

Original Research Article

Right renal vein lengthening with cava patch in cadaveric donor kidney transplantation: cohort study

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ABSTRACT

Background: Right kidney transplant can become a surgical challenge, due to anatomical length disparity between the right and left veins. From 2011, lengthening of the right renal vein has been used in our program. The objective was to evaluate the outcome among kidney transplant recipients with or without the use of a cava patch, comparing safety, complications and patient / graft survival in both groups.

Methods: Retrospective single center cohort study between 2011-2020 in a Kidney transplant program at Mexico.

Results: 27 right cadaveric kidney transplant recipients were identified, 13 (48%) with and 14 (52%) without right renal vein lengthening (RRVL). Median overall operative time was 135 (120-157) minutes, with no significant difference between groups ($p=0.181$), even in overweight or obese recipients. Perioperative bleeding and postoperative drainage output was similar in both groups. There were two graft failures among recipients without RRVL one due to arterial bleeding and the other secondary to venous thrombosis. After one year of follow up, renal graft function and graft survival was similar in both groups.

Conclusions: RRVL technique is safe and facilitates anastomoses in complex cases. Although no statistically significant difference in operative time was found between the groups, the RRVL technique in overweight / obese patients was thirty minutes faster. Routine use of this technique is suggested in cadaveric donor right kidney transplants.

Keywords: Right kidney transplant, Cava patch, Bench-surgery

INTRODUCTION

Right kidney transplantation (KT) can become a surgical challenge, because anatomically the left renal vein (LRV) is twice as long compared to the right renal vein (RRV) (LRV 5.9 ± 1.5 cm versus RRV 2.4 ± 0.78 cm) making a more demanding anastomosis; especially in obese recipients, when the same fossa is to be used for re-

transplantation and/or in transplants to the left iliac vessels where by anatomy they are located in deeper planes.¹⁻⁴

Therefore, multiple surgical techniques have been described for managing these short veins, including the use of biological allografts such as vena cava segments, LRV or gonadal vein; biological autografts such as saphenous vein, as well as synthetic materials like dacron or

polytetrafluoroethylene, allowing vascular elongation for up to 3 to 6 cm.⁵⁻¹⁰

In our Kidney transplant program from November 1987 to March 2020, 713 KT, 561 (78%) and 152 (22%) of living and deceased donors respectively, have been performed. Since 2011, right renal vein lengthening (RRVL) technique has been used in bench surgery. The overall aim of the study was to assess outcome among KT recipients with or without RRVL, comparing safety of the surgical technique, complications and patient / graft survival in both groups.

METHODS

Retrospective single center cohort study between 2011-2020 at the Kidney transplant program at the High Specialty Medical Unit, “Ignacio García Téllez” National Medical Center, Mexican Social Security Institute, Yucatán, Mexico.

Study population

Our inclusion criteria were recipients between ages 18-65, of a right kidney graft from a deceased donor with or without RRVL, and completed the first-year follow-up, excluding those with incomplete clinical records. Comparison of demographic and clinical characteristics by age, gender, body mass index, etiology of chronic kidney disease (CKD), time on renal replacement therapy (RRT) prior to KT; in deceased donors: cause of death, gender, age, Kidney donor profile index (KDPI) and Kidney donor risk index (KDRI); transplant surgery variables: graft anatomical features (number of arteries and site of anastomosis), characteristics of the surgical procedure (operative time, bleeding, transfusions, intraoperative urine output and type of induction). During follow-up, we evaluated: post-surgical complications (reoperation, fluid collections), drain output, primary and delayed graft function, incidence of rejection, estimated glomerular filtration rate (eGFR) by the Chronic kidney disease epidemiology collaboration (CKD-EPI) equation and 1-year graft survival.

Surgical technique

Several techniques have been described for RRVL using vena cava allograft (11-13). In our program, we carried out the lengthening through transverse incisions to the vena cava 3 mm above and below the ostium of both LRV and RRV, suturing the openings within the supra and infrarenal cava with continuous running monofilament polypropylene 6-0 suture, as shown in Figure 1 (A-B). Subsequently, any leak was verified by arterial infusion with custodiol HTK preservation solution and gentle outflow occlusion to promote venous engorgement (figure 1 (C-D)); end -to-side venous anastomosis was performed in all cases with a continuous running fashion (Figure 1 (E-F)).

