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Original Article

Results of Open Surgical Repair of Chronic Juxtarenal Aortic Occlusion

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Purpose: The aim of study was to review the results of open surgical repair (OSR) of chronic juxtarenal aortic occlusion (JRAO).

Materials and Methods: We retrospectively reviewed the results of OSR performed in 47 patients (male, 92%; mean age, 59.9±9.3 years [range, 44-79]) with chronic JRAO during the past 21 years. In order to reduce intraoperative renal ischemic time (RIT), we excised a portion of the occluded segment of the infrarenal aorta without proximal aortic clamping. We then performed suprarenal aortic clamping with both renal arteries clamped, removed the proximal aortic thrombus cap, confirmed both renal artery orifices, and moved the suprarenal aortic clamp to the infrarenal aorta to allow renal perfusion and standard aortoiliac reconstruction. We investigated early (<30 days) postoperative surgical morbidity (particularly renal function), operative mortality, and longterm patient survival. We conducted risk factor analysis for postoperative renal insufficiency.

Results: The mean intraoperative RIT was 10.7±5.5 minutes (range, 3-25), including 6 patients who underwent concomitant pararenal aortic thromboendarterectomy. Postoperatively, five (11%) patients had transient renal insufficiency, one had pneumonia, and one patient had an acute myocardial infarction. However, there was no operative mortality or newly developed dialysis-dependent renal failure. Postoperative follow up was available in 36 (77%) patients for a mean period of 6.3 years (range, 1 month-17 years). Kaplan Meier calculations of patient survival at 5 and 10 years after surgery were 91.2% and 83.6%, respectively.

Conclusion: We have experienced short RIT, acceptable early postoperative results and long-term survival after OSR of chronic JRAO.

Key Words: Juxtarenal aortic occlusion, Surgical results, Renal ischemic time, Renal complication

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INTRODUCTION

The majority of chronic aortoiliac occlusive lesions arise from the terminal abdominal aorta and its bifurcation and progress proximally or distally; this is known as Leriche syndrome [1,2]. Juxtarenal aortic occlusion (JRAO) is an infrequent form of chronic aortoiliac occlusion accounting for less than 10% of chronic aortoiliac occlusive diseases.

JRAO carries the risk of renal insufficiency, renovascular hypertension and rare bowel infarctions due to the proximal progression of the aortic occlusive lesion, in addition to leg or pelvic ischemic symptoms [3]. Though endovascular approaches for the treatment of JRAO have been reported, their efficacy remains debatable. So far, open surgical repair (OSR) remains the gold standard for treatment of patients with JRAO [4-6]. During OSR of JRAO, suprarenal aortic clamping is required to prevent renal artery embolism from infrarenal aortic clamping, which increases the risk of postoperative renal insufficiency (PORI) [7].

The aim of the present study was to introduce our surgical procedures to reduce intraoperative renal ischemic time (RIT) and report the short- and long-term results of OSR for patients with JRAO.

MATERIALS AND METHODS

We performed 47 OSRs for patients (male, 92%; mean age, 59.9 years; range, 44-79 years) with chronic JRAO between June 1993 and May 2014. The diagnosis of JRAO was made when aortic occlusion extended up to the level of the renal arteries on angiogram and required supra- or interrenal (between the 2 renal arteries) aortic cross clamping during the OSR. The database of patients was reviewed to investigate patient demographics, preexisting comorbidities, presenting symptoms, perioperative data, and early and long-term postoperative results.

During the open surgical aortic reconstructions, we tried to prevent renal artery embolization and reduce RIT. The pararenal aorta was exposed through a transperitoneal vertical midline incision. To minimize RIT, a portion of the occluded infrarenal aorta was transected without proximal aortic clamping, and the distal aortic stump was sewn over. After control of both renal arteries with silastic vessel loops, we performed suprarenal aortic cross clamping (SRACC) and completely removed the thrombotic cap through the divided end of the infrarenal aorta (transaortic route). During this procedure, a vertical aortotomy was made in six patients to facilitate a pararenal aortic thromboendarterectomy. The suprarenal aortic cross clamp was then transferred to the infrarenal aorta to allow renal artery reperfusion (Fig. 1).

