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FOR DEBATE

Trans-Iliac Bypass Grafting for Vascular Groin Complications

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WHAT THIS PAPER ADDS

This represents the largest series of trans-iliac bypass grafting to date, with a review of the published data. An evaluation of this rare extra-anatomic bypass technique was performed. Patency as well as limb salvage and patient survival were good and may be comparable to those reported for autologous *in situ* repair and obturator canal bypass grafting.

Objectives: Groin complications following vascular reconstruction, extensive trauma, or severe radiation induced scarring may complicate future revascularisation procedures of the lower limb. Although several techniques have been described, only few cases of trans-iliac bypass grafting have been published. The aim of this study was to perform a review of the literature on trans-ilac bypass grafting and add the authors' experience.
Methods: A single centre retrospective data analysis and a literature review of all trans-iliac bypass procedures was performed. Data on indication, patency, limb salvage, and survival were collected. Study endpoints were patency, limb salvage, and patient survival.
Results: Eight trans-iliac wing bypass grafting procedures were performed in our institution between 2003 and 2018, which represents the largest single centre series. Twenty-three procedures were reported in the literature between 1989 and 2018. Prior to the bypass procedure in the eight patients, six had local infection and two irradiation of the groin. The indication for operation was ischaemia in six cases, bleeding in one case, and infection in another case. The external iliac artery was most often used for the proximal (6 cases) and the superficial femoral artery for distal anastomosis (6 cases). Great saphenous vein was the most commonly used graft material (6 cases). The median follow up was five years with three bypass occlusions after 1, 2, and 8 months, followed by two successful thrombectomy procedures. There were no major amputations and only one death after five months, which was not procedure related.
Conclusions: Trans-iliac bypass grafting is a viable alternative extra-anatomic bypass technique in patients with vascular groin complications. Patency as well as limb salvage and survival are good and may be comparable to those reported for autologous *in situ* repair and obturator canal bypass grafting.

Keywords: Extra-anatomic bypass, Groin infection, Groin radiation, Trans-iliac wing bypass
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INTRODUCTION

Despite endovascular advances, complications of the groin remain a challenging topic in vascular surgery. This is caused by its proximity to the perineum, surgical division of lymphatic vessels and the superficial location of graft materials.[1] Reports of up to 30% surgical site infections of the groin after lower extremity revascularisation add significantly to the morbidity and mortality of patients, as well as infections of vascular grafts, septic pseudoaneurysms resulting from local drug administration, and extensive trauma.[2–5] The reported frequencies for prosthetic graft infections after femoral arterial bypass are between 2.6% and 6%.[6,7] Excision, debridement, and *in situ* repair with an autologous vein graft are considered the standard strategy in these cases.[1,8,9] Although the superficial femoral vein (SFV) is relatively resistant to infection, because of its thicker wall,[10] its harvesting is more invasive than

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harvesting of the great saphenous vein (GSV). Alternatively, cryopreserved vein grafts can be used with adequate results, but their resistance to infection is limited.[10–12] *In situ* repair has limitations in cases of deep infections of the groin or severe radiation induced scarring, which may necessitate procedures that avoid the affected groin region.

In the absence of alternatives, extra-anatomic bypass procedures are still recommended by the ESVS guidelines on peripheral arterial disease.[13] The obturator canal bypass (OCB), first described by Shaw et al., in 1963, is the most commonly used extra-anatomic bypass procedure, but it cannot be applied when the medial approach is unfavourable because of extended infections or after extensive radiotherapy of the groin and pelvic region.[1,14,15] As an alternative technique Brzezinski et al. introduced the trans-iliac bypass (TIB) in 1989.[16] Since then, only case reports or small series of this procedure have been published.[1,15,17–24] Therefore, there is no adequate information on the outcome of TIB. The aim of this study was to collect all published cases on TIB and evaluate them together with the procedures performed in our institution.

MATERIALS AND METHODS

Case selection

A single centre retrospective data analysis was carried out of all TIB procedures at the study institution from 2003 to 2018. The collected data included patient characteristics, indications for the procedure, graft material, anastomotic sites, patency, limb salvage, and patient survival.

Articles identified on literature search were included if they reported TIB with data on patient characteristics, indication for the procedure, graft material, and anastomotic sites. The outcomes of interest were patency, limb salvage, and patient survival. All articles that did not explicitly report TIB were excluded.

Search strategy and data sources

A comprehensive search of articles published in English, French, and German between January 1989 and March 2018 was conducted in the MEDLINE database and Excerpta Medica Database (EMBASE) by two independent investigators. The descriptors used to find articles of interest were “extra anatomic bypass,” “extra anatomic revascularization,” “iliac wing,” “trans iliac bypass,” “trans iliac wing,” and “vascular groin infection.”

