

# Sonographic Findings in Rheumatic Diseases

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## Abstract

Ultrasonography is a common tool for clinicians to evaluate abdominal, cardiac or gynecological problems for decades but the musculoskeletal ultrasonography is gaining increased acceptance at the beginning of the 21<sup>st</sup> century<sup>1</sup>. It has been shown to be more sensitive than physical examination or plain radiography. It is a quick, handy and versatile tool bringing the rheumatologist in close contact with the patient enhancing detailed integration of clinical and imaging findings. The musculoskeletal ultrasonography offers an accurate and immediate image with lower cost and higher patient acceptability in the diagnosis and follow-up of most rheumatic diseases. This paper reports the evidence for the application of musculoskeletal ultrasonography in rheumatology. ( J Intern Med Taiwan 2007; 18: 332-341 )

**Key Words** : Ultrasonography, Musculoskeletal, Power doppler

## Introduction

The musculoskeletal ultrasonography is characterized by the flexible, repeatable and real-time imaging for clinical diagnosis, monitoring and intervention of rheumatologic practice. The high-resolution image with innovative features such as tissue harmonics power Doppler technology improves the di-

agnostic capability<sup>1,2</sup>. Because of the wide availability of the computed tomography (CT scan) and magnetic resonance imaging, the musculoskeletal ultrasonography has been underutilized in Taiwan. It is available on a routine basis at only a limited number of facilities. Most rheumatologic training courses do not include this modality as part of their curriculum<sup>3,4</sup>. As cost constraints in health insurance affect clinical

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management decisions, the musculoskeletal ultrasonography may become the preferred method over more expensive examinations. In this report, we describe the broad spectrum of clinical applications of sonography and the advantages of integrating this technology into everyday rheumatology clinical practice.

## Rheumatoid arthritis

Rheumatoid arthritis (RA) is a chronic inflammatory arthritis. A more possible RA diagnosis could be made when marginal erosions are identified in the characteristic symmetric distribution on radiographs. Sometimes, diagnosis may be delayed due to the limited sensitivity of small erosions with conventional radiography or incorrect clinical diagnosis of mono-, oligo- and polyarthritis. The presence of joint effusion under ultrasonography is a valuable indicator of active joint disease. The classification criteria of RA and the clinical diagnosis of mono-, oligo- and polyarthritis will probably need to be re-evaluated in the future due to the more widespread use of ultrasonography<sup>2</sup>. Marginal ero-

sions are identified as crater-like defects in the bony contours along the edges of the articular cartilage and ultrasound has been shown to be almost 7-fold more sensitive than plain radiography in the early diagnosis of rheumatoid erosions<sup>5</sup>. As a result, diagnosis may be made earlier by using musculoskeletal ultrasonography and joint destruction can be prevented with proper treatment in advance.

The musculoskeletal ultrasonography helps in localizing the fluid collections in small joints (proximal interphalangeal joints or metatarsal-phalangeal joints) or large joints (hip and knee joints) to be aspirated successfully. Using ultrasonography to guide aspiration produced a 3-fold increase in the rate of successful aspiration compared with conventional aspiration of the peripheral joints<sup>6</sup>. Monitoring of therapy by ultrasound is another promising field. Quantitative estimates of joint effusion and proliferation are valuable for objective assessment of the severity of knee joint synovitis<sup>7</sup> (Fig. 1).

With the explosion of drug development for RA, many new approaches were developed for monitoring the impact of therapy. Several recent stud-

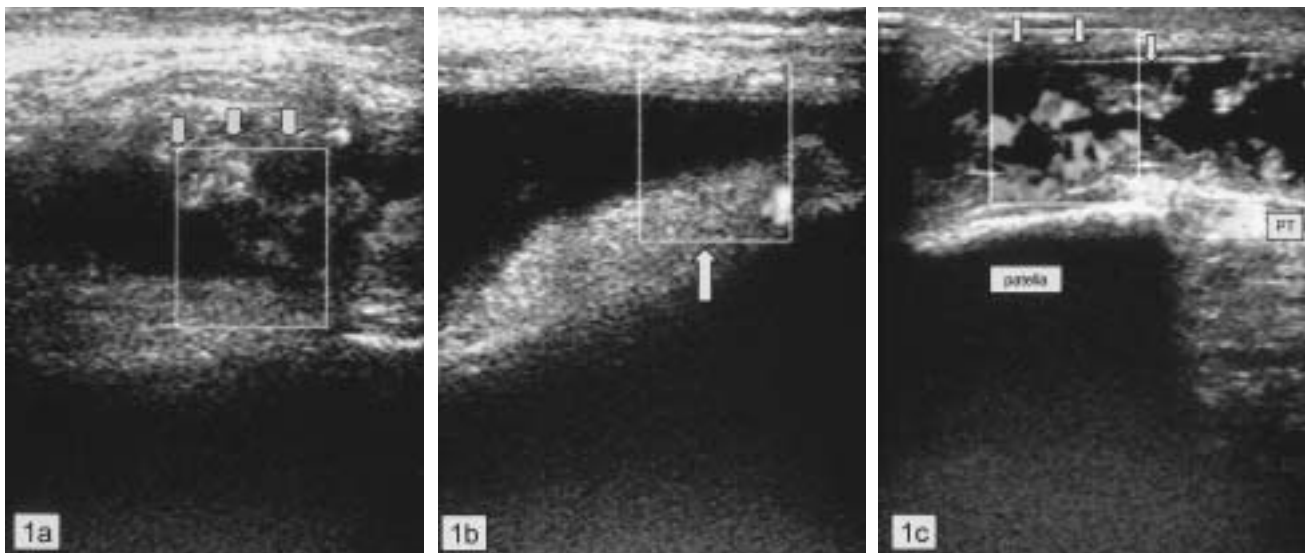


Fig.1. Sonographic imaging of knee joint synovitis in rheumatoid arthritis patients; (a) Longitudinal scan through suprapatellar (patient recumbent) shows villo-nodular pattern (arrows); (b) Longitudinal scan through medial parapatellar shows uniform hypertrophic synovium and intense enhancement with power Doppler (arrow) and (c) Pre-patellar bursitis. Longitudinal section over the anterior aspect of the knee shows the fluid-filled bursa (arrows) lying anterior to the patella and patellar tendon (PT).

ies used ultrasound to evaluate RA joints<sup>8, 9, 10, 11</sup>. These approaches can be divided into use of B-mode (gray-scale) ultrasound versus use of Doppler techniques, and also based on the method for assessing changes (qualitatively like absence or presence), semi-quantitatively (scoring), or quantitatively (measurement of thickness or use of an index)<sup>12</sup>. All methods involve some degree of subjectivity and the standardization was not yet determined<sup>12</sup>. Ultrasound could be a method for monitoring the inflammation of finger joints in rheumatoid arthritis in the future.

Power Doppler adds considerable advantages to standard musculoskeletal ultrasonography and allows imaging of smaller degrees of synovitis with a reported accuracy equal to dynamic MRI<sup>13</sup>. Increased microvascular blood flow by visualizing the movement of blood cells within a vessel under power Doppler is an evidence of synovial inflammation<sup>14</sup> (Fig. 1). This increased vascularity may lead to increased perfusion and thus to hyperemia<sup>15</sup>. Breidahl et al. examined 39 patients with joint effusions and found that power Doppler sonography could help distinguish inflammatory fluid collections from those that are non-inflammatory<sup>15</sup>.

## Painful shoulders

Shoulder pain is a common complaint in daily rheumatological practice. It could be caused by an articular process or peri-articular soft tissue complications. The acromioclavicular joint is a common site of involvement in rheumatoid arthritis or other inflammatory arthropathies as well as septic arthritis in immune-compromised patients<sup>16</sup>. If clinical doubt as to possible infectious process exists, ultrasound-guided needle aspiration may improve early diagnosis<sup>16</sup>.

As the shoulder is a complex joint structure, sonography plays a major role in the accurate diagnosis of shoulder diseases<sup>17</sup> (Fig. 2). The clinical diagnosis of periarticular shoulder conditions depends on a number of physical examinations but it may be difficult to differentiate the pain patterns of the subacromial-subdeltoid bursitis, biceps tendon, and rotator cuff lesions<sup>17</sup>. Plain radiography only show non-specific indirect signs of chronic rotator cuff lesions limiting its use for ruling out osteoarthritis, periarticular calcification and other bony causes of shoulder pain<sup>17</sup>. Other diagnostic procedures such as CT scan, arthrography, arthroscopy or MRI can-

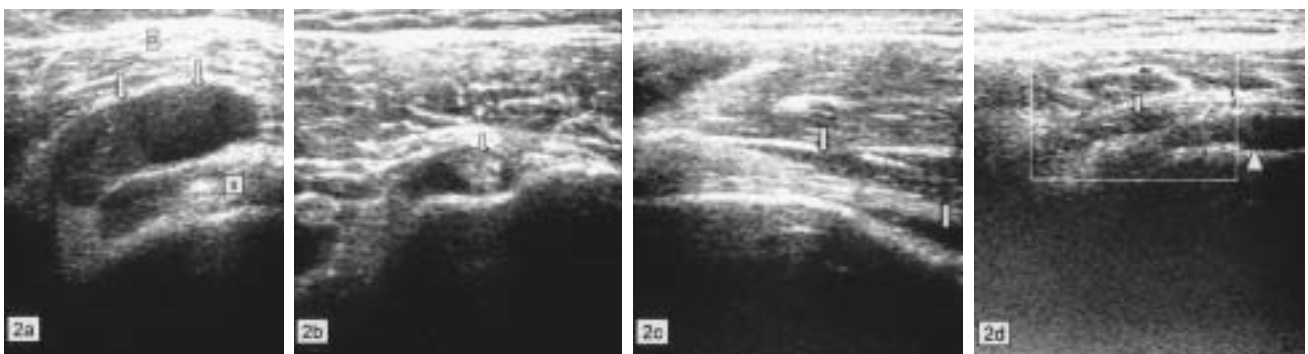


Fig. 2. Sonographic imaging of rheumatoid arthritis patients with chronic shoulder pain; (a) Coronal-orientated image of left supraspinatus tendon. A massive quantity of subacromial subdeltoid bursal fluid (arrows) separates the supraspinatus tendon (S) from deltoid muscle (D); (b) Transverse ultrasound image through the right bicipital groove shows fluid distension of the long head of biceps tendon sheath (arrow); (c) Longitudinal image along the length of the right biceps tendon in the bicipital groove shows abnormal quantity of fluid within biceps tendon sheath (arrows) (d) Coronal-orientated image of left supraspinatus tendon showing a fluid-filled cuff tear. Fluid can be seen at the joint surface (arrowhead) and at the bursal surface (arrow). A full-thickness tear was confirmed by the communicating defect with alternating compression with the probe and a little shoulder movement.

not be considered for routine examination because of the invasiveness and the expensiveness<sup>17</sup>.

Rotator cuff tear can be either full or partial thickness. A full thickness (or complete) tears extend from the articular surface to the bursal surface of the cuff allowing communication between the subacromial subdeltoid bursa and the glenohumeral joint (Fig. 2d). Partial thickness (or incomplete) tears only involve one or other of the surfaces of the supraspinatus tendon<sup>18</sup>. Another vital role of sonography is to determine what stage the shoulder disease has progressed to and consequently which form of treatment is to be undertaken. If a full-thickness cuff tear is present, surgical repair should be considered.

Subacromial-subdeltoid bursal aspiration and corticosteroid injection can be guided by ultrasound. It is generally from a lateral or anterior approach with a direct ultrasound screening of the needle during its entry into the bursa. Calcific tendinopathy is not an uncommon disorder and ultrasound can detect it early. Supra-spinatus calcification barbotage can be used in the patients suffering from severe acute pain as a consequence of crystal shedding into the subacromial subdeltoid bursa<sup>18,19</sup>. The technique for aspiration is similar to subacromial-subdeltoid bursal aspiration and local anesthetic is injected into the subacromial-subdeltoid bursa. After the bursa has been infiltrated, the needle is advanced into the calcium and an aspirate is performed with agitation of the needle within the lesion<sup>18</sup>. Following this, a small amount of corticosteroid with local anesthetic is injected<sup>18</sup>. It is generally reserved for the patients who didn't respond to medical treatment and often brings about a rapid and effective response<sup>18,19</sup>.

