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ABSTRACT
The diagnosis of deep vein thrombosis has always been difficult. The myriad of signs and symptoms that can be associated with DVT and the fact that many thrombi are asymptomatic, make it exceedingly difficult to rely on the clinical presentation. The management of patients with clinical diagnosis of DVT in the lower extremity needs to identify the presence of thrombus, its nature, location and extent. The present study was performed with the objective of assessing the role of colour Doppler USG in the diagnosis of DVT of lower extremity.

KEY WORDS- Colour doppler, Deep venous thrombosis, Compressibility, Valsalva maneuver, Doppler effect.

I. INTRODUCTION
Deep Vein Thrombosis of lower extremities is one common cause for pulmonary embolism which in turn is responsible for majority of deaths. It is a common clinical problem that complicates many medical and surgical disorders. It is also a most timely subject as it continues to be an elusive diagnosis. Failure to detect deep venous thrombosis, can lead to catastrophic results. It usually presents as pain and swelling of the affected limbs and may also cause structural damage to the valves of deep veins, which results in post phlebitis syndrome. (1) Development of a thrombus within a vein may be considered functionally as an exaggeration of the normal process of hemostasis. Group of patient with the high risk of developing DVT are the patients after a major surgery, trauma, prolonged immobilization and postoperative convalescence. Other risk factors to mention are neoplasms, pregnancy, oral contraceptive pills and hyper coagulablestates. Formation of clotted blood within the non-interrupted vascular system is called thrombus. A DVT occurs along a continuum with propagation, extension and progression. (2) Most venous thrombi are clinically silent when they are first detectable by objective methods, probably because they do not totally obstruct the vein and also because of collateral circulation. Even among the fraction of patients with deep vein thrombosis who have symptoms in the lower extremities, fewer than the third present with classic syndrome of calf discomfort, edema, venous distension, and pain on forced dorsiflexion of the foot (Homans sign). When symptoms are initially attributed to deep vein thrombosis, reassessment by objective methods shows that this attribution is correct less than half the time.

Hence a need of an objective technique to supplement and confirm clinical diagnosis of DVT is very important to prevent the complications and sequelae by early and appropriate treatment instillation.

The introduction of Doppler ultrasound technique has irrevocably altered the diagnosis and treatment of DVT. The rationale is quite simple: thrombotic obstruction of the underlying vein distorts the venous flow pattern and these perturbations are readily detected by the Doppler instrument. This technique is noninvasive, repeatable, can be performed rapidly in the clinic, at patient’s bedside or even at home and the results are available immediately. It can be used in pregnant women, permits multiple views in various positions of the leg and the study is, painless inexpensive. The present study aims to evaluate the role of colour Doppler clinically suspected patients of deep venous thrombosis of lower limbs.

AIMS AND OBJECTIVES
AIM:
To assess the role of colour Doppler in the evaluation of deep vein thrombosis of the lower limbs.

OBJECTIVES:
1. To study the spectrum of findings on colour Doppler ultrasound in patients who presented with clinical symptoms and signs of deep venous thrombosis.
2. To evaluate the distribution of thrombi in proximal and distal deep veins of lower limbs.
3. To know the sensitivity, specificity and reliability of ultrasound in detection of deep vein thrombosis.

INSTRUMENTATION

Doppler Effect:
The Doppler effect is the phenomenon by which the frequency of a wave received after reflection by a moving target is shifted from that of the source. The phenomenon can be explained by considering the compression of transmitted waves into a contracting space and vice versa.

An ultrasound acoustic wave is a longitudinal compressional wave consisting of a series of compressions and rarefactions. The characteristics of acoustic wave important for understanding the Doppler effect are propagation velocity, frequency, reflection, and scattering.

In medical USG the Doppler signal, of interest are predominantly the result of scattering from RBC’s.

Doppler shift occurs when reflectors move relative to the transducer. Movement of the reflector (i.e. movement due to flowing blood cells) results in change in wavelength. The frequency of echoes signals from moving reflectors is higher or lower than the transmitted frequency transmitted by the transducer, depending on whether the motion is towards or away from the transducer. The Doppler shift frequency is the difference between the received and transmitted frequencies.

Doppler Equation:
When the speed of ultrasound in the medium is, the transmitted frequency is, the velocity of reflector towards the transducer is, the wavelength of the waves traveling from the source to the reflector is given by

$$\lambda_s = \frac{C}{f}$$  \hspace{1cm} (1)

As the reflector is moving either towards or away from the source, it encounters more or less cycles respectively of ultrasound than it would have done had it been stationary.

The actual number of extracycles per second = \(\frac{V_r}{\lambda_s}\).

This frequency is added to the frequency transmitted by the source to obtain the frequency which is reradiated towards the receiver by the reflector.

The Doppler frequency \(f_D\) is thus

$$f_D = \frac{2V_r}{\lambda_s} = 2f_Vr/c$$  \hspace{1cm} (2)

(Substituting \(\lambda_s\) from equation (1)).

The factor two appears in the equation as the reflector moves with respect to the ultrasound waves. In practice, it is seldom that the reflector moves exactly along the effective direction of the ultrasound beam. The direction of movement of the reflector and the ultrasonic beam are at some angle called the angle of attack \(\theta\).

