SIGNIFICANCE OF ULTRASOUND IN DIAGNOSIS OF VARIOUS MUSCULOSKELETAL DISORDER

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ABSTRACT

Introduction

Ultrasound is a safe, highly cost effective and non-invasive imaging technique without any absolute contraindication. It is also one of the most useful investigations in all medical specialities worldwide. The trend of use of ultrasound in the diagnosis and management of various musculoskeletal disorders (MSD) is tremendously rising in orthopedics practice in Nepal over the last few years.

Objectives

The study was conducted to fulfill the existing lacunae in medical literature about use and benefits of ultrasound in context of Nepal. The objective of the study was to assess the effectiveness of ultrasound in the diagnosis of MSD among patients attending orthopedic department.

Methodology

All the consecutive patients who visited department of orthopedics and received the diagnosis of MSD and had undergone ultrasonography from February 2017 to February 2019 were included in the study. The effectiveness of ultrasound was evaluated by assessing the correlation between clinical and ultrasound based diagnosis.

Result

Out of 420 patients, majorities were female (55%). Out of 6 different anatomical sites identified, maximum patients had problem around wrist and hand (31%) followed by ankle and foot (22.9%). Similarly the most common diagnosis was related to tendon pathology including tendonitis, tenosynovitis and tendinopathy (31.9%). There was statistically significant correlation between ultrasound and clinical diagnosis with P value <0.01.

Conclusion

Overuse tendon injury are common pathology around wrist and ankle that can be diagnosed by ultrasound along with many other MSD. The use of ultrasound is gradually widening in scope but has to be performed by the expert to improve the diagnostic accuracy and also to avoid misleading diagnoses. Since there is significant correlation between clinical and ultrasound based diagnosis, it can be beneficial even for young doctors for making effective diagnosis of MSD.

KEY WORDS

Ultrasound, musculoskeletal disorder

INTRODUCTION

There is increasing awareness in use of ultrasound as a diagnostic modality in combination with other imaging modalities in clinical practice and management of various musculoskeletal disorders (MSD). Ultrasound is the sound above the audible range of frequency (20 Hz to 20 KHz) and is widely used by medical professionals for diagnosis and management of various disorders in all medical specialities.[1] The use of ultrasound in the frequency range between 2 MHz and 10 MHz for diagnostic and 0.5 MHz for therapeutic purpose is universally accepted.[1] MSD is defined as pain in the musculoskeletal system including the joints, ligaments, muscles, nerves, tendon and structures that supports limb, neck and back.[2] As we all know, the significant strength of diagnostic ultrasound is its safety and relative availability, but disadvantage are the dependence on a skilled operator and the long learning curve. Diagnostic ultrasound requires sound knowledge of anatomy and operating skill among the operators for proper and accurate diagnosis of the musculoskeletal disorder. This tool in an inexperienced operator may lead to dangerously inaccurate scan results. Although the use of ultrasound in the diagnosis and management of various MSD among the orthopedic surgeon in Nepal is widely in practice, there is no available literature that could measure and justify the use and benefits of ultrasound among indigenous Nepalese population up till now, in the national and or international literature. Hence the study was conducted to establish baseline information about the benefits of use of ultrasound in the diagnosis of various MSD.

METHODOLOGY

We conducted an observational cross sectional hospital based retrospective study at department of orthopedics and department of radiology of Birat Medical College and Teaching Hospital All the consecutive patients who visited department of orthopedics and received the diagnosis of MSD and had undergone ultrasonography from February 2017 to February 2019 were included in the study. Patients with incomplete information in hospital data base were excluded from the study. Information like age, sex, ultrasound based diagnosis and clinical diagnosis were separately recorded in a separate paper for each participant and was double entered in the personal computer and kept confidential. Ultrasound based diagnosis and findings were tabulated for 6 different anatomical sites 1. Wrist and hand 2. Elbow and forearm 3. Axilla, shoulder and arm 4. Hip, inguinal region and thigh 5. Knee and leg 6. Ankle and foot. Data regarding age and gender of patient, anatomical site involved, ultrasound based diagnosis of MSD and the clinical diagnosis were collected and entered in Microsoft Excel then coded and further analysed using appropriate statistical tool- SPSS version 23.

