

Management of acute peripheral arterial injury by using doppler ultrasonography

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ABSTRACT

Objective

To determine the effectiveness of the duplex ultrasonography scanning in the management acute peripheral arterial injury .

Materials and methods

Its a prospective evaluation comparing duplex scanning with operative exploration finding in 78 patients. Duplex scan was used alone for 98 patients having clinical finding of acute vascular insufficiency.

Results

Duplex scanning had 100% sensitivity and 95.23% specificity compared with operative exploration in the 78 cases. Duplex scanning detected 78 injuries, 77 of which were confirmed by correlation with operative exploration and 20 patients did not have vascular injury. One false-positive result was due to spasm of the superficial femoral artery.

Conclusions

Duplex scanning is a noninvasive, safe, effective , rapid and lesion localising method of initial evaluation for acute peripheral vascular injury having clinical features of vascular insufficiency.

Key words: arterial injury, duplex scan, operative exploration.

Introduction

Most extremity injuries are localized to a specific region and occur in patients with an otherwise normal vessel. Arteriographic assessment of an injured limb gives a

global overview of only the arterial system of an entire extremity. Though contrast arteriography has served as the historical ‘gold standard’ for diagnosis of arterial disease, recent improvements in noninvasive diagnostic methods have made it possible to plan surgical

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treatment without subjecting patients to this invasive procedure. The complications associated with arteriography include allergic reactions, renal failure, puncture site problems, stroke and death. Radiographic contrast media cause severe anaphylactic reactions in less than 2% of cases.¹ Duplex scanning provides real time focused assessment of blood flow velocities and waveform characteristics of both arterial and venous abnormality in acute trauma which allows the vascular surgeon making decisions regarding operation when no other diagnostic methods are available. The diagnosis of vascular trauma has increased steadily since routine repair of vascular injuries was initiated during the Korean war. During this war period there was a high incidence of associated injuries and therefore routine exploration of all penetrating wounds in proximity to a neurovascular bundle was the norm.² Improvements in the accuracy of non-invasive testing, together with a mandate to reduce the cost, unwanted complication and limited time, have prompted many vascular surgeons to consider performing vascular surgical procedures based on the results of non-invasive duplex scan alone.

Materials and Methods

This prospective study was done between jan2010 to sep 2011. All the traumatic cases with clinical findings suggesting of acute arterial insufficiency like pulselessness, pallor, paresthesia, pain, paralysis, peripheral cooling, arterial bleeding, rapidly expanding hematoma, cyanosis and poor capillary refill having history of trauma within eight hours of incident or whose duplex has already been done showing trauma to major vessels were directly taken to the operation theatre.

In the theatre vascular surgeon used the portable ultrasound Doppler of 3-5 MHz linear probe covered by sterile plastic cover, performed the duplex scan and findings like luminal narrowing, widening, defect, or occlusion of major vessels were recorded. Other Doppler findings like accelerated or blunted peak velocity, spectral broadening were also recorded. Operative findings and the procedure done were recorded. Other injury like fractured bone, joint disruption, muscle injury were also recorded. Immediate postoperative flow was checked by vascular surgeon by Doppler ultrasound. Mode of injury was recorded. Patients with multiple trauma were excluded until other life-threatening injuries were treated. Operative findings were compared with Doppler finding. Post procedure limb viability and the complication related with post perfusion were recorded. Statistical analysis were done by student t test, z test and other appropriate test.

Results

Using sterile plastic ultrasound probe cover, duplex scans on all patients in this study were of satisfactory quality to allow determination of the presence or absence of vascular injury. There were 98 patients of trauma to periphery having features of peripheral insufficiency had undergone duplex ultrasonography. Seventy eight patients (79.5%) had extremities injuries like arterial occlusion, intimal flap, incomplete transection and complete transection. Sixty (61.2%) cases of lower limb vessels were involved. Out of this mostly popliteal artery injury of 32(32.6%) cases followed by 22(22.4%) cases of superficial femoris/profonda femoris artery injuries were observed.

Table 1: Major vessels involvement by Doppler ultrasound.

Peripheral region	Major arterial segment	Number of arterial injury	Cases	Normal finding	Missed injury	Total patient
Upper limb	Subclavian	1 (1%)	18 (18.3%)	20 (20.4%)	Nil(0)	98
	Axillary	3(3%)				
	Branchial	9(9.1%)				
	Radial/Ulnar	5(5.1%)				
Lower limb	Common femoral	3(3%)	60 (61.2%)	20 (20.4%)	Nil(0)	98
	Superficial femoral/Profunda femoris	22(22.4%)				
	Popliteal	32(32.6%)				
	Tibial	3(3%)				
Total		78 (79.5%)	78 (79.5%)			

Table 2: Type of pathology by exploration.

Pathology	Number of cases	Number of positive exploration	Number of negative exploration	Number of total exploration	No exploration	Total patients
Intimal injury	46(55.2%)					
Complete transection	16(19.2%)	77(92.4%)	1(1.2%)	78	20	98
Incomplete transection	15(18%)					

Surgical exploration of 78 patients were performed for correlation. One(1.2%) patient had false positive scan. There was no evidence of missed vascular injury. There were no false-negative duplex scans. Duplex scanning had a sensitivity of 100%, a specificity of 97.3%, and an overall accuracy of 98.71% compared with operative exploration.