The Doppler frequency shift arises because the reflector has an effective component of velocity \(V_{eff}\) along the direction of the ultrasonic beam, the magnitude of which is calculated by trigonometric relationship.

$$V_{eff} = Vr \cos \theta$$

The Doppler shift frequency is thus given by

$$f_D = \frac{2V_r \cos \theta}{c}$$

The angle of attack \(\theta\) strongly influences the detected doppler frequency for a given velocity reflector.

When \(\theta = 0\),

Then \(\cos \theta = 1\) and \(V_r = V_{eff}\)

For the sound beam incident at an angle other than 0°, the detected Doppler frequency is reduced according to the cos \(\theta\) term. The transducer beam is usually oriented to make a 30 to 60 degree angle with the vessel lumen.
Fig. 1: Principles of Doppler Effect Arrangement for detecting Doppler signals from blood. The angle $\theta$ is the Doppler angle, which is the angle between the direction of motion and the beam axis, looking towards the transducer.

**INSTRUMENTATION:**
The ideal instrument for venous studies comprise a high resolution gray-scale imager with pulsed and colour Doppler capabilities sensitive to low-flow states.

**Continuous Wave Doppler:**
Continuous Wave Doppler operation is used in a variety of instruments, ranging from simple, inexpensive hand held Doppler units to duplex scanners in which CW Doppler may be one of these several operating modes. The transmitter is continuously on. With CW Doppler instruments, reflectors and scatterers anywhere within the beam of the transducer contribute to the instantaneous Doppler signal. The frequency difference signal may be presented audibly as well as graphically. Only the magnitude of the Doppler frequency is detected. A continuous wave pencil probe is available on some commercially available duplex equipment and can be very useful for peri-orbital Doppler studies and for tumour evaluation.

**Advantage:** This system measures a wider range of velocities without limit.

**Disadvantages:**
1. Lack of axial resolution as the Doppler sample volume includes all structures within the entire overlapping regions of the transmitted and received beams, allowing vascular structures at different depths to be sampled simultaneously.
2. It does not indicate the direction flow, whether it is towards or away from the transducer.

**Pulsed Wave Doppler**
Pulsed wave Doppler overcomes the position insensitivity of CWD to a large extent. The major difference between pulsed and continuous wave is the amount of time that the beam is turned on. Asingle transducer assembly transmits the sound pulse and detects the returning echo. The time delay between the pulse and the returning echo depends on the velocity of sound and directly relates to the depth of the reflector.

**Advantage:** It is possible to measure selectively the velocity at specific locations in the beam.

**Disadvantages:**
1. Parameters including pulse length and duty cycle place an upper limit on the maximum velocity that can be measured.
2. The precise source is difficult to determine as the picture of subsurface anatomy is not shown.

**Pulse Duplex Doppler:**
Duplex ultrasound instruments are real time B-mode scanners with built-in Doppler capabilities. Duplex imaging is possible with a single machine that produces both image and velocity information. As the optimal requirements for imaging and velocity information are slightly different, many systems use two transducers located in one probe for duplex imaging. This device allows the operator to interrogate the flow characteristics of any isolated area.
on the corresponding B image and to display the flow data as a continuous time velocity waveform called Doppler spectral waveform. It detects all the velocities within the region of interest together with their variation in time over the cardiac and respiratory cycles. The technique thus provides a temporal display of hemodynamics. It is clinically useful in evaluating carotid vessels, foetal, uterine and abdominal vessels.

**Spectral waveform:**

The Doppler spectrum is an image of the Doppler frequencies produced by the moving blood. It is a quantitative graphic display of velocities and directions of moving RBCs present in Doppler sample volume. The Doppler spectrum displays velocities on Y-axis and time on X-axis. Frequency shift is first calculated and then the angle between the Doppler beam and long axis of blood is measured. Taking both these into consideration and in addition to the knowledge of original frequency beam, the velocity of sound is calculated. Complex mathematical processes called the Fast Fourier transformation do this.

The frequency spectrum shows blood flow from a specific location called “Doppler sample volume”. Flow towards the transducer is displayed above the spectral base line while flow in opposite direction is shown below the baseline. Various Doppler indices have been evaluated for quantitative assessment of Doppler waveform. They are based on PSV, EDV and mean velocity (M).

**The commonly used indices are:**

1) **Pulsatility index** = \( \text{PSV - EDV} \) / \( \text{M} \)

2) **Resistance index** = \( \text{PSV - EDV} \) / \( \text{PSV} \)

3) **Systolic to diastolic ratio** = \( \frac{\text{PSV}}{\text{EDV}} \)

**Colour Doppler sonography:**

This has been one of the most remarkable developments in US instrumentation. This method extracts velocity information from the return of the echoes and adds this information to the conventional twodimensional image as colour information. It is the real-time encoding of the Doppler flow signals as a colour map. Returning echoes are analyzed for amplitude, phase and frequency shift. Amplitude data provide a gray scale or tissue image. Moving targets produce phase and frequency shifts. Colour assignment (either blue or red) depends on flow direction with respect to the transducer and is selected by the operator. Colour saturation or phase difference frequency shift, which is dependent on flow velocity and the angle of the sound beam in relation to the longitudinal axis of the flow lumen.

High frequency shifts result in greater colour saturation towards the whiter shades of red and blue. The amplitude of doppler signal is dependent on power output, reflectivity of the moving RBCs and receiver gain. A display threshold setting controls the amplitude of the colour flow signal on the video display terminal. Frame rates in colour flow imaging are lower than in standard B mode imaging.

In colour flow Doppler imaging, the velocity of flow and direction of flow is determined. The velocity information for the entire image is made available. This imaging is done by estimating and displaying the mean velocity of scatterers and reflectors in a scanned region. The Doppler shift is determined by the above mentioned equation. The direction of flow is decided by whether the returning echo has a higher or lower frequency than the transmitted by the transducer. A higher frequency i.e. a positive Doppler shift indicates that flow is towards the transducer. Lower frequency or negative Doppler shift indicates that flow is away from the transducer. By convention, flow towards the transducer is designated red and colour and flow...

away from it is seen in blue colour. However this can be interchanged.

The blood moves slowly in the veins, so different settings are used. Most scanners come with a menu of recommended settings for different applications including peripheral venous studies.

Advantages of colour flow imaging:

1. It permits physiologic and anatomic interrogation of the venous system in real-time.
2. Has potential to produce totally lower extremity venous imaging studies non-invasively.
3. Technical efficiency: Presence of blood flow can be easily assessed.
4. Requires little time for examination.
5. Assists in sorting out anatomy.
6. Helps in differentiating vascular and non-vascular structures.
7. Ability to visualize spontaneous venous flow in colour. With the advent of flow sensitivity software upgrade, spontaneous colour flow signal outlining the full cross sectional area of the vein during maximum flow can be appreciated in normal patients.
8. The location, velocity and direction of flowing blood are displayed in a real-time colour Doppler flow image.
9. Combines the advantages of compression sonographic technique.
10. Demonstrates recanalized venous segments that cannot be shown by compression B-mode USG.
11. Flow can be assessed in the entire lumen.
12. Colour flow imaging can detect low velocity flow in residual lumen and helps in differentiating partial occlusion and total occlusion.
13. Improves evaluation of blood flow in the pelvic veins which are amenable to US compression.

Disadvantages of colour flow imaging:

1. Flow information is qualitative and not quantitative.
2. Low PRF and low frame rates.
   As a lot of information needs to be processed there is a resultant delay. PRF (number of pulses sent out by the transducer) and frame rate (number of times second monitor screen is renewed) both are reduced.
   - Degradation of B mode images.
   - Aliasing.
   - Visualization of rapidly moving structures is hampered e.g. cardiac valves.
3. Flow detection is angle dependent. If the transducer is kept at an angle of 90 degrees, flow is not detected.
4. Flow directions are arbitrary. Colour assigned to the transducer is arbitrary and may be changed.
5. Skill and experience required to obtain suitable and satisfactory images of the veins. Grey scale images identify thrombus, duplex assessment provides a measurement of blood flow velocity through a vessel and colour Doppler imaging enables the rapid localisation of occlusion.

EXAMINATION TECHNIQUE IN LOWER LIMB DOPPLER

Patient’s position:

Clear visualization of the lower extremity veins requires adequate distention of the venous system. Therefore, the extremity must be dependent. This can be accomplished by tilting down the feet at about 15 or 20 degrees or by examining the patient in the sitting position. All venous segments are examined for the characteristics of venous flow and the effects of compression. Spectral analysis is not performed routinely as all relevant Doppler information is encoded in a colour flow signal throughout the full length of the venous segment being imaged at any one time.

COLOUR DOPPLER FINDINGS IN VENOUS THROMBOSIS:

The distinction between acute and chronic thrombus is important because acute DVT has a greater potential for embolization. Acute clot is not very echogenic and may be difficult to identify sonographically. This type of thrombus can be identified by the following sonographic features:

1) Low echogenicity intraluminal material producing a flow void: Recently formed thrombus has low echogenicity, is seen as a large anechoic area on the grey-scale image and difficult to visualize, is identified by a flow void on colour Doppler images. Patients with a large anechoic clot usually have a history of DVT if less than
oneweek duration. Olderclots are more echogenic. The absence of spontaneous flow is characteristics of complete venous thrombosis. Smallland nonocclusive thrombi, which are also difficult to visualize, are indicated by a flow void on colour Doppler images.

2) Venous distension:
Increase venous diameter is a sign of acute clot. The acutely thrombosed vein enlarges twicethesize of the corresponding artery in many patiens. Exception is partial occlusion. Venous distension is a significant finding because it helps to distinguish between acute and older thrombus. In late cases, the thrombosed vein may be normal in size or smaller than adjacent artery. A significant correlation exists between the age of thrombosis and the venous diameter (p < 0.001). Loss of compressibility:
Excellent results for diagnosing venous thrombosis of any age have been reported on the basis of this criterion alone. Complete compression of the venous lumen is the most reliable criteria of normality when one evaluates the possibility of DVT. The degree of force necessary to completely collapse the vein lumen may be greater when examining the calf veins than when examining the femoralpopliteal system. If the collapse of the vein is incomplete following compression, it indicates the presence of partially occludingthrombus. But it is difficult to demonstrate the compressibility, if the vein is surrounded by thick muscular structure as in adductor canal.
Compression US usually have sensitivity of88% and specificity of96% for identification of calfveinthrombosis.

a. Free floating thrombus: Proximal end of acute clot may not adhere to the veinwall. In such cases the thrombus is freely floating in the venous lumen and has potential for pulmonary embolization. Unnecessary manipulation of such a vein is dangerous thoroughly, dislodgement of a thrombus during USG examination has been reported.

b. Doppler signal abnormalities: - When the Doppler probe is directly over an obstructed vein, no spontaneous signal will be detected. If the probe is over a patent vein but distal to an obstruction, the signal may be absent or reduced and isoechocontinuous, showing lilttle respiratory variation.