Fig. 2 demonstrates pararenal aortic thromboendarterectomy procedures for patients with aortic plaque involving the renal artery ostium. A vertical aortotomy was made on the anterior aortic wall between the two renal arteries,

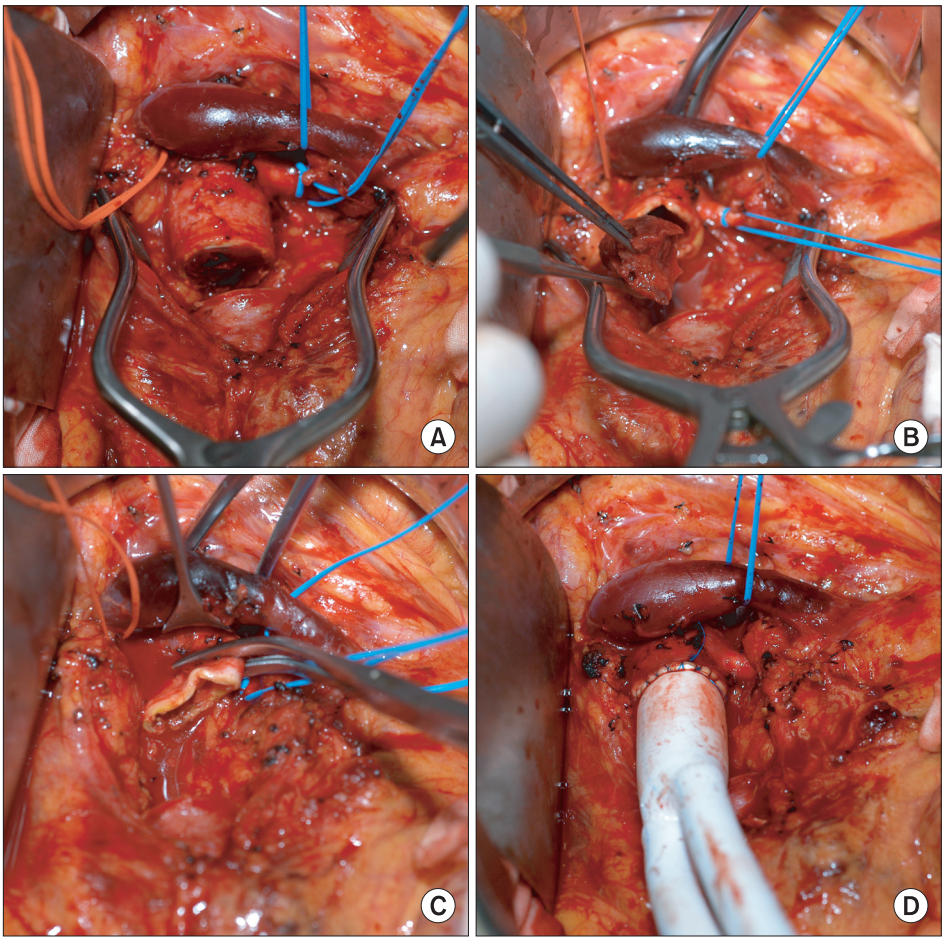


Fig. 1. Surgical photograms showing surgical procedures for a patient with juxtarenal aortic occlusion. (A) Resection of a segment of occluded infrarenal aorta without suprarenal aortic clamping. (B) Removal of thrombotic cap under the suprarenal aortic clamp, with both renal arteries controlled. (C) Transfer suprarenal aortic clamping to the infrarenal aorta allowing renal perfusion. (D) Standard aorto-femoral bypass under the infrarenal aortic clamping.

