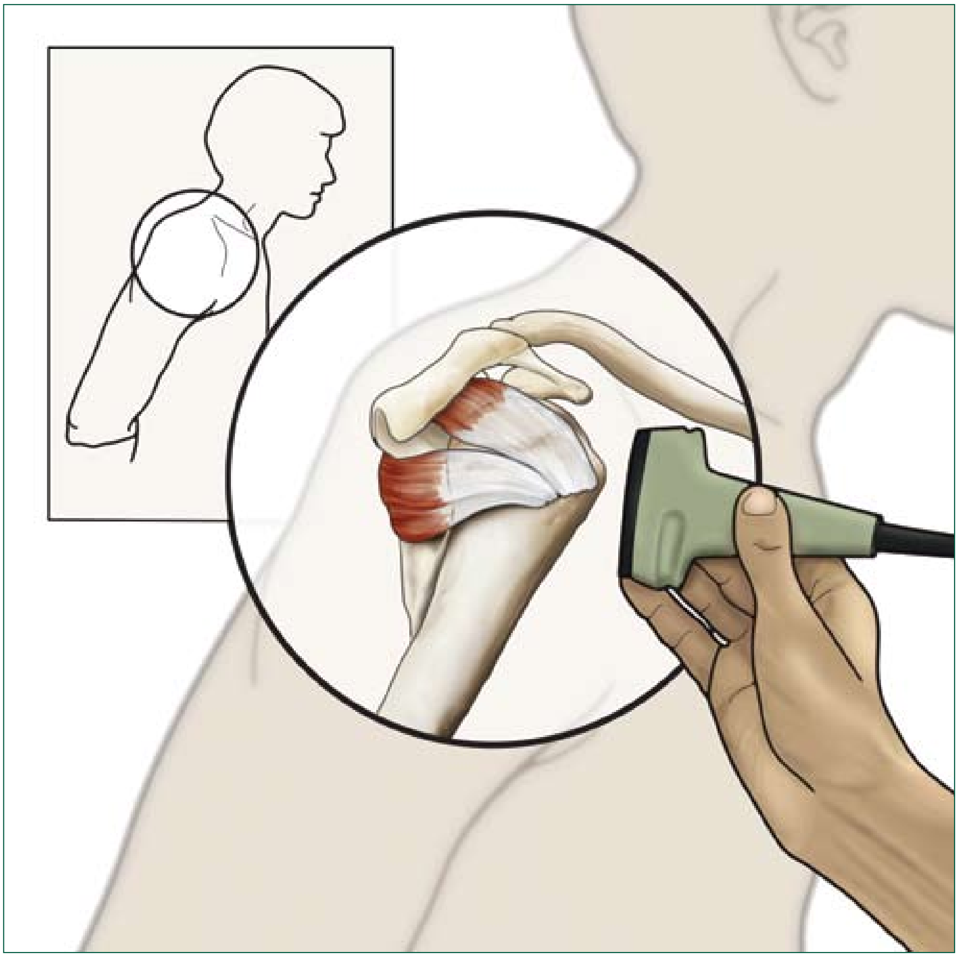
BK Medical

Musculoskeletal Ultrasound

Application note



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Musculoskeletal Ultrasound

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There is a growing interest in using ultrasonography in the diagnosis and treatment of diseases of the musculoskeletal system. Ultrasonography is an easy, quick and non-invasive technique, enabling constant interaction with the clinical examination. Technological advances have made it possible to obtain high-resolution dynamic images, which may even make ultrasonography a better alternative to magnetic resonance imaging (MRI) in a great number of patients with soft tissue abnormalities. Ultrasonography is also the best modality for image-guided interventional procedures.

EXAMINATION TECHNIQUE

An ultrasound examination of the musculoskeletal system is performed without any preparation and has no contraindications. It should follow some important rules regarding:

1. Choice of transducer.
2. Patient position.
3. Ultrasound examination.

1. Choice of transducer

A high frequency linear array is mandatory.

The use of high frequencies (7 - 12 MHz) provides exquisite image resolution (Figure 1), often better than with other imaging modalities (CT, MRI). Even higher frequencies (15 MHz) are available with small transducers best suited for examination of the superficial structures of the wrist/hand or ankle/foot (Figure 2). If a higher penetration is requested (obese or athletic patient, examination of menisci in the knee or anterior glenoid labrum in the shoulder), a frequency of 5-6 MHz is preferable.

A linear array provides a large field of view in the near-field zone, but cannot give the same overview that is available


Type 8805 (5 -12 MHz)


Type 8811 (5 -12 MHz)

Figure1. High frequency linear array transducers

Figure 2A. Very high-frequency linear array transducer, Type 8809, (6-15 MHz) for examination of very superficial structures (wrist/hand and ankle/foot).

Figure 2B. Transducer Type 8809 Equipped with puncture guide.

with computed tomography (CT) or MRI. The most important advantage of a linear array is that the ultrasound beams are all parallel. Therefore they can be simultaneously oriented perpendicular to the reflective structures of the soft tissues (e.g. tendons and muscles), thus avoiding the anisotropic artifact (see sub-section, "Ultrasound Examination").

2. Patient position

Patient position depends on the examined region–supine for the quadriceps tendon, the patellar tendon or the anterior glenoid labrum of the shoulder; prone for the popliteal fossa; prone with the feet lying over the bed for the Achilles tendon or the plantar fascia; seated for the rotator cuff of the shoulder (Figure 3A). A small cuff can be placed under the knee or ankle to straighten the fibers of the extensor mechanism of the knee or the Achilles tendon. Adduction of the shoulder with the arm behind the back has same effect on the supraspinatus tendon.

3. Ultrasound examination

Perpendicular examination. Most musculoskeletal structures (tendons, ligaments, muscles and menisci) should be examined perpendicularly, to provide strong reflections and good visualization of the anatomical details. This is important in order to differentiate true pathology from the anisotropic artifact, which appears when anatomical structures are examined with a certain angle and are falsely hypoechoic (Figure 4).

Comparison with the contralateral side. Always examine the opposite limb as a reference if there is any doubt about the image. The split-screen facility makes it easier to compare subtle differences in size, form or echogenicity between both sides (Figure 5).

Interaction with the clinical find-

Figure 3A. Ultrasound examination of the shoulder with the patient seated.

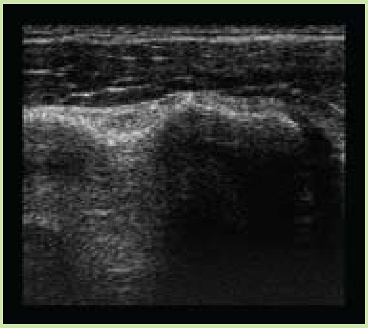


Figure 3B. Corresponding normal transverse scan of the long head of the biceps in the bicipital groove.

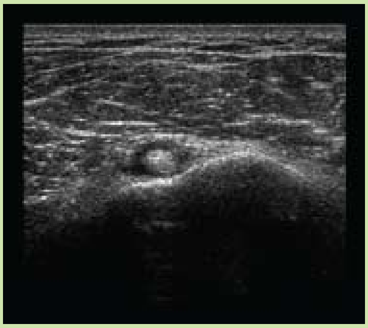


Figure 3C. Transverse scan of the bicipital groove in a patient with effusion in the bicipital tendon sheath.

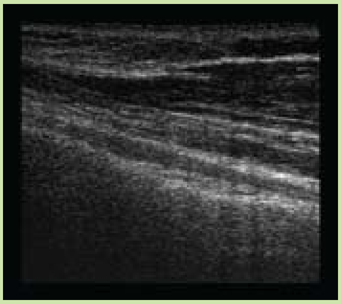


Figure 4A. Longitudinal scan of the long head of the biceps, appearing falsely hypoechoic due to the angle between the ultrasound beam and the tendon fibers (anisotropic artifact).

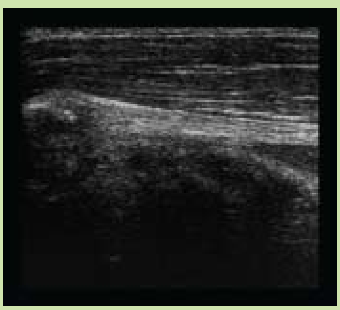


Figure 4B. Correct perpendicular position of the transducer showing the normal fibrillar structure of the long head of the biceps.

ings. One of the important advantages of ultrasonography is the direct interaction with the clinical examination (symptoms and palpation findings).

Sonopalpation. Compression with the transducer may provide information about the structure (fluid vs. solid) and elasticity (malignant tumor or fibrosis vs. benign tumor or fat) of the soft tissues. On the other hand, the use of a large amount of gel and minimal pressure (or no contact between transducer and skin) may be important for visualizing of superficial soft structures, as they may "disappear" when examined with too much compression (bursitis, tenosynovitis).

Power Doppler examination. Detection of soft tissue vessels makes it possible to differentiate between solid tissue and fluid areas or cysts, and to identify regions that may represent inflammation (Figures 6E and 6F), tissue regeneration or tumors.

Dynamic examination. Use scanning during active mobilization of the soft tissues whenever it may provide additional information. This is also one of the strengths of ultrasonography. The physiological information thus obtained makes it easier to recognize anatomical structures and to situate the position, extension and boundaries of pathological changes. Dynamic tests may help the visualization of small tendon or muscle tears, muscle hernias, tendon subluxation, glenoid labrum lesions, shoulder impingement and joint instability.

Ultrasound-guided interventional procedures. Ultrasonography provides "real-time" images and is ideal for the guidance of interventional procedures. When needed, they should be an integral part of the ultrasound examination. Using a guided (Fig. 2B) or free-hand puncture, the following diagnostic and therapeutic procedures may be performed:

- evacuation of fluid collections (abscess, hematoma, seroma, bursitis, cysts and joint effusions) by puncture and drainage
- needle biopsies (soft tissue tumors, enlarged lymph nodes, suspected recurrence in patients with operated sarcomas); steroid injection (joint or bursa)
- aspiration of tendon calcification
- preoperative needle localization of small pathological changes
- removal of foreign bodies
- intraarticular injection of contrast (arthrography)

Overall, ultrasonography is relatively inexpensive and widely available, quick and easy to perform, well tolerated and radiation free. Ultrasonography is therefore valuable for following patients with sports injury, for controlling drained fluid collections, and for diagnosing postoperative complications or recurrences of malignant diseases.

ULTRASONOGRAPHY OF NORMAL ANATOMICAL STRUCTURES

1. Tendons, tendon sheaths and bursae

Normal tendons have a hyperechoic tight fibrillar structure on longitudinal scanning planes with the ultrasound beam perpendicular to the tendon (to avoid the anisotropic artifact) (Figure 4). On transverse scanning planes, tendons are filled with bright echoes. Tendons are either surrounded by a synovial tendon sheath (very thin hypoechoic rim around the tendon as the synovial cavity is virtual) or a thin fibrous epitendineum (thin hyperechoic layer). There is very little or no intratendinous flow on power Doppler examination. Bone insertions are slightly hypoechoic, due to a fibrocartilaginous structure and the oblique orientation of fibers. Tendons move freely during the dynamic examination.

Only a few synovial bursae are demonstrable when they are normal. The subdeltoid-subacromial bursa is

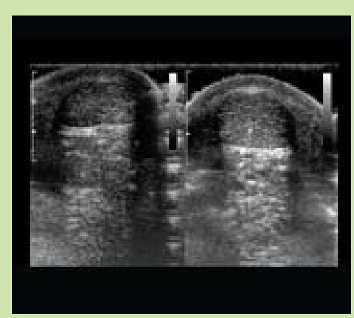


Figure 5. Split screen modality showing a transverse scan of an Achilles tendinopathy (right) compared to the contralateral normal Achilles tendon (left)

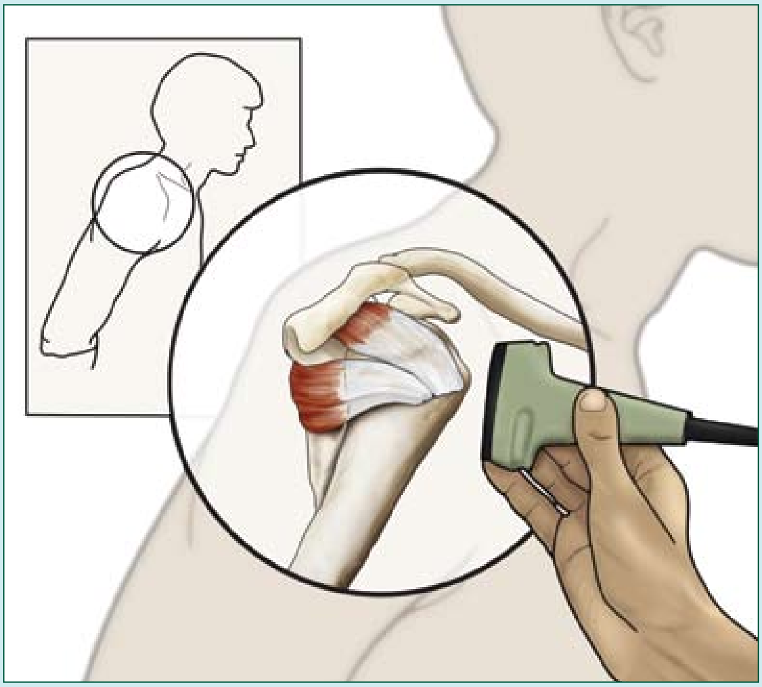


Figure 6A

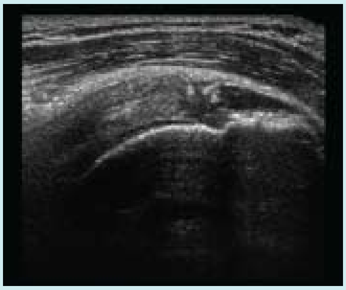


Figure 6B

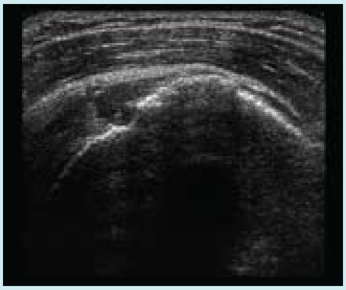


Figure 6C

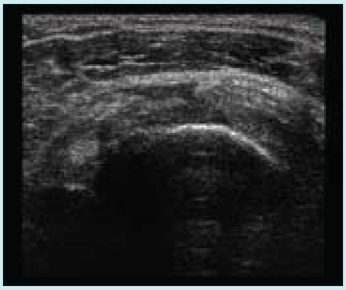


Figure 6D

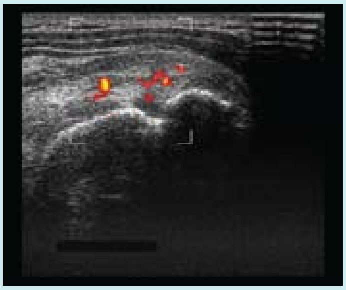


Figure 6E

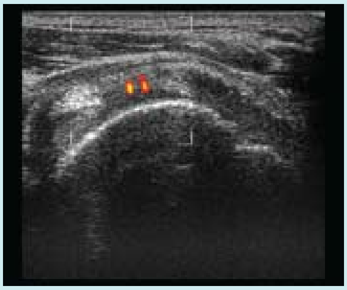


Figure 6F

Figure 6
A: Drawing showing the position of the patient and the transducer during longitudinal examination of the supraspinatus tendon of the shoulder. Longitudinal (B,C) and transversal (D) scans of the supraspinatus tendon with a complete tear. Longitudinal (E) and transverse (F) power Doppler examination of a supraspinatus tendon with hyperemia (tendinitis).

seen as a thin hypoechoic layer between the deltoid muscle and the rotator cuff. The deep infrapatellar bursa and the retrocalcaneal bursa are inconstantly seen as small, triangular, anechoic structures.

2. Joints

Ultrasonographic detection of the normal synovial membrane is not possible. Synovial recesses with a minimal amount of fluid are nevertheless often seen as small hypoechoic structures in relation to the joint line. Cartilage and menisci may be assessed in certain regions (not covered by bone). Cartilage is seen as a hypoechoic band overlying the bone, with a smooth thin hyperechoic border. The menisci in the knee and the glenoid labrum in the shoulder are seen as triangular homogeneously hyperechoic structures (fibrocartilage). Ligaments are seen as hyperechoic fibrillar structures, similar to tendons, bridging over the joint lines. The medial collateral ligament of the knee is about nine cm long and has a trilaminar structure: hyperechoic and fibrillar superficial; heterogeneous, hyperechoic or hypoechoic nonfibrillar fibroadipose; hyperechoic and fibrillar profound adherent to the medial meniscus. Stress tests may give information about the stability of joints.

