Inverted kidney transplantation in patients with iliac atherosclerosis: Experiences from three cases and literature review

Ninh Viet Khai[1], Do Hai Dang[1], Hoang Tuan[1], Duong Duc Hung[1, 2]

1. Viet Duc University Hospital, 2. VNU School of Medicine and Pharmacy

Corresponding author:
Ninh Viet Khai
Viet Duc University Hospital
40 Trang Thi, Hoan Kiem, Hanoi, Vietnam
Mobile: +84 903 407 799
Email: drninhvietkhai@gmail.com

Received date: 17/3/2025
Accepted date: 20/5/2025
Published date: 11/8/2025

Abstract

Kidney transplantation (KT) provided the best outcomes for patients with end-stage renal disease. Inverted kidney transplantation in which the renal pelvis orientation is reversed upward, is a technique initially used for right kidney transplants with short renal veins placed into the right iliac fossa. Consequently, the use of inverted KT was limited to cases of severe iliac atherosclerosis. This study evaluates the outcomes of inverted KT in patients with iliac atherosclerosis. We retrospectively analyzed three patients who underwent inverted KT from living donors at Viet Duc University Hospital due to iliac atherosclerosis. We performed the vessel anastomoses at the non-atherosclerotic segment of the external iliac artery. All three patients recovered well without complications and were discharged after two weeks. This study demonstrates the feasibility and safety of inverted KT in patients with iliac atherosclerosis, providing an alternative approach when conventional vascular anastomosis is challenging.

Keywords: inverted kidney transplant, iliac atherosclerosis, case report

Introduction

Kidney transplantation (KT) is one of the most effective treatments for patients with end-stage renal disease, and many techniques in KT have been described [1]. Inverted KT was first introduced in cases where a right kidney transplant with a short renal vein was transplanted into the right iliac fossa. In this technique, the orientation of the renal pelvis to the ureter of the transplanted kidney is reversed upward (toward the head). When performing inverted kidney transplantation, it is necessary to rotate the ureter to ensure that it does not twist and bend, causing ureteral stenosis, when inserted into the bladder. At our center, this technique was routinely performed for ipsilateral KT before 2020 [2]. However, afterwards, due to the adoption of various methods to handle short renal veins such as external iliac vein transposition, lengthening with preserved iliac veins or the accompanying gonadal vein of the transplanted kidney and concerns about of ureteral angulation, we no longer routinely perform this technique [3] and changed the indication for this procedure for patients with severe iliac atherosclerosis, especially on the upper half. Our aim is to report the outcomes of inverted kidney transplantation in these patients and summarize the current evidence regarding it's feasibility and safety.

Patients and methods:

This is a descriptive, retrospective study on three patients who underwent inverted kidney transplantation from living donors at Viet Duc University Hospital due to iliac atherosclerosis. The grade of atherosclerosis was assessed. All patients were regularly followed up in our hospital after the KT. The study was approved by the Institutional Ethical Review Board (No 01.2024.NCVĐ). Baseline characteristics (age, gender, BMI, medical history, hemodialysis, history of previous kidney transplantation, cardiovascular diseases), technical details (step by step, site of iliac vessel atherosclerosis, vessel reconstruction...), operation time, renal function after KT, complications were collected.

Surgical procedure for inverted KT in iliac atherosclerosis:

Incision is made in the right lower quadrant, start in the midline, 1-2 cm above the pubic bone, extend superiorly and along the lateral edge of the rectus muscle, stop at the level of umbilicus. Expose the retrospective space of right lower quadrant, dissect free and mobilize the internal iliac artery, external iliac artery, and external iliac vein.

Palpate along the iliac artery, assess the location and extent of atherosclerosis, and identify the safe area for vascular anastomosis (lower part of external iliac artery).

Place the kidney in the inverted position, anastomose the renal vein.

Place clamps on both ends of the non-atherosclerotic segment of the iliac artery and perform the arterial anastomosis.

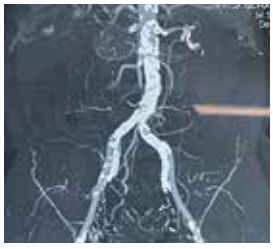
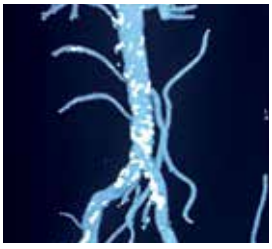
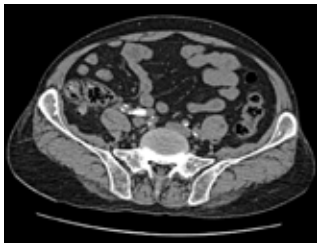
The avascular space attached to the lower pole of graft kidney was dissected, avoiding damage to the arterial branches supplying the ureter. Prepare the ureter, perform the Lich-Gregoir ureterovesical anastomosis, and place a JJ catheter.

