Value of 2d High Frequency Ultrasonography in Determining the Causes of Acute Lower Limb Pain

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Abstract: Background: Acute lower limb pain represents one of the most common presentations at emergency department and rheumatology outpatient clinic, its accurate diagnosis is needed for rapid and proper treatment. The availability of 2D high frequency US machines should help in its diagnosis. **Aim of the work:** 1) Clearing up of most common causes that lead to acute lower limb pain, Assess the role and accuracy of 2D high frequency US in diagnosis of acute limb pain with absence of color flow Doppler (CFD) units at the emergency department (ED) and rheumatology outpatient clinics 3) Applying a diagnostic protocol for acute limb pain including physical examination, D high frequency US. **Subjects:** 200 patients were presented by acute lower limb pain at emergency department and/or rheumatology outpatient clinic of Sohag University Hospital. **Methods:** Patients were examined clinically and by B-mode 2D high frequency U/S unit. **Results:** 40 patients had thrombosed veins, had acute ischemia, had cellullitis, had acute leg hematoma, had ruptured Baker's cyst, had leg abscess, had acute tenosynovitis of peroneii and tibialis posterior tendons, had knee arthritis and injuries, had ankle joint arthritis, and one case had tennis leg. **Conclusions;** 2D high frequency US can replace CFD in rapid assessment of most cases presented by acute lower limb pain and save time for the physician in decision making.
[Saad Rezk Abdul Wahed, Mohamed Ali Ismail and Esam M. Abu-Al Fadl. **Value of 2d High Frequency Ultrasonography in Determining the Causes of Acute Lower Limb Pain.** *J Am Sci* 2014;10(3):29-34]. (ISSN: 1545-1003). http://www.jofamericanscience.org. 4

Key Words: Lower limb, Ultrasound, Color flow Doppler, Deep venous thrombosis, Musclo-skletal US.

1.Introduction:

Acute LL pain represents a common presentation at the Emergency and Rheumatology Departments. Its proper evaluation is crucial, and faulty diagnosis is serious specifically with acute ischemia and DVT, acute gouty arthritis, ruptured Baker's cyst, acute knee or ankle arthritis, or acute neuropathic pain. CFD is considered the primary noninvasive diagnostic method for DVT. It is considered as primary investigatory module for venous diseases according to the standards of the Inter-societal Commission for the Accreditation of Vascular Laboratories (ICAVL) (1).

However CFD units are expensive ones and usually unavailable at ED and primary health care units. In addition, expert radiologists will not be available along whole 24 hours of the day. B-mode US units can be used easily instead of CFD units (1).

In this study, we aim to highlight the causes of acute LL pain and how to diagnose them by B-mode US units.

2. Material and Methods

The study was carried out on 200 patients presented by acute lower limb pain for duration of 18 months from January 2012 to June 2013. All patients referred to ED and rheumatology outpatient clinic, Sohag University Hospitals, by acute lower limb pain were admitted & included in the study after taking informed consent.

Patients with previous history of DVT in the same limb and those who had investigations with proved diagnosis were excluded from the study. All patients were subjected to full clinical examination by vascular surgeon and rheumatologist to assess the suspected cause of acute limb pain with special concern to critical vascular or rheumatological problems as acute ischemia & DVT or other causes regarding musculoskeletal & neurological problems.

Immediately after clinical assessment, all patients were examined by 2D high frequency U/S. Those patients were referred to radiology department to the second check US then by CFD by senior radiologist. CFD results were taken as the Gold standard method of examination and finally these results were compared. Blood samples for D-diamer were taken from some patients with clinically suspected DVT and unclear radiological diagnosis. U/S was performed by Logiq 100 machine, GE medical systems with Linear (5-15 MHZ) and convex (3-12 MHZ) probes. CFD U/S was performed by sono line versa plus machine, Siemens medical systems, Erlangen, Germany.

Other investigations as abdominal and pelvic US with attention to IVC, iliac vessels, enlarged lymph nodes, pelvi-abdominal masses might be needed.