After transferring all 1692 citations to a database, duplicates were removed. Two independent reviewers screened the remaining 1479 titles and abstracts to identify articles meeting the eligibility criteria. Some 142 articles were retrieved in full text and screened for TIB, resulting in the selection of 11 publications.[1,15–24]

Indication

The indications for TIB grafting were categorised as either severe radiation induced scarring or infection of the groin, including graft infections and septic pseudoaneurysms. Symptoms leading to the extra-anatomic revascularisation were categorizeded into limb ischaemia, infection, or acute bleeding.

Surgical technique and follow up

With the patient under general anaesthesia a wide operative field from the abdomen to both ankles is prepared, in case the contralateral GSV is needed. In infected vascular grafts and bleeding pseudoaneurysms of the groin, the technique begins with a transverse abdominal incision parallel to the inguinal ligament for retroperitoneal access to the common (CIA) or external iliac artery (EIA) for proximal control. A slightly larger incision is necessary than for the standard iliac artery approach to expose the iliac crest and to drill. Next, the site for distal anastomosis is exposed, according to the extent of the groin complication and concurrent peripheral arterial disease. To prepare a path for the graft, a small part of the iliacus muscle is separated bluntly from the iliac wing at its origin. Above the greater trochanter a counter incision is made 4 cm below the iliac crest, with blunt dissection of gluteus medius and minimus muscles. Next, a 10 mm wide tunnel is drilled at the upper part of the iliac wing with a 30° downwards angle from inside out and the edges are smoothed. Additional haemostasis has been described with bone wax,[19] but, in the authors’ experience, this is not necessary. Especially, in patients with systemic bacteremia, we prefer to use GSV. In cases without suitable veins our standard graft material is 8 mm expanded polytetrafluoroethylene (ePTFE). Preparation of the proximal and distal anastomotic sites as well as graft harvest were followed by systemic heparinisation. A subcutaneous tunnel from the distal anastomotic site to the iliac wing is then prepared. Tunnelling is combined with a medial approach for the SFA and the PA above or below the knee. The authors prefer subcutaneous tunnelling because it facilitates duplex surveillance and re-intervention. The graft is passed through the bone tunnel and anastomosed end to side to the CIA or EIA as well as to the distal anastomotic site (Fig. 1). After wound closure and coverage with drapes, excision and debridement of the infected area were performed.

Outpatient follow up of all patients was scheduled for 1, 3, 6, and 12 months and annually thereafter. All examinations included measurements of the ankle brachial index (ABI) and duplex sonography of the bypass graft.

Definitions and study endpoints

Patency was defined according to the reporting guidelines for peripheral arterial disease.[25] The study endpoints were patency, limb salvage, and patient survival.

Statistical analysis

To evaluate the cases, available patient and bypass graft characteristics were collected. Categorical variables are reported as frequencies. The R statistics environment (version 3.2.1, R Foundation for Statistical Computing, www.r-project.org) was used for statistical analysis.

