

# Kidney Transplant Anastomosis Internal or External Iliac Artery?

Wagner E Matheus, Leonardo Oliveira Reis, Ubirajara Ferreira, Marilda Mazzali,  
Fernandes Denardi, Victor A Leita, Renato N Pedro, Nelson R Netto Jr

**Introduction:** We compared the best technique for arterial anastomosis in kidney transplantation, end-to-side anastomosis to the external iliac artery or end-to-end anastomosis to the internal iliac artery.

**Materials and Methods:** A total of 38 patients with end-stage renal disease who received a kidney transplant from a deceased donor were randomized into two groups in order to undergo either end-to-end anastomosis to the internal iliac artery or end-to-side anastomosis to the external iliac artery. Length of arterial anastomosis, cold ischemia time, hospital stay, serum creatinine level, recovery of urinary output, and surgical and clinical complications during hospitalization were evaluated. After 3 years, in the patients with a functioning allograft, creatinine clearance measure, Doppler ultrasonographic study, survival, graft loss, and erectile function were compared between the two groups.

**Results:** Postoperative analyses showed similar recovery of urinary output ( $P = .39$ ) and creatinine ( $P = .95$ ) between the two groups. No differences in clinical ( $P = .55$ ) and surgical ( $P = .80$ ) complications or in hospital stay ( $P = .90$ ) were noted. The 3-year follow-up demonstrated no differences in Doppler ultrasonography results, creatinine clearance ( $P = .80$ ), patient survival ( $P = .22$ ), and graft loss ( $P = .72$ ). Erectile dysfunction was similar, being related only to pre-operative medical history and age.

**Conclusion:** Both techniques showed similar results in short- and long-term follow-ups. Larger prospective studies are warranted to clarify the risk of renal artery stenosis and development of erectile dysfunction.

**Keywords:** kidney transplantation,  
surgical anastomosis, renal artery,  
survival, erectile dysfunction

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## INTRODUCTION

Results of kidney transplantation have dramatically improved during the past 3 decades due to refinements in surgical instruments, new immunosuppressive regimens, improved kidney preservation, and advances in antimicrobial therapy.<sup>(1-4)</sup> However, the principles of the vascular anastomosis technique proposed by Carrel in 1902 and the accomplishment of the implantation in the iliac vessels

by Kuss in 1951 are still in use.<sup>(5-7)</sup> There are scarce data comparing vascular anastomosis techniques, and while there is no difference in the incidence of transplant renal artery stenosis following end-to-end (hypogastric artery) or end-to-side (common or external iliac artery) arterial anastomosis, most of data come from retrospective studies.<sup>(8)</sup>

Although some doubts persist about what the best technique for

Division of Urology, State University  
of Campinas, São Paulo, Brazil

**Corresponding Author:**  
Leonardo Oliveira Reis, MD  
Rua Votorantim, 51, Ap 43 – Vila  
Nova, Campinas, São Paulo, Brazil  
– 13073-090  
Tel: + 55 19 3521 7481  
E-mail: reisleo@unicamp.br

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arterial anastomosis is, end-to-side anastomosis to the external iliac artery is the preferred technique in deceased donors, because of the large Carrel patch obtained from the aorta.<sup>(9)</sup> On the other hand, in the absence of this advantage, when a kidney from a living donor is transplanted, the usual option is the end-to-end anastomosis to the internal iliac artery (hypogastric) at many centers.<sup>(9)</sup> However, no well-designed prospective studies comparing the results of these two techniques are available with long-term follow-up.

The purpose of this prospective study was to compare long-term outcomes of kidney transplants using two different techniques of arterial anastomosis to the internal or the external iliac artery.

## MATERIALS AND METHODS

### Patients

From May 2000 to February 2001, a total of 62 patients with end-stage renal disease received a kidney from a deceased donor, of whom 38 fulfilled the inclusion criteria and were divided into 2 groups; group 1 received end-to-end anastomosis to the internal iliac artery and group 2 underwent end-to-side anastomosis to the external iliac artery. The study protocol was approved by the Research Ethics Board and all of the patients consented to participate in the study.