The aim of 2D high frequency US was to assess venous system for DVT , superficial thrombophelibitis, complicated varicose veins,

assessment of arterial system for thrombosis, emboli, complicated aneurysms, assessment of knee joint for effusion, gouty arthritis and Baker's cyst, assessment of ankle joint for tenosynovitis and gouty arthritis, assessment of leg muscles for contusions and intermuscular hematoma, assessment of leg edema, inguinal lymph nodes, associated abscesses, assessment of bony structures for cortical fractures, osteomyelitis, erosions and masses.

3. Results

The study included 200 patients, 102 males and 98 females. Their ages ranged from 18 to 67 years old with mean age 46±5.

Knee arthritis and injuries was the most common cause of acute lower limb pain, accounting for about one quadrant of all cases (49 cases, 24.5%). This is followed by venous thrombosis cases (40 cases, 20%), then cellulitis (22 cases, 11%), hematoma (19 cases, 9.5%), ruptured Baker's cyst (18 cases, 9%), ankle arthritis (17 cases, 8.5%), tenosynovitis and acute ischemia (14 cases, 7% each), leg abscess (6 cases, 3%) and lastly one case (0.5%) with tennis elbow (Table 1). Among the cases of knee affection, degenerative osteoarthritis accounted for two thirds of the cases (33/49), followed by internal derangement (10/49) and lastly gouty arthritis (6/49) (Table 2). Ankle arthritis were mostly gouty (11/17) but degenerative arthritis also was present in 6 cases (Table 3). All cases were diagnosed by US, except 13 case out of the 40 cases of venous thrombosis, who were only diagnosed by CFD.

Table (1):- Results of acute limb pain

No.	Diagnosis	No. of cases	%
I	Venous thrombosis	40	20
II	Acute Ischemia	14	7
III	Cellullitis	22	11
IV	Hematoma	19	9.5
V	Ruptured Baker cyst	18	9
VI	Leg abscess	6	3
VII	Tenosynovitis	14	7
VIII	Knee arthritis and Injury	49	24.5
IX	Ankle arthritis	17	8.5
X	Tennis leg	1	0.5

Table (2):- Knee Injury

No.	Diagnosis	No. of cases	%
I	Degenerative (Osteoarthritis)	33	67.4
II	Gouty arthritis	6	12.2
III	Internal Derangement	10	20.4

Table (3):- Ankle Arthritis

No.	Diagnosis	No. of cases	%
I	Degenerative (Osteoarthritis)	6	35.3
II	Gouty Arthritis	11	64.7

4. Discussion

Acute LL pain is one of the most common complaints presented at Emergency and Rheumatology Departments. Its diagnosis is important for early and proper treatment. With lack of CFD units and CFD machine specialists at ED or rheumatology outpatient clinic, primary health care units, it is mandatory to use simple 2D high frequency US machines to deal with these cases.

US is increasing in use at ED and Rheumatology practice because it allows detailed anatomical evaluation of blood vessels, lymphatics, joints and surrounding soft tissues. It is safe, portable, and inexpensive in comparison with computed tomography (CT) and magnetic resonance imaging (MRI) scanning and can be performed rapidly (1).

Acute LL pain were related to vascular, musculoskeletal, inflammatory, neurological affection, trauma or others.

The most common vascular causes included DVT and acute ischemia. The most common musculoskeletal causes included acute gouty arthritis, internal derangement, osteoarthritis, ruptured Baker's cyst and acute tenosynovitis.

Venous thrombosis; affected deep or superficial veins. The affected deep veins were small sized venules, infra-popliteal veins, popliteal, femoral or iliac veins. The superficial venous thrombosis were thrombosed great saphenous or short saphenous veins. The major deep and superficial veins were assessed easily by B mode US machines (1). The classical clinical picture of deep venous thrombosis included pain, tenderness, swelling, warmth, redness and distention of superficial veins.

