Usefulness of Ultrasound Doppler in Vascular Surgery Practice

Dr. Shanmugavelayutham.C ¹, a, Prof M.Rajkumar ²,b
¹PG in MCh Vascular Surgery, Madras Medical College & RGGGH, Chennai, India
²Professor of Vascular Surgery, Madras Medical College & RGGGH, Chennai, India
a drshanmuga@gmail.com, b dr_rajkumar47@rediffmail.com

Background: Vascular surgery patients comprise of arterial, venous and lymphatic diseases and vascular trauma. They cause considerable expenditure to the health department and morbidity (limb loss) and mortality to the patients, if not diagnosed and treated early.

Aim: To analyse the diagnostic and therapeutic potential of Ultrasound Doppler.

Materials and methods:
The study used Tripleix – B mode ultrasound (Freq 5-8 MHz) with Doppler and color flow imaging

Inclusion criteria:
Patients with
- symptoms of venous diseases
- arterial diseases with
  - claudication
  - renal failure (in whom CT angiogram was contraindicated)
- previous failed AV fistulas
- Treated with US guided compression, permcath insertion, foam sclerotherapy and endovenous RF ablation.

Patients with arterial diseases without CKD and arteriovenous malformations were excluded.

Results: Ultrasound Doppler has a 95% accuracy in identifying venous reflux (superficial/deep), 90 - 100% efficacy in diagnosing DVT. 80-90% accuracy in identifying arterial pathology. Interventional procedures done under US guidance had fewer complications.

Conclusion: Doppler ultrasound is gold standard methods in evaluating venous diseases. US guided interventional procedures have fewer complications.

Keywords: claudication, varicose veins, ablation, arteriovenous malformation, angiogram

Introduction:
Vascular surgery deals with diseases of the arterial, venous and lymphatic systems, arteriovenous malformations and vascular trauma. Vascular diseases cause considerable morbidity (limb loss) and mortality to the patients, if not diagnosed and treated early. They cause considerable expenditure to the health department and socioeconomic loss to the patients.

Arterial diseases:
Patients with arterial diseases present with symptoms of claudication (pain on exertion) in the early phase, gangrene and tissue loss in the form of ulcer or loss of toe in the late phase. Patients with mild to moderate claudication can be medically managed. Patients with incapacitating claudication, gangrene and tissue loss need surgical intervention (open/endovascular). CT peripheral angiogram is the gold standard investigation for such patients.

Arterial duplex is the investigation of choice for claudicants and patients with renal disease. It is a non invasive, cost effective modality suitable for serial examinations.

B mode ultrasound is useful in imaging the tissue and evaluation of the vessel and plaque morphology.[2]
Blood flow characteristics can be assessed by color Doppler imaging, power Doppler imaging, and Pulsed Doppler spectral analysis. Duplex alone is enough for evaluation of patients for carotid endarterectomy. By serial examinations disease progression, regression and response to procedures can be assessed.

B mode ultrasound: this was done with the linear array transducer placed perpendicular to the axis of the artery. The vessel diameter, intimomedial thickening and plaque morphology were studied.

Color flow imaging: the flow velocity distribution is depicted as a color encoded map. Sites of arterial stenosis, turbulence can be identified.

Pulsed Doppler spectral analysis:
Time varying flow velocity distribution at set sample volume is studied. The transducer is placed at an angle of 60° to the longitudinal axis of the vessel is studied. The normal spectrum is triphasic. In diseased states there is widening of the spectrum and the pattern is monophasic. The acceleration time, peak systolic velocity (PSV), End diastolic velocity (EDV), pulsatility and resistive indices are calculated.

By analyzing these, presence and severity of the lesion, site of the lesion and nature of the lesion can be assessed.

Venous diseases: patients with venous diseases present with swelling of the limb, varicosities, non healing ulcer etc. among the venous diseases, Deep venous thrombosis (DVT) and varicose veins account for 95% of the cases. Venous thrombo embolism is the leading cause of preventable in - hospital mortality.
Venous duplex: it is the investigation of choice in diagnosing the above conditions.
It takes the following in to account:
1. visualization of the vein and any thrombus within it
2. compressibility of the vein
3. flow in the vein and any flow reversal(reflux)
4. augmentation of flow

Acute thrombosis: acute thrombi are hypoechoic, homogenous and partially compressible. Veins appear echolucent, distended with smooth walls and spongy on compression.
Chronic thrombosis: older thrombi appear organized hyperechoic, heterogenous and non compressible with collateralization. Vein wall is thickened and irregular with or without reflux.

