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A comparison of native vessel and prosthetic graft hood, as inflow for Infrainguinal bypass in aorto-iliac occusive disease

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ABSTRACT

Introduction:

Sequential peripheral bypass is a commonly used modality for revascularization of critical limb ischaemia with multilevel occlusion involving aorto-iliac, as well as infra-inguinal territories. Selecting an appropriate inflow for the infra-inguinal component of the bypass is of paramount importance to ensure graft patency and wound healing. This study compared the post-operative outcomes of patients who received infra-inguinal bypass inflow from the hood of the ilio-femoral prosthetic graft , to those in whom inflow was taken from native femoral artery.

Methods:

Type of study : Retrospective cohort study using

Study duration: April 2018 to March 2022

Inclusion criteria –

1. Patients older than 18yrs, with CLTI with TASC C and D aorto-iliac lesion with tandem infra-inguinal occlusion, who required sequential ilio-femoral + infrainguinal bypass, either staged or single sitting.

Exclusion criteria –

1. Either aorto-iliac or infra-inguinal lesion treated with endovascular modality
2. Extra anatomic bypass for inflow

Primary objectives: Graft patency at 1 and 6 month follow up

Retrospective analysis of all sequential bypasses conducted at our hospital for 4 years was done. Ilio-femoral, aorto-unifemoral as well as aorto-bifemoral bypasses with sequential bypass to unilateral popliteal or crural arteries were included. All patients underwent an infrainguinal bypass with non-reversed autologous LSV. Graft patency at 1 and 6 months, freedom from major amputation were accessed from OPD and subsequent admission records.

Results:

A total of 56 patients were identified during the period of study, who met the inclusion criteria. Of these, 29 had inflow from native artery, whereas 27 had inflow from prosthetic graft hood. Of the former, 17 received inflow from SFA(58.6%), whereas 10(34.4%) received inflow from CFA and 2(6.9%) from PFA . Graft patency rates at 1 and 6 months were 93.1% and 89.6% for native artery inflow arm and 92.6% and 81.5% for the prosthetic graft arm

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respectively (p-0.41). freedom from major amputations at 6 months in these groups were 86.2% and 88.9% respectively (p-0.77)

Conclusion:
Sequential bypass is an essential procedure for those patients with aorto-iliac multilevel occlusion, for whom endovascular options cannot be exercised. The technique of infrainguinal bypass construction is important to ensuring patency of the bypass. In our study, bypass inflow derived from native artery showed better patency rates than those derived from prosthetic graft hood, though not statistically significant.
Keywords: Aortoiliac disease, Peripheral bypass, Peripheral artery disease,

INTRODUCTION

Aorto-iliac occlusive disease is a common cause of chronic limb threatening ischaemia (CLTI). These patients often have multilevel occlusion (aorto-iliac segment as well as tandem infra-inguinal occlusions). Wound healing and prevention of major tissue loss in these patients require the revascularization of both tandem lesions and restoration of inline flow to the pedal arteries(1). Modalities for the same may be endovascular, open or hybrid. Despite a greater number of endovascular procedures, Open surgical bypass has proven to be a time tested method for revascularization offering robustness and prolonged patency in select patients. Both the BASIL-1(2) and more recent BEST-CLI (3) trials have shown the efficacy of vein bypass in establishing and maintaining blood flow to chronically occluded limbs.

Patients with anatomy too complex for an endovascular or hybrid procedure require a ‘sequential bypass’ where aorto-iliac and infrainguinal occlusions are treated in tandem with the supra-inguinal bypass procedure providing ‘inflow’ for the distal bypass. Many authors have demonstrated the safety of simultaneous performance of both these components at the same sitting(4)(5), that might not be feasible in patients with advanced comorbid conditions who may require staged procedures. In our centre, all such procedures are done as a single stage.