Clinical manifestations of DVT were unreliable. If clinical signs alone were used to diagnose DVT, 42% of patients would receive unnecessary anticoagulation therapy. Because of its high sensitivity (95%) and specificity (100%), particularly proximal to the knee. US was the best initial test to detect DVT. By US, the normal vein was compressible, had thin wall and sonolucent lumen. With deep venous thrombosis, the lack of compressibility and presence of echo genic thrombus were sufficient for its diagnosis (2).

In our study, the second most common cause of acute LL pain was venous thrombosis which presents 20 % of all cases (40 cases). 27/40 patients were diagnosed by 2D high frequency US. Of these 27 cases, 15 had ileo-femoral DVT, 8 had popliteal DVT and 4 had great or short saphenous vein thrombosis. The remaining 13 cases could only be diagnosed by CFD and all of them had infra-popliteal DVT.

Acute LL ischemia; it was usually diagnosed clinically by pallor, coldness, pulseless, painful limb, paraesthetic feeling and paralysis. 2D high frequency

US provided valuable data about arterial tree. B-mode US detected arteriosclerosis, athermatous plaques, absence arterial pulsations, emboli, thrombi, and might visualize uncommon pathology e.g. thrombosed aneurysms. With arteriosclerosis; thickened arterial wall, irregular intima, and arterial wall calcifications were seen clearly by B-mode US. The athennatous plaques were detected specifically if calcified. B- mode US assessed its size, extent, surface and % of stenosis. However, it could not assess % of luminal patency, specifically, with large sized calcified plaques (3).

The embolus appeared as echo genic focus that might be or not associated with thrombus. It usually showed to and fro movements with each cardiac cycle. The emboli were usually impacted at common femoral bifurcation, distal superficial femoral artery at level of adductor canal or at popliteal bifurcation. The distal arterial tree was thrombosed or patent. If patent, it was collapsed and showed easily compressibility like that of adjacent vein. The patients usually had cardiac arrhythmias or history of valvular heart disease (3).

In our study, 14 cases had acute lower limb ischemia (7 cases had arterial emboli, 5 had arterial thrombosis and 2 cases had infra-popliteal thrombosis), and all of them were diagnosed by US.

Cellulitis; is a spreading inflammatory reaction occurring along subcutaneous and fascial planes with edema and hyperemia. Cellulitis is probably the most common form of musculoskeletal infection encountered in hospital practice. It usually results from a *Streptococcus pyogenes* or *Staphylococcus aureus* infection. The ultrasound appearance of cellulitis varies depending on the stage and severity. The initial appearance may be generalized swelling and increased echogenicity of the skin and subcutaneous tissues. As cellulitis progresses and the amount of subcutaneous fluid increases, hyperechoic fat lobules become separated by hypoechoic fluid-filled areas. This later stage of cellulitis is most typical and has been described as having a cobblestone appearance (4). US can be helpful to detect occult abscesses that necessitated drainage procedures. This can support the use of ultrasound in the evaluation of most patients with cellulitis (5).

In our study, 22 cases had cellullitis. 7 cases had diabetes mellitus, 5 cases had liver cirrhosis, 6 cases received chemotherapy for different types of malignancy and 4 cases had no concomitant disease. All cases had manifestations of cellulitis as hotness, redness, tenderness, edematous leg with enlarged inguinal lymph nodes. They responded well to medical treatment.

Leg collections; were related to hematoma, ruptured Baker's cyst or abscess formation. B-mode US detected the collection easily, however, it could not differentiate between different types of fluids. The distinction between them required diagnostic aspiration. US helped to determine the centre of collection to guide the needle through it. Aspiration were made for all contents as a therapeutic tool or just a sample to be sent for laboratory assessment (6).

