

## Single-Center Experience on Extra-Anatomic Arterial Revascularisation Applications

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### ABSTRACT

**Objective:** Atherosclerosis and thrombotic disorders disrupts distal limb perfusion and threatens organ viability. The distal flow should be provided with interventional or surgical procedures. However, it is not possible every time due to the loss of normal anatomical conditions. Extra-anatomic ways can be used for providing distal blood supply in such these conditions. In current study we aimed to present our extra-anatomic bypass applications in cases who has not chance for anatomical revascularization.

**Method:** Extra-anatomic bypass intervention was applied to medical cases in our clinic between 2010 and 2018. Age, sex and accompanying diseases were recorded retrospectively. The polytetrafluoroethylene (PTFE) or otogenous saphenous vein graft was used for extra-anatomic revascularization.

**Results:** Nine (75%) of the patients were male and 3 of them (25%) were female. The mean age of the patients was 56.08 years. Lower extremity revascularization was performed in all cases. For the lower extremity, a femoro-femoral bypass in eight cases, an axillo-femoral bypass in two cases, and femoro-infrapopliteal bypass 18 in two cases were performed respectively. Two (18%) complications were encountered in the immediate postoperative period. Late-period mortality was not observed during the follow-up period. In terms of late-period morbidity (6 months after surgery), graft thrombosis was observed in one case.

**Conclusion:** Although the increase in the number of endovascular interventions in recent years restricts surgical intervention, extra-anatomic bypass procedures should be considered as an alternative surgical approach in cases with co-morbidity factors such as previous vascular bypass surgery, diabetes, and obesity etc.

**Keywords:** extra-anatomic bypass, revascularization, treatment

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### INTRODUCTION

Extra-anatomic arterial bypass grafting applications, one of the surgical methods of peripheral arterial diseases, is a method that can be used in the absence of proper bypass at the anatomical site. This bypass technique is usually chosen in cases where classical vascular procedures are not performed, in case of incompatibility of the vascular source in the anatomic location or the risk of this modality. Besides, in cases where high mortality may result due to the presence of co-morbidity factors at the patient, it can be considered surgical interventions to increase blood flow to the ischemic area [1,2].

Extra-anatomic bypass (EAB) was first described by Freeman and Leeds in 1952

when the revascularization of the femoral artery was transferred to the contralateral superficial femoral artery by a subcutaneous passage. Blaisdel and Hall proposed the axillofemoral (AF) bypass in 1962; Sauvage and Wood performed the axillofemoral bypass (AFF) surgery in 1966. Shaw and Baue performed the obturator bypass (OB) surgery in patients with localized graft infection in inguinal region for the first time [2-4]. Many patients for whom amputation may have to apply to in the past can now be successfully treated with the development of surgical methods, repair techniques (repair techniques for what?) and materials, as well as the use of endovascular interventions, one of the surgical treatment techniques of peripheral arterial disease [4,5].

Currently, although endovascular applications are used more widely with developing technology and experience gained, in particular, except for upper and lower extremity revascularization in selected patient groups, extra-anatomic bypass grafting can be applied to the thoracic aorta, carotid, vertebral and renal arteries [5,6]. Extra-anatomic bypass grafting is preferred when general anesthesia and/or surgery are considered to be high-risk such as critical limb ischemia, severe coronary artery disease, coronary disease, chronic obstructive pulmonary disease, arterial hypertension, cerebrovascular insufficiency, diabetes, and renal failure [2-5]. Besides, EAB is applied to facilitate the surgical technique in case of an inability to pass the graft through the anatomical region due to infection, tumor invasion, previous operation or radiotherapy, and in case of postural degeneration and inability to position the patient or extremity [5-7]. For the treatment of patients who have previously undergone bypass grafting but have been infected with the graft, the ischemic problem of the extremity is treated and bloodstream is restored [5,6].

In this study, we aimed to evaluate extra-anatomic bypass applications in cases where anatomic bypass operations cannot be performed in lower extremity ischemia for the patients evaluated in our clinic and inappropriate for endovascular intervention or anatomic bypass.

## MATERIAL AND METHOD

A retrospective review was performed on twelve patients undergoing extra-anatomic arterial bypass grafting in our department between the dates of January 2010 and December 2018. All operations were made by single surgeon and follow-up were made by same clinic. The demographical variables such as age, sex, smoking history, body mass index (BMI), accompanying disease, and previous vascular intervention with cardiovascular risk factors history were recorded.

