Aneurysms Of The Upper Limb

*S.M.A. BABAR**

Summary:

Fiftyone aneurysms of the upper limb were studied prospectively in a four-year period between 1986 and 1990, in the Department of Vascular Surgery of Dow Medical College and Civil Hospital, Karachi. Most of these aneurysms had resulted from penetrating trauma and the majority of patients (98 %) underwent angiography and operative treatment within one year of onset. The urban setting and criminal violence were the main reasons for male preponderance (92 %). Distal subclavian and Axillary arteries were most commonly involved, revealing a pulsatile lump in the majority (80 %) of the patients. Most of these vascular injuries were associated with neurological trauma (68.6 %) and the resultant decrements were produced by nerve divisions (57 %) and neuropathy (43 %). Excision of the aneurysm and long saphenous vein interposition graft was the commonest procedure (82 %) used. Patency rate of the anastomotic conduit was 96 % at six weeks. This was an excellent result. Unfortunately poor reattendance of the patients at subsequent follow-ups has resulted in a great unreliability of this patency rate. Lack of education, lack of awareness and poor compliance were the main causes of failure to reattend after such a major injury and salvage, and it is hoped that in the future more of these patients can be traced to determine the outcome of the management.

Keywords:

1. Aneurysm
2. Upper limb
3. Neurovascular injury
4. Angiography
5. Clavioaxillary trauma
6. Penetrating injury

Materials and Methods:

Fiftyone patients were included in this prospective ongoing study at the Department of Vascular Surgery at Dow Medical College and Civil Hospital, Karachi, in a four-year period (1986-1990). Most patients were referred from various Outpatient Clinics with established aneurysm formation or with clear and stable signs of neurovascular trauma after initial haemostasis.

All patients underwent clinical neurovascular assessment followed by doppler flow studies, simple radiology and electrophysiological assessment where neurological lesion was clinically present.

Angiography was performed in 50 patients (Figures 1 to 4). Due to technical failure, angiography was not performed in 1 patient (Ulnar Artery aneurysm). 50 patients underwent operative procedures while one patient (Subclavian I Aneurysm) refused operation for personal reasons and is being conservatively managed.

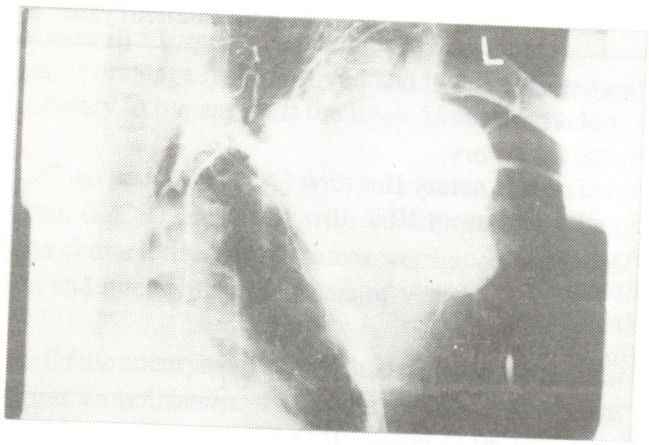

Fig. 1: A Small and a Large S/C Aneurysm with an Associated A/V Fistula.

In all of the operated patients, local excision of the aneurysm was carried out followed by revascularisation procedures in most but not all patients.

Results of the available patients were assessed during hospitalisation and at 6 weeks, 3 months, 1 year and 4 years. Graft patency was determined by clinical and doppler assessments. All patients were advised to stay on oral warfarin from the time of hospital dis-

* Head of the Depts. of Vascular Surgery, Dow Medical College and Civil Hospital, Karachi, Pakistan.

charge to three months post-operatively and the therapy was then changed over to antiplatelet and vasoactive agents according to current indications.

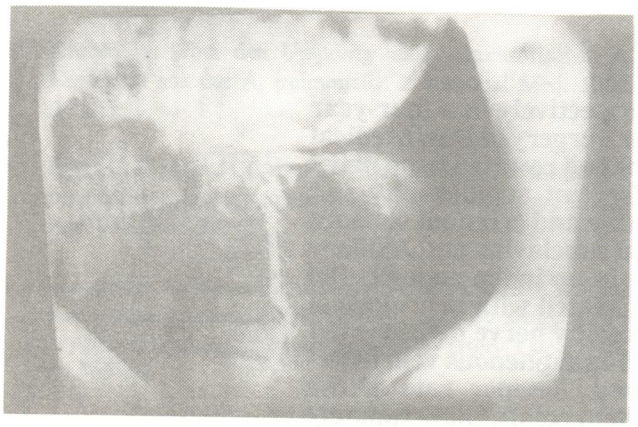

Fig. 2: Vertebral Artery Aneurysm.

Results and Findings:

TABLE - 1

Anatomical Incidence of pseudoaneurysm

Innominate	1
Subclavian I	1
Vertebral Artery	1
Subclavian Artery II	13
Subclavian Artery III	5
Axillary	20
Brachial	5
Radial	3
Ulnar	2
	51

Causes of Aneurysm:

TABLE - 2

Cause of Pseudoaneurysm

Gunshot Wound	46
Blunt Injury	1
Iatrogenic	2
Fracture	1
Knife Stab	1

The main cause of pseudoaneurysms in our series was a penetrating trauma (96 %) and in this respect pistol and high powered rifle bullet injuries were the commonest mechanisms (90 %) involved. The average distance of bullet fire was 5 metres.

TABLE - 3

Mean age	42
Male	47
Female	4
Presentation delay	1 year

The age on presentation ranged from 14 to 70 (mean=28). The predominant sufferers were males (92 %) and this was in keeping with the rise of criminal gunshot violence associated with men. Only 4 patients (7.8 %) were females of a younger age group and this group included patients presenting with blunt trauma to the vertebral artery, fracture of the arm with resultant axillary aneurysm, a patient with ulnar artery needle aspiration aneurysm and a subclavian artery spontaneous aneurysm.

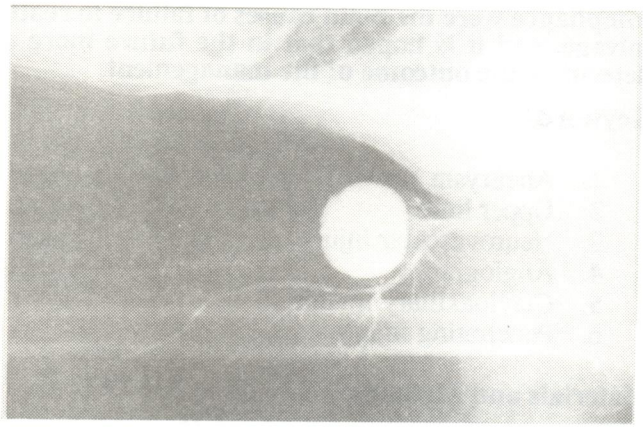

Fig. 3: Angiographic Diag = Prox Brachial Aneurysm.

Most patients presented with established aneurysms at a mean delay of one year.

Clinical Features:

TABLE-4

Clinical Feature

Visible/Palpable Lump	41
Neither Visible Nor Palpable	10
Local Pulsation/Bruit	43
No Pulsation or Bruit	8
Associated Nerve Injury	35
- Nerve Division	20
- Neuropathy	15
VBS	2
Embolisation to Digits	8
Intra - Aneurysmal Thrombosis	40

The aneurysmal lump was either visible or palpable in the majority of patients (80 %). In the remainder, the aneurysm was suspected on the basis of an overlying or distally conducted bruit or on the predictable behaviour pattern. Where the lump was impalpable, its location was usually deep, such as in the chest or behind the clavicle.

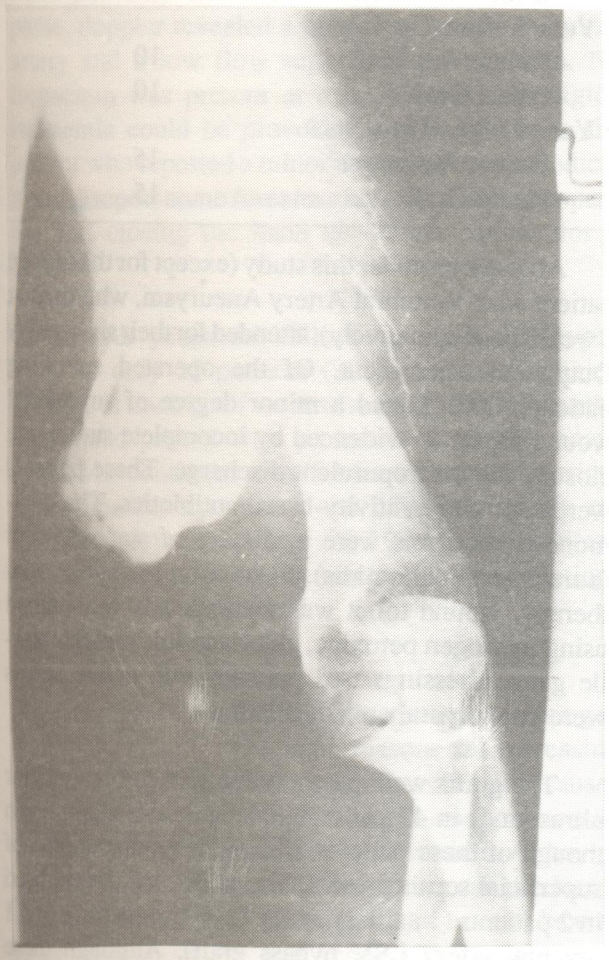

Fig. 4: Partially Thrombosed Giant Aneurysm.

Bruit was detected by stethoscope or doppler examination in the majority (84.3 %) of the patients, overlying the lesion or distally in the line of the artery. In the Innominate aneurysm, this bruit was conducted into both divisions of the bifurcation.

Concurrent with pseudoaneurysm formation, the initial trauma had also resulted in an associated nerve injury in 68. 6 % of cases. The predominant sufferers were again male patients and of the neural trauma, 57 % had sustained a total division of the concerned nerve while the remainder 42.8 % had developed a neuropathy as a result of neuropyrexia or neuroemesis. All of the patients (9.8 %) suffering from S/C III aneurysms had sustained a nerve injury (11.4 %) suffering from a nerve division and 2.8 % suffering from neuropyrexia). 75 % patients suffering from Axillary Artery aneurysms had sustained an associated nerve injury (40 %) suffering from nerve division while the remainder (46.6 %) sustaining a neuropyrexic lesion. All of the patients in this series with Brachial Artery pseudoaneurysms (9.8 %) had developed a nerve lesion (neuropyrexia). The neural injuries were treated on merit concurrent with vascular surgical procedures and the results are being assessed in a different study.

Two patients had sustained a major associated venous injury (1 subclavian and the other axillary vein) and these had been ligated during initial haemostatic surgery. With the passage of time, the venous drainage had improved and it was not deemed necessary to bypass graft the ligated venous segment.

Two patients (3.9 %) with subclavian artery aneurysms (S/C I) presented with vertebrobasilar symptoms characterised by dizziness, vertigo on head rotation and intermittent disorders of vision.

Of the aneurysms, 15. 6 % had resulted in manifest digital embolisation. 4 patients with S/C II lesions (7.8%), 1 patient with S/C III lesion (1.96 %), 2 patients with Axillary Artery lesion (3.9 %) and 1 patient with Brachial pseudoaneurysm (1.9 %) had experienced such an embolisation, recurrently.

An examination of the aneurysm, preoperatively correlated well with angiography in showing intraaneurysmal thromboses in 78.4 % of the patients in this study.

Angiography was performed in 98 % patients. In one patient with distal ulnar artery aneurysm, angi-

ography was not performed due to machine default. This patient underwent surgery on the basis of the clinical and doppler findings.

Operative Treatment:

TABLE-5

Management

Angiography	50
No Angiography	1
Operative	50
Refused Operation	1
Excision + Ligation	3
Excision + End to End Anastomosis	3
Excision + LSV Graft	41
Excision + CV graft	2
Excision + Synthetic Graft	1

Fifty patients (98 %) underwent elective operations. 1 patient with S/C I aneurysm refused operation despite vertebrobasilar symptoms for domestic and personal reasons and therefore remains under our Follow-up.

Three patients (6 %), 1 with Vertebral Artery Aneurysm and the other two (with ulnar artery aneurysms) underwent excision of the aneurysm and ligation of the two ends of the involved vessel without restorative grafts.

Three patients (6 %), 2 with Axillary Artery aneurysms and 1 with Brachial Aneurysm underwent excision of the aneurysm followed by end to end anastomosis of the native mobilised vessel.

Majority of the patients (82 %) required excision of the aneurysm and reversed Long Saphenous Vein (LSV) interposition graft.

Two of the patients (4 %) with Axillary Artery aneurysm, for reasons of technical ease and proximity, underwent excision of the aneurysm followed by a cephalic vein interposition graft.

Only one patient with Innominate Aneurysm required a synthetic replacement graft after excision of the aneurysm under a carotid bypass shunt.

Results of Surgical Treatment:

TABLE-6

Results

6/52 Follow Up		
- Patients Attended	50	
- Patient died	1	
- Post Op. Wound Sepsis	15	
- Patent Graft	48	
- Graft Thrombosis	2	
3/12 Follow Up		
- Patient Attended	32	
- Sepsis	0	
- Patent Graft	30	
- Graft Thrombosis	2	same
1 Year Follow Up		
- Patient Attended	10	
- Patent Graft	10	
4 Year Follow Up		
- Patient Attended	15	
- Patent Graft	15	

All patients under this study (except for the female patient with Vertebral Artery Aneurysm, who died at 3 weeks post-operatively), attended for their six-weekly Outpatient assessment. Of the operated surviving patients, 30.6 % had a minor degree of superficial wound sepsis as evidenced by incomplete suture line closure and a seropurulent discharge. These patients were kept on sensitivity-based antibiotics. The commonest pathogens were a mixture of staphylococci (aureus and epidermidis). In addition to antibacterial therapy, wound toilet was meticulously maintained using hydrogen peroxide, chlorhexidine and dry sterile gauze dressings. All patients with active sepsis were kept on oral anticoagulation.

The grafts were patent (clinically and on doppler ultrasound) in 47 patients (96 %) at this stage, even though of these patients 27.6 % had some degree of superficial sepsis present. The grafts had thrombosed in 2 patients (1 axillary artery LSV bypass graft and 1 brachial artery LSV bypass graft). Although these patients had shown a non-systemic local infection superficially, they had defaulted on oral anticoagulation and did not have regular wound dressings applied. Both had kept fairly tight crepe bandages on the dressings for several days for comfort and conven-

ience. The overall thrombosis rate of the grafted patients was 4 %.

In sharp contrast to the earlier Outpatient attendance, the 3-monthly clinic was very poorly attended. Only 32 patients (64 %) attended. Of the operated patients, those who attended at this stage showed a complete absence of sepsis. The previously noted graft patency had continued with considerable symptom-alleviation and with no evidence of hand claudication or embolisation. The two previously noted patients with graft thromboses had collateralised adequately and their sepsis had resolved fully. One of these patients reported some degree of hand claudication on severe physical provocation but reported a progressive improvement. The other was symptom-free. In both of these patients, although wrist pulses were not palpable, doppler revealed a poor flow radial and ulnar artery and a low flow superficial palmar arch. No ischaemia was present at rest. Although no digital ischaemia could be provoked in these patients, the patient who reported a minor degree of hand claudication did report some forearm cramps on actively opening and closing the hand @ 60 per minute for 2 minutes.

At four years, the follow-up rate had dropped down to only 15 patients (30 %) despite repeated attempts at tracing. Of those who attended, one was the unoperated patient with proximal subclavian aneurysm (who continued to suffer from periodic transient vertebrobasilar symptoms and who persistently refused surgery) and the other (28.5 %) operated patients showed good graft patency and symptom-resolution.

Discussion:

Peripheral upper limb aneurysms are increasing in frequency (1,2,3). The main reasons are increasing RTAs, knife and gunshot injuries. Less frequent causes include iatrogenic trauma (blood gas study, transaxillary angiography, drug abuse by addicts etc. Although rare, but a displaced clavicular fracture can produce a subclavian aneurysm (although major arterial lacerations, exsanguination and venous trauma are commoner). If the aneurysm remains small in size, it may remain concealed in the depths of thoracic inlet and may produce embolic digital gangrene, as reported by McCready (4). The incidence of axillary arterial injury ranges (in civilian and military series) beween 2.9 to 9% (5,6,7). With axillary pseudoaneurysms, despite extensive scapular-profunda anastomosis, the risk of distal ischaemia is substantial and occasionally dramatic (1,4,8,9,10,11,12,13). The collateral circulation, here, is so rich that in many cases, despite arterial interruption (transection, total thrombosis), the radial pulse is palpably present (12). Therefore a high index of suspicion is necessary to recognise such injuries and angiography should be undertaken for all stable patients with upper limb aneurysms.

In the periphery, pseudoaneurysms are commoner than true congenital variety. The incidence is higher in males. Firearm injuries, RTAs, motorcycle trauma, fracture spikes puncturing arteries in the upper limb, violent compression of axillobrachial arteries against the humerus (14,15) are mostly ascribable to male-orientated activities.

Arterial disruption can occur in the track of a bullet. This is associated with considerable regional neurovascular injury due to the secondary shock wave effect of the passing bullet. This readily explains the much wider neural injury associated with a small bullet track. Usually, the development of a pseudoaneurysm is a slow process starting with bruising of the arterial wall, disruption by pulsatile force of the entire wall, leakage of blood, expansion of haematoma and intermittent pulsatile stretch of the surrounding tissue which results in gradual condensation of the surrounding tissue into a rigid capsule (11). The resultant aneurysm may remain in continuity with the parent artery via a patent ostium or may develop intrinsic thrombi. Adhesive organisation of these thrombi attach these thrombi by septa to the false capsule, compartmentalising smaller cavities (11, 16, 17). Many such multiloculations tend to discharge microthrombi into the distal circulation even in a seemingly stable state (17, 18, 19, 20, 21). The size of the aneurysm (22) relates to local compressive manifestations, such as neuropathy, venous oedema and venous thrombosis (10,23). Neuropathy caused by the initial mechanism is further compounded by the pulsatile arterial force of the aneurysm and late decompression may not restore the nerve functions fully. Early decompression is therefore advised (11). Raju and Carner reported six patients with penetrating injuries of the subclavioaxillary vessels in whom the first clinical sign was a delayed and secondary brachial plexus palsy caused by an expending aneurysm (16,24).

European and North American literature does not report long term effects of giant aneurysms, because these tend to be treated earlier (22).

The main danger from an upper limb aneurysm such as the Subclavian, which may have remained asymptomatic for quite some time, is micro and macro-embolic digital gangrene (9,10,25,26). Similar implications apply to the post-stenotic dilatation of Subclavian Artery in thoracic outlet syndromes (9,25).

In the upper third of the arm, the abundant collaterals between thyrocervical trunk, profunda brachii artery and others, may protect the area from manifest ischaemia even on total occlusion of the Axillary artery, when this develops slowly. An abrupt occlusion or disruption (embolism, acute thrombosis, dissection, injury) may not allow for proper development of such collaterals, resulting in gangrene or major decompensation.

Below the level of the axilla, if the aneurysm ruptures, even an aggressive haemorrhage can be controlled by extrinsic compression. The commonest haemostatic treatment offered in most Centres, is proximal and distal ligation. Such patients tend to suffer from decompensation which can range from hand claudication to frank gangrene.

With most Vertebral Artery aneurysms, a simple excision with proximal and distal ligation, should suffice, because of abundant contralateral compensation, but when there is a history present of vertebro-basilar symptoms or when angiography reveals an inefficient Circle of Willis, a long saphenous vein graft should be considered (27,28,29,30,31).

For an Innominate Artery lesion (aneurysm or atherothrombosis), a reversed synthetic aortic bifurcate graft from the Ascending Aorta to both divisions of the Innominate (using a carotid shunt), is advisable. Alternatively, an Aortocarotid tube graft (under carotid shunt) can be performed (32, 33).

Localised giant subclavian aneurysms are rare (8,22). Smaller aneurysms are commoner. The confines of the area are relatively small and if the aneurysm expands, it usually tracks along the axillary sheath (34). Subclavian I aneurysms are mainly intrathoracic and access in emergency (rupture) is difficult and requires a median sternotomy (right side) or a high thoracotomy (left side).