Table 3: Results of duplex scan with operative exploration

	Operative exploration result		Duplex scan result	
	Positive	Negative	Positive	Negative
Positive			77	0
Negative			1	20

Ages ranged from 13 to 62 years with a median age of 26 years. There were 86(87.7%) Male and 12(12.2%) female. Most injuries, 82(83.6%) were sustained in road traffic accidents (RTA) (Table-4). Stabbings accounted for 6(6.1%) injuries. Ten patients (10.2%) suffered from fall injury. Eighty six patients(87.7%) of blunt and 12(12.3%) patients of penetrating injuries were observed. Table 5 showed the relation with and without associated fractures.

Table 4: Mechanism of vascular injury

Mechanism	Frequency	Cases
RTA(Pedestrian)	10(10.2%)	
RTA(Motorcycle)	34(34.6%)	
RTA(Four wheeler)	24(24.4%)	82(83.6%)
RTA(Bicycle)	14(14.2%)	
Fall injury	10(10.2%)	
Stabbing	6(6.1%)	

Table 5: Associated fracture

Associated with Fracture	Total blunt injury	Total penetrating injury
Penetrating	3(3.%)	
Blunt	67(68.3%)	
Not associated with Fracture but having soft tissue injury	86(87.7%)	12(12.3%)
Penetrating	9(9.1%)	
Blunt	19(19.3%)	

Table 6: Demographic profile

Male	86(87.7%)
Female	12(12.2%)
Range(age)	13-62 years
Mean age	26 years
Total cases	98
Total injury	77(78.54%)

Table-7: Surgical procedure

Surgical procedure	Frequency	Total
Reversed vein graft	44 (52.8%)	
Primary repair	8(9.6%)	
End to end anastomosis	16(19.2%)	77
Patch repair	5(6.4%)	
Radial / ulnar/tibial artery tie	4(4.8%)	

Two patients (2.4%) had neurological insufficiency in which one patient of subclavian artery injury had brachial plexus avulsion. Interposition graft using reversed long saphenous vein was the most common procedure performed in 44 (52.8%) patients (Table-7). Fasciotomy was performed during the primary operation in 6(7.2%) patient but two(2.4%) further patients required decompression for compartment

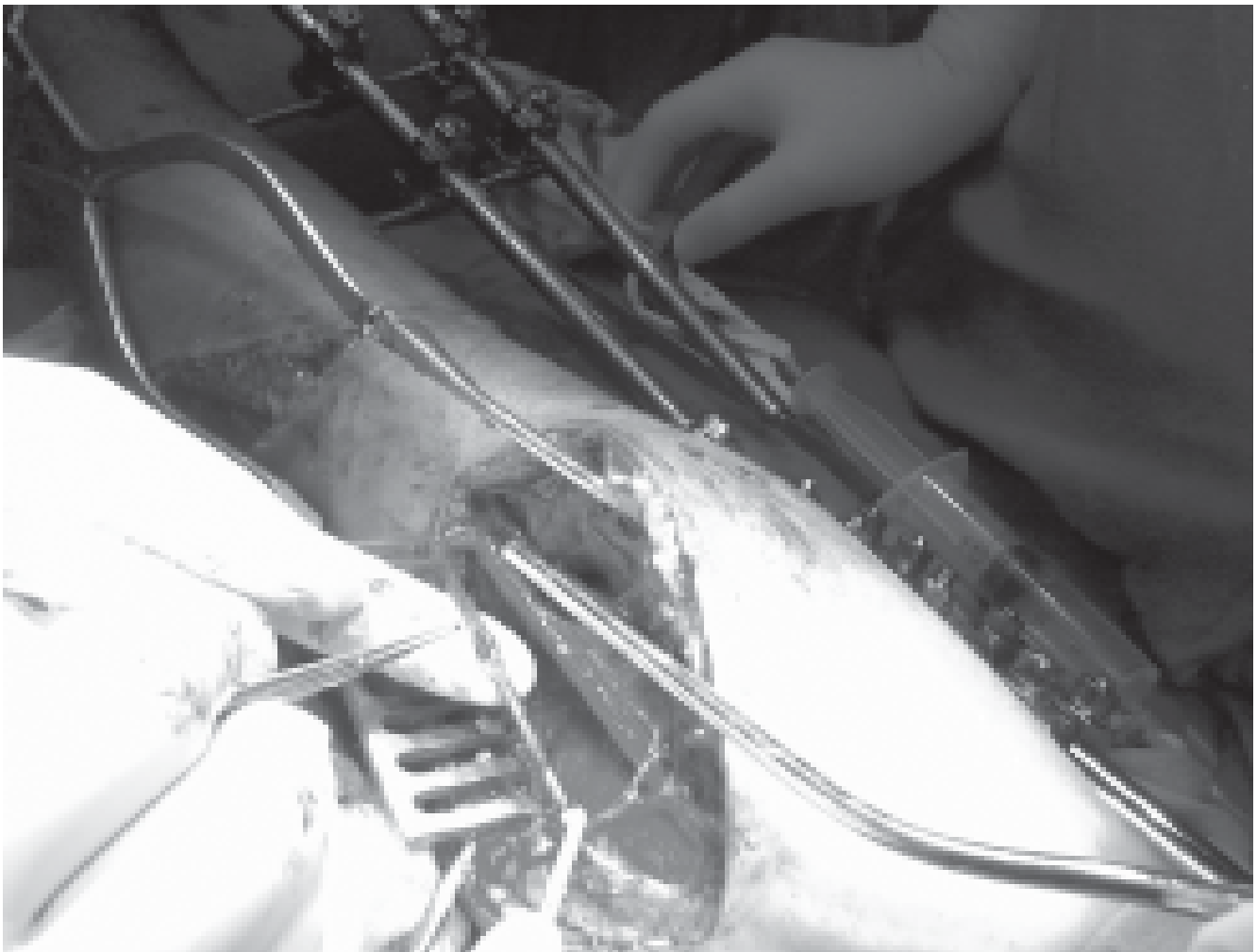
syndrome. In two patients (2.4%) grafts were thrombosed and undergone thrombectomy. Three patients(3.6%) underwent post repair amputation. Twelve patients(14.4%) had undergone repeated debridement. Six patients(7.2%) had delayed wound healing. Eight patients(9.6%) had malunion of fractured bone. We salvaged limb in 74(88.8%) out of 77 patients.