With the RRVL, an end-to-side arterial anastomosis could be performed avoiding artery kinking, as shown in figure 2. Especially when multiple renal arteries or extensive atheromatous plaques were found and Carrel’s patch was preserved, as shown in figure 3.

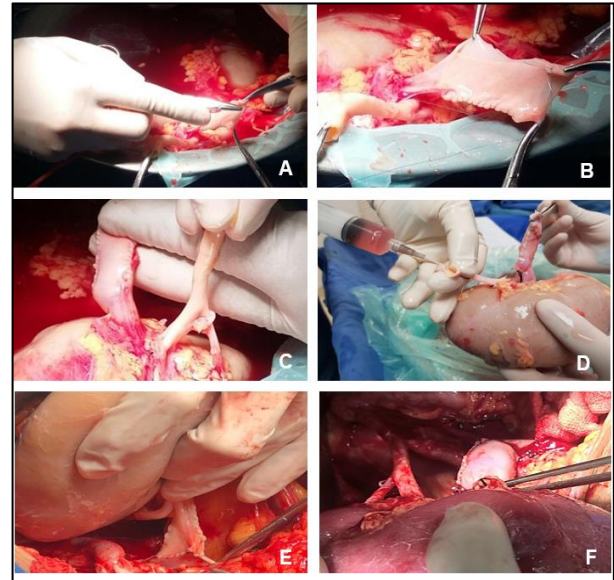


Figure 1: Technique for right renal vein lengthening. (A and B) vena cava raffia; (C and D) leak testing; (E and F) raffia and anastomosis.

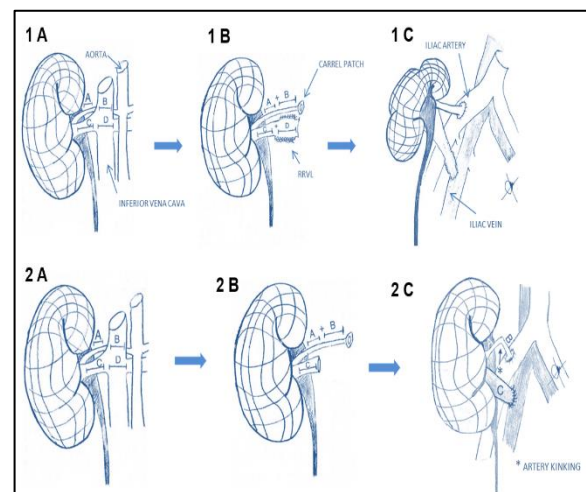


Figure 2: Schematic surgical drawings of the anastomosis without and with arterial kinking. Right renal vein lengthening with (1A-1C) and without cava patch (2A-2C). Schematic surgical drawings of the anastomosis without (1C) and with (2C) arterial kinking if the RRVL is or not used and the complete length of the artery / Carrel patch is adopted.

Statistical analysis

Descriptive statistics were used according to the variable’s measurement level. Categorical variables are shown as frequencies and proportions. Numerical continuous

variables were evaluated with Kolmogorov-Smirnov's Z test; those with a normal distribution are presented as means and standard deviation, while those without a normal distribution, as medians and minimum-maximum. Two-group comparison was performed with the chi square test for categorical variables and Fisher's exact test if warranted, and either Student's t or Mann-Whitney's U was used for continuous numerical variables. Time-dependent events were analyzed with the Kaplan-Meier method and results were compared with the log rank test and the Cox proportional hazard model. A two-tailed p value below 0.05 was considered significant in all analyses. The STATA version 13 statistical package (College Station, TX, USA) was used.

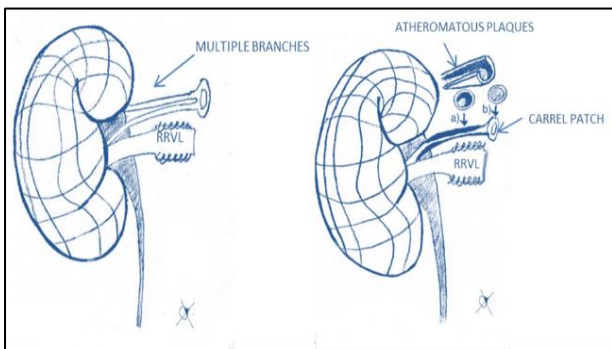


Figure 3: Schematic surgical drawings when multiple renal arteries or extensive atheromatous plaques are found. Right renal vein lengthening with cava patch. a) Atheromatous plaques b) Carrel patch. Schematic surgical drawings when multiple renal arteries or extensive atheromatous plaques are found and a single or wider anastomosis is preferred with an aortic patch.

