REVASCULARIZATION OF THE ISCHEMIC UPPER LIMB

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ABSTRACT

Eighteen cases of upper limb ischemia were operated during a 24 month period. Eleven patients presented with features of chronic ischemia, while 7 had acute ischemia with a threatened limb. There were 15 males and 3 females. The average age was 38 years. Associated medical problems were present in 8 patients. Limb perfusion was restored in all patients after direct arterial (bypass) surgery, intra-arterial thrombolysis or percutaneous transluminal angioplasty (PTA). There was no mortality. The limb salvage rate was 100 per cent. Follow-up of upto 24 months reveals a patent bypass in all patients with no recurrence of symptoms. Upper limb ischemia is not uncommon, and can be treated by thrombolysis, angioplasty or bypass surgery. Direct arterial surgery for upper limb revascularization, though technically demanding, is safe and results in relief of symptoms in the vast majority of patients.

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Introduction

Upper limb ischemia due to occlusive arterial disease is not uncommon in clinical practice [1]. Atherosclerosis as an etiological factor accounts for the vast majority of these patients [2]. Trauma, Raynaud's disease, aortic arch (Takayasu's arteritis) and subclavian aneurysm [3] account for the large majority of the remainder. Patients present with features of chronic limb ischemia in the form of pain, a tired sensation in the arm or digital ulceration. Severe symptoms are rare because of excellent collateral circulation in the upper limb. Features of cerebral ischemia - the so called subclavian steal syndrome [4] - is peculiar to proximal subclavian artery occlusion. Restoration of circulation is recommended in symptomatic patients, and carotid - subclavian bypass is the surgical procedure of choice [5]. This report presents the clinical presentation and management of 18 cases of upper limb ischemia managed by direct arterial surgery, intra-arterial thrombolysis and PTA.

Material and Methods

Eighteen patients with upper limb ischemia were managed during 24 months period (Feb 94 - Jan 96) in a Service Hospital at Pune. The mean age at operation was 38 years with a range of 21-58 years. Fifteen patients were male and 3 were female. Seven patients presented with acute symptoms while 11 patients presented with chronic ischemia (Table 1). Eight patients suffered from 16 associated medical illnesses: Hypertension (4), IHD (3),

diabetes mellitus (2), rheumatic valvular heart disease (2), aortic regurgitation (1), bronchial asthma (1), Pulmonary tuberculosis (1), dermatitis (1), and paraplegia (1).

TABLE I

Clinical presentation of upper limb ischemia

Symptom	Number of patients
Acute ischemia (7 patients)	
Pain, pallor, paresthesia, pulselessness	7
Digit gangrene	2
Ischemic contracture	1
Chronic ischemia (11 patients)	
Pain in extremity	11
Subclavian steal syndrome	1
Finger ulceration	1
Old acute ischemia (recovered)	1
Superior vena cava syndrome	1

All patients were initially evaluated by a detailed history and physical examination. The radial pulse was absent or weak on the affected side in all patients. Bruits in supraclavicular and carotid regions were specially searched for, and the heart auscultated for murmurs. Blood pressure was recorded in both limbs and a pressure difference of more than 20 mm Hg was taken as significant. A detailed assessment of the heart and cardiovascular system was done by the cardiologist in all patients with chronic ischemia. Routine investigations included a complete hemogram, urinalysis and a chest radiograph in all patients. Cervical spine radiograph were done if thoracic outlet syndrome (TOS) was suspected. A portable doppler was used to detect the arterial signal and to measure the blood pressure in all cases. Colour doppler (duplex) scan

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was done in 8 patients. Angiography was done in 16 patients. Two patients with acute ischemia were operated without an angiogram as the diagnosis was obvious and it was felt that the delay could have an adverse outcome on limb salvage.

All patients were treated by either intra-arterial thrombolysis, PTA or surgery. Four patients with acute ischemia were treated with intra-arterial thrombolysis utilizing urokinase. 50,000 IU of Inj Urokinase were injected through the arterial catheter introduced via the femoral artery and placed as close to the lesion as possible. This was followed by infusion of 2,00,000 IU over the next 1-4 hours. The patients were heparinised and monitored in intensive care unit with frequent analysis of coagulation parameters. Angiography was performed prior to the removal of arterial catheter to document the outcome. Two patients in the acute ischemia group underwent emergency surgery : one had a compression of brachial artery at elbow due to supracondylar fracture of humerus while the other had an embolic occlusion of brachial artery at its bifurcation. Two other patients were operated as semi-emergency : one after failed thrombolysis while the other for spreading gangrene of 3 fingers due to neglected ischemia.