## SURGICAL TECHNIQUE

The femoro-femoral bypass were applied under general anesthesia and both femoral regions were opened. 1 cc heparin was given in vitro. To decide whether the femoral artery that inflow flow will be provided is appropriate for revascularization, embolectomy was performed with a 6 F Fogarty catheter. The sheet (6 F) was placed and the contrast agent was given. The structure of the distal vascular bed was monitored by arteriography under fluoroscopy, after surgical confirmation, the bypass was performed.

The distal arterial structure was checked and prepared for the patients to be performed femoro-infrapopliteal bypass. After a balloon embolectomy was made with a 3 F Fogarty catheter, 4 F sheet was placed and the distal arterial structure was observed. Thereafter, the contrast agent was given again in the late phase and the venous system was evaluated. Femoral artery was opened and bypass was performed.

In axillofemoral bypasses, 120-cm-length ring handle graft instruments, specially produced for this purpose, for anastomosis of the femoral artery with a single distal end of the proximal end were preferred. The proximal edge of the graft was inserted subcutaneously into the right or left axillary artery, and the distal edges, likewise, were subcutaneously inserted through tunnels opening to the femoral artery. During this procedure, it was cared to ensure that the graft did not make a ring and the flow form did not deteriorate. Proximal anastomosis axillary was sutured to the artery by continuous suture pattern by 6/0 prolene suture (edge to side), similarly, distal anastomoses were sutured to femoral artery with 5/0 prolene sutures with the same technique. For femoro-femoral suprapubic bypasses, ringed PTFE grafts (Gore-Tex® Vascular graft, WL Gore & Associates, Newark, Delaware, USA) were preferred again and the graft was passed through the tunnel opened subcutaneously. The patients were given LMWH (Low Molecular Weight Heparin) twice daily from their hospitalization until the morning of surgical operation. Following the postoperative period, in the early period, 5,000 units of heparin were routinely used 4 times a day for the first 2 days; thereafter, heparin was used twice daily until Warfarin dose was effective with INR (International Normalized Ratio) monitoring. Acetylsalicylic acid (300 mg/day) and warfarin sodium (5 mg/day) and atorvastatin were started immediately after extubation. When "PTZ" and "INR" values reached 1.5-2 times normal, heparin was discontinued. After the patients were discharged, they were called for periodic inspections in the first week and after 1-2-3 and 6th months, then for annual inspection.

## Follow-up Period

Following the postoperative discharge of the patient, their painless walking distance was examined by checking regularly their history in the 1<sup>st</sup> month, 3<sup>rd</sup> month, 6<sup>th</sup> month and 12<sup>th</sup> month; besides, their physical examination and Doppler ultrasonography controls were performed.

## Statistical Analyse

Continuous variables were indicated as mean±standard deviation, and categorical variables were expressed as frequency (n) and percentage. SPSS 21 package (IL, Chicago, USA) was used for descriptive statistics.

## RESULTS

Totally 12 patients were included to the study. Nine (75%) of the patients were male and three (25%) of them were female, the mean age was found as 56.08±6.03. Ten patients (83%) were active smokers. Two patients were ex-smokers. Hypertension (91%), diabetes (91%), coronary artery disease (83%) and chronic obstructive pulmonary disease (25%) (Below forced expiratory volume at first second <1 L/sec) were observed and there was previous vascular intervention surgery in five patients. There was colostomy in four patients. BMI was over 25 in four patients (33.01±2.03 kg/m<sup>2</sup>). EF was less than 40% in four patients

**Table 1.** Demographical data of extra-anatomic bypass cases

	n	%
Age	56.08±6.03	-
Gender(m)	9	75%
Hypertension	11	91%
Diabetes mellitus	11	91%
Coronary artery disease	10	83%
Smoking	10	83%
COPD*	3	25%
Lower EF**	4	33%
Previous surgery (bypass)	5	41%
Colostomy	4	33%
Body mass index ≥25 n (mean±SD) kg/m <sup>2</sup> )	4 (33.01±2.03)	33%
Claudication (850m)	9	75%

\*COPD: Chronic obstructive pulmonary disease, \*\*Lower EF: Ejection fraction with <40%

(Table 1). Claudication intermittent at a short distance (50 m) was observed in nine cases, and resting pain in two cases, besides, no peripheral cyanosis was observed. In nine patients, the ankle brachial index (ABI) was found as 0.95 and thought as significant narrowing of one or more blood vessels in the legs.