Results

Our center has performed more than two thousand kidney transplantations, including 80 cases using the inverted KT technique. And three patients underwent inverted kidney transplantation due to unfavorable arterial anastomosis due to atherosclerotic conditions. All patients recovered well without any complications and were discharged after 2 weeks. Routine ultrasound on day 1, day 3 and day 7 showed normal findings. All patients had good graft function and survival in the latest follow-up.

The summary is shown below.

Table 1. Summary of patient characteristics

	Case 1	Case 2	Case 3
Age	53	61	47
Gender	Male	Male	Male
BMI	21.45	23.87	22.70
Medical History	Hypertension, type 2 diabetes, coronary stent, hepatitis C	Type 2 diabetes, GI bleeding	Hepatitis C
Donor	Female, 31 y/o	Male, 31 y/o	Male, 35 y/o
Site of kidney	Right	Right	Right
Site of transplant	Right	Right	Right
Atherosclerosis	Upper half part of external iliac artery, internal, common iliac artery	Upper two thirds part of external/ common iliac artery	Upper two thirds part of external/ common iliac artery
Number of arteries	2, separated	1	2, reconstruction into 1 orifice
Number of veins	1	1	1
Operation time	270 minutes	210 minutes	240 minutes
Complications	None	None	None
Imaging			

Detailed operation procedure:

Patient 1: The patient received a right kidney transplant, which had 2 arteries and 1 vein. The external iliac artery was found to have severe atherosclerosis at the upper half, with palpable atheromatous plaques primarily near the central end close to the bifurcation of the right common iliac artery. We proceeded with inverted KT to position the arterial anastomosis site towards the peripheral part of the external iliac artery segment that was free of atherosclerosis. The anastomoses were carried out sequentially: the renal vein was anastomosed to the external iliac vein, and the 2 renal arteries were separately anastomosed to the non-atherosclerotic segment of the external iliac artery.

Patient 2: The patient received a right kidney transplant, which had 1 artery and 1 vein. The common iliac, external iliac, and internal iliac

arteries were found to be extensively atherosclerotic, particularly on the posterior and lateral aspects, with a 3cm segment of the external iliac artery free of atherosclerosis (lower third). We chose inverted KT to position the arterial anastomosis site towards the peripheral part of the external iliac artery segment that was free of atherosclerosis. The anastomoses were carried out sequentially: the renal vein was anastomosed to the external iliac vein, and the renal artery was anastomosed to the non-atherosclerotic segment of the external iliac artery. The total surgery time was 3 hours and 30 minutes.

Patient 3: The patient received a right kidney transplant, which had 2 arteries and 1 vein. During the dissection and mobilization of the iliac vessels, the external and common iliac arteries were found to be extensively atherosclerotic, particularly on the posterior aspect and scattered on the anterior aspect, with a 2cm segment of the peripheral part (lower third) of the external iliac artery free of atherosclerosis. The anastomoses were carried out sequentially: the renal vein was anastomosed to the external iliac vein, and the 2 renal arteries, which were reconstructed into a common trunk, were anastomosed to the non-atherosclerotic segment of the external iliac artery.

Discussion

The standard technique for kidney transplantation involves placing the transplanted kidney in the right iliac fossa, with the renal vein to external iliac vein and renal artery anastomosed to the common or upper half of the external iliac artery (end to side fashion) or internal iliac artery (end to end fashion), and the ureter anastomosed to the anterior lateral surface of the bladder. The inverted kidney transplantation (KT) technique, which reorients the renal pelvis upward, facilitates venous anastomosis by bringing the renal vein closer to the iliac vein, minimizing intraoperative and postoperative complications. This technique has been primarily applied in cases with a short right renal vein, though alternatives such as renal vein transposition, internal iliac vein branch ligation, or renal vein lengthening are also feasible options[3], and later on, we decided to adopt this technique for patients with severe iliac atherosclerosis.