The role of adjunct cervicodorsal sympathectomy (much more common with post-stenotic dilatations of Subclavian Artery), for proximal upper limb large sized aneurysms with compromised collaterals, is controversial (23,25).

Pulsatile lumps should not be mishandled. Where doppler assessment is available, the "compressibility" test should never be performed for fear of dislodging emboli (1,36,49). Diagnostic needle aspiration tests, in pulsatile lumps, serve no useful purpose and may indeed result in protracted bleeding, dissection, arteriovenous fistula formation and embolisation (26). If an aneurysm is totally thrombosed, it may not transmit any pulsations and may not be outlined on angiography.

An intravenous Digital Subtraction Angiogram (DSA) may not accurately localise the ostium of the dynamic aneurysm. An arterial DSA is preferable for this purpose, DSA is certainly much less invasive than conventional angiography (36, 37) and the risks of extravasation, arrythmia, thromboses, allergy etc. are fairly small.

When the ostium of a pseudoaneurysm is accessible to a fine guide wire, the aneurysm can be readily embolised and it will then regress in size but the local compressive effect will only be reduced and not abolished. Thus a secondary venous oedema or neuropathy may not fully resolve. Because many of our patients in this series, had also exhibited concomitant nerve lesions, we had preferred excision of the aneurysm instead, and had undertaken a one-stage combined neurovascular reconstruction (16).

With aneurysms such as the Brachial, which is subjected to a greater extrinsic compression posturally, intraaneurysmal thromboses can extend more easily. Purely from a vascular point of view, the aneurysm should be totally excluded from distal circulation (end-to-end vein graft anastomosis), if extension thrombosis is to be avoided into the graft. End-to-side anastomosis, thus carries a significant risk of distal embolisation (1,9). However, the left over in-situ aneurysm would then continue to cause its local compression. For this reason, excision of the entire aneurysm, by way of decompression, is necessary in most cases.

Long Saphenous Vein (LSV) patency rate is good in upper limb revascularisation procedures, provided no anastomotic tension is allowed and enough slack is provided in the relaying site or over joints, to allow for mobility-stretch. Over a period of time, the graft arterialises and withstands postural stretches better (8). In the majority of elective procedures near the shoulder joint, it is fairly easy to harvest the adjacent Cephalic Vein. This vein is more difficult to handle, is thin and delicate and should be used with caution. We have used locally harvested series with good results. Graft thrombosis is a hazard with any conduit but using native autologous vein, such risks are minimised. LSV is a more readily obtained native tissue, impervious to blood, relatively non-thrombogenic and easy to handle. Its future thrombosis is not so much related to its structure as it is to technique, infection, age and atherothrombolic potentials in the given patient (36).

In clavioaxillary neurovascular penetrating trauma, distal ischaemia, neural deficit and an expanding arterial haematoma warrant immediate decompression and revasculrisation procedure (38,39). It may not be immediately apparent if the neural injury is primarily caused by the bullet injury or is caused by an expanding haematoma or a pulsatile aneurysm. Exploratory surgery has therefore become accepted with a high index of suspicion alone, even if no frank ischaemia is present because a prompt decompression very often benefits the clavioaxillary nerves (2,4,40,41).

The current civilian incidence of brachial plexus (BP) injury associated with axillary and subclavian arterial trauma (aneurysm, laceration, avf) is around 25 %, as opposed to 9 % reported during the Vietnam war (6,12,42,43), therefore both vascular as well as neurological investigations are essential in a stable patient (44).

In acute neurovascular injuries, the primary salvage is vascular orientated and if immediate revascularisation procedure is not carried out, at the time of surgical haematoma, the damaged nerves and vessels should at least be identified and tagged for delayed repair.

When patients present with pseudoaneurysms, a combined protocol must be used for evaluation (doppler, angiography, electromyography, nerve conduction studies, evoked potentials etc.). An early one-stage neurovascular repair has definite advantages. The divided nerve ends are more easy to locate, reaction of degeneration is minimal, making neurography possible or at least requiring shorter neural grafts and neurotization, if necessary, can be performed (45,46). If primary nerve repair is not feasible at this stage, then after aneurysmal excision, the revascularising graft should be sited and routed via a different fascial plane, away from the tagged nerves so that at a later exploration, the vascular graft is not compromised (39,41,47,48).

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