Of the 11 patients with chronic ischemia, 4 were treated with PTA, while the rest underwent direct arterial surgery. PTA was done by the transfemoral Seldinger technique in the Cardiac cath lab of MH(CTC) under image intensification and heparinisation. Check angiography was done at the end of the procedure to document the outcome of the procedure. All surgical operations were performed under general anaesthesia. Carotid-subclavian bypass was the commonest procedure employed. Standard techniques were employed for the exposure and control of blood vessels [6]. A single supraclavicular incision was employed to expose the carotid and subclavian arteries at the root of the neck. Axillary artery was exposed by an infraclavicular incision. Carotid artery "stump pressure" was routinely measured during carotid-subclavian bypass and a policy of selective shunting (using a shunt if carotid stump pressure was below 50 mm Hg) was employed to safeguard cerebral blood flow during surgery [7]. Median sternotomy with supraclavicular extension was used in the patient with subclavian aneurysm. Patients were heparinised systemically during surgery, and post-operative anticoagulation continued for a period of 3 to 6 months after the operation.

Results

Portable doppler examination revealed a mean arterial systolic pressure of 70 mm Hg (range 40-110 mm Hg) in the ischemic limb as compared to a mean systolic pressure of 130 mm Hg (range 110-170 mm Hg) after successful revascularization, the mean increase in doppler pressure was 50 mm Hg (range 30-80 mm Hg). Colour doppler performed in 8 patients with chronic ischemia demonstrated significant occlusive lesions in all cases. The results of angiographic studies performed in 16 patients are summarised in Table 2.

TABLE 2
Angiography findings (16 patients)

Nature of lesion	Number of patients
Subclavian artery block	5
Brachial artery block	5
Palmar arch block	2
Subclavian dilatation	2
Subclavian aneurysm	1
Subclavian block with vertebral "steal"	1

Intra-arterial thrombolysis was attempted in 4 patients with acute ischemia. A successful clinical and radiological outcome was documented in 3 cases. One patient did not improve, the surgery was required : a successful thrombectomy was performed using Fogarty balloon catheter. None of the patients had any complications attributable to thrombolytic therapy. PTA of the subclavian and brachial arteries was done in 4 patients with chronic ischemia. Successful outcome was obtained in 3 patients, while the fourth patient required direct arterial surgery later. One patient had acute thrombosis of the distal artery following a successful PTA. This responded well to thrombolysis and heparinisation, with no residual lesion or symptoms.

Direct arterial surgery was employed as the primary modality in 10 patients while one patient each from the thrombolysis and PTA group required surgery due to failure of the later procedures. Four patients with acute ischemia underwent surgery (thrombo-embolectomy or patch angioplasty) while 8 patients with chronic ischemia were operated, and a bypass procedure was done to revascularize the limb. The nature of operations is listed in Table 3. The average operation time for a bypass procedure was 4 hours (range 2 hours - 6 hours). Reversed saphenous vein was used as the bypass conduit in 3 patients while PTFE (Gore Tex) was used in 5 patients. Blood transfusion was required in only 3 patients. There were no intra-operative complications.

TABLE 3
Nature of operation

Operation	No of patients	Comment
Acute ischemia (4 patients)		
Brachial artery embolectomy	2	Cardiac source of embolus
Vein interposition graft (brachial artery)	1	Thrombectomy of forearm arteries also
Vein patch repair of brachial artery injury	1	'Intimal flap' found occluding the artery
Chronic ischemia (8 patients)		
Carotid - subclavian bypass	4	For proximal subclavian block
Carotid - axillary bypass	1	For distal subclavian block
Excision subclavian aneurysm and carotid-subclavian bypass	1	Subclavian block also present
Ligation subclavian artery dilatation and subclavian - axillary bypass	2	Cervical and first ribs also excised

There was no mortality. There were 2 major complications (16%), both requiring reoperation. One patient had post-operative thrombosis of bypass graft which required thrombectomy using Fogarty catheter. The blood circulation was expeditiously restored and no deleterious effect followed. The other patient had an intrathoracic bleed following subclavian artery aneurysm resection on the second post-op day. Resternotomy revealed a slipped ligature from a vein; this was transfixed and the bleeding controlled. The patient had uneventful recovery thereafter and was discharged on the 10th day. One patient required amputation of distal thumb, ring, and little fingers. He already had established gangrene of these digits due to neglected acute ischemia. The rest of the hand which was also threatened by spreading gangrene, was however saved after revascularization of the limb.

Follow-up of upto 24 months reveals that distal circulation is well maintained in all patients. All 8 bypass grafts remain patent by clinical and doppler examination. The distal perfusion is also

Fig. 1 :

Fig. 2 :

excellent in patients where thrombectomy/vein patch repair was done.