Image 1: Schematc diagram of a typical sequential bypass with patient having tandem aorto-iliac as well as fem-pop occlusion. C demonstrates aorto-femoral bypass (inflow procedure) while A demonstrates femoro-popliteal (infrainguinal) bypass
Source: https://radiologykey.com/graft-surveillance-and-preoperative-vein-mapping-for-bypass-surgery/

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Previous studies have been undertaken to evaluate the factors determining patency of the sequential bypass. Lam et al (6) demonstrated that inflow taken from the prosthetic hood of an inflow conduit is an independent risk factor for occlusion of the infra-inguinal bypass. More recently, Russo et al (7) demonstrated better, though not significant patency rates when infrainguinal bypass inflow was taken from a native artery as opposed to the prosthetic inflow graft. However, in this study, procedures were often staged.

The purpose of this study was to compare the patency of when infrainguinal bypass was constructed with inflow from native artery versus that from prosthetic graft hood, in single-stage sequential bypass.

MATERIALS AND METHODS

This was a retrospective cohort study undertaken at the dept of Vascular Surgery at Madurai medical college, Madurai, TN, India. The patients who underwent elective lower limb revascularization procedures during the period April 2018 to March 2022 were identified . Their out-patient notes, In-patient charts, Operation notes were accessed to obtain data regarding general characteristics, level of occlusion, class of ischaemia, procedure done, post-op course and long-term follow-up. Of these, 56 patients met the criteria for our review.

The patients included in our study were those with TASC C & D aorto-iliac occlusion, with multilevel occlusion requiring the use of aorto-femoral or ilio-femoral bypass (inflow procedure) along with a concomitant or staged infra-inguinal bypass (Sequential bypass). Those treated with endovascular modality for either the supra- or infra-inguinal occlusion, were excluded.

The data collected included demographic data, comorbidities, history of smoking, Level of occlusion, Rutherford staging of CLI, ABI and PPCI values, Basic blood investigations, Cardiac evaluation, CT angiogram reports. From the in-patient charts, nature of procedure and post-op course for any secondary interventions were obtained. Follow-up details were ascertained from clinical, ABI and duplex reports from out-patient notes and further re-admission charts.

The subjects were divided into 2 groups. The first group, who had the inflow of the infra-inguinal bypass from a segment of native artery downstream to the distal anastomosis of the inflow procedure (native artery group) ; and the second group who had inflow of the infra-inguinal bypass was from the graft hood of the distal anastomosis from the inflow procedure (prosthetic hood group).

The primary outcomes studied were graft patency rates at 1 and 6 months. The secondary outcome studied was freedom from MALE at 6 months.

Surgical procedure: Ilio-femoral-distal sequential bypass is more commonly done as a single stage procedure at our centre; however, some patients did require a staged infra-inguinal bypass after initial inflow procedure. For Inflow procedures, either infra-renal aorta or common iliac artery by either retroperitoneal or transperitoneal approach, were chosen as site of inflow. Endarterectomy was conducted as and when needed at the inflow site. PTFE or polyester graft tunneled in the retroperitoneal plane was used as conduit. Distal anastomosis was almost universally at the common femoral artery with or without a concomitant endarterectomy. For infra-inguinal bypass, the conduit chosen were either non reversed great saphenous vein (NRGSV) graft or PTFE graft. Use of PTFE graft was restricted to above knee popliteal bypass. All grafts were placed in an anatomical or sub-sartorial plane. Inflow was obtained either by sewing the proximal end of the graft to the hood of the inflow graft (prosthetic hood inflow) (fig B) or to native vessel distal to the prosthetic graft anastomosis (native vessel inflow) (fig A).