RESULTS

From November 2011 to February 2020, 27 right cadaveric kidney transplants recipients were identified, 13 (48%) were men; mean age was 38.1±9.5 years, recipients with RRVL were older than recipients without RRVL (41.8±9.4 versus 34.5±8.6; p=0.04), main cause of CKD was unknown 20 (74%), 14 (51.8%) were on peritoneal dialysis prior KT, median time on RRT was 7 (4-9) years prior KT; 13 (48.1%) had overweight or obesity. Most donors were men (22, 84.4%), mean age was 33.8±12.9 years, 18 (67%) had traumatic brain injury as cause of brain death, 13 (48%) were overweight or obese, median KDPI and KDRI were 28 (13-48) and 0.8 (0.6-0.9) respectively, other baseline conditions of the cohort and comparisons between groups are shown in table 1.

About graft procurement procedure and graft anatomical characteristics, 88% renal veins underwent end-to-side external iliac implantation; remaining surgical approaches varied from seizing of common iliac vein, vena cava or left gonadal vein, the latter due to hemodialysis catheter-associated stenosis. About the artery, 81% were single, 11% had double branches and 7% triple. Although in most

cases (77%) arterial anastomosis was performed to external or common iliac artery, end-to-end hypogastric anastomosis was also performed in some cases.

Median cold ischemic time was statistically significant greater in RRVL recipients (1380 (780-1440) minutes versus 589 (420-870) minutes; p=0.017); there were no significant difference between operative time in both groups, even in overweight or obese recipients, other kidney graft and transplant surgery characteristics were similar between groups as shown in table 2.

Perioperative blood loss was similar in both groups; only one recipient without RRVL required blood transfusion, as shown in figure 3. Postoperative doppler ultrasound was normal in 92% of cases, 3 recipients without RRVL developed perinephric fluid collections of 30, 180 and 195 cc on days 3, 11 and 18 after KT, respectively. All fluid collections were located in the upper pole of the grafts, without clinical significance and received conservative treatment.

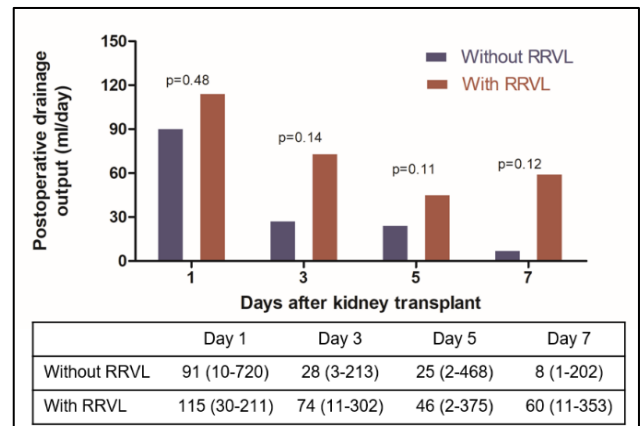


Figure 4: Postoperative drainage output. RRVL, right renal vein lengthening; postoperative bleeding, ml/day, median (min-max).

During follow up period, there were two graft failures among recipients without RRVL. One patient had two postoperative surgeries, on days 1 and 11 due to arterial bleeding at the hypogastric anastomotic site, transplantectomy was performed in the last surgery; the second recipient, developed graft venous thrombosis associated with diastolic hypotension at trans and postoperative period. During follow-up, 8 (29.6%) recipients developed delayed graft function, similar between groups. At first year median estimated glomerular filtration rate was 68.5 (39.6-82.8) ml/min/1.73 m², with no differences for both groups. (Figure 4).

Induction with antithymocyte globulin (Thymoglobulin®, Sanofi-Genzyme, Lyon, France) was frequent in recipients with RRVL (11 (84.6%) versus 4 (28.5%) recipients without RRVL; p=0.003). Almost all patients (21, 61.7%) were under immunosuppressive maintenance therapy with cyclosporine, mycophenolate mofetil and prednisone.

The incidence of acute rejection was 2 (7.4%), recipients without RRVL did not present rejection events. One-year graft survival was similar in both groups ($p = 0.375$). (Figure 5).

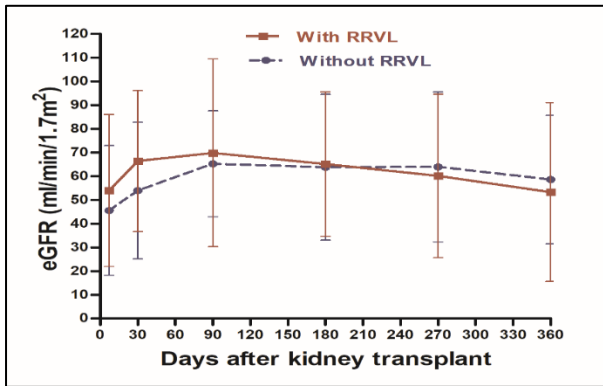


Figure 5: Renal Function at one year after transplantation. RRVL, right renal vein lengthening; eGFR estimated glomerular filtration rate.

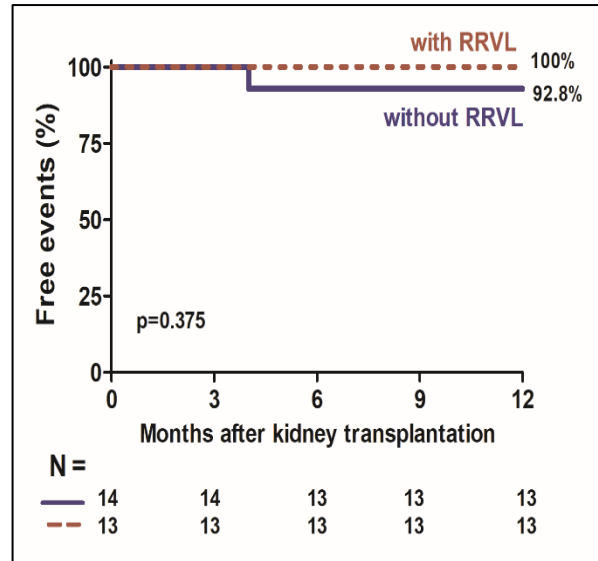


Figure 6: One-year graft survival rate. RVVL, right renal vein lengthening.

Table 1: Baseline characteristics.

Variable	Total (n=27)	With RRVL (n=13)	Without RRVL (n=14)	P value
	N (%)	N (%)	N (%)	
Male recipients	13 (48)	6 (46)	7 (50)	0.842
Age at KT (mean±S.D.) years	38.1±9.5	41.8±9.4	34.5±8.6	0.046
Cause of CKD,				
Unknown	20 (74)	9 (69)	11 (78.5)	0.608
Nephrolithiasis	1 (3.7)	0	1 (7.1)	
Other	3 (11.1)	2 (15.3)	1 (7.1)	
Polycystic kidney	3 (11.1)	2 (15.3)	1 (7.1)	
Years on dialysis, (median, IQR)	7 (4-9)	8 (6-9)	5 (4-9)	0.123
RRT modality prior KT				
Peritoneal dialysis	14 (51.8)	5 (38.4)	9 (64.2)	0.348
Hemodialysis	4 (14.8)	2 (15.3)	2 (14.2)	
Both (PD+HD)	9 (33.3)	6 (46.1)	3 (21.4)	
Overweight/Obese Receptor,	13 (48.1)	8 (61.5)	5 (35.7)	0.180
Previous renal transplantation,	3 (11.1)	1 (7.6)	2 (14.3)	0.586
Male Donors,	22 (84.4)	8 (61.5)	12 (85.7)	0.869
Brain death cause				
Stroke	7(26)	4 (30)	3 (21.4)	0.337
TBI	18 (67)	9 (70)	8 (57.1)	
Other	2 (7)	0	3 (21.4)	
Donor age, (mean, SD)	33.8 ±12.9	31.9 ± 14.6	37.6 ± 8.4	0.443
Overweight/Obese Donor	13 (48)	8 (61.5)	5 (35.7)	0.180
KDPI, (median, IQR)	28 (13-48)	20 (12-41)	44 (28-48)	0.177
KDRI, (median, IQR)	0.8 (0.6-0.9)	0.7 (0.6-0.9)	0.9 (0.8-0.9)	0.197

KT, kidney transplantation; RRVL, right renal vein lengthening; CKD, chronic kidney disease; IQR, interquartile range; RRT, renal replacement therapy ; PD; peritoneal dialysis; HD, hemodialysis; BMI, body mass index; TBI, traumatic brain injury; SD, standard deviation; KDPI, kidney donor profile index ; KDRI, kidney donor risk index.

Table 2: Kidney graft and transplant surgery characteristics.

Variable	Total (n=27)	With RRVL (n=13)	Without RRVL (n=14)	P value
	N (%)	N (%)	N (%)	
Number of arteries				
1 artery	22 (81.4)	10 (76.9)	12 (85.7)	0.787
2 arteries	3 (11.1)	2 (15.3)	1 (7.1)	
3 arteries	2 (7.5)	1 (7.5)	1 (7.1)	
Arterial anastomosis (n=22)				
End-to-side	17 (77)	7 (70)	10 (83.3)	0.457
End-to-end	5 (33)	3 (30)	2 (16.7)	
Arterial anastomosis placement (n=25)				
External iliac	13 (52)	6 (50)	7 (53.8)	0.827
Common iliac	5 (20)	3 (25)	2 (15.3)	
hypogastric	7 (28)	3 (25)	4 (30.7)	
Venous anastomosis placement				
External iliac	24 (88.8)	12(92)	12 (85.7)	0.397
Common iliac	1 (3.7)	0	1 (7.14)	
Cava	1 (3.7)	0	1 (7.14)	
Gonadal	1 (3.7)	1 (8)	0	
Cold Ischemic time, minutes (median, IQR)	840 (440-1020)	1380 (780-1440)	589 (420-870)	0.017
Operative time, minutes (median, IQR)	135 (120-157)	135 (117.5-144)	155 (130-170)	0.181
Operative time in overweight or obese recipients, minutes (median, IQR)	144 (132.5-175)	135 (127.5-161.5)	167.5 (142.5-180)	0.303
Perioperative bleeding, milliliters (median, IQR)	200 (200-300)	210 (200-300)	200 (150-300)	0.254
Perioperative urine output, milliliters	21 (77.8)	10 (76.9)	11 (78.5)	0.918
Perioperative blood transfusion,	1 (3.7)	0	1 (7.1)	0.326
Thymoglobulin induction	15 (55.5)	11 (84.6)	4 (28.5)	0.003

RRVL, Right renal vein lengthening; IQR, Interquartile range.

DISCUSSION

For the transplant surgeon, morphometric and anatomical variants of the right renal vessels are of particular interest since a short vein can make a technically difficult slower anastomosis, prolonging the ischemia time. Furthermore, excessive tension can cause suture line wall tearing. It also reduces graft mobility with poor visibility for bleeding management after reperfusion. The use of RRVL can be especially appropriate if thrombosis of the iliac vein is found, due to the need for a longer vessel for implantation in the cava or the gonadal vein.¹⁴⁻¹⁶

A short vein can also affect blood inflow in multiple ways. Artery kinking can result from the large disparity in length between the vein and right renal artery. This can be difficult to avoid if the surgeon wishes to preserve a Carrel patch.¹⁷⁻¹⁸ For example, when multiple renal arteries are found and a single anastomosis is preferred or in the event that extensive atheromatous plaques are observed and the use of an aortic patch can achieve a wider anastomosis.

Finally, unnecessary vessels tension can cause changes in the arterial and venous flow velocity, promoting thrombosis of either. En bloc vena cava removal during cadaveric organ harvesting is routine in our program, as in many others worldwide, and does not interfere with standard multiorgan procurement surgery.¹⁹ It may add a few more minutes of bench-surgery, but it makes KT much easier and can prevent serious complications during implantation.

Finally, our limitations were retrospective analysis where data are observational and surgical technique allocation was not randomized, the small sample size, unicentric study, and another limitation was that the RRVL procedure was made by only one surgeon with high experience in the technique. It is necessary to compare our results with larger multicentric cohorts.

CONCLUSION

RRVL technique is safe and facilitates anastomoses in complex cases (anatomical variants in recipient veins or donor arteries, as well as certain clinical settings example-

obese patients). Although no statistically significant difference in operative time was found between the groups, the RRVL technique in overweight / obese patients was thirty minutes faster. Routine use of this technique is suggested in cadaveric donor right kidney transplants.

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Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee

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