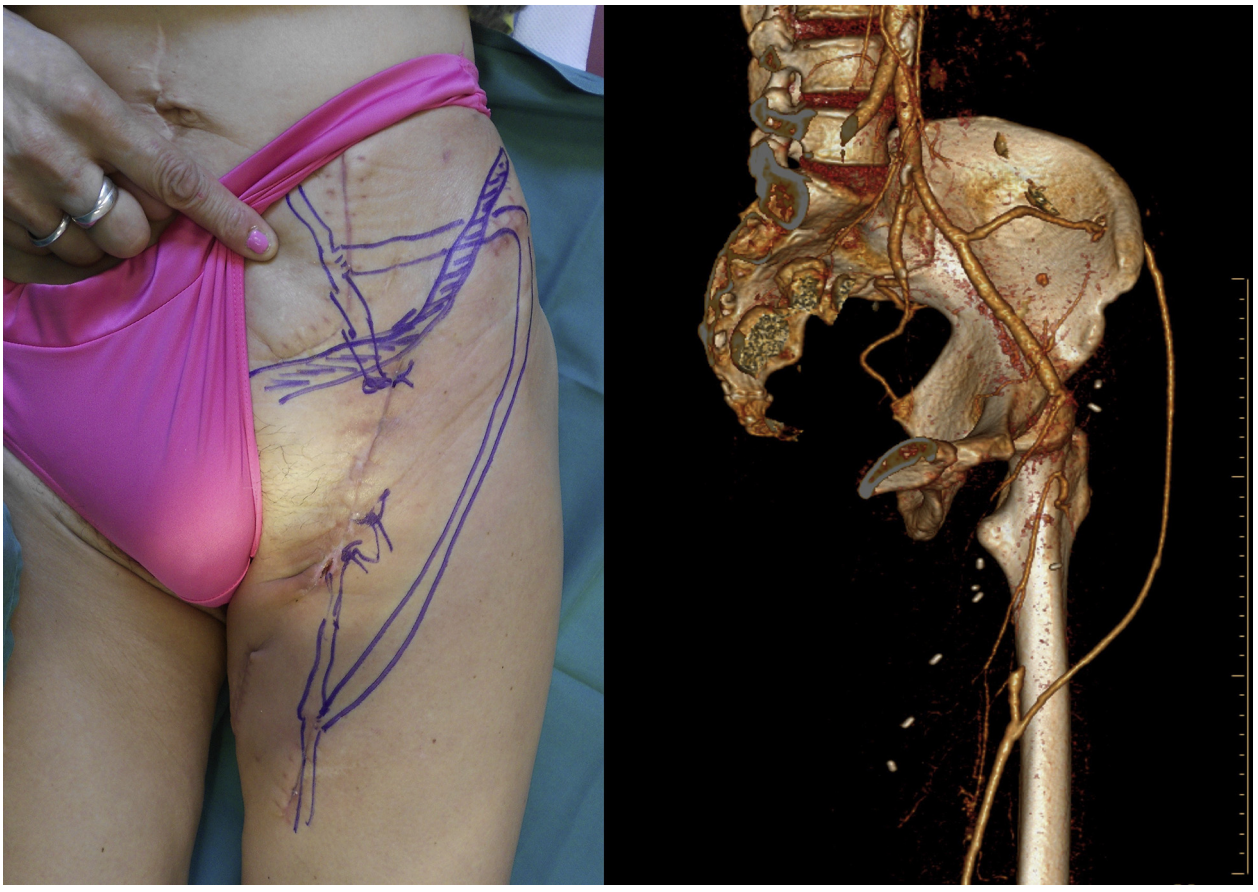

Figure 1. Trans-iliac bypass graft spanning from the left external iliac artery through the iliac wing to the superficial femoral artery with ipsilateral non-reversed great saphenous vein in a patient with septic groin pseudoaneurysm due to intravenous drug abuse. Left: post-operative image with outline of the bypass graft. Right: post-operative computed tomography angiography.

Ethical approval

Because of its retrospective design the Institutional Review Board approved the study and waived a requirement for informed patient consent.

RESULTS

Patient characteristics and technical features

The eight TIBs performed at the study institution are described in detail. The causes of vascular groin complications that led to TIB were categorised as associated with either infection (6 cases) or radiation therapy (2 cases). Three patients had infected vascular grafts in the groin (2 iliofemoral bypass grafts and one femoropopliteal bypass graft). The two infected iliofemoral bypasses were initially managed with OCB but subsequently had to be replaced with TIB because of re-infection. In two patients the TIB was performed because of septic pseudoaneurysms caused by drug abuse and one patient had groin infection after trauma.

The three clinical indications for TIB were classified as acute bleeding in one case, deep groin infection in one case, and limb ischaemia in six cases. The most commonly used proximal anastomotic site was the EIA in six cases, followed by the CIA in two cases.

The distal anastomosis was performed to the SFA in six patients, the above knee PA (PA I) in one patient, and the below knee PA (PA III) in another patient.

GSV was the most commonly used graft material in six cases, followed by ePTFE in two. Antithrombotic therapy comprised aspirin (100 mg) in five patients, rivaroxaban (20 mg) in two patients with atrial fibrillation, and clopidogrel (75 mg) in one patient, who was a non-responder to aspirin.

Antibiotic therapy was individually adapted according to bacterial cultures in all eight cases. None of the patients received long-term antibiotic therapy exceeding six weeks.

Peri-operative phase

Within the first 30 days there were no procedure related major amputations or deaths. One TIB occluded after one month. There were no other major post-operative complications.