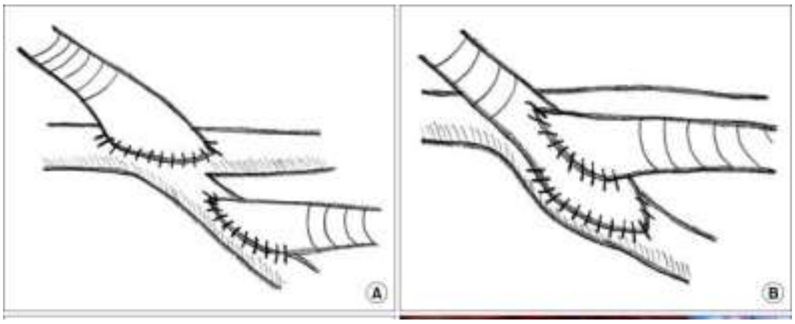

Image 2: ref: Kim, Yoon-Sub & Yun, Woo-Sung & Park, Kihyuk. (2014). Long-term outcome of crossover femoro-femoro-popliteal bypass using side-to-side anastomosis in ilio-femoral occlusive disease. Annals of surgical treatment and research. (8)

Native vessel from which the inflow was taken was either common femoral artery (CFA), Profunda femoris artery (PFA) or Superficial femoral artery (SFA). SFA inflow was taken almost invariably after an eversion endarterectomy of the proximal SFA with end-to-end anastomosis of the SFA stump to the graft. Distal anastomosis were to the above knee or below knee popliteal or crural arteries (anterior tibial, posterior tibial or peroneal arteries)

Follow up: Patients' post-op course was noted and any procedures to assist primary patency were documented. Subsequently patients were screened for graft patency at 1- and 6-months post-op with ABI measurement and Duplex screening. Any patients lost to follow up were censored. Freedom from primary amputation was defined as not having required either a below knee or above knee amputation in the post procedural period, and was measured at 6 months post op.

Statistical Analysis: Graft patency rates were plotted on a Kaplan Meier Plot

RESULTS

Between April 2018 and March 2022, 67 patients were identified who met the inclusion criteria. Of these, 11 were excluded due to use of endovascular interventions or lost to follow up within first 6 months post-op. Of the 56 patients in the final cohort, 27 were identified as belonging to the prosthetic hood group and 29 were identified as belonging to the native artery group.

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Their basic demographic characteristics were as follows – The median age was slightly higher in the prosthetic hood group (57.5) vs the native artery group (54.5). Native artery group had 22 males, 7 females. Prosthetic group had 18 males and 9 females.

	Native group (n = 29)	**Prosthetic group (n = 27)**
Median age	54.5	57.5
Males	22	18
Females	7	9

The comorbid conditions – Diabetes mellitus, Hypertension, Coronary artery disease (CAD), Chronic kidney disease (CKD) and history of smoking (current or reformed) between the two groups were similar

	Native group (n = 29)	**Prosthetic group (n = 27)**
Smoking	20	18
Diabetes	10	12
Hypertension	17	15
CAD	13	11
CKD	4	5

The severity of limb ischaemia was classified and stratified according to Rutherford staging of chronic limb ischaemia. All patients who received sequential bypass were of Rutherford class 4 (rest pain), 5 (small ischaemic ulcers or toe gangrene) or 6 (extensive ulcers or gangrene proximal to metatarsophalyngeal joint), with a majority belonging to Rutherford

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class 5 in both groups. In the Native vessel group, 4 (13.7%) had Class 4 CLI, 14 (48.2%) had Class 5 CLI, and 11 (37.9%) had class 6 CLI. In the prosthetic hood group, 2 (7.4%) had class 4 CLI, 16 (59.2%) had class 5 CLI and 9 (33.3%) had class 6 CLI. It was noted that none of these patients were operated for lifestyle limiting claudication (LLC) alone i.e Rutherford class 3 CLI. Retrospectively, it was found that these patients underwent only open Inflow procedures or hybrid procedures, and hence were not under the ambit of this study. The distribution between these groups was similar.

Rutherford class	Native group (n = 29)	Prosthetic group (n = 27)
4	4	2
5	14	16
6	11	9

The inflow procedures for both groups were classified as Aorto-femoral, Ilio-femoral, or femoro-femoral crossover. In the native artery group, 6 (20.6%) underwent aorto-femoral bypass vs 8 (29.6%) in the prosthetic hood group. In the native artery group, 22 (75.8%) underwent ilio-femoral bypass against 19 (70.4%) in the prosthetic hood group. Only 1 patient underwent femoro-femoral crossover bypass (3.4%), who belonged to the native artery group. The distribution between these groups was similar.

