



## Outcome Analysis of Upper Limb Ischemia – Our Institutional Experience

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### Abstract

**Introduction:** Upper limb ischaemia (ULI) is a relatively uncommon, but well recognized vascular condition. It includes between 15-18% of the procedures that have been done for critical limb ischemia. This research study was aimed at developing not only a comprehensive but also a broad overview of ULI, specific to the population we serve.

**Aim:** The objective of this study was to review the experience of upper limb ischemia, both acute and chronic, of a single centre, the Institute of Vascular Surgery, Madras medical college, with particular emphasis on the pattern and distribution of the disease, their pathological profile, and reporting their outcomes with comparison to the literature on this topic.

**Methods:** Retrospective descriptive analysis. All patients who were admitted with symptoms and signs of upper limb ischemia were identified between august 2012 and august 2015 were included in the audit. Data were collected from the patients' case notes and hospital registries. Upon collection of the data, the findings were analysed and compared to the recent literature on this topic.

**Results:** A total of 192 patients were included in the study. Of which 111 patients underwent revascularization procedures. The most common etiology for acute upper limb ischemia was traumatic injury (n=58) followed by thromboembolic disease (n=37) and that for chronic limb ischemia was atherosclerosis (n=47) followed by thromboangiitis obliterans (n=17). The mean age of distribution is 41.1 years. The extent of neurological damage could not be elicited for all the patients with traumatic injury

and conclusive data on the functional status of the salvaged limb were lacking. All patients who underwent embolectomy had a fasciotomy done routinely as part of the institutional protocol for thromboembolic disease. No mortality occurred in this group. Most of the patients with atherosclerotic occlusion and TAO were managed conservatively. All patients with TOS had their limb salvaged.

**Conclusion:** Upper limb ischemia though relatively uncommon, has a major impact on the functional status of the patients. Although firm conclusions cannot be drawn, it is anticipated that our institutional data will provide clinical awareness and facilitate comparison of similar experiences in different institutes enabling pooled data analysis. This may further define the various patterns of upper limb arterial disease and improve the outcome, perhaps by identifying other confounders

### Introduction

Upper limb ischaemia (ULI) is a relatively uncommon, but well recognized vascular entity when compared to lower limb ischemia [1-4]. Upper limb revascularization comprises only 4% of all vascular surgeries and approximately 15-18% of them have been done for critical limb ischemia [4, 5]. Studies that combine both the acute and chronic upper limb ischemia are rare[1-4]. Acute upper limb ischemia commonly occurs following trauma, thromboembolic phenomenon and iatrogenic injuries, though, trauma and iatrogenic injuries may also present as chronic limb ischemia. Common pathology causing chronic upper limb ischemia includes atherosclerosis, arterial thoracic outlet syndrome, arteritis, and thromboangiitis

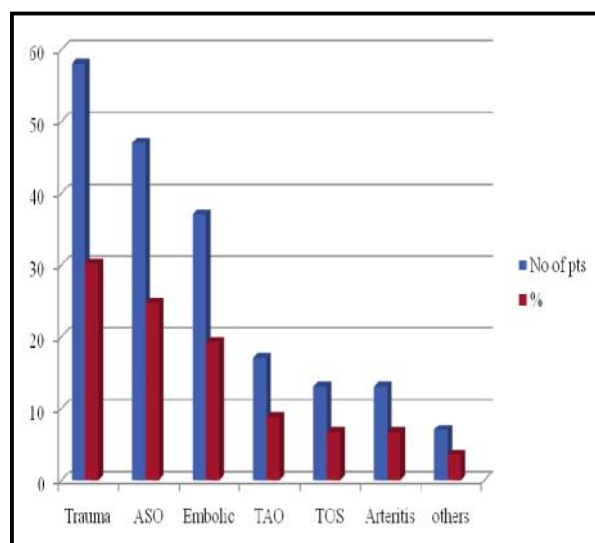
obliterans. Acute upper limb ischemia can be managed with various treatment options including thrombolysis, embolectomy, primary repair of the injured artery or a bypass procedure using autologous vein graft. At present, there are no real guidelines as to when a conservative approach is warranted. Likewise, chronic upper limb ischemia can also be managed with various open surgical and endovascular approaches or conservatively, individualized to the patient and the pathology. But most of the previous literatures have not included the patients who were treated conservatively, who may or may not have functional limb impairment. This group of patients forms a significant cohort. This study aims at determining the pattern, distribution of pathology and analyse the outcome after treatment, and the future perspective of the need for a pooled data system.