- Although augmentation may be observed with partial venous occlusion, astrogen response is usually not seen with complete venous occlusion. A weak response suggests partial thrombus or complete occlusion with venous return via collaterals.
- Little or no increase in flow will be detected with limb compression when the probe is positioned cephalad to an obstruction, although the spontaneous flow pattern may closely resemble that found in normal limbs.
- Non-occlusive mural thrombus has a single eccentric flow lumen.
- When the normal phasic pattern is absent in a vein it is called continuous flow. This flow pattern indicates substantial obstruction proximal to distal in the site of thrombus. Doppler examination. The phasic pattern may persist when thrombus does not substantially obstruct the vein lumen and therefore identification of a phasic flow pattern does not exclude thrombosis.

c. Valsalva Maneuver: This technique is used to verify indirectly the patency of deep venous system in the abdomenand pelvis.

In normal iliofemoral venous system, the diameter of the CFV increases in response to the Valsalva maneuver or during coughing. The maneuver is inefficient. This criteria does not apply to DVT distal to the CFV. The sensitivity and specificity of this criterion are 93% and 100% respectively.

d. Collateralisation: Periarterial and intramuscular collateral venous channels enlarge rapidly during the acute phase of venous thrombosis and these channels are often visible during Doppler USG examination. These suggest the presence of collaterals:
1. A vein located 1 cm or so away from the artery is almost surely a collateral. Normally major deep veins immediately adjacent to the artery are same name.
2. Tracing the vein inferiorly or distally. Major deep veins are straight and adherent to well-defined anatomic pathways, while collaterals are usually circuous and difficult to follow.
3. Collaterals being quite superficial are obliterated by minimal compression of the skin.
CHRONIC THROMBOSIS:
1) **Increased echogenicity:** The thrombus gradually becomes more echogenic. Heterogeneity observed during clot and recanalization may be caused by clot fragmentation or penetration by capillaries. Visualization of an echogenic band in the CFV, PV or both is considered to be a highly sensitive criterion for proximal vein thrombosis and has a sensitivity of 99% and specificity of 52%.

2) **Incomplete compression:** This is due to intimal thickening in a recanalized vein or less commonly persistent venous occlusion by organized thrombus. In the former circumstance, the vein is seen to compress but not obliterate. How ever the vein wall does not coapt as a result of the interposed intima.

3) **Decreased thrombus size:** Detraction and lysis may reduce the size of the thrombus, as seen on serial examinations. Clot is more rigid on examination and may demonstrate irregular borders.

4) **Reduced vein size:** With retraction and lysis, the thrombus becomes less distended and may demonstrate irregular borders.

5) **Adherence of thrombus:** Free floating acute thrombus becomes attached to the vein wall.

6) **Resumption of flow:** With traction and lysis, the thrombus is squeeze out of the vein and may have an eccentric flow channel filled with color signal.

7) **Collateral vessels:** These tend to be larger than during the acute phase. However, not all thrombosed vessels recanalize. Some remain sp emantically occluded.

**PITFALLS IN THE DIAGNOSIS OF DVT:**
The following pitfalls can occur while performing the lower limb doppler and caution must be exercised while interpreting the results. Careful and meticulous scanning is required to avoid these and obtain a good quality image.

1) **Due to suboptimal image quality:** This results in diagnostic error. Though venous patency can be confirmed grossly, small and nonocclusive thrombus cannot be clotted.

2) **Compression difficulties:** They are encountered for iliac veins due to restriction from overlying abdominal contents. The adductor segment of the CFV and in many patients the proximal calf veins are difficult to compress due to resistance from overlying muscle. Voluntary and involuntary muscle contraction may also limit the compression. This may lead to false positive diagnosis of DVT. Color Doppler imaging is useful to assess such areas.

3) **Mistaken identity:** This may lead to serious diagnostic errors. Usually occurs in the presence of venous occlusion, when large collateralism mistaken for an occluded vein.

4) **Assessment of thrombus age:** Fresh thrombus is anechoic to hypoechoic while chronic thrombus is strongly echogenic. Between these extremes, the age of the thrombus cannot be determined with certainty.

5) **Improper use of color Doppler image:** Color blooming occurs if the sensitivity or gain levels of the Doppler image are set too high, causing the flow information to bleed into the B-mode image. This may also obscure small to medium sized thrombi. False positive diagnosis of thrombus may occur if spurious flow voids are generated by an improper gain setting, an inadequate Doppler angle or use of wrong velocity range.

**II. MATERIALS AND METHODS**

**Source of data:** The present study is carried out on patients with clinical suspicion of deep venous thrombosis referred to the Department of Radiodiagnosis, Osmania Medical College, from January 2021 to January 2022. The study design is randomised cross sectional study. The sample size is 80.

**Inclusion criteria:**
- Clinically suspected cases of deep venous thrombosis
- Patients who are at risk of DVT.

**Exclusion criteria:**
- Paediatric cases
• Neoplastic conditions.

Methods:
In all patients, the following protocol was followed:
• Detailed clinical history was elicited with reference to onset, duration and progress of the symptoms and special reference to risk factors and any evidence suggestive of pulmonary embolism.
• Patients with the following symptoms were included in the study:
  - Pain in the lower limb particularly located to the calf (unilateral or bilateral).
  - Edema of lower limb (unilateral or bilateral).
  - Pain and edema combined.
  - Prior history of deep vein thrombosis.
  - Shortness of breath (rule out pulmonary embolism).

Standard examination would evaluate common femoral vein and superficial femoral vein first, followed by popliteal and calf veins. External iliac veins and IVC were evaluated last. The patient was examined in a supine position with the legs abducted and extremely rotated with slight flexion of knees. Evaluation of femoral venous segment. Patient was given a prone position for evaluation of popliteal vein. Calf veins were evaluated in supine position and the knee slightly flexed, internally rotated for the anterior tibial veins and externally rotated for the posterior tibial and peroneal veins. 7.5 MHz linear array transducer was used for femoral and popliteal venous segments and calf veins. While 3.5 MHz convex transducer was used for evaluation of the iliopopliteal segment.

The Doppler report described presence or absence of deep vein thrombosis, location, extent, nature (acute or chronic) and complications, if any.

Machine details:
GE LOGIQ F8 AND LOGIQ P5.
• Image storage: Hard disc
• Type of transducer: Linear array
• Frequency of transducer: 3.5 MHz, 7.5 MHz

All patients included in the study were evaluated by the above-mentioned colour Doppler ultrasound machine.

III. OBSERVATION AND RESULTS

<table>
<thead>
<tr>
<th>TABLE 1: AGE DISTRIBUTION</th>
</tr>
</thead>
</table>

A study of 80 patients with symptoms of lower extremities were included in this study. Following observations were made:

<table>
<thead>
<tr>
<th>Age group (in years)</th>
<th>Cases with suspected DVT (n=80)</th>
<th>Cases with evidence of DVT (n=62)</th>
<th>Rate of evidence of DVT against suspected (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No.</td>
<td>Percentage</td>
<td>No.</td>
</tr>
<tr>
<td>21–30</td>
<td>12</td>
<td>15</td>
<td>10</td>
</tr>
<tr>
<td>31–40</td>
<td>22</td>
<td>27.5</td>
<td>20</td>
</tr>
<tr>
<td>41–50</td>
<td>12</td>
<td>15</td>
<td>8</td>
</tr>
<tr>
<td>51–60</td>
<td>24</td>
<td>30</td>
<td>18</td>
</tr>
<tr>
<td>61–70</td>
<td>6</td>
<td>7.5</td>
<td>4</td>
</tr>
<tr>
<td>71–80</td>
<td>4</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>80</td>
<td>100</td>
<td>62</td>
</tr>
</tbody>
</table>

Age of patients ranged from 21 to 79 yrs. 57.5% patients were older than 40 yrs of age. The mean age of cases suspected to have DVT being 48.7 yrs and mean age of cases how to have DVT being 46.25 yrs.
Male predominance was found in our study. Of 80 patients, 56 (70%) were males and 24 (30%) were females.

<table>
<thead>
<tr>
<th>Sex</th>
<th>Cases with suspected DVT (n=80)</th>
<th>Cases shown evidence of DVT (n=62)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No.</td>
<td>Percentage</td>
</tr>
<tr>
<td>Male</td>
<td>56</td>
<td>70</td>
</tr>
<tr>
<td>Female</td>
<td>24</td>
<td>30</td>
</tr>
<tr>
<td>Total</td>
<td>80</td>
<td>100</td>
</tr>
</tbody>
</table>

TABLE 2: SEX DISTRIBUTION
TABLE 3: DISTRIBUTION OF CASES BY SIGNS AND SYMPTOMS (MULTIPLE RESPONSE)

<table>
<thead>
<tr>
<th>Symptoms</th>
<th>Cases with suspected DVT (n = 80)</th>
<th>%</th>
<th>Cases shown evidence of DVT (n = 62)</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pain</td>
<td>16</td>
<td>20</td>
<td>12</td>
<td>19.35</td>
</tr>
<tr>
<td>Edema</td>
<td>32</td>
<td>40</td>
<td>28</td>
<td>45.16</td>
</tr>
<tr>
<td>Pain and edema</td>
<td>20</td>
<td>25</td>
<td>16</td>
<td>25.80</td>
</tr>
<tr>
<td>Pulmonary embolism</td>
<td>6</td>
<td>7.5</td>
<td>4</td>
<td>6.45</td>
</tr>
<tr>
<td>Asymptomatic</td>
<td>6</td>
<td>7.5</td>
<td>2</td>
<td>3.2</td>
</tr>
</tbody>
</table>