RESULTS

In total, 420 patients were included in study with mean age of 36.05 ± 14.37 years. More than 65% of patients were youth with age ranged between 15-44 years (Table 1). More than half (55%) of the patients were female (Table 2). Out of 6 different anatomical site, highest percentage of patients were found having problem in wrist and hand (31%) followed by ankle and foot (22.9%) and elbow and forearm (20.7%) (Table 3). While observing the ultrasound based diagnosis, maximum patients were diagnosed with tendon related pathology (31.9%) (Figure 1) followed by abscess and cellulitis (28.6%) (Figure 2), ganglion (11.7%) (Figure 3) and bursitis (6.4%). Diagnosis like trigger finger/thumb, foreign body, inguinal lymphadenitis, bakers cyst, Achilles tendon rupture (partial/complete), synovitis, tendon injury, carpal tunnel syndrome, lipoma, hematoma, granuloma, hemangioma, fibromatosis, thrombophlebitis, myositis, fracture waist of scaphoid, sebaceous cyst (Figure 4), amelia (absence of femur) comprised rest of the 25 % of patient. There was statistically significant positive correlation between ultrasound based diagnosis and clinical diagnosis with Pearson correlation coefficient (r) 0.792 and p-value < 0.01 (Table 5).

Table 1: Age distribution

Age Group	Frequency(n)	Percentage (%)
0-14 Years	20	4.8
15-24 Years	86	20.5
25 - 34Years	103	24.5
35 - 44 Years	90	21.4
45 and above	121	28.8
Mean Age ± SD	**36.05± 14.37**	

Table 2: Gender distribution

Sex	Number(n)	Percentage (%)
Male	187	44.5
Female	233	55.5
Total	**420**	**100.0**

Table 3: Anatomical site distribution of the musculoskeletal disease

Anatomical site involved	Frequency (n)	Percentage (%)
Wrist and Hand	130	31.0
Elbow and Forearm	87	20.7
Shoulder, Arm and Axilla	7	1.7
Inguinal region, Hip and Thigh	45	10.7
Knee and Leg	55	13.1
Ankle and Foot	96	22.9
Total	**420**	**100.0**

Figure 1: Ultrasonographic image demonstrating tennis elbow

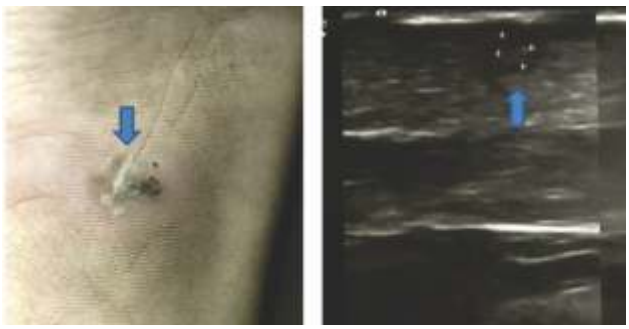

Figure 2: Ultrasonographic image demonstrating cellulitis and abscess of sole.

Figure 3: Ultrasonographic image demonstrating ganglion cyst of wrist

Table 4: Frequency of Ultrasound based diagnosis and clinical diagnosis of Musculoskeletal disorder

Diagnosis	Ultrasound Diagnosis (%)	Clinical Diagnosis (%)
Tendenitis/Tenosynovitis / Tendinopathy	134 (31.9)	119 (28.3)
Ganglion	49 (11.7)	44 (10.5)
Abscess/Cellulitis	120 (28.6)	110 (26.2)
Trigger finger/Trigger thumb	13 (3.1)	13 (3.1)
Foreign body	13 (3.1)	23 (5.5)
Carpel Tunnel Syndrome	6 (1.4)	4 (1)
Fracture waist of Scaphoid	1 (0.2)	1 (0.2)
Tendon Injury	1 (0.2)	6 (1.4)
Hand Hemangioma	1 (0.2)	0
Thrombophlebitis	2 (0.5)	2 (0.5)
Fibromatosis	2 (0.5)	2 (0.5)
Granuloma	3 (0.7)	0
Lipoma	4 (1)	5 (1.2)
Synovitis	10 (2.4)	11 (2.6)
Hematoma	3 (0.7)	15 (3.6)
Inguinal lymphadenitis	12 (2.9)	13 ()3.1
Thigh Myositis	2 (0.5)	0
Sebaceous cyst	3 (0.7)	1 (0.2)
Absence of Femur (Amelia)	1 (0.2)	0
Bursitis	27 (6.4)	25 (6)
Bakers Cysts	9 (2.1)	8 (1.9)
Achilles Tendon Tear (Partial/Complete)	4 (1)	3 (0.7)
Equivocal	0	15 (3.6)
Total	**420**	**420**