Table 8: Secondary procedure

Procedure	Frequency	Total
Thrombectomy	2(2.4%)	77
Fasciotomy	6(7.2%)	
Skin graft	12(14.4%)	
Redo bypass	1(1.2%)	

Table 9: Complication

Complication	Frequency	Total cases
Compartment syndrome	2(2.4%)	77
Post repair amputation	3(3.6%)	
delayed wound healing	6(7.2%)	
Neurological defecit	2(2.4%)	
Malunion	8(9.6%)	
Debridement	12(14.4%)	



Exploration of femero-popliteal artery showing intimal injury

Discussion

Early recognition of limb ischemia may allow prompt, effective therapy for peripheral arterial injuries. Ischemia may be difficult to recognize in patients with soft tissue or skeletal trauma, but the presence of distal pallor, coolness, paresis, cyanosis, anesthesia, poor capillary refill and disproportionate pain indicates significant arterial damage and necessitates surgical exploration. Clinical evaluation is the important factor to be considered for early recognition of the vascular trauma as mentioned by many authors.^{3,4,5}

This can be supplemented by duplex scan in operation theatre. In this study there was no any delay in the exploration. The amputation rate was almost negligible after revascularisation procedure. The few amputation rate was not because of arterial insufficiency but because of extensive soft tissue injury and development of septic site. There can be some delay in the diagnosis of major arterial trauma by using arteriography which may be hazardous to the patient presenting in late stage in salvaging the limb. Lynch K et al showed that there could be a delay up to 2.4 hours while doing arteriography.⁶

In this study we used the duplex ultrasound extensively in perioperative period. Most of the patients had blunt injury and few patients had penetrating injury. Every patients having features of vascular compromise distal to the injury were taken to theatre immediately and duplex scan were done and operative exploration was done at the same time. This aggressive approach helped a lot to salvage the limb as described by Asworth EM.

In a animal model of arterial injury like occlusion, laceration, intimal flap and hematoma, duplex scanning and arteriography had similar accuracy; however,

duplex scanning was significantly more sensitive than arteriography (90% versus 80%) in identifying arterial lacerations.⁸

Duplex sonography is rapid, noninvasive, inexpensive, and portable device used extensively by vascular surgeon for the diagnosis of vascular injury having excellent sensitivity and specificity that was shown by this study. Many authors support this mode of diagnosis very much.^{9,10,11,12,13}

Many blunt trauma cases were injured from vehicle accident. Younger male populations were involved. This is supported by some author.¹⁴

Most common pathology was thrombotic occlusion which were approved by exploration showing intimal injury. Other few patients had incomplete and complete transection. Such types of injuries were most common in blunt trauma. Many of our patients were treated with reversed long saphenous auto graft. Some of the patients underwent end to end anastomosis and few had undergone for patch repair. we ligated very few vessels like radial or tibial artery provided that the distal portion should have adequate perfusion. These types of management are commonly performed.¹⁵

Very few number of patients underwent intraoperative fasciotomy and post operative compartment syndrome were also less. So routine fasciotomy may not be necessary.⁷

We did not perform any primary amputation. It's rate is also very low.¹⁶

Some of the cases of soft tissue and bone related complications like delayed wound healing, malunion

and repeated debridement were observed which were minor in nature.

Conclusion

The early recognition in the casualty plays a pivotal role in the prompt diagnosis and initial management of vascular injuries. Understanding basic rules of diagnosis of vascular pathology in vascular trauma by using non invasive, cost effective, non time consuming method of duplex scan could salvage the limb to the maximum whose diagnostic accuracy is parallel to the operative finding and as good as to conventional arteriography or other methods of investigation.

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