## Carpal tunnel syndrome

Carpal tunnel syndrome is a complication of several connective tissue diseases including scleroderma, polymyositis, polymyalgia rheumatica and, most commonly, rheumatoid arthritis<sup>20</sup>. Sonography can identify the median nerve from tendons and ob-

tain information of the cause of nerve compression through imaging of tenosynovitis or tendon effusion, amyloid deposition, ganglion cyst, variant median artery or hypertrophied accessory muscle<sup>2</sup>. Patients complain of burning sensations, numbness and tingling in the fingers. The diagnosis of carpal tunnel syndrome is usually based on the patient's history and clinical findings. A cross-section area in the proximal carpal tunnel larger than 11mm<sup>2</sup> in combination with compression signs on longitudinal scans is believed to be diagnostic of carpal tunnel syndrome<sup>21</sup>. Ultrasound is comparable to electrophysiology with a more complete view of the condition<sup>21</sup>. It is suggested as the initial investigation for carpal tunnel syndrome and offers an accurate local injection to the small size of the target space between the flexor carpi radialis tendon and the median nerve<sup>2,21,22</sup>.

## Seronegative spondyloarthropathies

Enthesopathy is one of the characteristic signs in seronegative spondyloarthropathies. The diagnosis of enthesitis is usually based on the clinical symptoms at the insertion part of the tendon, ligament, joint capsule or fascia into the bone. Ultrasonography



Fig.3.Retrocalcaneal bursitis. Sagittal image of pre-Achilles bursa. The bursa is filled with poorly reflective fluid (arrow).

is more sensitive in detection of enthesitis than clinical examination<sup>23</sup>. Thickened enthesis, enthesophyte and adjacent bursitis could be revealed by ultrasonography and an abnormal power Doppler signal at the cortical bone of enthesis regarded as a highly specific feature of the spondyloarthropathies<sup>24</sup>. Loss of signal is linked to clinical improvement<sup>24</sup>. Sonographic examinations of ligamentous insertions offer objective changes in enthesopathy and helps in the differential diagnosis of the inflammation of the surrounding soft tissues such as retrocalcaneal bursitis (Fig. 3). Besides, sonography-guided local intra-lesional therapy is safer avoiding the dangerous contact between the tip of the needle and the tendon.

### Hip joint involvement in rheumatic disease

Hip involvement can be underestimated in rheumatic diseases by conventional radiography<sup>25</sup>. The detection of effusion or synovitis within the hip joint or its adjacent bursa is helpful in the assessment of hip joints. During examination, the patient is lying supine with the heel and the hip externally rotated 10-15°. When the joint capsule could be fol-

lowed from the acetabulum to the point of its fixation to the neck, measurements on a magnified picture on the monitor were made. The measuring points were the lower edge of the capsule and the upper edge of the osseous. The longest ultrasonic intra-articular distance from the joint capsule to the femur was measured. Ultrasonic distances of 7mm or more, or a difference between both hips of 1 mm and more, were considered as intracapsular effusion in the hip joint<sup>25,26</sup> (Fig. 4). Ultrasonography is a method of diagnosis that should be considered in hip joint evaluation<sup>25,26</sup>.