Patients who received a primary kidney transplant and were older than 18 years of age at surgery were included. The exclusion criteria for donors were sepsis or cancer as death causes, as well as positive serology for human immunodeficiency virus and hepatitis B or C viruses. The exclusion criteria were atherosclerotic plaques in the iliac vessels, kidneys with multiple arteries, internal or external iliac artery stenosis, pancreas/kidney transplantation, diabetes mellitus, uncontrolled hypertension, and taking phosphodiesterase 5 inhibitors. All the surgical procedures were performed by the same surgeon and by unilateral retroperitoneal approach to the iliac vessels. Anastomosis was performed using 5-0 Prolene running stitches in the end-to-side fashion and separated stitches in the end-to-end fashion.

The patients were previously evaluated through anamnesis, physical examination, and pelvic computed tomography. Centralized computed generated randomization was utilized to define anastomosis technique in each pair of the kidneys from the same deceased donor to distribute equally the same donor between groups.

Erectile dysfunction (ED) was evaluated before and 3 years after the transplantation. All of the patients were asked to fill out the previously validated self-administered abridged 5-item version of the International Index of Erectile Function questionnaire (IIEF-5), also described as Sexual Health Inventory for Men, items 2, 4, 5, 7, and 15 from the full-scale IIEF.<sup>(10)</sup> The maximal score is 25; lower domain scores indicate impaired sexual function. The respondents were asked to report their experience over the past 60 days. The abbreviated score was used for its simplicity and immediacy.<sup>(11)</sup>

### Evaluation of Engraftment

Duration of arterial anastomosis, cold ischemia time, hospital stay, serum creatinine levels, recovery of urinary output, and surgical and clinical complications during postoperative period of hospitalization were evaluated. After discharge, the patients were evaluated every month until clinical and laboratory stabilization. Afterwards, the patients were followed every 2 to 3 months, depending on graft function and clinical outcome. During 3 years of follow-up, patients with a functioning graft were compared using biannual creatinine clearance (Cockcroft-Gault) and clinical complications. All these patients underwent Doppler ultrasonography with measurement of peak systolic velocity and resistive indexes in the main and segmental arteries, in order to exclude renal artery stenosis.<sup>(12)</sup>

### Statistical Analyses

Statistical evaluation between the 2 groups was performed using the Mann-Whitney test (for numerical variables without normal distribution) and the chi-square test (for categorical measures). Comparison of data variations between the groups over time was performed by the analysis of variance test. The Wilcoxon test was performed

to compare survival between the two groups. In all statistical analyses, the level of significance adopted was 5% ( $P < .05$ ).

## RESULTS

The mean age of the kidney transplant recipients was  $46.5 \pm 2.3$  years and  $51.9 \pm 1.5$  years in groups 1 and 2, respectively ( $P = .05$ ). Regarding gender, the two groups were similar (7 women and 12 men in group 1 versus 8 women and 11 men in group 2,  $P = .74$ ). The groups were also comparable in arterial anastomosis duration, cold ischemia interval, hospital stay, and follow-up (Table 1). No statistical difference between the curves of urinary flow recovery ( $P = .39$ ), and decrease in serum creatinine level ( $P = .95$ ) were encountered (Figures 1 and 2).

Surgical and clinical complications related to

kidney transplantation occurred in both groups with a comparable overall incidence ( $P = .80$  and  $P = .55$ , respectively). Surgical complications occurred in 4 patients (21.0%) in each group and clinical complications occurred in 4 patients in group 1 (21.0%) and 5 in group 2 (26.3%). Arterial thrombosis developed in 2 patients in group 1 (internal iliac artery anastomosis) and 1 in group 2 (external iliac artery anastomosis; Table 2).

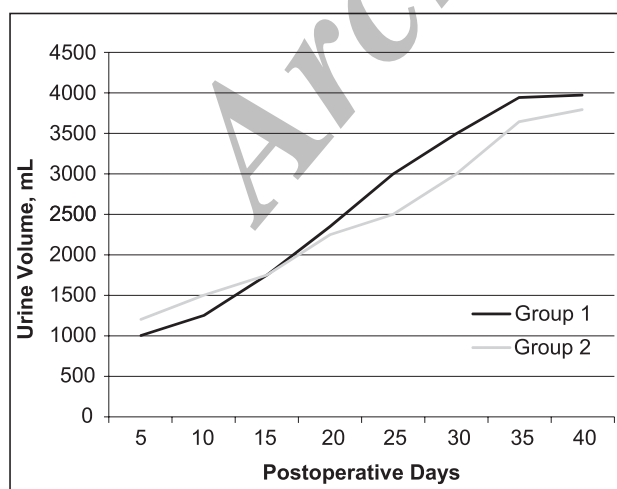
In the functioning grafts, renal flow measured by Doppler ultrasonography was also comparable between the two groups. The transplanted kidneys were evaluated for peak systolic velocity and resistive indexes in the main renal artery and the upper, middle, and lower segmental branches. No differences between groups were encountered when data was corrected by age (Table 3).