## Materials and methods

Retrospective descriptive analysis. All patients who were admitted with symptoms and signs of upper limb ischemia were identified between august 2012 and august 2015 were included in the audit. Data were collected from the patients' case notes and hospital registries. Upon collection of the data, the findings were analysed and compared to the recent literature on this topic.

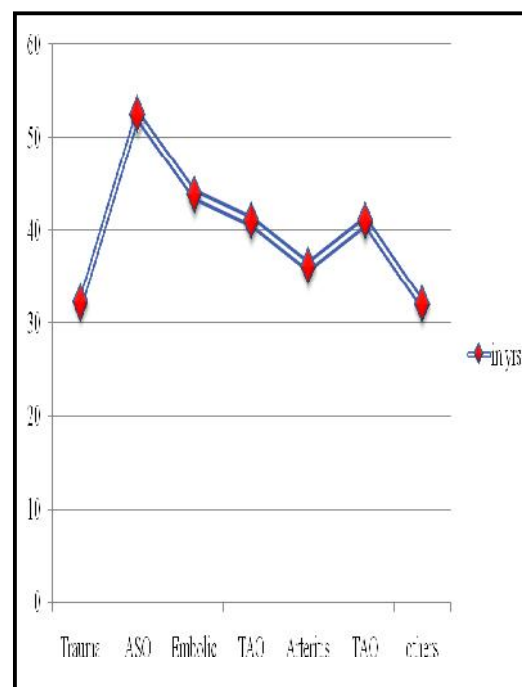
## Results

A total of 192 patients were included in the study. Of which 111 patients underwent revascularization procedures. There was almost equal distribution of patients between acute and chronic upper limb ischemia (51.4% vs. 48.6%). Traumatic vascular injury was the most common cause of upper limb ischemia overall (30.2%). The most common etiology for acute upper limb ischemia was traumatic injury (n=58) followed by thromboembolic disease (n=37) and that for chronic limb ischemia was atherosclerosis (n=47) followed by thromboangiitis obliterans (n=17) and arteritis/aTOS(n=13 each)(fig 1).



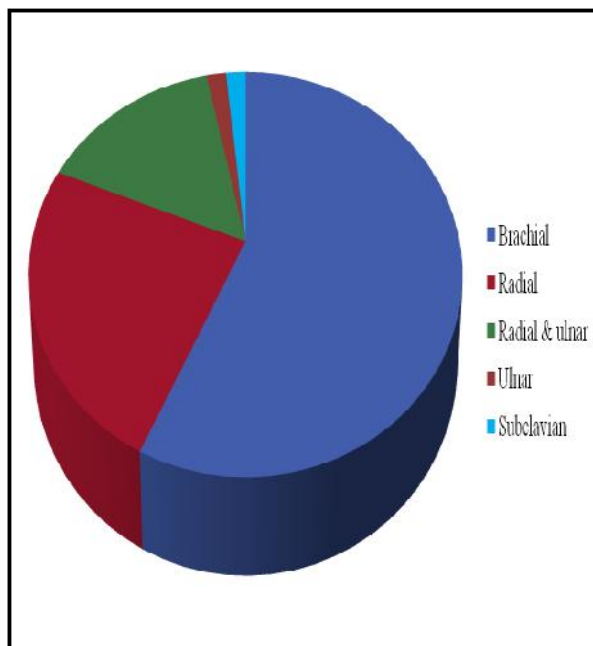
**Fig 1: Distribution of patients with upper limb ischemia based on etiology**

The mean age of distribution is 41.1 years with the mean age of patients being below 45 years in all except atherosclerosis. Male preponderance was noticed in every pathology.