Tennis leg; means complete or partial rupture of the fibers of the musculotendinous junction of the medial head of the gastrocnemius muscle. It is one of the most common muscle injuries that occur with running by hyperextension of the knee and forced dorsiflexion of the ankle. It causes acute leg swelling and tenderness with significant functional impairment, but usually resolves after few weeks with a low recurrence rate. US allows for rapid confirmation of the clinical diagnosis and exclusion of other diseases. Partial muscle tears are seen on US as either small (< 2 cm), heterogeneous, echogenic areas or focal hypo echoic change within the muscle fibers, whereas complete tears are larger and are often associated with a hypoechoic hematoma. When a large hematoma or fluid collection is present, US guided drainage may produce rapid relief of symptoms and restoration of function. Tennis leg was found to be associated with DVT in 10% of patients (7). In our study, we diagnosed one case of tennis leg.

In our study, 19 cases had **leg hematoma**. Hematomas were liquefied or organized. The liquefied hematoma appeared as hypo echoic fluid collection and was completely aspirated under US guidance. The organized hematoma had mixed hypoechoic and hyperechoic contents with difficult complete aspiration that required surgical evacuation.

Baker cysts are the most common cystic lesions seen around the knee. It represents enlargement of the gastrocnemio-semimembranosus bursa. Baker cysts are usually secondary to degenerative changes of the knee, but they can result from meniscal rupture, pigmented villonodular synovitis, chronic infectious processes, and inflammatory arthritis especially rheumatoid arthritis. The medial gastrocnemius-semimembranosus bursa communicates with the knee joint in more than 50% of patients older than 50 years. In a study by Langsfeld *et al.,* who used US to rule out DVT, Baker cysts were found in 3% (8).

Asymptomatic popliteal cysts are considered an incidental finding. Symptoms usually arise from growth, leak or rupture of the cyst. Dissection of the calf musculature causes pain and edema, symptoms that can simulate DVT. Musculoskeletall ultrasound (MSUS) is the preferred investigation as it is inexpensive, sensitive, and widely available (9).

Our study included 18 cases had ruptured Baker's cysts. They were presented by acute swollen limb with diffuse edema. 2D high frequency US

properly detected the collection between gastrocnemius and soleus muscles that had extension toward the popliteal fossa. US guided aspiration was performed for all cases, followed by tight bandage with high success rate. Aspiration relieved the pain rapidly and bandage prevented its re-accumulation in 16 out of the 18 cases (88.9%).

Tenosynovitis; the normal tendons on US had a fibrillar pattern on longitudinal scan and a punctate pattern with hypo echoic rims around, representing the synovial sheath, and a small content of fluid (thickness of the surrounding halo < 2mm), in transverse scan. Synovitis was visualized as an anechoic or hypoechoic intracapsular material represented by two components: effusion and synovial hypertrophy (10).

In our study, we detected 14 cases with tenosynovitis involving the peroneii tendons (7 cases), tibialis posterior tendon (4 cases) and Achilles tendon (3 cases). They were presented by acute swollen ankle, after inversion/eversion trauma to the ankle. The plain X-ray films were -ve for fractures. BY US, the affected tendons appeared swollen and edematous with hyperechoic echopattern. Associated effusion was seen within their tendon sheaths which appeared as hypo echoic fluid rim > 3 mm thickness.

Knee arthritis and injury; Acute knee arthritis was presented by acute painful and swollen leg maximally around knee region that might be mistaken as DVT. Knee arthritis is mostly degenerative, but gouty arthritis may also be present. Knee injury that can cause acute lower limb pain includes internal derangement (cruciate or menischial injury).

The epidemiological study of knee osteoarthritis (OA) has had many barriers; a major problem being the definition of knee OA. The most commonly used outcome measure in studies of OA has been radiological criteria, such as those described by Kellgren and Lawrence (11). Radiographs have limitations, such as the need for low level radiation exposure and the inability to view soft tissue structures and assess inflammation (12). Inflammation has been shown to be a consistent feature of OA and has also been found to contribute to its progression (13-15). Demonstration of inflammation requires more sensitive modalities like ultrasound and magnetic resonance imaging(MRI); the inflammation can also then be quantified. Iagnocco *et al.* demonstrated a high prevalence of ultrasound defined effusions (43%) in 82 patients with knee OA in Italy and also showed a high correlation between the total ultrasound score and the Lequesne index (a validated measure of severity of knee OA) as well as the patient's global assessment of knee pain, which provides some evidence for its concurrent validity. Ultrasound has the advantage over MRI in that it is cheaper, convenient and easier to use, is dynamic and has no contra-indications to its use (16, 17).