Discussion

Upper limb ischemia due to occlusive disease is rare as compared to lower limb ischemia [1,8]. Fields reported that only 17 per cent lesions on arteriography involved the subclavian or innominate arteries [8]. McCarthy et al found that symptomatic atherosclerotic disease of the upper extremities was present in only 5 per cent of patients with limb ischemia [9]. Welling reported that arterial insufficiency of upper limb involved only 0.5 per cent of 6149 patients, and the 48 upper extremity bypasses in their series constituted only 0.9 per cent of total vascular experience over a 15 year period [1]. This is in contrast with our findings where these 18 cases are a part of 71 vascular interventions during this period, thereby constituting almost 25 per cent of vascular surgical operations. The reasons for this discrepancy are not apparent as no other similar figures are available in Indian literature.

Fig. 3 :

Similarly, the reported mean age at presentation in western literature is in the patients in 50's [10] whereas the mean age at operation in this series is only 38 years. However, concomitant medical illnesses were found in 44 per cent of our cases, a figure very similar (27-65%) to that available in Western literature [10].

Atherosclerosis accounts for about 78 per cent of chronic arterial occlusions of upper limb in the reported series [2]. Out of a total of 11 cases of chronic ischemia, causes other than atherosclerosis were found in 55 per cent (Arteritis, 2; thoracic outlet syndrome, 2; subclavian aneurysm, 1 case; unclear etiology, 2 cases) of our patients with chronic ischemia. Subclavian aneurysms are rare; the report from Houston analysed only 16 reported cases over a 25 year period [3], while a large subclavian aneurysm causing superior vena cava obstruction was etiological factor for chronic limb ischemia in one of our patients. Thoracic outlet syndrome causing post-stenotic dilatation of subclavian artery, and resulting emboli from such dilatations causing limb ischemia are not uncommon [11]. Two patients in our series presented in this fashion, and excision of the dilated artery alongwith arterial bypass ameliorated their symptoms. It is recommended that the offending structure causing arterial compression be removed; we therefore excised a cervical rib and 2 first ribs during the bypass procedure.

Embolism from the heart is the commonest cause of acute upper limb ischemia (2 cases). One patient had paradoxical embolism to his brachial artery from venous thrombosis in calf; a patent foramen ovale was demonstrated in this patient by cardiac catheterisation. One patient had acute digit ischemia following intra-arterial drug injection; this has been reported separately as a case report. One patient had a brachial ar-

tery injury due to displaced fracture of humerus. The etiology in 2 of the patients of acute ischemia is unclear.

The preferred modality of severe upper limb ischemia is by direct arterial surgery [11], though intra-arterial thrombolysis [12] and PTA [13] are increasingly being reported for the management of acute and chronic ischemia respectively. We have utilized intra-arterial thrombolysis in four patients with acute ischemia with 75 per cent success; this compares favourably with reported results [12]. The results of PTA in management of chronic upper limb ischemia are said to be as good as that of surgery [13], and the successful outcome in 3 of our 4 initial patients is encouraging.

Carotid-subclavian bypass is the standard treatment for proximal subclavian occlusions [14]. Extra-anatomic bypass [15] is not currently favoured. Transposition of subclavian artery to the carotid artery [16], is not widely practiced. There are some reports to suggest that prosthetic (dacron/PTFE) bypass works better than reversed saphenous vein bypass in this situation [14,17]. We used 5 prosthetic and 3 venous bypasses in our patients, and all have remained patent during two year follow-up. There is no evidence of any "steal" of blood from cerebral circulation after these proximal bypasses [18].

Carotid-subclavian bypass is a safe procedure with excellent long term patency of the grafts. A mortality rate of nil is reported from several series [11,15]. However perioperative stroke due to carotid artery clamping is a known complication [19]. We did not have any mortality. There was no stroke in our patients, because we routinely measured carotid stump pressures after carotid cross-clamping, and planned to use an intraluminal shunt if carotid circulation was thought to be compromised. Brunkwall et al have reported a 96 per cent patency rate at 1 year and 80 per cent patency at 10 years in 48 patients [20]. All our bypass grafts are patent at short term follow-up of upto 24 months.

Upper limb ischemia is not uncommon in vascular surgical practice. Acute ischemia may be treated by intra-arterial thrombolysis or thrombectomy. Limb revascularization by PTA or direct arterial surgery using synthetic or venous graft is indicated in chronic ischemia if patient is severely symptomatic. It is a safe procedure in trained hands with excellent results.

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