Thus, edema (40%) was the most common presenting symptom in patients who were diagnosed as DVT on colour Doppler, followed by pain (20%) as the second most common presenting symptom in our study.
TABLE – 4: CLINICAL CONDITIONS IN STUDY POPULATION FOR DOPPLER ULTRASOUND EXAMINATION FOR SUSPECTED DVT

<table>
<thead>
<tr>
<th>Clinical conditions</th>
<th>Cases with suspected DVT(n=80)</th>
<th>Cases shown evidence of DVT(n=62)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No.</td>
<td>Percentage</td>
</tr>
<tr>
<td>Prolonged hospitalization</td>
<td>24</td>
<td>30</td>
</tr>
<tr>
<td>Post-operative</td>
<td>6</td>
<td>7.5</td>
</tr>
<tr>
<td>Trauma</td>
<td>6</td>
<td>7.5</td>
</tr>
<tr>
<td>OC pill users</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Dialysis</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Others (Snake bite)</td>
<td>2</td>
<td>2.5</td>
</tr>
<tr>
<td>No known predisposing condition</td>
<td>34</td>
<td>42.5</td>
</tr>
</tbody>
</table>

In our study it was found that prolonged hospitalization (30%) was the most common predisposing factor, followed by post-operative (7.5%) and trauma (7.5%). However, in 42.5% of patients with deep venous thrombosis, no predisposing factor was found.
<table>
<thead>
<tr>
<th>Clinical conditions</th>
<th>Cases with suspected DVT (n=80)</th>
<th>Cases shown evidence of DVT (n=62)</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prolonged hospitalization</td>
<td>30</td>
<td>42.5</td>
<td>38.7</td>
</tr>
<tr>
<td>Post-operative</td>
<td>29.03</td>
<td>2.5</td>
<td>3.22</td>
</tr>
<tr>
<td>Trauma</td>
<td>7.5</td>
<td>7.5</td>
<td>9.67</td>
</tr>
<tr>
<td>CC pill users</td>
<td>9.67</td>
<td>6.45</td>
<td>6.45</td>
</tr>
<tr>
<td>Dialysis</td>
<td>6.45</td>
<td>6.45</td>
<td></td>
</tr>
<tr>
<td>Others</td>
<td>6.45</td>
<td>6.45</td>
<td></td>
</tr>
<tr>
<td>(Shake bite)</td>
<td>2.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No known precipitating condition</td>
<td>2.5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**TABLE – 5 : TYPE OF INVOLVEMENT IN STUDY POPULATION EVIDENCE OF DVT ON DOPPLER ULTRA-SONOGRAPHY**

<table>
<thead>
<tr>
<th></th>
<th>No. of cases</th>
<th>% of cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unilateral</td>
<td>60</td>
<td>96.77</td>
</tr>
<tr>
<td>Bilateral</td>
<td>2</td>
<td>3.23</td>
</tr>
<tr>
<td>Total</td>
<td>62</td>
<td>100</td>
</tr>
</tbody>
</table>
Our study showed unilateral limb predominance (96.77%).

<table>
<thead>
<tr>
<th>TABLE 6: DISTRIBUTION OF THROMBI IN RIGHT AND LEFT LIMB IN STUDY POPULATION WITH EVIDENCE OF DVT ON DOPPLER ULTRASONOGRAPHY</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of extremities involved</td>
</tr>
<tr>
<td>Right lower extremity</td>
</tr>
<tr>
<td>Left lower extremity</td>
</tr>
</tbody>
</table>

Two cases showing bilateral involvement, total number of extremities showing evidence of thrombosis are 64. Left lower extremity predominance was noted in our study.
TABLE 7: ANATOMIC DISTRIBUTION OF THROMBI IN STUDY POPULATION WITH EVIDENCE OF DVT ON DOPPLER USG

<table>
<thead>
<tr>
<th></th>
<th>CFV</th>
<th>SFV</th>
<th>PV</th>
<th>PT</th>
<th>AT</th>
<th>PER</th>
<th>CIV</th>
<th>EIV</th>
<th>SVS</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of cases</td>
<td>18</td>
<td>26</td>
<td>23</td>
<td>20</td>
<td>14</td>
<td>12</td>
<td>3</td>
<td>8</td>
<td>4</td>
</tr>
<tr>
<td>Percentage of cases showing involvement</td>
<td>58.06</td>
<td>83.87</td>
<td>74.19</td>
<td>64.51</td>
<td>45.16</td>
<td>38.70</td>
<td>9.67</td>
<td>25.80</td>
<td>12.90</td>
</tr>
</tbody>
</table>

Predominant distribution of thrombi was seen in SFV (83.87%) followed by popliteal vein (74.19%) and calf veins (posterior tibial vein—74.19%). Thus thrombus involvement is more common in proximal segments (femoropopliteal) than in distal segments (calf veins).
TABLE – 8 : STAGE OF INVOLVEMENT IN STUDY POPULATION WITH EVIDENCE OF DVT ON DOPPLER ULTRASONOGRAPHY

<table>
<thead>
<tr>
<th>Nos. of cases</th>
<th>Percentage of cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute</td>
<td>36</td>
</tr>
<tr>
<td>Chronic</td>
<td>26</td>
</tr>
<tr>
<td>Total</td>
<td>62</td>
</tr>
</tbody>
</table>

In our study acute thrombosis (58.06%) predominance was noted.
Fig.2: Transverse image of the common femoral vein thrombosis: showing echogenic thrombus (chronic) in the common femoral vein.