### Localized scleroderma

Ultrasound imaging has been validated in the diagnosis of localized scleroderma and provides objective and noninvasive monitoring of the skin lesions<sup>27</sup>. Diagnosis of localized scleroderma is often made clinically<sup>27</sup>. Histological examination is usually compatible with diagnosis but not specific<sup>27,28</sup>. A disfiguring scar is often seen after a biopsy. Under ultrasound, undulations of the dermis, disorganization, loss of thickness, thickened hyperechoic bands in the hypodermis and the "yo-yo" image had 92%

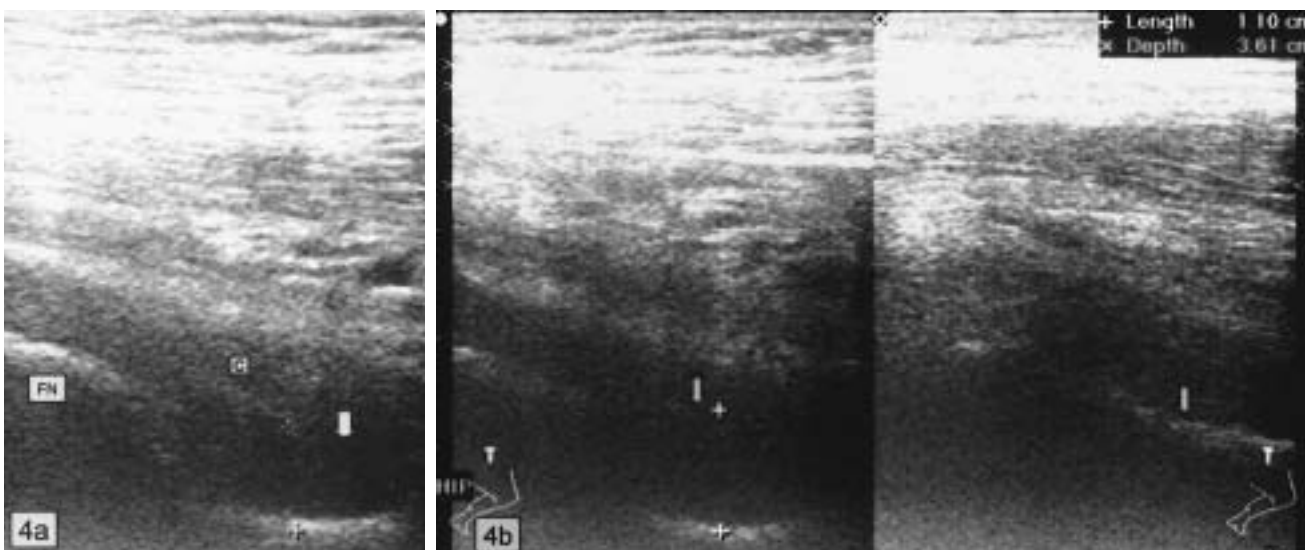


Fig.4.(a) Long-axis view of right hip showing effusion (arrow) separating the capsule (C) from the femoral neck (FN) in an ankylosing spondylitis patient. (b) Split screen view comparing asymptomatic (left) and symptomatic (right) hips. The effusion is demonstrated by upward convexity of the capsule on the abnormal compared to the normal side (arrows).

sensitivity and 100% specificity for localized scleroderma<sup>27</sup>. The "yo-yo" image is the dense image at the dermal-hypodermal junction whose shape resembled a flattened "yo-yo" or a snap fastener. The hypodermis is thinner compared with adjacent normal skin (with a mean loss of 41%) and disorganized with dense widened bundles in all directions<sup>27</sup>. Ultrasound may be a valuable tool for the diagnosis of localized scleroderma in the future.

## Sjögren's syndrome

Salivary glands histological examination, sialography and scintigraphy are considered to be reliable methods for the assessment of the salivary gland involvement. Because of the inconvenience and a risk of complications, ultrasound is another reliable and non-invasive method for the diagnosis of the salivary involvement<sup>29,30</sup>. The presence of parenchymal inhomogeneity of the salivary glands is the most important sonographic change in Sjögren's syndrome and showed a good correlation with parotid sialography, scintigraphy and the histology of the minor salivary glands (87.3, 84.7 and 84.3%)<sup>29</sup>. The parenchymal structure of the glands was categorized into five stages: stage 0= normal; stage 1= mild parenchymal inhomogeneity (PIH) (hypoechoic areas < 2 mm); stage 2= evident PIH (hypoechoic areas of 2-6 mm); stage 3= gross PIH (hypo-