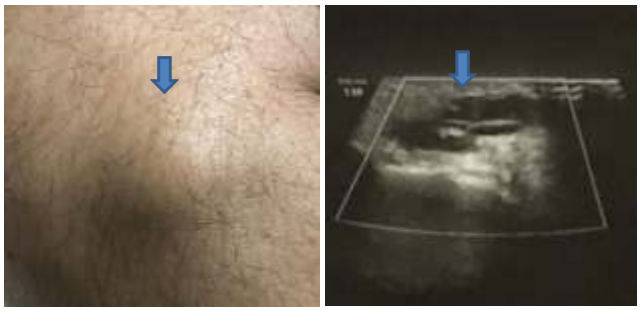

Figure 4: Ultrasonographic image demostrating sebaceous cyst around knee

Table 5: Correlation between ultrasound based diagnosis and clinical diagnosis

		Ultrasound Diagnosis	Clinical Diagnosis
Ultrasound Diagnosis	Pearson Correlation	1	0.792**
	Sig. (2-tailed)		0.000
	N	420	420
Clinical Diagnosis	Pearson Correlation	0.792**	1
	Sig. (2-tailed)	0.000	
	N	420	420

DISCUSSION

The ultrasound works under the principle of variable acoustic impedance produced at tissue interphases as sound waves are reflected at various organ surface. The reflected sound waves produce anatomic information about the size, shape and internal structure of normal as well as pathological process. These information from the reflected waves are digitalized and thousands of such measurements generates an ultrasound cross-sectional image which is then recorded on the monitor.[3] Several types of transducers are available for clinical imaging based on their frequencies, for superficial small structure scan higher frequency probes (5-7 MHz) are available, while for adult scan and for deeper structure the lower frequency probes are preferable (3-5 MHz).[4] Technical innovations in ultrasound eg. colour doppler, 3D reconstruction and ultrasound contrast agents have led to better understanding of the role of diagnostic ultrasound in clinical orthopedic practice.

Ultrasonography is well known for safe, noninvasive, without significant side effects, can also be repeated as necessary so is considered as a very useful procedure for monitoring the treatment. It is a painless investigation, it does not require sedation and above all it does not involve the use of ionizing radiation.[1,4-6] Different tissues absorb ultrasound at different rate e g. air and bone absorbs the sound most followed by fat, soft tissue and water.[1] It is often used as an adjunct to other modalities like magnetic resonance imaging (MRI) in the assessment of soft tissue disorders. There is also enough evidence that suggests that ultrasound does not expose patients to ionizing electromagnetic radiation and energy displaced in tissue is free from harmful side effects.[5,7]

The advantage of ultrasound examination in the analysis of moving parts and their interrelationship makes it a superior to other modalities of investigation. Abundant amount of literature also supports the role of real time scanning; it is widely used now days by orthopedic surgeons for the dynamic assessment of movement and stability of the joints and tendon.[8] Real time screening or assessment technique used in ultrasound procedure is often referred as “orthopedic

surgeons stethoscope".[5] Because of these properties apart from the diagnostic purpose the ultrasound can also be used for therapeutic purpose like cyst aspiration or intra-lesional injection. It is demonstrated that the accuracy of placement of an intra-articular injection may be as low as 29%, if performed blindly.[9] Ultrasound helps in the accurate deposition of intra articular injections and can also be used to guide the therapeutic extraction of deposits eg. calcium salts at joints as is commonly seen in the shoulder joints in rotator cuff syndrome.[10]

There is few established area of orthopedic practice in which use of ultrasound has been proven in well-controlled trails. Developmental dysplasia of the hip in the infants where the relationship of the un-ossified femoral head to the acetabulum is seen better by ultrasound than by plain films since the cartilage can be appreciated.[11] There is general agreement that ultrasound increase the rate of detection of abnormalities of the hip, but it is not yet clear whether widespread population screening is cost effective, hence current consensus is that screening of high risk group is prudent.[12] In irritable hip it helps to detect effusion allowing aspiration of the joint for symptomatic relief and the exclusion of septic arthritis.[13] Similarly it is also used to visualize fragmentation of the femoral head in Perthes disease and detecting a slipped capital femoral epiphysis.[14,15]

Pathology of rotator cuff especially supraspinatus tendon is visualized with arm in adduction and internal rotation where even the small tears can be seen and measured by dynamic test.[16] Soft tissue mass like popliteal cyst and neuroma are better visualized by ultrasonography.[17,18]

Ultrasound now rivals MRI in the assessment of tendon pathology, the ease of scanning the opposite limb and the patient participation in the procedure helps to detect more subtle problems. Ultrasound is commonly used in the diagnosis of patellar tendinosis, rupture of tendo achillis, tennis and golfers elbow, tendinopathy, tendon ruptures.[6] Ultrasound shows versatility in peripheral neuropathy of hands, wrist, elbow and ankle by helping in diagnosis of carpal tunnel syndrome, tarsal tunnel syndrome, compression of ulnar nerve in Guyon's canal, posterior interosseous nerve torsion at Leash of Henry, Wartenberg syndrome.[19, 20,] Callus at the site of the osteotomy in limb lengthening is visualized much easier by ultrasound than by plain films. If the distraction at the osteotomy is too slow then the gap will fill rapidly while if the distraction is too quick formation of a cyst can be seen in the gap and this can be detected on ultrasound before changes occur on plain films.[21]