Fig.3: Longitudinal image of the CFV, SFV and DFV thrombosis: showing absence of colour flow in the common femoral vein, superficial femoral and deep femoral veins suggestive of thrombosis.
Fig. 4: Transverse image of the common femoral vein thrombosis: showing lack of compressibility of common femoral vein with increased venous diameter and absence of spontaneous colour flows suggestive of thrombosis.

Fig. 5: Longitudinal image of popliteal fossa showing popliteal vein thrombosis evidence of absence of colour flow noted in the popliteal vein.
Fig.6: Transverse image of chronic popliteal vein thrombosis: showing dilated popliteal vein with partial filling of colour suggestive of thrombosis with partial recanalization

IV. DISCUSSION

The diagnosis of deep vein thrombosis has always been difficult. The myriad of signs and symptoms that can be associated with DVT and the fact that many thrombi are asymptomatic, make it exceedingly difficult to rely on the clinical presentation. The management of patients with clinical diagnosis of DVT in the lower extremity needs to identify the presence of thrombus, its nature, location and extent. The present study was performed with the objective of assessing the role of colour Doppler USG in the diagnosis of DVT of lower extremity. It included detection and assessment of spectrum of findings of DVT by using colour Doppler ultrasonography. We studied the colour flow findings in patients who presented with pain, edema or both of the lower extremities, pulmonary embolism and prior history of DVT. Our technique involves a complete survey of all major deep veins and superficial veins of the lower limb. Amongst the total 80 cases studied for suspected DVT of lower limbs, 62 cases showed the presence of thrombus. In 18 patients, although there was clinical suspicion of DVT of lower limbs, the colour Doppler study was negative for DVT.

Age:
The range of age of patients with suspected DVT in our study was 21-80 years, with a mean age of cases suspected to have DVT being 48.7 years and mean age of cases shown to have DVT being 46.25 years.

Sex:
Males contribute a major group (70%) in our study of cases with suspected DVT and they also have a higher incidence (74.19%) of positive Doppler study. In the present study, of the cases with suspected DVT, 24 (30%) are females, with 16 (25.80%) showing evidence of DVT.

The symptoms that prompted Doppler examination were pain in 16 patients (20%), edema in 32 (40%), pain and edema in 20 (25%), symptoms of pulmonary embolism in 6 (7.5%), prior history of DVT in 10 (12.5%) and 6 (7.5%) patients were asymptomatic.

In cases showing evidence of DVT, 12 (19.35%) had pain as presenting symptom, 28 (45.16%) had edema, 16 (25.80%) had pain and edema, 4 (6.45%) had symptoms of pulmonary embolism, 10 (16.12%) had prior history of DVT while 2 (3.2%) were asymptomatic. Amongst the patients showing evidence of DVT, the common symptom suggestive of DVT was edema. In the present study only one case with bilateral pain and edema showed evidence of thrombosis.

Colour Doppler USG was advised to rule out DVT of lower limbs as the source of pulmonary embolism in 6 cases. This is based on the concept that majority of pulmonary embolism originate in lower extremity veins. Amongst the 6 patients with suspected pulmonary embolism, colour Doppler USG revealed DVT in only 4 cases who had left-sided calf tenderness on clinical examination.

Clinical condition that prompted for colour Doppler
In the present study, 24 cases (30%) with suspected DVT were bedridden (prolonged hospitalization). 6 (7.5%) were post-operative, 6 (7.5%) had history of recent trauma, 4 (5%) were OC pill users, 4 (5%) were dialysis patients and 2 (2.5%) was patient with snake bite. In cases showing evidence of thrombosis on colour Doppler USG: 18 (29.03%) were bedridden (prolonged hospitalization), 6 (9.67%) were post-operative, 6 (9.67%) had history of trauma, 4 (6.45%) were OC pill users, 4 (6.45%) was dialysis patient and 2 (3.23%) was patient with snakebite.

**Type of involvement:**
In the present study, 60 cases showed unilateral involvement, 58 cases with unilateral symptoms showed involvement of the same symptomatic limb while 2 cases with unilateral involvement had bilateral symptoms. 2 cases (3.23%) with bilateral involvement was asymptomatic. In 77.41% of cases with evidence of DVT on colour Doppler USG the thrombus was localised to left limb, while in 25.80% of cases, thrombosis was localised to right limb.

**Localisation and extent of thrombosis:**
Colour Doppler USG helps in exact localisation of the thrombus. The distribution of thrombi in present study is 9.67% in common iliac vein, 25.80% in external iliac vein, 58.06% in the CFV, 83.87% in SFV, 74.19% in the popliteal vein, 64.51% in posterior tibial vein, 45.16% in anterior tibial vein, 38.70% in peroneal vein and 12.9% in the superficial veins. All the 61 cases in our study with evidence of thrombus on colour Doppler USG were showing both proximal and distal extension i.e. into common iliac vein and common femoral vein. Identifying the thrombus in proximal veins of lower extremity is important for the pose greater risk in terms of both embolism and local residual changes. Calf vein thrombi often resolve spontaneously and do not result in embolism. So they are considered clinically insignificant. The presence of faboveknee DVT greatly increases the risk for pulmonary embolism and eventual post-phlebitic syndrome.