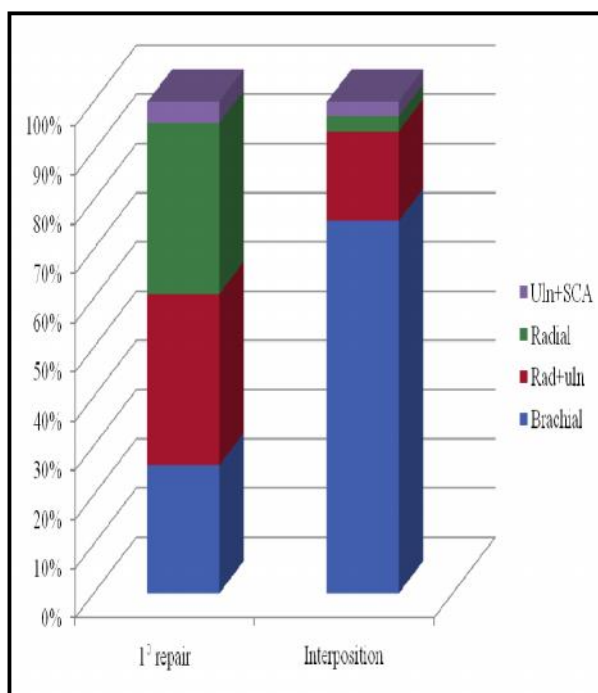


**Fig 2: Age distribution of patients with upper limb ischemia**

58 patients presented with acute arm ischemia secondary to a traumatic injury. The mean age of this group was 32.3 years, and there was a male preponderance. The main mode of trauma was road traffic accident and occupational injuries, the exact number could not be elicited from the records. The majority of injuries (n = 33) involved the brachial artery. Isolated radial artery was injured in 14 patients. Combined radial and ulnar arteries were injured in 9 patients. Only 2 cases of subclavian artery injury were seen (fig 3). Injuries that were distal to pronator teres were usually treated by plastic surgeons and were not included in the series. 33 underwent autologous vein bypass grafting and the remaining 23 underwent primary repair (fig 4). 2 patients with brachial artery injury had extensive soft tissue and bone injury and primary above elbow amputation had to be done. 1 patient who underwent brachial artery repair with autologous vein bypass developed severe postoperative wound infection with soft tissue necrosis and above elbow amputation was done. The extent of neurological damage could not be elicited for all the patients and conclusive data on the functional status of the salvaged limb were lacking.



**Fig 3: Distribution of arterial injury following trauma**



**Fig 4: Distribution of procedures done for vascular trauma in upper limb**

Thromboembolic occlusion was seen in 37 of the patients. The mean age of presentation was 43.8 years with a male preponderance in the ratio of 2.7:1. Only in approximately one-fifth of the patients was a cardiac abnormality detected. Angiogram could not be done in all the patients due to affordability issues and hence the source of embolus could not be identified in the remainder. 81% of the occlusion was at the level of the brachial artery (n=24). The remainder were in the subclavian (n=2) and the axillary artery (n=4). 3 patients presented with class I ischemia and were managed conservatively. 4 patients presented with ageable limb and had to undergo amputation. One patient had recurrent occlusion and repeat thromboembolectomy was done which could not be sustained either. Patient developed gangrene of the hand and had to undergo amputation. All patients who underwent embolectomy had a fasciotomy done routinely as part of the institutional protocol. No mortality occurred.

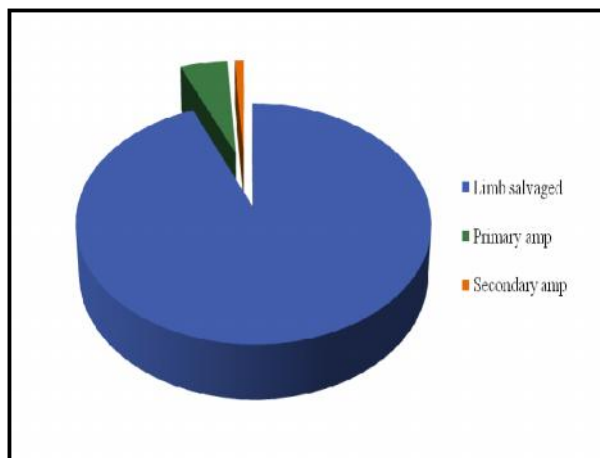
Four patients had iatrogenic injury of the brachial artery during orthopaedic procedure for fracture humerus. Two of them needed autologous vein bypass whereas the other two were managed with patch angioplasty with autologous vein patch. All the four limbs were salvaged.

Atherosclerosis was the leading cause in chronic ischemic limb of the upper limb. This accounted to about 25% of the patients (n=47). The mean age of presentation was 52.4 years with a 2.6:1 ratio in favour of men. Only 4 patients required surgical revascularization with autologous venous graft, 2 of them for brachial artery disease and one patient each with axillary artery and subclavian artery disease. All the remaining patients were managed conservatively with or without minor tissue loss except for two patients who presented with brachial artery occlusion with non-salvageable limb who underwent amputation.

Thirteen patients presented with arterial TOS, 11 of them required cervical rib excision with revascularization. Seven of them were managed with tailoring of the subclavian artery, whereas bypass with autologous vein and prosthetic graft was required in two patients each respectively. Six patients required concurrent thrombectomy. All the limbs were salvaged.