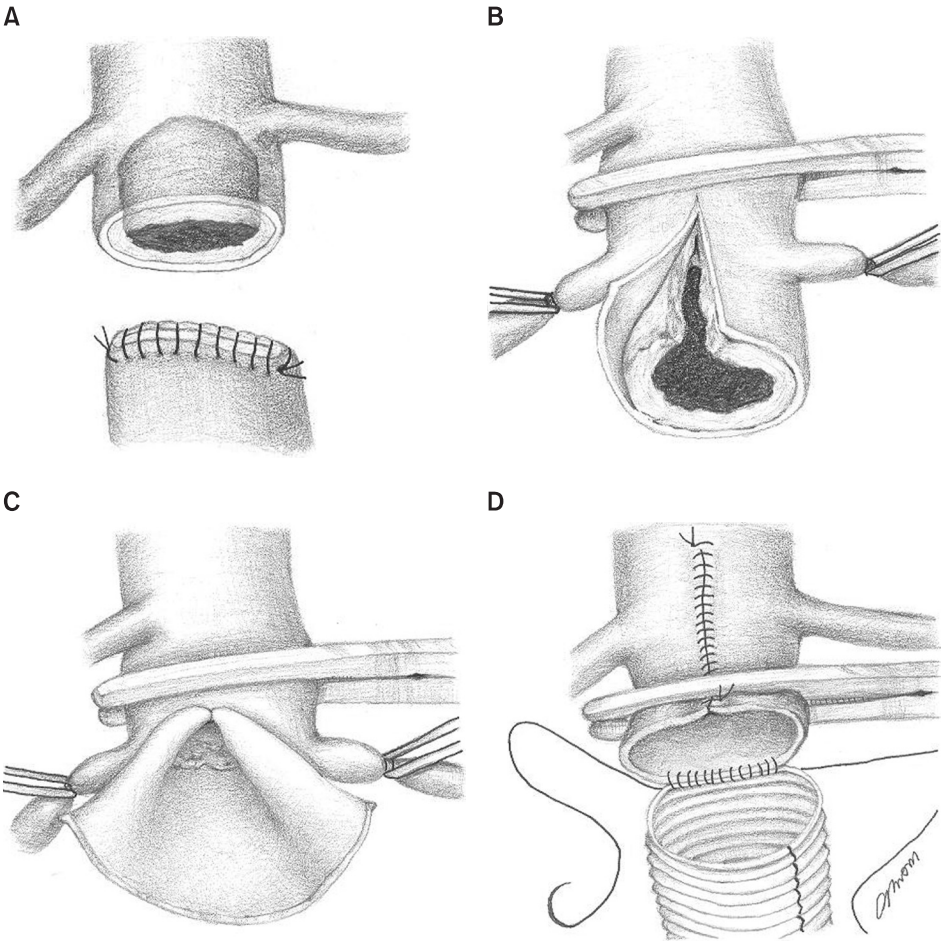


Fig. 2. Schematic drawing of the surgical reconstruction of the juxtarenal aortic occlusion to minimize renal ischemic time. (A) Segmental excision of the occluded infra-renal aortic segment (3 cm in length) without supra-renal aortic clamping. (B) Vertical aortotomy under the supra-renal aortic cross clamping and bilateral renal artery control (left renal vein division may be required during this procedure). (C) Pararenal aortic thromboendarterectomyor renal ostialendarterectomy (if required) through the vertical aortotomy. (D) Proximal aortic anastomosis after vertical aortotomy closure after moving the aortic clamp to the infrarenal aorta.

and thromboendarterectomy of the pararenal aorta and renal artery ostia was performed. After clearing the plaque or thrombotic debris from the aortic wall and renal artery ostia, the vertical aortotomy was closed and the suprarenal aortic cross clamp was transferred to the infrarenal aorta. A proximal aortic anastomosis was performed using a standard technique to allow renal reperfusion (Fig. 2).

Systemic intravenous heparinization and intravenous infusion of 12.5 g of 12.5% mannitol (n=30, 64%) and/or furosemide (n=5, 11%) were given to induce diuresis before renal artery clamping. Renal perfusion with cold heparin saline was performed only in 1 (2%) patient for renal protection.

To investigate early (within 30-day) postoperative morbidities, PORI was defined as serum creatinine (sCr) ≥1.5 mg/dL in association with an increased sCr level ≥150% from the preoperative level. Postoperative pulmonary failure was defined as requiring mechanical ventilation for 48 hours or longer, reintubation due to respiratory difficulty, or new occurrence of pneumonic consolidation on radiologic modalities. Acute myocardial infarction (MI) was defined by elevation of serum troponin I >0.8 ng/mL, as well as characteristic electrocardiographic changes of an acute MI.

Statistical analysis was conducted to determine risk factors for PORI using Fisher's exact test.

To check long-term postoperative survival, patients were periodically examined in the outpatient clinic. When outpatient clinic follow-up was unavailable, a telephone survey was conducted.

PASW Statistics ver. 18.0 (IBM Co., Armonk, NY, USA) was for statistical analysis.

RESULTS

Demographic and preoperative clinical features of the patients are summarized in Table 1.

During OSR, aortic cross clamping was suprarenal (above both renal arteries) in 42 (89%) patients, interrenal (oblique aortic clamping between the two renal arteries) in 4 (9%) patients, and supraceliac in 1 (2%) patient. Data for intraoperative RIT were available in 34 (72%) patients, and the mean duration of RIT was 10.7±5.5 minutes, ranging from 3 to 25 minutes. Surgical procedure details are summarized in Table 2.

