

Original Article

Our clinical experience on renal protection with custadiol solution during juxtarenal clamping in open repair of abdominal aorta aneurysm

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Abstract

Aim: Technological developments on endovascular stents have increased the percutaneous repair of abdominal aortic aneurysm(AAAs). Open repair of abdominal aneurysm remains as the first option for treatment of aneurysm with compromising necks that need suprarenal aortic clamping(SAC). Open surgical repair with suprarenal aortic clamping may be associated with renal ischemia that may lead into renal injury. Our study focused on our clinical experience on the use of custadiol solution for renal protection during open repair of abdominal aortic aneurysm with suprarenal aortic clamping.

Material and Methods: Our study consisted of 25 patients who underwent open repair for abdominal aortic aneurysm with suprarenal aortic clamping. During the repair, cold custadiol solution was used for renal protection in all patients. Outcomes included postoperative renal functions, mortality, hospital stay, need of postoperative dialysis and readmission due to renal injury.

Results: 2 (8%) of our patients died, 2 patients (8%) experienced acute renal injury, hemodialysis was required in 8 patients (32%). There were 3 cases of morbidity, which included ileus in one patient, pneumonia in one patient and wound infection in one patient. Graft interposition was performed in one patient (4%) while aortobifemoral bypass was performed in 24 patients (96%).

Conclusion: In our clinical experience, cold custadiol solution has shown to be safe as a renal protective solution during suprarenal aortic clamping in open repair of abdominal aortic aneurysm with well-preserved perioperative renal functions.

Keywords: Abdominal aortic aneurysm, suprarenal aortic clamping, custadiol solution

INTRODUCTION

Technological developments on endovascular stents have increased the percutaneous repair of abdominal aortic aneurysm (AAA) [1,2]. Open repair of abdominal aneurysm remains as the first option for treatment of aneurysm with compromising necks

that need suprarenal aortic clamping (SAC) [3,4]. Fenestrated EVAR and chimney EVAR have recently been used in treatment of juxtarenal AAAs by some centers, but the long term durability is a great concern [5]. Hence, open repair remains the first option for treatment of juxtarenal AAAs.

CITATION

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Suprarenal aortic clamping is associated with renal ischemia which may lead to renal injury. A large number of studies have described the use of various renal protective solutions such as cold ringer's solution for renal protection during SAC [6,7,8]. Our study aimed at presenting our clinical experience on renal protective effect of custadiol solutions during juxtarenal aortic clamping in open repair of juxtarenal abdominal aorta aneurysm.

MATERIALS AND METHODS

Our study was a single-centered, prospective, observational study. Our study included patients who underwent primary open repair of juxtarenal AAAs. The study protocol was approved by the institutional review board of Istanbul Mehmet Akif Ersoy Thoracic and Cardiovascular Surgery Research and Training hospital (No: 2022.04.23). The informed patient consent was obtained from all patients.

Our study consisted of 25 patients (23 male, 2 female). Mean age was 66.9 ± 15.0 years. The study included patients who were candidates for open repair requiring SAC. Aortic clamping was determined by surgeon considering the presence of calcification, intraluminal thrombus, and anatomical suitability based on the aneurysm's proximity to the renal artery. None of our patients had clamps placed proximal to the origin of the superior mesenteric artery. All patients received cold custodiol solution of about 4°C - 8°C during aortic clamping. Patients who had infrarenal aortic clamping were not included in our study. All patients had contrast enhanced computed tomography (CT) scans except in some cases with compromised renal functions who had non-enhanced abdominal CT.

Surgical Procedure

All patients were operated under general anesthesia, a transperitoneal midline approach was used in all cases. The left renal vein was mobilized by dissecting the ipsilateral gonadal and renal veins. Renal arteries were individually isolated and clamped before aortic clamp placement. With the aid of osteal cannula, cold custodiol solution of about 4°C - 8°C was given directly to ostium of renal artery throughout clamping time at a rate of 15mL/min. In this study, other intravenous medication for renal protection was not administered. After intravenous infusion of heparin sodium (70–100 U/kg), the aortic clamp was placed suprarenally or interrenally. The proximal anastomosis was reconstructed by suturing the graft to the juxtarenal aorta in an end-to-end fashion. Renal ischemia time refers to the time from aortacomp placement until the time last renal artery was reperfused. We used a dacron graft in all cases.

Postoperative outcomes

Postoperative outcomes included in-hospital complications such as acute renal injury, ileus, revision due to haemorrhage (bleeding) or colon ischemia, pulmonary complications, longer ICU and hospital stay, cardiac complications (myocardial

infarction, arrhythmia), wound infection and in-hospital mortality. Postoperative acute renal injury was defined as serum creatinine $\geq 200\%$ increase over baseline or ≥ 0.5 mg/dl increase to at least 4.0 mg/dl.

Statistical analysis: Mean, standard deviation, median, minimum, maximum value frequency and percentage were used for descriptive statistics. SPSS 27.0 was used for statistical analyses.

RESULTS

The results are summarized in Table 1 and Table 2. 2 patients (8%) died due to severe pneumonia after long ventilation in one patient and sepsis due to complicated wound infection with long hospital stay. 2 patients experienced acute renal injury (8%), hemodialysis was required in 8 patients (32%). There were 3 cases of morbidity, which included ileus in one patient, pneumonia in one patient and wound infection in one patient. Graft interposition was performed in one patient (4%) while aortobifemoral bypass was performed in 24 patients (96%). The mean cross clamping time was 28.2 ± 4.2 minutes. The median ICU (intensive care unit) stay was 4 hours and the median hospital stay was 9 days. We had revision due to bleeding in 7 patients (28%).