Table 1. Clinical characteristics and results of the trans-iliac bypass grafting in the literature and at the authors' institution

Reference	#[a]	Mean age	Cause of groin complication	Indication for TIW	Proximal anastomosis	Distal anastomosis	Graft material	Follow up
Brzezinski et al. 1989[16]	1	71	Graft infection	Infection	Limb of aortobifemoral (ABF) bypass	Superficial femoral artery (SFA)	Expanded polytetrafluoroethylene (ePTFE)	Patent for 11 months
Favre et al. 1993[17]	5	60	Graft infection (3), mycotic aneurysm (1), radiation (1)	Infection (4) ischaemia (1)	Limb of ABF bypass/common iliac artery (CIA)	Profunda femoris artery (PFA)/SFA	ePTFE	Three patent for two years, one major amputation at 18 months, one death after cardiac surgery
Sekanina et al. 1995[18]	2	74	Graft infection (2)	Bleeding (1) ischaemia (1)	CIA	Anterior tibial artery (ATA)	ePTFE	Patent for 12 and 15 months
Donayre et al. 1999[19]	1	21	Graft infection, gun shot	Bleeding	CIA	Popliteal artery above knee (Pop I)	Polyester	Patent for nine months, planned ligation and *in situ* repair
Katsamouris et at. 2000[15]	4	–	Graft infection (1), radiation (3)	Bleeding (2) infection (1) ischaemia (1)	CIA	Pop I/popliteal artery below knee (Pop III)	Polyester/ePTFE	Three patent for six, 16 and 55 months, one major amputation at 15 months
Besirli et al. 2005[20]	2	44	Graft infection (1), radiation (1)	Bleeding (1) ischaemia (1)	CIA/external iliac artery (EIA)	SFA	ePTFE	No follow up data
Engin et a. 2005[1]	2	57	Graft infection (2)	Bleeding (2)	CIA	Pop III/SFA	ePTFE	Patent for over four years
Tiesenhausen et al. 2007[21]	1	51	Graft infection	Infection	CIA	Pop I	ePTFE	Patent for 12 years
Heldenberg et al. 2014[22]	1	46	Graft infection	Infection	Aorta	ATA	ePTFE	Patent for 12 months
Kontopodis et al. 2016[23]	1	59	Graft infection	Infection	Limb of ABF bypass	PFA	ePTFE	Patent for two years
Fichelle et al. 2017[24]	3	–	Radiation (3)	Ischaemia (3)	Aorta/CIA	PFA/SFA	ePTFE	Patent for over three years
Enzmann et al. (present study)	8	63						
		44	Septic pseudoaneurysm (PSA)	Bleeding	EIA	SFA	Greater saphenous vein (GSV)	Occlusion after one month, successful thrombectomy
		50	Graft infection	Ischaemia	EIA	SFA	GSV	Patent for 14 years
		67	Radiation	Ischaemia	CIA	Pop I	ePTFE	Thrombectomy at eight months, patent for nine years
		54	Septic PSA	Infection	EIA	SFA	GSV	Patent for five years
		83	Groin infection	Ischaemia	EIA	SFA	GSV	Patent for five years
		45	Graft infection	Ischaemia	CIA	SFA	GSV	Patent for 4.5 years
		81	Radiation	Ischaemia	EIA	SFA	GSV	Patent for four years
		84	Graft infection	Ischaemia	EIA	Pop III	ePTFE	Failed thrombectomy at two months, death after five months

ABF = aortobifemoral; ATA = anterior tibial artery; CIA = common iliac artery; EIA = external iliac artery; ePTFE = expanded polytetrafluoroethylene; GSV = great saphenous vein; PFA = profunda femoris artery; Pop I = popliteal artery above knee; Pop III = popliteal artery below knee; PSA = pseudoaneurysm; SFA = superficial femoral artery; TIW = trans-iliac wing.

[a] Number of trans-iliac bypass grafts in the publication.

Table 2. Demographics and indications for trans-iliac bypass (TIB) grafting in literature (A) and the authors' institution (B)

Variable[a]	Patients A (n = 23)	Patients B (n = 8)
Mean age, years	56 (±13.3)	63 (±17.5)
Male gender	18 (78%)	3 (38%)
Peripheral arterial disease	12 (52%)	1 (13%)
Cause of groin complication		
Infection	15 (65%)	6 (75%)
Irradiation	8 (35%)	2 (25%)
Indication for TIB		
Bleeding	7 (30%)	1 (13%)
Infection	9 (39%)	1 (13%)
Ischaemia	7 (30%)	6 (75%)

[a] Continuous data are shown as mean ± standard deviation (SD) and categorical data as n (%).

Study endpoints

The median follow up was five years (range 0.5—14 years). None of the eight patients was lost to follow up. There were three occlusions after 1, 2, and 8 months, followed by two successful thrombectomy procedures. There were no major amputations during follow up. One patient died after five months from congestive heart failure, which was not procedure related. No graft re-infections or major procedure related complications were encountered. No problems were observed associated with the tunnel in the iliac wing.