Complications were encountered in two patients (20.5%) in the immediate postoperative period. Two patients who underwent femoro-femoral bypass were taken to the operating room for revision due to hemorrhage. No hospital mortality was observed. The patients were discharged from the hospital after the operation on the 5<sup>th</sup> day at the earliest and on the 14<sup>th</sup> day at the latest. Due to the development of graft thrombosis 6 months after surgery, one femoro-femoral bypass patient was taken under operation and graft thrombectomy was performed.

## DISCUSSION

Extra-anatomic bypass grafts such as axillofemoral and subclavio-femoral femoro-femoral can be applied in the patients having the infected aortic grafts, in the patients undergoing colostomy and ileostomy after the previous laparotomy, having acute myocardial infarction, severe congestive heart failure, severe chronic renal disease or renal failure requiring hemodialysis, malignancy, resting dyspnea, patients with chronic obstructive pulmonary disease (COPD) [8,9].

Axillo-femoral bypass grafting may be preferred instead of femoro-femoral bypass in patients with operation-related graft infections [10]. In our series, two patients had previous aortobifemoral bypass surgery. Axillofemoral bypass was applied to patients with an ankle-brachial index greater than one. Femoro-femoral (FF) bypass can be preferred in cases where anatomic bypass cannot be performed due to an extremely plaque with unilateral iliofemoral obstruction and

is also at high risk, and if the contralateral femoral artery flow is angiographic and hemodynamically sufficient [9,10]. It has been reported that the 5-year patency rate is significantly reduced if there is an obstruction in the superficial femoral artery [11]. Adequate blood flow to the donor femoral artery prior to femoro-femoral bypass intervention can be achieved by percutaneous transluminal angioplasty and reconstruction of the iliac artery with stenosis in contralateral iliac artery stenosis accompanying unilateral iliac artery obstruction [3,10]. Femoro-femoral bypass method can be preferred in cases where the same side iliac artery occlusions cannot be opened by thrombectomy and the risk of surgery and/or anesthesia is high [3,10]. Mortality rates were reported as 2 to 8% for thirty days and 23 to 73% for five years in axillo-femoral bypass series [10]. In femoro-femoral bypass series the mortality rates were reported as 2.26% for 30 days and the causes of mortality were indicated as intracranial hemorrhage, acute respiratory failure and myocardial infarction [12]. Additionally primary patency rates were reported as 70% for five years and 31% for ten years [12]. Although anatomical bypass has superior outcomes, the extra-anatomic procedures can be applied for supplying distal blood flow in ischemic conditions that circumvent the “normal” anatomic pathways [13]. Superficial femoral artery occlusion was shown as a reason for poor primary patency rates for femoro-femoral bypass applications [8]. We did not find any early occlusion in patients for whom we applied eight femoro-femoral bypasses in our clinic. The higher incidence of amputation risk was reported in femoro-femoral bypass series, but previous reports identified as this can be related with disrupted distal vascular bed and long term poor blood supply to distal tissues. Moreover, the increased mortality rates can be related with abnormal anatomical bed presentation of selected patients for femoro-femoral bypass [12-14]. Appleton et al reported that patients with extra-anatomic bypass, who did not require amputation in first year, have more chance to long-term limb salvage [14]. The endovascular approach is suggested as a first line treatment for femoro-popliteal artery stenosis/occlusion in accordance to 2017 ESC (European Society of Cardiology) Guideline [15]. Again in ESC 2017 guideline, on the other hand, endovascular treatment in short (<25 mm) lesions and autologous vein graft in long (≥25 mm) lesions are presented as the first strategy with class I indication [15]. In our series, the stenosis lengths were above 3 cm in two patients. Primary patency rates were found as 100% for all patients during 30 days. Graft thrombosis was observed in one femoro-femoral bypass and treated with embolectomy. We observed that it was beneficial in postoperative follow-up to observe the distal vascular bed by contrast arteriography after the preparation of the vessel to be bypassed intraoperatively in all surgical procedures.

In conclusion extra anatomic bypass is important for providing distal blood supply in ischemic limb cases who

does not have to chance for anatomical revascularization. It seems to have good outcomes in experienced hands. Moreover, multidisciplinary approach remains the alternative surgical approach in the high-risk patient group for extra-anatomic arterial revascularization with appropriate patient selection.

#### Limitations of Study

The main limitation of the study is concerning about small sample size. Although previous literature has presented findings with different sample size groups, the comprehensive cohorts are necessary for obtaining powerful and exact results. The second limitation is the retrospective nature of the study. Prospective follow-up studies may reveal more comprehensive outcomes.

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