CFV demonstrated thrombosis in 18 cases (58.06%), SFV in 26 (83.87%), CIV in 6 (19.35%) and EIV in 9 (29.03%) cases.

In our study, DVT isolated to SFV was seen in two patients (3.23%) and DVT isolated to popliteal vein was seen in another two patients (3.23%). Hence we conclude that complete colour Doppler examination should be done in all symptomatic patients, in order to reduce examination time and also to avoid missing the thrombus isolated to single vein.

**Acute vs chronic:**
Acute thrombosis was found in 36 (58.06%) and chronic in 22 (41.94%). This finding was roughly correlated with the study by Grosser et al 1990. They found that cases of older thrombolytic and colour Doppler of which finding was confirmed phlebographically in 4 cases. In the study, the positivity rate for acute DVT is 45% (36 cases amongst 80 suspected cases of DVT). This is higher than that in the study by Hill et al (1997) who determined the positivity rate of 17.4% for acute DVT in symptomatic patients.

**Pattern of involvement:** The four different types of thrombosis according to anatomical segments and patterns are:
1. Isolated thrombus confined to one venous segment.
2. Thrombi extending across two contiguous segments.
3. Thrombi in multiple different non-contiguous locations in non-extremity.

In the present study, 6.45% were isolated thrombi confined to one segment, 93.55% were multiple contiguous thrombi. There is not a single case showing multiple non-contiguous involvement. The pattern of involvement which constituted the major group in our study is one with multiple contiguous involvement of venous segments in single extremity. It is found that the age of patients with contiguous thrombosis or bilateral thrombosis was greater than the age of patients with isolated thrombosis.

**Venous distension:**
The criterion included in the diagnosis of acute thrombosis was increased venous diameter which was found in all 36 cases of acute thrombosis. This correlated with the study by van Gemmeren et al 1991 who had found a significant correlation between age of thrombosis and the venous diameter (P<0.001). In 13 cases with chronic thrombosis, 11 had normal dimension while 2 had diameter less than adjacent artery.

**Loss of compressibility:**
Compressibility of veins was lost in all 62 cases (acute and chronic) with DVT. In 20 cases with incomplete thrombosis, involved veins were not completely compressible. In one case with...
suspected DVT and prior history of DVT, the femoral venous segment in the region of adductor canal was not compressible. The diagnosis of DVT in this segment was excluded on demonstrating normal colour flow signal. This is in correlation with the study by Wright DJ et al in 1990. If the disease is suspected, it is difficult to demonstrate the compressibility of the vein due to thick muscular structure as an adductor canal.

**Free floating thrombus**: In present study, two cases with acute DVT showed free floating proximal endof thrombus. Norris C et al in 1985 found 5 cases out of 78 (6%) with free floating thrombi on venography. Presence of signal void even on augmentation was considered as a criterion for DVT which was found in 14 cases with complete thrombosis. Eccentric flow was demonstrated in 20 patients with partial thrombosis. The color Doppler flow imaging diagnosis based primarily on the presence of a focal void within the colour encoded blood flow or the absence of visible flow within a segment of a vessel, correlated with the study by Rose SC et al in 1990. In 6 patients with acute DVT collateral vessels were demonstrated while in 10 patients with chronic DVT collaterals and increased flow through saphenous veins was noted. This correlated with the study by Persson AV et al in 1990, who found an increase in the size and flow in collateral veins, in the majority of patients with acute deep venous thrombosis. All the 6 cases with CIV involvement and 16 cases with EIV involvement showed contiguous involvement of femoral venous system.

**Conditions mimicking DVT**: 18 cases (22.5%) in the study population demonstrated clinical conditions mimicking DVT. 2 showed presence of Baker's cyst of the calf, 2 had ruptured Baker's cyst, clinical presentation with pain and marked swelling of the calf, clinically indistinguishable from DVT. 4 cases showed evidence of cellulitis with subcutaneous swelling. Inflamed bursa was found in 4 cases as the cause of pain in patients with suspected DVT of which one was associated with fasciitis. Additional findings of intramuscular haematoma were found in 4 patients who also had Doppler evidence of partially recanalized thrombus in the distal SFV. Probably it might have been contributed to the presenting symptom of pain in these cases.

**V. CONCLUSION**
The clinical diagnosis of DVT is erroneous in approximately half of the cases in which the disease is suspected. If diagnostic accuracy is to be improved and the appropriate therapy instituted, an objective technique is necessary. Doppler USG is a non-invasive, accurate, easily repeatable, widely available and relatively sensitive technique in the diagnosis of lower extremity deep vein thrombosis and also helps in providing valuable information of therapeutic significance and risk of pulmonary embolism.

**REFERENCES**

[20]. Anand S.S et al. Does this patient have deep vein thrombosis. JAMA 1998; 279; 1094-1099