choic areas > 6 mm); stage 4= adipose degeneration of the gland (adipose tissue echogenicity and parenchymal atrophy)<sup>30</sup>. As the risk of developing a lymphoma in the salivary glands of Sjögren's syndrome patients, ultrasound can detect early malignant complications<sup>31</sup>. On ultrasound, intraparotid lymphomatous nodes are large, usually very hypoechoic masses and occasionally so hypoechoic that they appear cystic<sup>31,32</sup>. This appearance can be explained by the monotonous arrangement of the lymphoma cells, which provides very few acoustical interfaces to generate internal echoes<sup>31,32,33</sup>. It is a promising alternative to the conventional invasive examinations providing information in the diagnosis and follow-up of Sjögren's syndrome.

## Osteoarthritis

Osteoarthritis is the most common joint disorder<sup>32,35</sup>. The disease processes not only affect the articular cartilage, but also involve the entire joint, including the subchondral bone, synovial membrane, periarticular muscles, capsule and ligaments<sup>32</sup>. Ultrasound can identify a number of osteoarthritis features and provides noninvasive prognostic indicator<sup>36</sup>. These include loss of joint space and cartilage (Fig. 5a), meniscal abnormalities, synovitis, osteophytes (Fig. 5b) and Baker's cyst<sup>32,36</sup> (Fig. 5c, 5d). Magnetic resonance imaging is regarded as the most

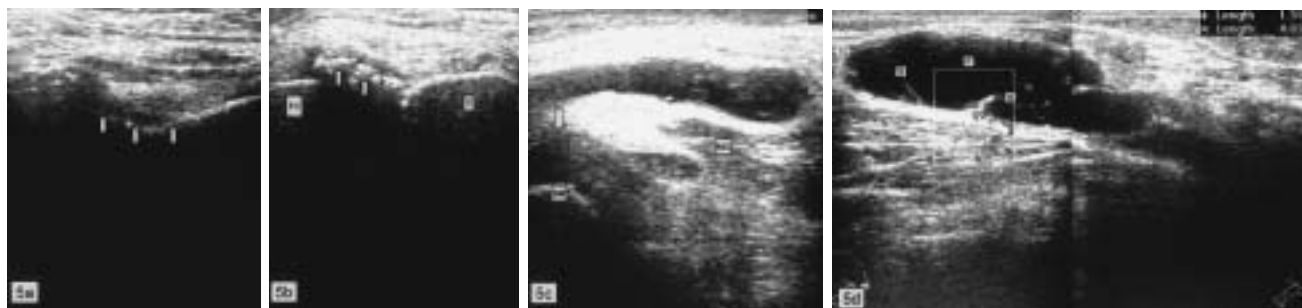


Fig.5. Osteoarthritis of the knee. (a) Transverse scans of the condylar cartilage shows diffuse thinning, nonhomogenous cartilaginous layer and blurring of the cartilage interface (arrows); (b) Longitudinal section over the medial aspect of left knee shows osteophytes (arrows) formation and narrowing of joint space in the femoral condyle (FC) and tibia (T) joint; (c) Transverse section shows the characteristic neck (arrow) to the popliteal bursa (Baker's cyst). The cyst arises between the medial head of gastrocnemius (MG) and the semimembranosus (SM); (d) Longitudinal section with fluid (F) and a thickened synovitis septum (S) demonstrated within the cyst.

powerful tool for evaluating cartilage. However, there are economic and technical limitations to the routine use of magnetic resonance imaging in assessing osteoarthritis cartilage. Under ultrasound, loss of the normal sharpness of synovial space and cartilage interface, loss of clarity of the cartilaginous layer, narrowing of the joint cartilage and increased intensity of the posterior bone cartilage interface are the features of osteoarthritis<sup>36</sup>. Due to no single feature of articular cartilage can be regarded as more reliable than others for diagnosing cartilaginous damage<sup>36, 37, 38</sup>. A combination of all parameters should be used. Reproducible sonographic evaluation may play a role in the assessment of osteoarthritis.