Table 1. Demographics and clinical features of patients with chronic juxtarenal aortic occlusion

Feature (n=47)	Data
Age (y)	
Mean±SD	59.9±9.3
Median (range)	59 (44-79)
Male, n (%)	43 (92)
Clinical, n (%)	
Leg claudication	22 (50)
Rest pain	4 (9)
Ischemic tissue loss	7 (16)
Coexisting risk or morbidities, n (%)	
Smoking	31 (66)
Coronary artery disease	14 (30)
Cerebrovascular disease	9 (19)
Chronic obstructive pulmonary disease	3 (6)
Hypertension	23 (49)
Diabetes mellitus	13 (28)
Chronic kidney disease	4 (9)
Preoperative serum creatinine (mg/dL)	
Mean±SD (range)	1.0±0.6 (0.3-4.0)

SD, standard deviation.
Smoking, currently or quit smoking <1 year ago; Hypertension, diastolic blood pressure >90 mmHg on at least two occasions or currently taking antihypertensive medication; Diabetes mellitus, history of diabetes diagnosed or fasting blood glucose >126 mg/dL; Chronic kidney disease, serum creatinine ≥2.0 mg/dL, on dialysis, or history of kidney transplantation; Coronary artery disease, history of myocardial infarction or coronary intervention or coronary artery bypass grafting.

Table 2. Operative procedures

Procedure (n=47)	Number (%)
Aortic reconstruction	
Aorto-biiliac	8 (17)
Aorto-bifemoral	37 (79)
Aorto-uniiliac and unifemoral	1 (2)
Aorto-unifemoral and unipopliteal	1 (2)
Aortic crossclamping site	
Supra-celiac	1 (2)
Supra-renal	42 (89)
Inter-renal	4 (9)
Graft material	
Dacron graft	26 (55)
Polytetrafluoroethylene graft	21 (45)
Renal protective measure	
12.5% mannitol infusion	30 (64)
Furosemide infusion	5 (11)
Cold saline perfusion into renal artery	1 (2)
Adjuvant procedure	
Vertical aortotomy	6 (13)
Renal artery reconstruction	8 (17)
Aorto-renal bypass	3 (6)
Unilateral	2 (4)
Bilateral	1 (2)
Renal artery orifice endarterectomy	5 (11)
Unilateral	1 (2)
Bilateral	4 (9)
Mesenteric artery reconstruction	3 (7)
Aorto-mesenteric bypass	2 (4)
Inferior mesenteric artery	1 (2)
Superior mesenteric artery	1 (2)
Reimplantation	1 (2)
Inferior mesenteric	1 (2)
Femoral artery	6 (13)
Patch angioplasty	1 (2)
Endarterectomy	6 (13)
Unilateral	4 (9)
Bilateral	2 (4)
Renal ischemic time (n=34[a])	
Minutes, mean±SD (range)	10.7±5.5 (3-25)

SD, standard deviation.
[a]Data for renal ischemic time were available in 34 patients.

Table 3 shows 30-day surgical morbidity and mortality. Five patients developed PORI, but sCr levels returned to preoperative levels within 2 weeks in all patients with conservative treatment. No patients required new hemodialysis.

We found no independent risk factors for the development of PORI after OSR of JRAO (Table 4).

During the follow-up period (mean, 75.4±52.2 months; range, 1.0-207.7 months), 6 patients died and 11 patients were lost to follow-up leading to a follow-up rate of 77%. The cumulative patient survival after OSR of JRAO at 5 and 10 years was 91.2% and 83.6%, respectively (Fig. 3).

DISCUSSION

JRAO carries the risk of dual ischemic insults, including lower extremity ischemia as well as the risk of renal or visceral ischemia. According to an old autopsy report from University of California, San Francisco, chronic renal failure accounted for about half of causes of death in untreated patients with JRAO [8]. Though endovascular interventions have been attempted for patients with JRAO, OSR remains the gold standard for treatment [9,10].