In few circumstances ultrasound is applied but has a less pivotal role in management like in deep venous thrombosis, detection and drainage of abscess, bone pathology like subperiosteal collection in osteomylelitis in early childhood.[6] Ultrasound has proved to be better at diagnosing rib fracture than plain films and it may also detect a small pneumothorax not visible on the chest radiograph.[22] It is possible to judge the extent of muscle injury and to help to predict the time of recovery using ultrasound along with that muscle herniation can also be confidently diagnosed where as it may be missed with MRI.[6] Metal fragments as small as 0.5 mm and wood >0.7 mm, glass >2 mm and plastic >4 mm in size can be detected by ultrasound thus aiding the clinician for preoperative localization of foreign body which will help to reduce the extent of the surgical incision required to excise the foreign material.[23]

Other use of ultrasound in fracture managements are also in practice. Beneficial effects of using therapeutic ultrasound (low intensity ultrasound of 0.03 W cm^2 at 1.5 MHz) for normally healing fresh fractures as well as those that demonstrated either delayed or non-union include significant reduction in the healing time. Ultrasound has overall success rate of 96% in the diagnosis and treatment of stress fracture.[4, 24] Low intensity ultrasound is also beneficial during distraction osteogenesis, in post spinal fusion surgery and in combination with porous intramedullary implants.[4] Similarly antenatal diagnosis of orthopedic problem like club foot, femoral anomalies in Down's syndrome, arthrogryposis and dwarfism can now be assessed and identified by the effective use of ultrasound in experienced hands.[6,25] Ultrasound can be beneficial in few bone tumors like osteochondroma to measure the thickness of cartilage cap or for the assessment of soft tissue element for example in Ewing's sarcoma. Ultrasound guided biopsy may be the simplest methods of confirming the diagnosis in many musculoskeletal tumors.[26] Apart from these, newer surgical techniques are being introduced e.g. ultrasound guided percutaneous Achilles tendon repair and implant removal under ultrasound guidance.[27] Ultrasound is also used for pre-operative anesthesia as well as for post operative pain control by doing ultrasound guided nerve root block in orthopedic surgery.[28]

Drakeford et al. demonstrated sensitivity of 92% and spedicificity of 95 % of ultrasound in identifying full thickness tendon tear.[29] Similarly, King et al. emphasized that ultrasound and CT-scan both gave a similar positive rate in confirming presence of an abnormality in tendon. However ultrasound was found more precise in defining the nature of any abnormality.[30] These findings were similar to our study. In this study, we have identified many ultrasound based diagnosis, apart from that many other uses and benefits of ultrasound are available which has to be considered in daily orthopedic practice. Tendon related overuse injuries along wrist, elbow, hand and ankle were more commonly seen in the youth population of our country. Ultrasound probably helps clinician to identify overuse injuries along with other musculoskeletal disorder in early and effective way. Appropriate use of ultrasound can be effective in diagnosing various MSD in the country like Nepal, where even the young doctors will be able to diagnose MSD more precisely by the use of ultrasound whenever in dilemma.

CONCLUSION

Application of ultrasound in orthopedics is gradually widening in terms of management of various sports injuries, infections, inflammatory condition and trauma. Overuse tendon injury are common pathology around wrist and

ankle that can be diagnosed by ultrasound along with many other MSD. The use of ultrasound is gradually widening in scope but has to be performed by the expert to improve the diagnostic accuracy and also to avoid misleading diagnoses. Since there is significant correlation between clinical and ultrasound based diagnosis, it can be beneficial even for young doctors for making effective diagnosis of MSD.

RECOMMENDATION

On the basis of the strong correlation between ultrasound based diagnosis and clinical diagnosis as shown in our study, we recommend use of ultrasound in diagnosing MSD where there are radiologists but expert orthopedic surgeons are lacking. Apart from the diagnostic advantage, it is also useful for various therapeutic and pain management procedures in orthopedic practice.

LIMITATION OF THE STUDY

This was a retrospective study conducted in single tertiary care centre. We assumed all the radiologists of our institute were efficient in diagnosing MSD on ultrasound. Radiologist doing ultrasound were not blinded about the clinical diagnosis.

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CONFLICT OF INTEREST

Authors declare no conflict of interest.

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