Atherosclerosis in patients with chronic kidney disease (CKD) is influenced by multiple factors, including endothelial dysfunction, chronic inflammation, increased oxidative stress, dyslipidemia, hyperphosphatemia, uremic toxins, hypertension, and hypercoagulability. Endothelial dysfunction marks an early step in atherosclerosis, while chronic inflammation and elevated oxidative stress further damage the blood vessels. Early atherosclerotic lesions are also common in chronic hepatitis C patients depending on the duration of hepatitis C and cirrhosis. Dyslipidemia contributes to plaque formation, and hyperphosphatemia can lead to vascular calcification. Uremic toxins directly damage vessels, and hypertension exacerbates atherosclerosis by causing mechanical stress while hypercoagulative state increases the risk of clot formation, compounding the issue. These interconnected mechanisms collectively accelerate the development of atherosclerosis in CKD patients [4, 5].

Performing arterial anastomosis in sclerotic areas might be risky and result in graft loss. Iliac artery atherosclerosis complicates arterial anastomosis as it requires careful identification of the appropriate site for opening the iliac artery to avoid areas with atheromatous plaques, arterial dissection, or plaque embolization; and the use of clamps for severe atherosclerotic vessels was limited. Some alternative approaches have been discussed, but inverted KT technique helps avoiding the need for complex arterial reconstruction or iliac artery replacement, thereby reducing surgical time and risk of thrombosis and plaque rupture [6-9]. Inverted KT might be a good option for these circumstances, which also reduces the risk, surgical time, and maximize graft survival.

In our experience, techniques such as soft clamps, bulldogs, or occluding vessels with a

Fogarty catheter were employed to prevent plaque rupture. Although the urological complication rate was higher, it remained acceptable compared to conventional techniques [2]. Until now, there have been few reports related to the inverted kidney transplantation technique in cases of iliac artery atherosclerosis. Most studies apply vascular reconstruction techniques (arterial replacement) to manage severe atherosclerosis cases. in 2023 Wakita et al. reported a clinical case of inverted KT for a 58-year-old male patient with severe atherosclerosis in the central segment of the iliac artery; however, the peripheral part was only mildly atherosclerotic, ensuring a suitable site for arterial anastomosis [10].

Our study, though limited by the small sample size and short follow-up period, indicates that inverted KT is a promising approach in managing severe iliac atherosclerosis. Further studies with improved methodology and extended follow-up are necessary to substantiate these findings.

Conclusion

Inverted kidney transplantation is a well established surgical procedure, however, it could also be useful for complicated circumstances, such as iliac atherosclerosis and should be further investigated.

References

1. Poggio, E.D., et al., Long-term kidney transplant graft survival-Making progress when most needed. American Journal of Transplantation, 2021. 21(8): p. 2824-2832.
2. Duc, H.D., et al., Experiences and outcomes of inverted kidney transplantation from a single Vietnamese institute. Langenbecks Arch Surg, 2024. 409(1): p. 358.
3. Viet, K.N., et al., Efficacy of lengthening right renal veins using accompanying gonadal veins in living donor kidney transplantation. World J Urol, 2024. 42(1): p. 407.
4. Düsing, P., et al., Vascular pathologies in chronic kidney disease: pathophysiological mechanisms and novel therapeutic approaches. J Mol Med (Berl), 2021. 99(3): p. 335-348.
5. Poznyak, A.V., et al. Atherosclerosis Specific Features in Chronic Kidney Disease (CKD). Biomedicines, 2022. 10, DOI: 10.3390/biomedicines10092094.
6. Galazka, Z., et al., Is Severe Atherosclerosis in the Aortoiliac Region a Contraindication for Kidney Transplantation? Transplantation Proceedings, 2011. 43(8): p. 2908-2910.
7. Garcia, L.E., et al., Arterial reconstruction with donor iliac vessels during kidney transplantation in a patient with severe atherosclerosis. J Vasc Surg Cases Innov Tech, 2019. 5(4): p. 443-446.
8. Sagban, T.A., et al., Vascular challenges in renal transplantation. Ann Transplant, 2014. 19: p. 464-71.
9. Le, V.N., et al., Application of homograft for intraoperative severe atherosclerotictic iliac vessel finding in renal transplantation: A case report. Int J Surg Case Rep, 2020. 77: p. 418-421.
10. Wakita, T., et al., Upside-Down Kidney Transplantation in a Recipient with Severe Arteriosclerosis: A Case Report. Transplantation Proceedings, 2023. 55(4): p. 1059-1061.