Title	Extra-anatomic Bypasses for Aortoiliac Occlusive Disease
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Citation	日本外科宝函 (1980), 49(2): 141-148
Issue Date	1980-03-01
URL	http://hdl.handle.net/2433/208422
Right	
Type	Departmental Bulletin Paper
Textversion	publisher

Arch Jap Chir 49 (2), 141~148, März, 1980

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Extra-anatomic Bypasses for Aortoiliac Occlusive Disease

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Received for Publication, Jan. 14, 1980

Introduction

In 1960 MACAUGHAN, KAHN[7] and VETTO[15] reported on the technique of femoro-femoral cross-over grafting for the treatment of unilateral diseases of the iliac or femoral artery, a technique consisting of bypassing subcutaneously in the abdominal wall from the contralateral vessel. This technique is of value, being simple and tolerated well by even high-risk patient. Unfortunately, not all high-risk patients with unilateral disabling claudication or gangrene have a contralateral iliac artery flow adequate for successful cross-over femoro-femoral grafting without the addition of an inflow procedure.

The unilateral axillofemoral Dacron bypass graft was introduced by BLAISDELL and HALL[1] in 1963. They reported three patients who had developed complications of previous aortic surgery and who therefore required extra-anatomic bypass. Subsequently, the use of axillofemoral grafts to bypass septic or thrombosed aortic grafts has gained considerable acceptance.

Both of these techniques can be performed under local anesthesia and are beneficial to high-risk patients of old age.

This is a report of a series of 24 consecutive patients undergoing extra-anatomic bypasses for iliac or aortoiliac disease.

Subjects and methods

From 1974, to November, 1979, 24 consecutive patients underwent extra-anatomic bypasses for iliac or aortoiliac disease. Four patients underwent across-over femoro-femoral

Key words : Femorofemoral, axillofemoral, Runoff, Graft failure, Innominoiliac.
索引語：大腿・大腿動脈バイパス，腋窩・大腿動脈バイパス，末梢血流，グラフト閉塞，腕頭・腸骨動脈バイパス．
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Table 1. Types of extra-anatomic bypasses in twenty-four patients with aortoiliac occlusive disease

Type of bypass	No. of patients
Femorofemoral	4
Unilateral axillofemoral	5
Bilateral axillofemoral	3
Axillofemorofemoral	7
Inferior mesentericofemoral	2
Innominoiliac	3

Table 2. Indications for extra-anatomic bypasses in twenty-four high-risk patients with aortoiliac occlusive disease

Indications	No. of Patients	%
Claudication	2	8
Rest pain	13	54
Gangrene	9	38

Fig. 1 Femorofemoral cross-over grafting

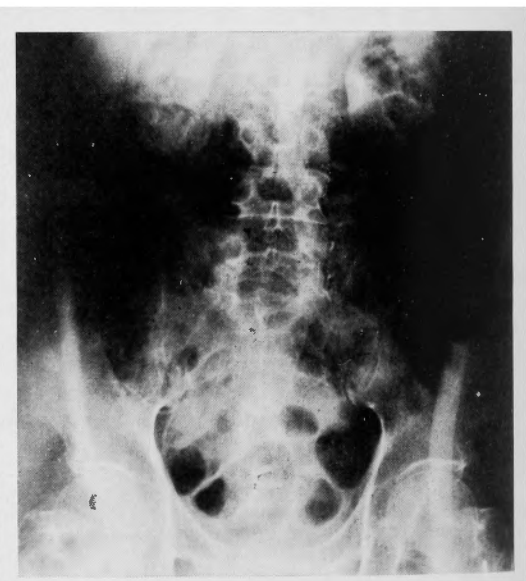

Fig. 2 Bilateral axillofemoral bypass

graft, five patients unilateral axillofemoral, three patients bilateral axillofemoral, seven patients axillofemoro-femoro-femoral, two patients inferior mesentericofemoral, three patients innominoiliac. All of these were male with a mean age of 64 years, ranged from 45 to 79 years. Twenty-two of the 24 patients presented with rest pain and/or gangrene, and two patients complained only of disabling claudication. All patients received prophylactic antibiotics prior to operation and there were continued for 7 to 14 days after operation. Femoro-