During the 3-year follow-up, there were 6 deaths

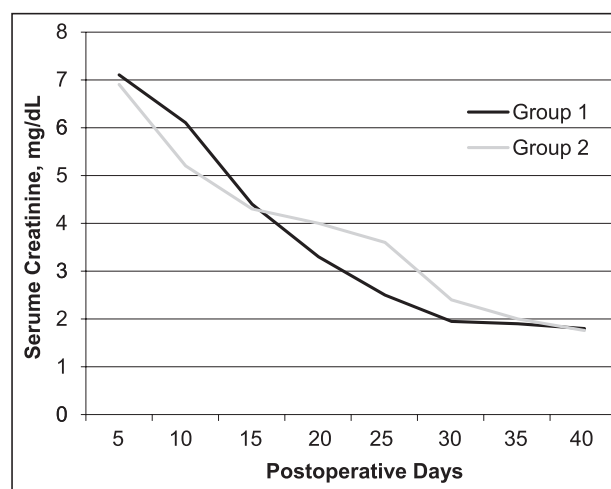
**Table 1.** Data on Demographic Criteria, Vascular Anastomosis, and Hospitalization in Two Groups of Kidney Transplant Recipients With Different Anastomosis Techniques\*

Variable	Kidney Transplant Recipients		P
	End-to-End Anastomosis to Internal Iliac Artery	End-to-Side Anastomosis to External Iliac Artery	
Number of patients	19	19	
Age, y	$46.5 \pm 2.3$	$51.9 \pm 1.5$	.05
Arterial anastomosis time, min	$21.6 \pm 5.5$	$25.6 \pm 6.8$	.07
Venous anastomosis time, min	$11.5 \pm 2.2$	$11.4 \pm 3.1$	.89
Cold ischemia time, min	$1085 \pm 246$	$1034 \pm 206$	.62
Hospital stay, d	$24.0 \pm 14.0$	$23.5 \pm 13.1$	.90
Follow-up, mo	$25.4 \pm 14.1$	$21.4 \pm 15.4$	.44

\*Data are presented as mean  $\pm$  standard deviation.



**Figure 1.** Recovery of urinary volume over time in the short-term follow-up of kidney recipients with end-to-end anastomosis to the internal iliac artery (group 1) and end-to-side anastomosis to the external iliac artery (group 2;  $P = .39$ ).



**Figure 2.** Decrease of serum creatinine level over time in the short-period analysis of kidney recipients with end-to-end anastomosis to the internal iliac artery (group 1) and end-to-side anastomosis to the external iliac artery (group 2;  $P = .95$ ).

**Table 2.** Surgical and Clinical Complications Following Kidney Transplantation in Two Groups With Different Anastomosis Techniques\*

Complications	Kidney Transplant Recipients	
	End-to-End Anastomosis to Internal Iliac Artery	End-to-Side Anastomosis to External Iliac Artery
Surgical		
Arterial thrombosis†	2 (10.5)	1 (5.3)
Urine leak	1 (5.3)	0
Lymphocele	1 (5.3)	0
Bleeding	0	1 (5.3)
Wound infection	0	1 (5.3)
Peritonitis‡	0	1 (5.3)
Clinical		
Rejection†	1 (5.3)	1 (5.3)
Sepsis‡	1 (5.3)	0
Cardiac disease‡	2 (10.5)	2 (10.5)
Benign prostatic hyperplasia	0	1 (5.3)
Genital herpes	0	1 (5.3)

\*Numbers in parentheses are percents.

†These complications resulted in 5 graft losses.

‡These complications resulted in 6 deaths.