Eleven publications were found reporting TIB from 1989 to 2017. Six were small series of two to five patients, whereas the other five publications were single case reports. The combined published literature comprised 23 cases. The clinical data and results of the TIB grafts from the literature, as well as the eight patients operated at the present study institution between 2003 and 2018, are detailed in Table 1.

Demographic data and indications for TIB grafting are summarised in Table 2 for the 23 cases in the literature and the present eight cases.

DISCUSSION

Management of groin complications in vascular surgery continues to be demanding. The decision making process involves several factors, one of the most important being the general condition of the patient. It is crucial to understand the cause of the groin complication, because in cases of previous radiation therapy the main idea for revascularisation is to circumvent the scarred region.[24]

The standard treatment for graft infection in the groin remains excision, debridement, and autologous *in situ* repair. In most studies the vein graft material of choice for iliofemoral revascularisations is the SFV because of its large diameter and increased infection resistance.[10]

Several other extra-anatomic techniques to restore arterial circulation have been described, including gluteopopliteal bypass, axillofemoral, or popliteal bypass.[26,27] However, the OCB has been the most propagated technique in groin complications since the 1960s.

Between 2003 and 2018 10 OCBs were performed at the present study institution according to the attending surgeon's preference, with similar results compared with the literature. Criteria for the decision making process were limitations of the OCB, as reported by several authors. Radiotherapy induced severe fibrosis of the proximal femoral and inguinal region can prohibit preparation at the obturator foramen. Extended infection from the inguinal ligament towards the retroperitoneum or involvement of deep adductor muscle layers are reported arguments against the use of OCB. Another point concerns reports of significant venous bleeding during tunnelling of the grafts, which was more severe in patients with ipsilateral iliac post-thrombotic syndrome.[1,15,20]

These limitations did not affect TIB grafting, and in two cases it was used for revascularisation after infection or occlusion of a prosthetic OCB. These cases had TIB with GSV. The present group is the only one using the GSV for TIB grafting, which is preferred especially in patients with systemic bacteraemia. In the literature, either ePTFE (83%) or polyester (17%) was used for TIB grafting, with no subsequent graft infections or evidence for inferior outcome compared with GSV. Therefore, synthetic graft materials with sufficient antibiotic therapy appear to be equivalent to GSV in TIB grafting. None of the previous publications on TIB mention the possibility of using autologous graft materials, which is surprising. Nevertheless, the present authors recommend use of autologous vein grafts, if available. Regarding the proximal anastomotic site, the CIA was most commonly used with 16 cases (70%) in the literature, followed by a non-infected limb of an aortofemoral graft in four (17%), the aorta in two (9%), and the EIA in one (4%) case. Conversely the present authors preferred the EIA in the majority of cases (75%).

In the literature, a distal anastomosis was performed to the SFA in eight patients (35%), the PFA in six (26%), the PA I in four (17%), the PA III in two (9%), and the ATA in three (13%) patients. In the present eight cases, the SFA (6), the PA I (1), and PA III (1) were used.

Interestingly, only two of the present eight patients received TIB for an infected pseudoaneurysm, and no cases of this were described in literature, although this pathology is relatively common. Some vascular surgeons tend to ligate the CFA or use one of the above described local reconstruction techniques. Considering the study endpoints in the literature, two TIBs occluded after 15 and 18 months, which led to major amputation in both cases. Planned ligation after 9 months with subsequent autologous *in situ* repair was performed in one case. Three patients died during a median follow up of two years with no peri-operative mortality. As in the present series, no graft re-infections or major procedure related complications were described. Similarly, no problems associated with the iliac wing tunnel were seen.

With eight patients, the present study institution has the largest experience in the literature so far. Because of the small group of eight patients, and with only 23 reported

cases in the literature, the influence of demographic parameters, causes of groin complication, indication for TIB grafting, site of proximal or distal anastomosis, or the graft used on patency, limb salvage, or survival could not be analysed. Nevertheless, none of the TIBs in patients after radiotherapy in the present series or literature occluded during follow up. There was also an unsurprising tendency for superior patency in patients without peripheral arterial disease.

Limitations of this study are its retrospective design and small sample size. The analysis of published case reports and small case series may also be strongly influenced by publication bias.

In conclusion, the TIB graft is a viable alternative extra-anatomic bypass technique in vascular complications of the groin as it is not as prone to local limitations as the OCB or autologous *in situ* repair. The tunnelling is safe and relatively easy to perform with no peri-operative mortality or major complications. No problems or stenoses were observed regarding the tunnel in the iliac wing. Patency as well as limb salvage and survival are good and may be comparable to those reported for autologous *in situ* repair and OCB.

CONFLICT OF INTEREST

None.

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None.

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