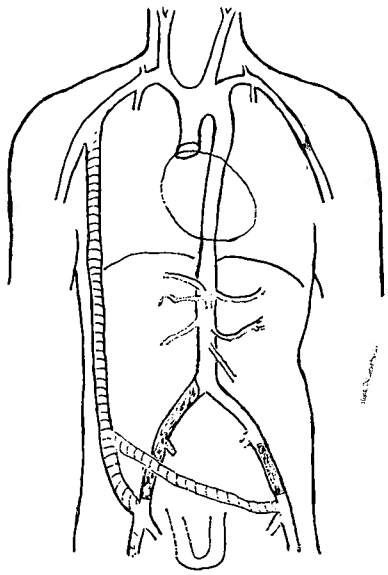

Fig. 3 Axillofemorofemoral bypass

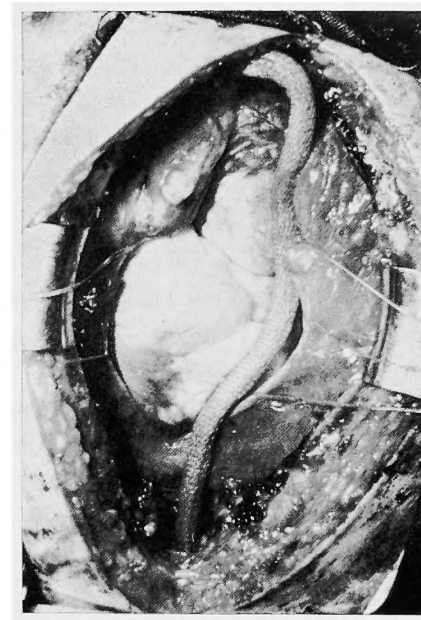

Fig. 4 Innominoiliac bypass anastomosed to the innominate artery

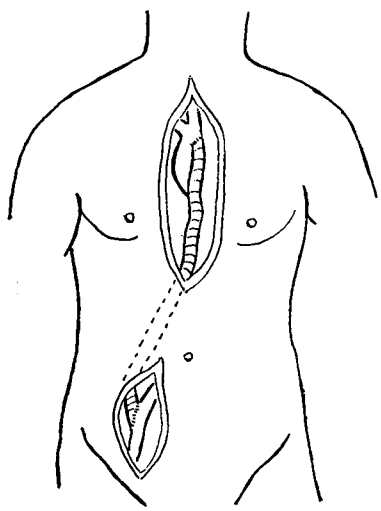

Fig. 5 Innominoiliac bypass

femoral cross-over grafting is used in aortiliac obstructive disease, unilateral in involvement (Fig. 1). The femoral vessels on both sides are exposed through vertical groin incisions and the groin incisions are connected by a subcutaneous suprapubic tunnel, with a graft extending through a tunnel in the subcutaneous layer of the abdominal wall. The axillofemoral bypass[9] (Fig. 2) is done with the patient in the supine position with both arms extended. The common, superficial and deep femoral arteries are exposed through longitudinal groin incisions. Systemic herparinization is utilized. A subclavicular transverse incision is then made on the selected side over the deltopectral groove. The pectralis minor muscle is retracted laterally. The axillary artery is isolated. A preclotted 10 mm Dacron prosthesis is anastomosed to the axillary artery and a tunneler is passed subcutaneously down to the groin incision. The graft is adjusted to the proper length and anastomosed to the common or deep femoral artery. The additiion of a femoro-femoral bypass to an axillofemoral bypass is an axillofemorofemoral bypass[10]. The axillary artery on the side with the poorer femoral runoff is preferred as the donor vessel. (Fig. 3) The innominoiliac bypass places the graft under the sternum

and the abdominal wall. The innominate artery is exposed through median sternotomy. The appropriate iliac artery is isolated extraperitoneally with pararectal muscle incision and extended toward the femoral artery. A 5 mm glutaraldehyde tanned umbilical cord vein is anastomosed to the innominate artery, then the graft passed extraperitoneally down to the iliac artery (Fig. 4) (Fig. 5).

Results

The cumulative graft failure rate at the end of the first year was 54 percent. One femoro-femoral, and two axillofemoral graft thrombosed on the day of operation and were not reexplored. This is attributed to poor patients selection. Three failed axillofemoral grafts became infected. Five amputations were done following graft failures and two with patient grafts. Two were above-knee amputations, five were below-knee amputations, and one was a transmetatarsal amputation. There were four deaths, 2 within a month after operation.