Bypass	Native group (n = 29)	Prosthetic group (n = 27)
Aorto-femoral	6	8
Ilio-femoral	22	19
Femoro-femoral	1	0

The type of graft used for inflow procedure was classified as PTFE or Polyester (Dacron). Dacron was used in 18 (62%) of those in the native artery group against 17 (62.9%) in the prosthetic hood group. PTFE was used in 11 (38%) of the native artery group versus 10 (37.1%) in the prosthetic artery group. The distribution between these groups was similar.

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Type of graft	Native group (n = 29)	Prosthetic group (n = 27)
PTFE	11	10
Dacron	18	17

Regarding the infra-inguinal bypass component, most of the bypasses were done with non-reversed GSV graft. Only two were done with PTFE graft, both of which were in the native artery group (6.9%). There were no prosthetic grafts used for infrainguinal bypass in the prosthetic hood group. The distribution between these groups was similar.

Type of graft	Native group (n = 29)	Prosthetic group (n = 27)
Non reversed GSV	27	27
PTFE	2	0

The inflow vessel in the native artery group was most commonly the superficial femoral artery (after eversion endarterectomy) (17 patients – 58.6%). Common femoral artery was in prevalence (10 patients – 34.4%) and Profunda femoris artery was least common, being used in only 2 patients (6.9%).

As for the distal anastomotic target vessel (outflow vessel), most of the bypasses were done to proximal (above knee) popliteal artery – 15 in the native group (51.7%) vs 13 in the prosthetic hood group (48.1%). This was followed by distal (below knee) popliteal artery – 9

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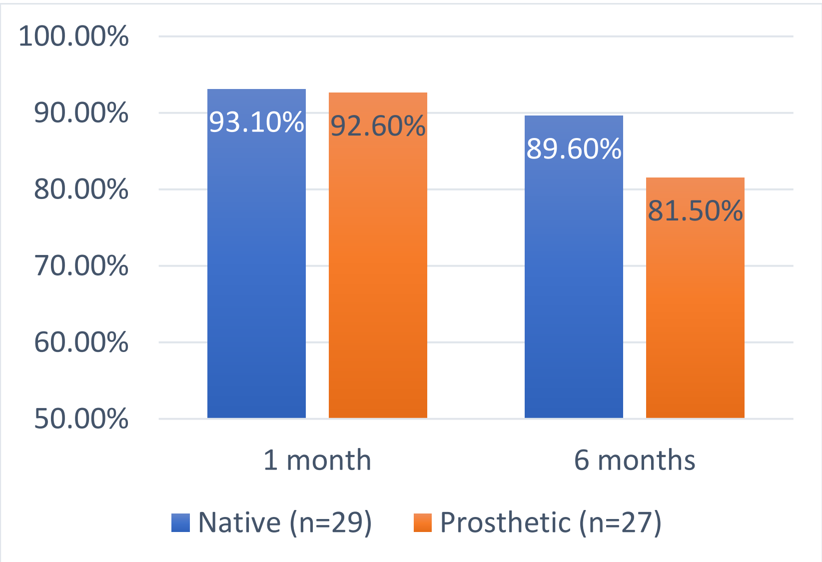
(31%) versus 10 (37%) respectively. Finally, least commonly, crural arteries (Anterior tibial, posterior tibial or peroneal arteries) were utilised for distal outflow – 5 (17.2%) vs 4 (14.8%) respectively. The distribution between these groups was similar.

Outflow	**Native group (n = 29)**	**Prosthetic group (n = 27)**
Proximal popliteal	15	13
Distal popliteal	9	10
Tibial	5	4

The primary assisted patency of the bypass procedures were recorded at 1 and 6 months post op. Here primary assisted patency is considered as the few patients who required revision or redo procedures, underwent them during the same admission as the first procedure, never later than POD-2.