During OSR of JRAO, aortic clamping above the level of one or both renal arteries is an essential part of the

Table 3. Early postoperative morbidity and mortality (within 30 days after surgery)

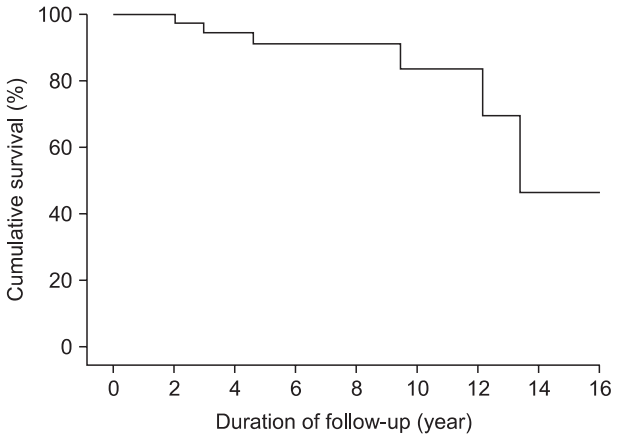
Morbidity and mortality (n=47)	No. of patients (%)
Renal	
Postoperative renal insufficiency[a]	5 (11)
New hemodialysis	0 (0)
Pulmonary	
Pneumonia	1 (2)
Pleural effusion	2 (4)
Atelectasis	1 (2)
Cardiac	
Myocardial infarction	1 (2)
Operative mortality	0 (0)

[a]Postoperative renal insufficiency (postoperative serum creatinine increase to >150% from preoperative level).

Table 4. Risk factor analysis for postoperative renal insufficiency (PORI) after open surgical repair of juxtarenal aortic occlusion

Factor	Number (%)	Patients with PORI	
		n	P-value[a]
Age (≥75 y)	6 (13)	1	0.511
Diabetes mellitus	13 (28)	2	0.607
Chronic kidney disease	4 (9)	0	0.999
No renal protective measure	16 (34)	1	0.648
Renal artery reconstruction	8 (17)	1	0.999
RIT ≥15 minutes[b]	10 (29)	2	0.618

RIT, renal ischemic time.
[a]Fisher's exact test. [b]Data for renal ischemic time were available in 34 patients.



	Year				
	1	3	5	10	15
Lost to follow-up	3	3	1	1	0
At risk (n)	37	33	24	9	2
Survival (%)	100	94.5	91.2	83.6	46.5

Fig. 3. Cumulative survival of patients after open surgical repair of juxtarenal aortic occlusion.

surgical procedure. Prolonged RIT due to interruption of renal blood flow can lead to ischemic damage of the renal tubular epithelium and renal microvasculature, which may result in PORI [11]. Many previous studies have reported that prolonged RIT increased the risk for PORI in patients who underwent aortic surgery [12-14].

We found that 9% of patients had already shown elevated levels of sCr before OSR of JRAO. This finding may suggest coexistence of renal artery disease or renal artery embolization from a juxtarenal aortic occlusive lesion.

During the OSR for patients with JRAO, it is important to reduce RIT to prevent PORI. Though there have been many previous reports describing surgical techniques of OSR of JRAO [8,15,16], Gupta and Veith [17] were the first reporters to illustrate surgical techniques in detail to reduce RIT during OSR of JRAO. Their method used suprarenal aortic clamping to allow removal of aortic clots and debris through the infrarenal vertical aortotomy under direct vision. This procedure allows more thorough removal of all debris without the risk of renal embolization. The suprarenal aortic clamp was then transferred to the infrarenal aorta, allowing renal perfusion.

We tried to further reduce RIT by transecting the infrarenal aortic segment first without proximal suprarenal aortic clamping, and then performing the procedures in the order described above. Renal protective measures were usually performed with intravenous infusion of 12.5% mannitol and furosemide. In cases requiring renal ostial endarterectomy (n=6), we performed a vertical aortotomy to facilitate the thromboendarterectomy. Including those patients who required adjuvant pararenal thromboendarterectomy, the mean length of SRACC time was around 11 minutes (range, 3-35 minutes). Compared to the other previously reported methods, our procedure achieved shorter RIT and more complete renal artery restoration with paraaortic thromboendarterectomy or adjuvant renal arterial reconstruction procedures.

Previous reports described higher operative morbidity and mortality rates after combined abdominal aortic replacement and renal artery reconstruction [18,19]. In this study, we observed 5 (11%) cases of early PORI, which resolved by conservative treatment within 2 weeks. No patients required new hemodialysis in the early postoperative period. There was no operative mortality. In addition, no association was found for independent risk factors of PORI.

Though our study has limitations stemming from a

retrospective design, small sample size, and available RIT data in only 72% of patients, we reduced RIT with our technique compared to previous other reports.

CONCLUSION

In conclusion, we were able to reduce RIT with modified surgical techniques, and found good early and long-term results after OSR of chronic JRAO.

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