In our study, 49 cases had acute knee arthritis or injury, and this was the most common cause of acute lower limb pain. By US, supra-patellar effusion and thickened synovium were noted.

Ankle arthritis; is usually associated with gout or degenerative process.

Although the best imaging method to investigate the presence of MSU crystal deposits in the early stages has not yet been established (18), ultrasound (US) has been demonstrated to be a valid imaging modality to detect musculoskeletal involvement in patients with gout (19-22).

The main US findings related to MSU crystal deposition include hyperechoic enhancement of the superficial margin of the hyaline cartilage (double contour sign) hyperechoic spots within tendons and soft tissues, tophi and bone erosions (20, 23, 24). Additionally, an increase of blood flow surrounding the MSU deposits detected by power Doppler (PD) has been described as an indicator of inflammatory activity (18, 20).

In erosive arthritides, musculoskeletal US has been shown to be a valuable imaging method to confirm early structural damage (25). Moreover, both magnetic resonance imaging and US are useful advanced imaging techniques to demonstrate occult destructive arthropathy in patients with gout and normal plain radiographs (26). However, to date, there is only a single US study demonstrating the existence of tophaceous deposits in asymptomatic hyperuricemic subjects; remarkably, that study was focused on the assessment of tendons and synovium pathology of knees and ankles (18).

17 cases had ankle arthritis were detected in our study. They had swollen ankle region. By US, diffuse synovial thickening were noted with or without effusion.

Leg abscess was found at 6 cases in our study. It was diagnosed by aspiration of pus. Pus was completely drained under US guidance in 4 cases. The other 2 cases needed open drainage due to their large sized cavities and septations. It was mandatory to seek for osteomyelitis with all cases presented by limb abscess nearby bone. Missed diagnosis might lead to re-accumulation of the abscess so clinical diagnosis alone was not sufficient.

Ultrasound examination may show features of osteomyelitis many days earlier than X-ray by visualization of juxtacortical soft-tissue swelling and periosteal thickening, then by increase of periosteal thickening and subperiosteal exudate. The sensitivity and specificity of ultrasound examination in diagnosis of osteomyelitis has not been determined. It

is not likely high as MRI or radioisotope studies as it is limited to outer cortical and juxtacortical tissues only (5).

Ultrasound gives a wide range of information that can be used as complementary data to the clinical assessment. It usually helps the rheumatologist in routine clinical practice to evaluate inflammatory and degenerative disorders as well as to adapt an appropriate treatment and monitor the therapeutic response. US allows comparison of different structures with minimal radiation exposure and assessment of lesions both in early and late disease and it can help, sometimes, in differential diagnosis among various rheumatic disorders Moreover it can assess the disease activity and severity in joints, tendons, early pathological features and evaluation of the residual pathology after therapy. Rapid diagnostic and therapeutic US guided injections for aspiration/biopsy and precise local drug deposition is another advantage of that method as well as the follow up of the treated patients with systemic and/or local therapies and after surgical procedures (27).

There are some limitations in the US evaluation of some structures because the US beam does not penetrate the bone cortex and metallic prosthesis. Also bony deformities and large calcifications stop the penetration of the US beam and limit the achievement of information. Moreover US is still considered an operator and machine dependent technique and standardization is still lacking for some issues. A huge effort has been made over the last years to prove the validity and reliability of US in the assessment of joint and tendon pathology. MSUS is a sensitive, useful method for ankle and foot area evaluation in rheumatic patients and may be considered as an integral part of the clinical assessment procedure in daily practice (28).

Recommendations

2D high frequency US training course should be essential program to all vascular residents dealing with emergency hospital patients and acute limb pain.

Conclusions: 2D high frequency US can replace CFD in rapid assessment of most cases presented by acute lower limb pain and save time for the physician in decisionmaking.

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3/1/2014