**Table 3.** Comparison of Doppler Ultrasonography Results in Two Groups of Kidney Transplant Recipients With Different Anastomosis Techniques\*

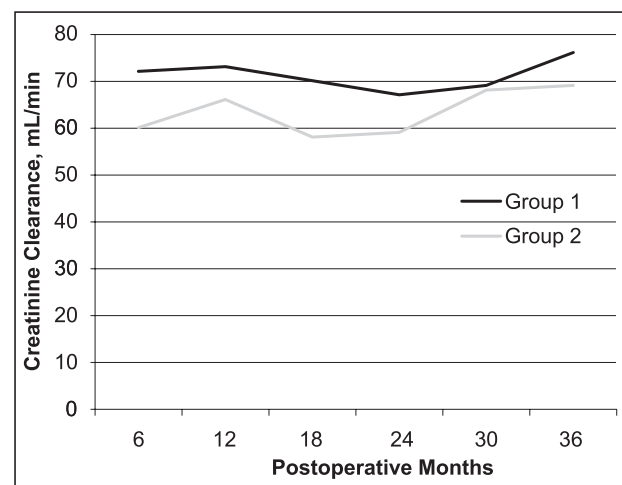
Ultrasonography Parameter	Kidney Transplant Recipients		P
	End-to-End Anastomosis to Internal Iliac Artery	End-to-Side Anastomosis to External Iliac Artery	
PS of renal artery	137.8 ± 57.5	106.6 ± 48.1	.21
RI of main renal artery	0.72 ± 0.07	0.76 ± 0.11	.38
RI of upper SB	0.66 ± 0.08	0.66 ± 0.09	.99
RI of middle SB	0.68 ± 0.08	0.69 ± 0.10	.72
RI of lower SB	0.67 ± 0.06	0.70 ± 0.13	.47

\*Data are presented as mean ± standard deviation. PS indicates peak systolic velocity; RI, resistive indexes; and SB, segmental branches.

(15.8%): 3 in group 1 (1 due to sepsis and 2 secondary to cardiologic complications) and 3 in group 2 (2 due to acute myocardial infarction and 1 due to secondary to peritonitis). Five graft losses (13%) including 3 in group 1 and 2 in group 2 were seen. In group 1, there were 2 patients who lost their kidneys shortly after the surgery due to arterial thrombosis (on the 1st and the 4th days after transplantation) and 1 due to chronic rejection, after 1 year. One patient in group 2 lost his kidney on the 1st day after transplantation due to arterial thrombosis and the other due to chronic rejection, after 2 years. In these patients, only 1 from group 1 was re-transplanted.

After 3 years of follow-up, 13 and 14 patients in groups 1 and 2 remained with a functioning allograft. Analysis of kidney function by means of biannual creatinine clearance measurement showed no differences with repeated measures corrected by age ( $P = .80$ ; Figure 3). The 3-year

graft and patient survival rates were 68.4% and 84.2 % in group 1 and 73.7% and 84.2 % in group 2, respectively ( $P = .22$  and  $P = .72$ , respectively).

**Figure 3.** Evolution of creatinine clearance every 6 months in kidney recipients with end-to-end anastomosis to the internal iliac artery (group 1) and end-to-side anastomosis to the external iliac artery (group 2;  $P = .80$ ).

Among patients who were followed for 3 years, 13 were men (8 in group 1 and 5 in group 2). Erectile dysfunction (ED) persisted after transplantation in all of the 7 patients who had pre-operative complaints (2 in group 1 and 5 in group 2). Only 1 patient (group 1) of 6 with previous normal erectile function initiated ED after transplantation. All patients older than 52 years had ED and all those younger than 52 years of age did not have ED, except for 1 patient in group 1 with de novo ED that was 50 years old.