Reflux: it is reversal of blood flow in the vein. It is assessed by performing the Doppler ultrasound in the standing osition. Labropoulos et al criteria[1] were used in the diagnosis of venous reflux. A reversal of flow
1. >500 msec for superficial and calf veins
2. >1000msec for femoral and popliteal veins and
3. outward flow in the perforator veins >350msec
are considered significant.

Aim: To analyse the diagnostic and therapeutic potential of Ultrasound Doppler in vascular surgery practice. Patients treated in our department from the year 2010 – 2013 were included in the study.

Materials and methods:
The study used Triplex – B mode ultrasound (Freq 5-8 MHz) with Doppler and color flow imaging.

Inclusion criteria:

Patients with

- symptoms of venous diseases
- arterial diseases with
  - claudication
  - renal failure (in whom CT angiogram was contraindicated)
- previous failed AV fistulas
- Treated with US guided compression, permcath insertion, foam sclerotherapy and endovenous RF ablation.

Patients with arterial diseases without CKD and arteriovenous malformations were excluded.

Therapeutic role of Ultrasound:

Ultrasound guidance is useful in many interventional procedures such as central venous and permanent catheter insertion, foam sclerotherapy / radiofrequency ablation for varicose veins, compression of pseudoaneurysm sac wall. This reduces the rate of complications such as injury to the vessels, injury to

Foam sclerotherapy: Ultrasound guided injection of foam (polydocanol) was done in 482 cases for below knee perforator incompetence / recurrent varicose veins / residual varicose veins. The use of ultrasound reduced the incidence of complications due to extravasation.

Radiofrequency ablation (RFA): patients with primary varicose veins due to SaphenoFemoral incompetence with or without perforator incompetence were selected. RFA of the long saphenous vein under Ultrasound guidance was done using closurefast VNUS[3] system. The hospital stay of the patient was reduced 1-2 days compared to 4-5 days for open surgery. There were no post procedural complications in these patients.

Permcath insertion: ultrasound guided permcath insertion for patients with chronic kidney disease on hemodialysis reduce the incidence of vessel injury.

Pseudoaneurysms: ultrasound guided compression of the pseudoaneurysm sac was successfully done in 3 cases of pseudoaneurysms following coronary angioram. This avoids the need for open surgery.

**TABLE 1**

<table>
<thead>
<tr>
<th>YEAR</th>
<th>DIAGNOSTIC US</th>
<th>THERAPEUTIC ULTRASOUND</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ARTERIAL</td>
<td>VENOUS</td>
<td></td>
</tr>
<tr>
<td></td>
<td>FOAM SCLEROTHERAPY</td>
<td>RADIOFREQUENCY ABLATION</td>
<td></td>
</tr>
<tr>
<td></td>
<td>PERMCATH INSERTION</td>
<td>PSEUDOANEURYSM COMPRESSION</td>
<td></td>
</tr>
<tr>
<td>2010</td>
<td>88</td>
<td>370</td>
<td>118</td>
</tr>
<tr>
<td>2011</td>
<td>96</td>
<td>365</td>
<td>136</td>
</tr>
<tr>
<td>2012</td>
<td>126</td>
<td>571</td>
<td>148</td>
</tr>
<tr>
<td>TILL SEP 2013</td>
<td>159</td>
<td>656</td>
<td>80</td>
</tr>
<tr>
<td></td>
<td>469</td>
<td>1962</td>
<td>482</td>
</tr>
</tbody>
</table>
Results: In all 2965 duplex scans were performed of which 2431 (81.9%) were diagnostic and 534 (18%) therapeutic. Among the diagnostic ultrasounds performed 1962 (80.7%) were venous duplex and 469 (19.3%) were arterial. Among therapeutic ultrasounds 528 (98.8%) were venous and 6 (1.2%) were arterial. Ultrasound Doppler has a 95% accuracy in identifying venous reflux (superficial/deep), 90 - 100% efficacy in diagnosing DVT. 80-90% accuracy in identifying arterial pathology. Interventional procedures done under US guidance had fewer complications.

Conclusion: Doppler ultrasound is gold standard methods in evaluating venous diseases. UltraSound guided interventional procedures have fewer complications.

References: