies were performed by laparoscopic approach. Intraperitoneal and retroperitoneal approaches were 87 and 33 cases, respectively. All renal arteries and veins were taken with an endovascular staple load. In all cases, a hand can be placed in the abdomen through the hand port for optimal retraction of renal vessels.

Data Analyses and Statistical Methods

We analyzed the clinical outcomes as follows: pneumoperitoneum time (PT), estimated blood loss (EBL), warm ischemia time (WIT), initial urine output time, length of hospital stay, and serum creatinine level at 1 month after surgery. Furthermore, we compared these outcomes between the anomalous LRV group and normal LRV group for evaluating the safety of laparoscopic donor nephrectomy. All measures were expressed as the median (range) within each group. All analyses were carried out using the EZR software program [2]. The relationships between 2 groups were analyzed using Mann-Whitney U-test and Fisher's exact test. P values of $<.05$ were considered to indicate statistical significance.

RESULTS

In the anomalous LRV group, the median age was 63 (54–70) years old. There were 3 men and 4 women included in the group. The median body mass index was 24.7 (21.0–27.7) kg/m^2. As for the operative procedure, intraperitoneal or retroperitoneal approach was done in 3 and 4 cases, respectively. Two cases had other anatomical anomalies, 3 left renal arteries were identified in Case 2, and double ureters were identified in Case 4 (Table 1). The median PT, EBL, WIT, initial urine output time, length of hospital stay, and serum creatinine level at 1 month after surgeries of the anomalous LRV group were 168 (108–191) minutes, 90 (23–170) mL, 4 (3–7) minutes, 7 (3–9) minutes, 7 (6–9) days, and 1.19 (0.84–1.74) mg/dL, respectively (Table 2). The median PT of the anomalous LRV group was significantly shorter than that of the normal LRV group (168 vs 203 minutes, respectively; $P = .014$). There was no significant difference in EBL, WIT, initial urine output time, length of hospital stay, and serum creatinine level at 1 month after surgery between the 2 groups (Table 3). There were no donors who need transfusion during the surgeries or conversion to open surgeries. The postoperative courses were uneventful, and there were no recipients with delayed graft function.

DISCUSSION

In the embryologic development of the left renal vein, there are anastomotic communications between the subcardinal and supracardinal channels that form a collar of veins encircling the aorta. The ventral portion of the circumaortic collar persists as the normal left renal vein. If the dorsal

Table 1. Backgrounds of the Donor With Anomalous Left Renal Vein

Case	Age (y)	Sex	BMI (kg/m^2)	Approach	Types	Remarks
1	58	Male	22.5	Intra	CLRV	-
2	65	Female	22.2	Intra	CLRV	3 renal arteries
3	69	Female	27.7	Intra	RLRV	-
4	54	Male	25.1	Retro	CLRV	Double ureter
5	70	Female	25.0	Retro	CLRV	-
6	63	Female	21.0	Retro	Hemiazygos	-
7	50	Female	24.7	Retro	CLRV	-
Median	63	-	24.7	-	-	-

Abbreviations: BMI, body mass index; CLRV, circumaortic left renal vein; Hemiazygos, left renal vein drainage into hemiazygos vein; Intra, intraperitoneal approach; Retro, retroperitoneal approach; RLRV, retroaortic left renal vein; Types, types of left venous anomaly.

Table 2. Clinical Outcomes of the Donor With Anomalous Left Renal Vein

Case	PT (min)	EBL (mL)	WIT (min)	IUO (min)	LOS (d)	Cr 1 mo (mg/dL)
1	189	170	7	7	6	1.19
2	180	95	4	6	7	1.04
3	168	165	3	3	9	1.05
4	191	85	5	4	8	1.74
5	130	90	3	7	7	1.28
6	117	30	4	9	8	1.19
7	108	23	6	15	7	0.84
Median	168 (108–191)	90 (23–170)	4 (3–7)	7 (3–9)	7 (6–9)	1.19 (0.84–1.74)

Abbreviations: Cr 1 mo, serum creatinine level at 1 month after surgery; EBL, estimated blood loss; IUO, initial urine output time; LOS, length of hospital stay; PT, pneumoperitoneum time; WIT, warm ischemia time.

Table 3. Comparison of Clinical Outcomes Between Anomalous Vein Group and Normal Vein Group

	Anomalous LRV	Normal LRV	*P* Value
Number	7	113	-
PT (min)	168	203	.014
EBL (mL)	90	150	.105
WIT (min)	4	4	.410
IUO (min)	7	7	.504
LOS (d)	7	7	.405
Cr 1 mo (mg/dL)	1.19	1.04	.309

Abbreviations: Cr 1 mo, serum creatinine level at 1 month after surgery; EBL, estimated blood loss; IUO, initial urine output time; LOS, length of hospital stay; PT, pneumoperitoneum time; WIT, warm ischemia time.

portion of this collar persists, then the left renal vein is posterior to the aorta, forming RLRV. The CLRV is due to the persistence of the intersupracardinal anastomosis, left subsupracardinal anastomosis, and left dorsal renal vein [1]. In this study, we experienced rare case of LRV drainage into the hemiazygos vein (Case 6), which might be classified into additional anomalies of the renal veins. At the present time, there are few reports about this rare type of anomalies. To the best of our knowledge, this is the first report of a living donor with this type of anomalies. According to the previous review, the median incidence of CLRV and RLRV were 7.0% (0.6–17.0) and 1.7% (0.5–3.5) in cadaver dissections and 1.8% (0.1–10.0) and 2.2% (0.4–9.3) in clinical investigations [3]. In this study, anomalous LRV were detected in 5.8% of the donors. The incidence of CLRV and RLRV were each 4.2% and 0.8%, suggesting almost same results of the previous review. Thus, imaging screening of potential kidney donors seems to be critical. These anomalies should be recognized in preoperative computed tomography (CT) with a careful inspection. In the previous study for incidence of LRV anomalies in routine abdominal CT scans, CLRV was detected in 0.9%, and RLRV was detected in 2.3% of 984 cases [4]. We also recognized all cases of anomalous LRV in CT scan, preoperatively. Regarding clinical outcomes, the previous study demonstrated no significant differences between donors with venous anomalies and those without venous anomalies [5]. We also found no significant differences in clinical outcomes between the 2 groups except for PT in this study. The reason why PT was shorter in anomalous LRV group is the difference of surgical approach. The ratio of retroperitoneal approach in the anomalous LRV group was higher than in the normal LRV group (57% vs 26%). Additionally, PT of retroperitoneal approach (n = 33) was significantly shorter than intraperitoneal approach (n = 87) in our hospital (148 vs 219 minutes, $P < .01$). As a result, PT was shorter in anomalous LRV group. Therefore, we conclude that renal venous anomalies had no correlation with the PT. These results demonstrated that clinical outcomes of laparoscopic donor nephrectomy for anomalous LRV did not differ from those for normal LRV. In view of the kidney's anatomy, the retroperitoneal approach may have the advantage of direct access to the renal artery surrounded by anomalous LRV.

CONCLUSION

In conclusion, laparoscopic donor nephrectomy was safe for donors with anomalous LRV. Preoperative recognition of anomalous LRV in CT is important for avoiding hemorrhagic complication.

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