At 1 month, the primary patency rate in the native vessel group was 93.1% (27 out of 29) compared to 92.6% (25 out of 27) in the prosthetic group. At 6 months, the primary patency rate had dropped in both groups - 89.6% (26 out of 29) in the native artery group against 81.5% (22 out of 27) in the prosthetic hood group.



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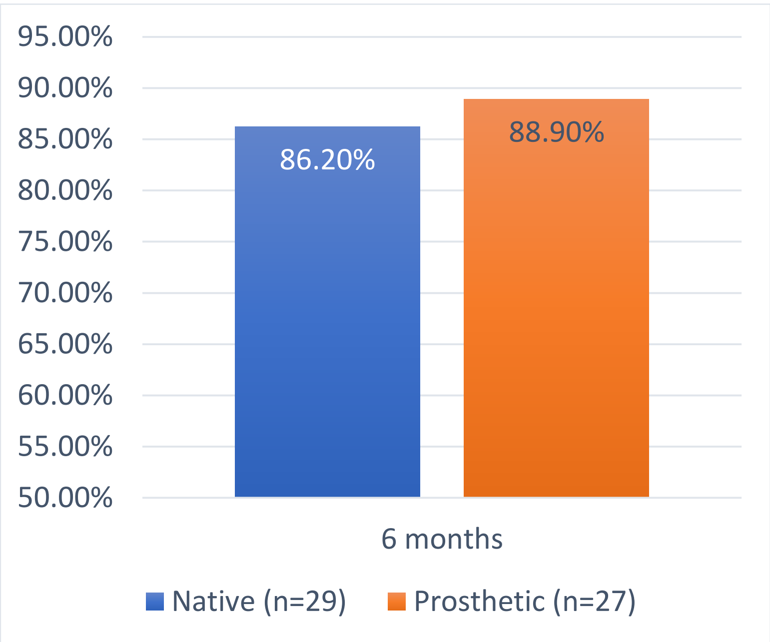
These results were plotted on a Kaplan-Meier curve and the graft patency in the native group was found to be not significantly better than that in the prosthetic group (p= 0.41) at 6 months post operatively.

The freedom from major amputation at 6 months in these two groups were also compared and found to be 25 out of 29 in the native artery group (86.2%), versus 24 out of 27 in the prosthetic hood group (88.9%) in the prosthetic group. This difference was also found to be not significant (p=0.77)



DISCUSSION

Multilevel arterial occlusion presents a challenge to surgeons in that disease process is more aggressive with a higher risk of progression to major tissue loss and amputation. At the same time, these patients are likely to have a myriad of comorbid conditions, increasing their operative risk. Previous authors have demonstrated the safety of a single stage sequential bypass. However, worse outcomes have been observed if multiple additional steps such as endarterectomy or profundoplasty are undertaken. In our centre, a majority of the patients presented with tissue loss (CLI grade 4 and 5), in whom staged procedures could not be undertaken due to ascending tissue loss, thus necessitating a single stage surgery.

Intra operatively, the decision on whether to choose native artery or prosthetic graft hood was usually taken based on length of CFA distal to the inflow anastomosis, PFA and SFA disease burden. PFA has been described by multiple authors as a robust and reliable inflow vessel for infrainguinal bypass procedures (9), but was used sparingly in our study population of 29 native artery group (n=2, 6.9%). Possible explanations could be prolonged operating time and extent of dissection involved. An alternative vessel used by our team was the proximal SFA. The SFA was invariably diseased in all our patients, however all patients for whom SFA was used as inflow (n=17 – 58.6%) underwent an eversion endarterectomy of the proximal 5-8cm, followed by an end-to-end anastomosis to the conduit vein/ graft. This technique has been demonstrated by various authors to be effective (10,11). In the remaining patients (n= 10, 34.4%), common femoral artery length downstream to the inflow procedure was sufficient to perform an anastomosis to the infrainguinal conduit.