Seventeen patients presented with thromboangiitis obliterans with a mean age of 41 years. One patient required midbrachial artery to distal radial artery vein graft bypass. 2 patients had amputation. Others were managed conservatively.

The overall limb salvage rate was 93.8%. 5.2% of the patients presented with non-salvageable limb and ended up with primary amputation.



**Fig 5: limb salvage rate distribution in patients with upper limb ischemia**

## Discussion

The published series of patients with upper limb ischemia have almost always excluded the patients who have been treated conservatively [6]. Hence the true incidence as well as an accurate ratio of acute to chronic presentation of upper limb ischemia is very difficult to determine. Also series that combine both acute and chronic upper limb ischemia are very rare [1-4, 7, 8]. Often, such attempts to discuss two different disease processes concurrently can lead to obscuring of important individual characteristics. Upper limb revascularization comprises only 4% of all vascular surgeries and approximately 15-18% of them have been done for critical limb ischemia [4, 5, 9]

Acute upper limb ischemia is most often caused by trauma and thromboembolic disease, and usually requires intervention. Only 10-20% of all the patients with acute limb ischemia will have their upper limb affected and it has been reported earlier to be more common in females [10]. In our series, males were more affected than females in all the diseases that caused acute upper limb ischemia.

Axillary and subclavian occlusion due to thromboembolism results in only <10% of limb loss believed due to the existence of preformed collateral pathways. Brachial artery occlusion distal to the deep branch results in only <5% of the patients with finger loss. Patients who were managed conservatively were reported to have persistent exercise-induced pain in up to 50% of them, and hence all efforts should be made to restore flow [11]. 3 patients who were managed conservatively in our series did not have any such complaints. After a successful brachial embolectomy, up to 95% of the patients will remain free of symptoms [12]. A surgically acceptable satisfactory result of acute upper limb ischemia were 91-100%, an amputation rate of 2% (13.5% in our series, patients presented with non-salvageable limb contributing to

this), and a postoperative mortality rate of 6-9% (nil in our series) after thromboembolectomy [13].

The most common mode of trauma is road traffic injuries and occupational trauma in our population. Stab injuries and missile injuries form a significant proportion in the developed countries. Brachial artery is the most commonly reported artery to be injured in upper limb accounting for nearly 50% [14]. Similar presentation was noted in our series too. Combined radial and ulnar arterial injuries vary from 10-50% [15], which was 24.1% in our series. Death due to upper limb vascular injury is rare, and is the result of multiple organ injuries in most cases [16].

Atherosclerosis is by far the most often pathological cause for chronic upper limb ischemia. Others include arterial thoracic outlet syndrome, thromboangiitis obliterans, and arteritis among others. Atherosclerosis may have a variable effect on different segments of the arteries with regards to the extent of involvement and the morphological pattern. No substantial evidence is available in the literature exists to differentiate the morphological pattern in upper limb atherosclerotic disease from other anatomically prone segments for atherosclerosis. Anecdotal evidence suggests that upper limb arterial disease involves frequently a single segment as opposed to multi-segmental involvement in symptomatic lower extremity disease. Moreover due to the chronicity of the disease and extensive collateral network development around the shoulder and elbow, intervention is usually not necessary. Indications for surgery is often tissue loss, rest pain and in a few centres, exertional arm pain [17]. Since the description of upper limb arterial bypass procedures in 1965 by Garret, only a few small surgical series within a single centre have been reported.

Most of the patients presenting with arterial TOS are young, active adults with mean age in the late thirties [18], in our series it was 42.3 years. Limb salvage should approach 100% in Scher stage I and II lesions, and minor tissue loss may result in stage III due to distal embolization, which was also achieved in our series [19].

Although thromboangiitis obliterans involves more often the lower extremities, approximately 50% of the patients also have upper extremity involvement [20], with the ulnar artery being the most commonly involved artery [21]. Revascularization is usually not feasible because of the diffuse, segmental involvement and the distal nature of the disease [22]. If the patient has critical limb ischemia and there is a distal target vessel, autologous vein graft bypass should be considered [22].

## Conclusion

Though our overall perspective of upper limb ischemia seems adequate there are unanswered questions. The true incidence and pattern of upper limb ischemia still remains speculative. The paucity of data on the patients who were managed conservatively is a major limiting factor. Poor adherence of the patients to follow up also has hampered reliable interpretation of the outcomes. The absence of a registry makes it inherent for a multi-centre trial to evaluate these questions. This may pave way for a collectible pooled data system for future analysis.

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