## The vasculitides

The vasculitides are a heterogenous group of diseases characterized by inflammatory cell infiltration and necrosis of blood vessel walls. The severity of vasculitis is related to the size, site and number of vessels affected. Ultrasound imaging can detect stenotic lesions in the carotid and subclavian vessels for Takayasu arteritis diagnosis<sup>39</sup>. Color Doppler flow imaging can assess blood flow in the scrotum when differentiating Henoch-Schonlein purpura with scrotal involvement or torsion<sup>40</sup>. Color Duplex ultrasonography has been used to detect inflammation in temporal vessels in giant cell arteritis, the typical appearance is hypoechoic halo around the perfused lumen of inflamed vessels, which may be due to edema of the artery wall<sup>41</sup>. Patients with typical clinical signs of temporal arteritis and a clear halo on ultrasonography might be treated without a biopsy<sup>41</sup>. Ultrasound is a quick, non-invasive technique and can be used as an additional diagnostic tool for the vasculitis.

## The inflammatory myopathies

The inflammatory myopathies include a group of acquired muscle disorders caused by auto-immune or infectious processes<sup>42</sup>. The application of ultra-

sound technique adds an important dimension to our understanding of myositis. It shows edema, fluid collection and vasculitis in soft tissues and muscles<sup>43</sup>. It also localizes these alterations and guides a needle aspiration or muscle biopsy to establish a correct diagnosis. It facilitates the assessment of disease activity, chronicity and damage like fibrosis and calcifications<sup>43</sup>. Sonographic imaging is non-invasive and should be considered in the diagnostic evaluation and to assist in treatment of inflammatory myopathies.

## Crystal-related arthropathies

Ultrasound findings in gout encompass synovial hypertrophy, bony erosions Baker's cysts and joint effusion<sup>2,44</sup>. In pseudogout patients, synovial proliferation, joint effusion and thinning of the cartilage can be seen. Chondrocalcinosis in pseudogout patients may involve the hyaline cartilage or menisci as hyperechoic calcification parallel to the bone surface (Fig. 6) which helps in differentiating from gout. Aspiration of synovial fluid can relieve symptoms and yield the definite diagnosis. Ultrasound assists the aspiration of synovial fluid and local injection of medication. The progression of the needle can be ac-



Fig.6. Chondrocalcinosis affecting the left medial meniscus (arrows). Femoral condyle (FC), tibia (T).

curately controlled on the monitor until the tip of the needle is properly placed on the selected target<sup>18, 45</sup>. It greatly improves the accuracy particularly in small joints and reduces the risk of injecting into the tendon, adipose tissue, muscle or nerve resulting in inefficacy and tissue damage<sup>18, 45</sup>. Essentially, attempted aspiration of a dry joint can be avoided.

## Conclusion

The evidence published to date suggests that the introduction of musculoskeletal ultrasound will improve diagnostic accuracy and therapeutic outcome. Fewer return visits by the patients will result in saving both the patients' and the clinicians' time. We should work on establishing the educational framework to equip the rheumatologist with the necessary knowledge and skills.

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## 風濕疾病的超音波檢查發現

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### 摘 要

超音波檢查已行之有年，是臨床醫師在評估腹部、心臟或婦產科疾病常用的工具。但肌肉骨骼超音波這項檢查，在前輩醫師努力推廣下，從21世紀初才開始逐漸被大家所接受。硬體儀器的進步、軟體的開發，肌肉骨骼超音波檢查已被證實和理學檢查與X光檢查相比，有更高的敏感性。加上快速、方便、多項功能且無游離輻射性考量下，將病人與醫生的距離拉近，使許多風濕疾病在超音波檢查下，能綜合臨床表徵與影像發現，做一更全面與仔細的評估。肌肉骨骼超音波檢查提供了準確的即時影像，也被較多的病人所接受，實不失為經濟實用的一項檢查技術，也成為醫師在診斷及追蹤風濕疾病的輔助利器。本文介紹肌肉骨骼超音波於風濕病領域上的應用證據，並以臨床常見疾病之適用性與優點做一闡述。