Table 1. Preoperative characteristics

	Min-Max	Median	Mean $\pm$ sd/n-%
Age (Years)	25.0 - 87.0	71.0	66.9 $\pm$ 15.0
Gender	Female		2 8.0%
	Male		23 92.0%
Weight (Kg)	67.0 - 97.0	82.0	81.5 $\pm$ 7.7
Height (Cm)	164.0 - 183.0	174.0	174.0 $\pm$ 5.5
BMI	21.6 - 32.7	27.4	26.9 $\pm$ 2.3
DM	(-)		13 52.0%
	(+)		12 48.0%
HT	(-)		16 64.0%
	(+)		9 36.0%
Smoking	(-)		13 52.0%
	(+)		12 48.0%
Hiperlipidemia	(-)		14 56.0%
	(+)		11 44.0%
CAD	(-)		9 36.0%
	(+)		16 64.0%
COPD	(-)		17 68.0%
	(+)		8 32.0%
ASA Score	III		7 28.0%
	IV		5 20.0%
	V		13 52.0%
Aneurysm Size	40.0 - 120.0	67.0	70.8 $\pm$ 21.5
Preop Creatinin	0.72 - 6.33	1.14	1.57 $\pm$ 1.20
Postop Creatinin	0.68 - 7.41	1.38	1.79 $\pm$ 1.32
Creatine Exchange Rate	0.40 - 2.18	1.17	1.24 $\pm$ 0.45

BMI-Body Mass Index, DM-Diabetes Mellitus, HT-Hypertension, CAD-Coronary Artery Disease, ASA-American society of Anesthesiologists COPD-Chronic Obstructive Pulmonary Disease

Table 2. Perioperative and postoperative characteristics

		Min-Max	Median	Mean±sd/n-%
ABF	(-)		1	4.0%
	(+)		24	96.0%
Graft Interposition	(-)		24	96.0%
	(+)		1	4.0%
Clamping Time,min		22.0 - 36.0	28.0	28.2 ± 4.2
Acute Renal Injury	(-)		23	92.0%
	(+)		2	8.0%
Hemodialysis Requirement	(-)		17	68.0%
	(+)		8	32.0%
Revision	(-)		18	72.0%
	(+)		7	28.0%
Morbidity	(-)		22	88.0%
	(+)		3	12.0%
ICU Stay,hours		1.0 - 100.0	4.0	9.3 ± 19.8
Hospital Stay,days		4.0 - 100.0	9.0	20.6 ± 23.2
Mortality	(-)		23	92.0%
	(+)		2	8.0%

ABF-Aortobifemoral, ICU-Intensive Care Unit

DISCUSSION

Infrarenal AAAs are nowadays commonly managed with EVAR [9]. EVAR is indicated in patients with a desirable proximal aortic neck for stent graft landing and proximal aorta fixation. Despite EVAR being performed in juxtarenal AAAs, it has been associated with increase of post procedural complications such as re-interventions, endoleaks, sac growth, and aneurysm-related mortality [10]. In patients with juxtarenal lesions, open surgical repair is indicated. During OSR, suprarenal aortic clamping is applied. Placement of aortic clamp above the renal arteries is associated with renal ischemia which may result in renal dysfunction and hence increase in morbidity and mortality. Therefore, renal protection strategy is necessary in patients undergoing AAAs repair with suprarenal aortic clamping.

Different forms of renal protection methods have been described. These methods include the use of fluid infusion and diuretics to sustain urine volume, facilitation of renal blood flow with continuous dopamine administration, hypothermia method and renal artery perfusion method using oxygenated blood [11,12]. Various centers have reported that no renal protective agents have been used during open repair of juxtarenal AAAs with aortic clamping [13]. Allen BT et al. and Chiesa R et al. have reported that hypothermia can provide protection with well-preserved renal function [8,14].

In our clinical experience, we used cold custodiol as a renal protective solution. Our results with custodiol renal protection

shows remarkable positive outcomes with well-preserved renal functions regardless of cross clamping time (Table 2). We experienced transient renal injury in two patients which resolved within 3 weeks. During postoperative follow up period, hemodialysis was performed in 8 patients mostly with compromised preoperative renal functions. In-hospital mortality in our study was not associated with surgical procedure, it was due to longer ICU stay as the result of pulmonary complication and postoperative wound infection.

Being a single-centred study and limited number of patients are limitations of our study. Regardless of this, renal protective effect of custodiol was observed in all patients with well-preserved postoperative renal functions. Further studies with large population, prospective and multicentered studies may be needed to evaluate the protective effect of custodiol solution during repair of juxtarenal AAAs with SAC.

CONCLUSION

In conclusion, our experience shows that cold custodiol solution may be safely used during renal perfusion for juxtarenal AAA that requires suprarenal aortic-cross clamp.

Ethics Committee Approval: The study protocol was approved by the institutional review board of Istanbul Mehmet Akif Ersoy Thoracic and Cardiovascular Surgery Research and Training hospital (No: 2022.04.23).

Patient Consent for Publication: Individual informed consent was waived due to retrospective design.

Data Sharing Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

Author Contributions: All authors contributed equally to the article.

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