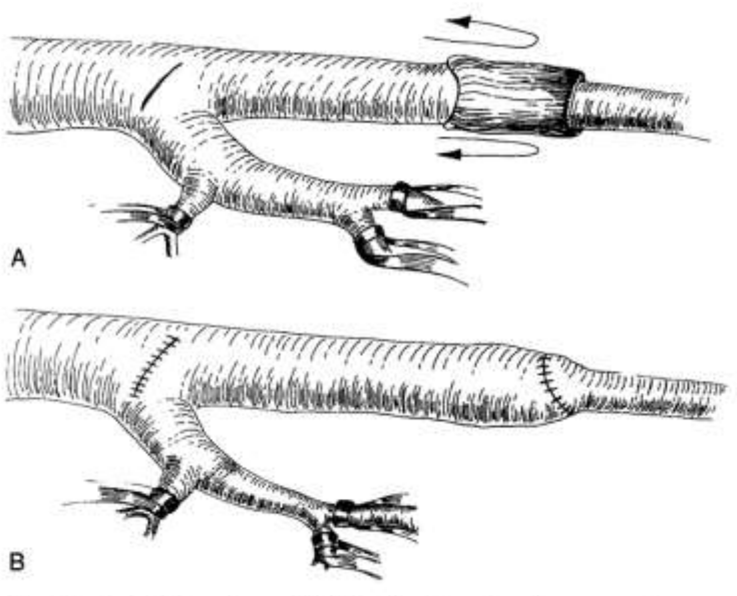


Fig. 1. A, Superficial femoral artery divided distally, with eversion endarterectomy in progress. **B,** Endarterectomized femoral artery is then sewn to a segment of autogenous vein, end-to-end, to construct a conduit for distal bypass.

Image 3: ref Taylor, S M et al. "Superficial femoral artery eversion endarterectomy: a useful adjunct for infrainguinal bypass in the presence of limited autogenous vein." *Journal of vascular surgery* vol. 26,3 (1997): 439-45; discussion 445-6 (10)

The choice of conduit for most procedures was non reversed GSV (NRGSV). Although studies have shown no significant difference between reversed and non-reversed GSV graft (12), NRGSV is the standard of care at our centre and hence reversed/ in situ bypass were not constructed. Two patients in the native artery group received a PTFE graft in view of poor vein availability. The distal target arteries between the two groups were similar. The patency rate at 1 and 6 months were higher in the native artery group when compared to the prosthetic hood group. (93.1% vs 92.6% at 1 month; and 89.6% vs 81.5% at 6 months). These values were found to be not significant (p = 0.41) and undoubtedly, higher numbers and would be required to show a significant difference. The amputation free survival was slightly higher in the prosthetic hood group, which was not significant (p = 0.77). This opposite trend could not be explained. Larger numbers and longer follow up would be required.

The causes of a slightly better patency in the native artery groups have been postulated by various authors as resulting from 1) presence of a continuous endothelised, non-thrombogenic surface in case of sewing the anastomosis to a native artery 2) Presence of a bulkier anastomotic complex in case of prosthetic graft hood as inflow, thereby increasing chances of extrinsic compression 3) inline flow in native artery configuration vs turbulent flow in case of prosthetic graft hood anastomosis 4) maintenance of infrainguinal graft flow via PFA collaterals in case of proximal (inflow) graft occlusion (7). This effect could not be demonstrated in our population due to gaps in record keeping.

The few limitations of our study are noted, the main one being a retrospective cohort study. Poor follow up beyond initial 6-7 months was another limitation. Apart from these, inability to evaluate adjunct procedures such as profundoplasty and endarterectomy due to limitations of our operative notes record keeping.

In conclusion, it is recommended that inflow for an infrainguinal bypass surgery be obtained from a native vessel distal to the inflow anastomosis wherever possible to enhance graft patency

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