## DISCUSSION

Since the first surgical reports of kidney transplantation procedures from Carrel in the beginning of the 20th century and Küss in the 1950s, few modifications in surgical technique have been described.<sup>(6,7,13)</sup> While great advances have achieved in immunosuppressive drug regimens, transplant immunology, infection prophylaxis, and development of better surgical instruments, the best arterial anastomosis technique remains controversial. The classical kidney transplantation surgery was described using end-to-side anastomosis to the external iliac vein and end-to-end anastomosis to the internal iliac artery. This technique is performed in many transplant centers until today.<sup>(14)</sup> However, some authors described the possibility of the occurrence of ED and renal artery stenosis with this type of anastomosis.<sup>(15,16)</sup> Arterial stenosis is a challenging issue, with a high incidence of complications during arterial stenosis correction, either by surgery or by stent insertion using percutaneous methods, due to the angle of the arterial anastomosis point.<sup>(8)</sup> These authors suggested that arterial anastomosis to the external iliac artery could reduce the incidence of ED, mainly in cases of a second transplant, in which the first kidney graft had been anastomosed to the contralateral internal iliac artery.<sup>(13-17)</sup> Nevertheless, the defenders of end-to-end internal iliac artery anastomosis worry about external iliac artery anastomosis complications, such as early obstruction, late stenosis, and the *steal phenomenon*, which could cause ischemia of the transplanted kidney during ambulation or intense physical effort, which are not frequent.<sup>(18-20)</sup>

In our study of end-to-end anastomosis to the internal iliac artery and end-to-side anastomosis to the external iliac artery, the two groups were comparable regarding age, sex, arterial anastomosis duration, cold ischemia time, hospital stay, and follow-up. In order to reduce possible differences between groups, we equalized some factors, such as donor characteristics (same donor source for both groups), cold ischemia time (reversed randomization for sequential deceased donors), immunosuppressive regimen (calcineurin inhibitor and purine synthesis inhibitor in all recipients), and the same surgeon utilizing a similar surgery technique in all transplants. In early postoperative period, both groups showed similarities in the recovery of kidney function measured by reduction of serum creatinine levels and recovery of urinary output. These parameters are frequently used to evaluate grafts function during the postoperative period of hospitalization.<sup>(21)</sup> We detected no significant differences in clinical and surgical complications or hospital stay. Some authors declared that the most common cause of death following kidney transplantation has been heart disease, and the most common cause of transplant failure has been rejection.<sup>(4)</sup> In our patients, we found heart disease as the most common cause of death.

The 3-year follow-up revealed comparable kidney function between the groups and Doppler ultrasonography also demonstrated similar results and confirmed appropriate renal flow in both groups. Furthermore, patient and graft survival rates were comparable. The 3-year patient survival rate in this study was 84.2% and graft survival rate was 71%, comparable with the review by Barry and colleagues; 82% and 63%, respectively.<sup>(4)</sup>

After 3 years of follow-up, there were no cases of renal artery stenosis, suspected or diagnosed. The frequency of this complication after kidney transplantation surgery is less than 2%.<sup>(19,22)</sup>

In the present study, an appropriate evaluation of ED was not possible due to the small number of patients in the 3-year follow-up (13 men). However, ED was more related to age and ED prior to surgery than to the kind of arterial



anastomosis technique. In this regard, current literature is controversial. Kidney transplantation has varying effects on erectile function, and in the majority of cases, it has no negative impact on the quality of erection. In the absence of associated vascular risk factors, unilateral interruption of the internal iliac artery decreases arterial penile blood flow, but not to a degree that compromise erectile function.<sup>(23)</sup> By the other side, Peng and coworkers recently described that 16 patients who received end-to-side revascularization to the external iliac artery experienced better erectile function recovery than 39 patients who underwent end-to-end revascularization to the internal iliac artery.<sup>(24)</sup>

Due to similar postoperative results in both arterial anastomosis groups in our study, the choice of anastomosis technique in cadaver grafts still depends on surgical circumstances such as arteriosclerosis involving internal or external iliac arteries, multiple renal arteries, kidney position, and surgery team preferences.<sup>(25-27)</sup> However, some considerations should be observed; first, living donor transplantation surgery is still performed using internal iliac artery due to the absence of the “Carrel patch”; second, men who have already had a kidney transplantation should undergo external iliac anastomosis in order to reduce the risk of erectile dysfunction.<sup>(16)</sup>

## CONCLUSION

In summary, to our knowledge, this is the first prospective study comparing internal and external iliac artery anastomosis techniques in kidney transplant recipients from the same deceased donor and our data suggests that both technical procedures, end-to-end anastomosis to the internal iliac artery and end-to-side anastomosis to the external iliac artery are safe for recipients of kidneys from deceased donors. They have a similar rate of surgical and clinical complications, as well as comparable kidney function in long-term follow-up. Larger prospective studies are warranted to better clarify the risk of renal artery stenosis and development of ED.

## CONFLICT OF INTEREST

None declared.

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