Discussion

Stenotic or obstructive aortoiliac. disease is treated surgically by thromboendoarterectomy when the lesion is relatively localized and by graft bypass operation when the lesion is more extensive. In high-risk patients with aortoiliac disease, the proper vascular reconstructive procedure often is difficult. Acceptable morbidity and mortality rates must be coupled with a durable reconstruction.

Extra-anatomic bypass is a procedure empoyed in high-risk patients in whom laparotomy should preferably be avoided ; for the purpose of shortening the duration of surgery, minimizing the extent of surgical intervention or reducing surgical isolation and resultant bleeding to the minimum following laparotomy, if performed ; or under the circumstances of the aorta undergoing arteriosclerotic changes or calcification so markedly and extensively as to make suturing of a vascular graft technically difficult.

It is also useful in cases of complicating infection of previous aortic surgery.

Femoro-femoral cross-over grafting is used in aortoiliac obstructive disease, unilateral in involvement. With a graft extending through a tunnel in the subcutaneous layer of the abdominal wall, the angle of anastomosis is unavoidably increased[5]. WESOLOWSKI[17], SZILAGY[14]

Table 3. Life-table analysis of extra-anatomic bypass grafts

Interval	No. of grafts at risk	No. of grafts failing	No. of death	Interval failure rate (%)
under 6 mo.	24	11	2	46
6 mo. to 1 yr.	10	2		20
1 yr. to 2 yr.	6	2	2	33
2 yr. to 3 yr.	2	0		
over 3 yr. 1	1			

et al. reported that with the increase in the angle of anastomosis there was a decrease in blood flow through a transplanted vessel with a greater propensity to turbulence. The course is more natural with an ileofemoral bypass. The inferior mesenteric artery not necessarily patent and often too small may also be used for the same purpose in some situation. A bypass between the inferior mesenteric and the femoral artery also is preferable in this respect (Fig. 4).

BRIEF and associates[2)16)] reported the long-term patency rates of a cross-over femoro-femoral graft over a period of 5 years. They contended that the femoro-femoral graft also appeared to protect the donor iliac artery from advancing atherosclerosis by increasing flow.

Patency of axillofemoral grafts is much better when both the superficial and deep femoral arteries are patent than when only deep femoral is open. Patients in whom only the deep femoral artery is patent and available are often at high-risk, presenting with severe circulatory failure of the lower limb. In some cases vascular reconstructive procedure for the treatment of femoro-popliteal occlusion could be performed simultaneously. The results were poor, however, as might reasonably be expected, in casess of so unsatisfactory profunda runoff only. Postoperative spasm of the peripheral circulatory system affects the prognosis, leading to decreased outflow. Utmost precautions should be exercised against this by using a potent vasodilator agent.

A vascular prosthesis 8-10 mm in diameter was often used in previous studies. Too large a vascular graft, used to achieve adequate blood flow, may lead to thrombus formation. When a long prosthesis is used, in particular, care must be taken to reduce the pressure on vessel wall by high flow. The long length of the axillofemoral bypass is probably the major weakness of the extra-anatomic bypass.

The addition of a cross-limb on an axillo-femoral grraft to form an axillobilateral femoral graft, axillary-femoro-femoral bypass was described by SAUVAGE and WOOD[13)] in 1966. They reasoned that the higher flow rate in the axillary limb of the axillobilateral femoral graft would result in an improved patency rate as compared with that of axillounilateral femoral grafts. The axillary artery on the side with the poorer femoral runoff is preferred as the donor vessel. This will result in a high flow rate in the axillary and cross-femoral limb of the graft. The lowest flow will be in the short segment of the axillofemoral graft below the takeoff of the cross limb. A proper material and caliber of such a graft of femoro-femoral bypass can be selected in consideration of peripheral

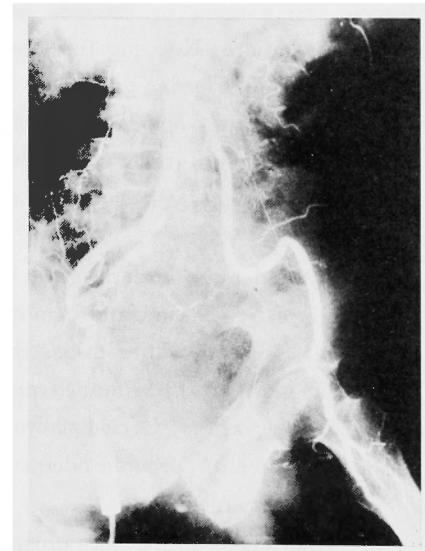

Fig. 6 Inferior mesentericofemoral bypass

blood flow required. The angle of anastomosis also can be adjusted easily. It is clear that axillobilateral or axillo-femoro-femoral grafts have a improved late patency rate as compared with axillounilateral femoral grafts attributable to the increased flow in the long axillofemoral limb of the grafts.

In the process of acclimation of such a prosthesis to the host, however, adverse phenomena may take place, including clot formation, growth and organization of thrombi and proliferation of fibrous tissue, leading to obstruction of the vessel. Marked scarring and induration pose a problem particularly when a prosthesis is implanted subcutaneously in the extremities abundant in connective tissue. Such a complication is likely to occur with a long vascular prosthesis. It is not surprising that flow and patency rates are closely related in Dacron grafts. REICHLE and associates[12] have shown that the neointima which forms in Dacron grafts consists of collagen and fibroblasts and is not a true endothelium. Therefore a high rate of shear must maintained in order to prevent the accumulation of fibrin and platelets on the neointima. In experimental Dacron grafts, they found that the neointima becomes stable at 24 to 27 months.

This led us to employ grafts with a marked antithrombotic property, such as a venous homograft, or glutaraldehyde tanned umbilical cord vein, expecting their elasticity and stretchiness conducting to the patency of the lumen by pulsation. Contrary to our expectation, obstruction due to early thrombus formation occurred in 6 but 1 case in which there was prolonged patency of a venous homograft.

The vascular graft, which courses subcutaneously in the body trunk, is subject to strain or compression due to cutaneous or subcutaneous edema or hematoma, which, together with an adverse position of the body, contributes much to narrowing or flexion of the lumen. With an axillofemoral bypass a segment of the graft near the axillary is readily undergoes compression or stenosis, leading to decreased inflow followed by early development of obstruction. Keeping the lumen patent is indispensable for satisfactory working of a vascular implant. Harder grafts are hoped for. We believe the thrombosis in the first few months appeared after operation is often a result of sleeping on the axillofemoral segment by compression of the graft against the bony chest wall. A simply prophylactic measure is to provide the patient with a gauze wristlet with which his opposite arm can be tied to the bedside[6)11)].

The reported rate of early graft failure is as high as 29%[6)8)]. To alleviate the major cause of failure by kinking and compression, we have performed the innomino-iliac bypass on 3 patients. Our procedure places the graft under the sternum and the abdominal wall.

A 5 mm glutaraldehyde tanned umbilical cord vein[4)] is anastomosed between the innominate and iliac artery. Occasionally it may be necessary to perform a ilio-femoral reconstruction in order to provide adequate runoff. Although follow-up ranges from 4 to 10 months, all grafts are patent.

Our experience with this procedure suggests that innominoiliac bypass effectively prevents postoperative thrombosis due to compression and kinking of the graft. We intend

to broaden indication of our method to form a femoro-femoral bypass with endoarterectomy of the iliac artery, common and deep femoral arteries or profundoplasty[3].

Conclusion

The technique of extra-anatomic bypass grafting is used clinically not only because of involving no serious procedure but for other reasons. A study was made in our own cases on the causes of low patency rate as a disadvantage of the procedure. We have performed the innomino-iliac bypass. This technique places the graft under the sternum and the abdominal wall extraperitoneally to alleviate the major cause of the failure by compression and kinking.

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和文抄録

腹部，腸骨動脈閉塞性疾患に対する Extra-anatomic bypass

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腹部，腸骨動脈の閉塞性疾患24例に，femorofemoral, axillofemoral, inferior mesenterico-femoral, innominoiliac バイパスの各術式を施行した．これらpoor-risk の症例は末梢側の runoff 不良例が多く開存率がきわめて低く，1年で54%に閉塞をきたした．

開存成績が悪い原因として，さらに graft が体腔内に存在しないため不自然な体位等により圧迫，屈曲がおこり血栓形成，閉塞にいたることが考えられる．

innominoiliac バイパスは graft が胸骨下，腹壁下を通るので開存成績向上に役立つであろう．症例により選ばれてよい術式と思われる．