3. Muscles

On longitudinal scanning planes, muscles have a hypoechoic background with fine and parallel hyperechoic lines (interfibrillar fibroadipose septae or perimysia). The orientation of these septae is typical and different types of muscles are described (longitudinal, unipennate, bipennate, circumpennate) (Figure 7A). On transverse scanning planes, the hypoechoic background is dotted with fine echoes and sometimes a few hyperechoic septae (Figure 7B). The hyperechoic boundaries around and

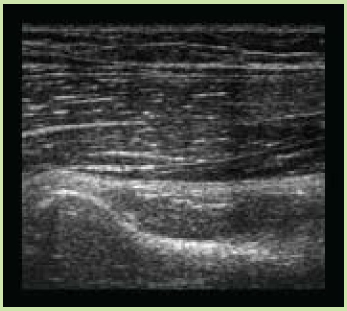


Figure 7A. Longitudinal scan of a normal muscle (brachioradialis).

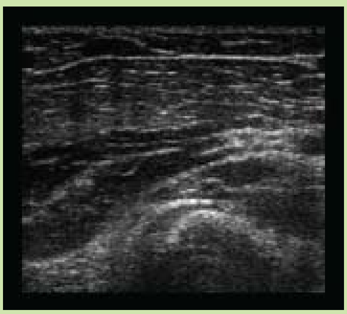


Figure 7B. Transverse scan of a normal muscle (brachioradialis).

between muscles are the muscle fascia. Vessels (anechoic tubular structures) and nerves (fascicular tubular structures) are visualized in and between muscles. Power Doppler examination is needed for detection of very small muscular vessels.

4. Nerves.

Nerves have a fascicular structure, which is slightly less echogenic than the fibrillar structure of tendons (hypoechoic fascicle in a hyperechoic connective stroma) (Figure 8).

5. Bone

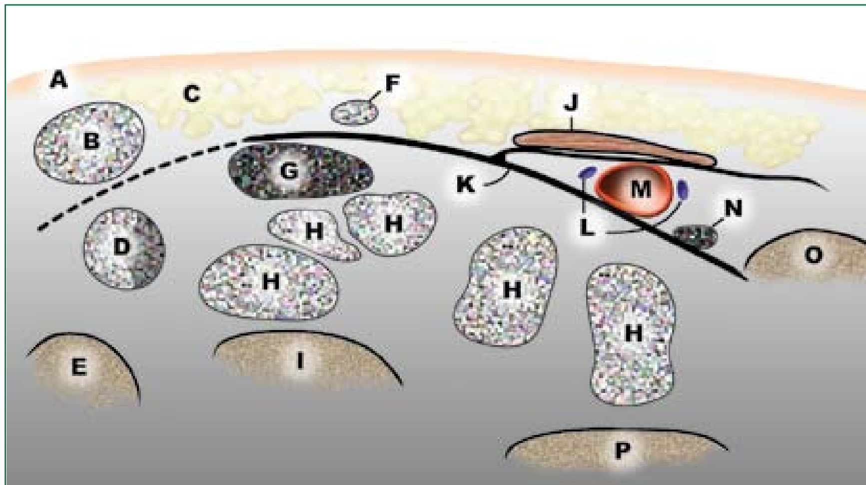
Intraosseous structure and changes cannot be assessed, but the bony surface is easy to analyze and is seen as relatively regular, hyperechoic, with strong shadowing.

6. Fat

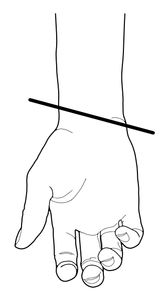
Fat has a typical aspect: hypoechoic background with thin hyperechoic linear septae running in different directions. The overall echostructure is therefore heterogeneous and generally hypoechoic (but may be relatively hyperechoic), and the anisotropic artifact is low or absent. The main fatty areas are the subcutaneous fat, Kager´s triangle (between the ankle and the Achilles tendon) and the intra-articular (intracapsular and extrasynovial) fat pads of the anterior knee (Hoffa's fat pad behind the patellar ligament), the anterior and posterior elbow and the anterior ankle.

7. Skin

The skin is a thin, hyperechoic and homogeneous layer.



A. Skin
B. Flexor carpi radialis tendon
C. Subcutaneous fat
D. Flexor pollicis longus tendon
E. Radius
F. Palmaris longus tendon
G. Median nerve
H. Flexor digitorum tendons (superficialis and profundus)
I. Lunate bone
J. Palmaris brevis muscle
K. Flexor retinaculum
L. Ulnar veins
M. Ulnar artery
N. Ulnar nerve
O. Pisiform bone
P. Triquetral bone



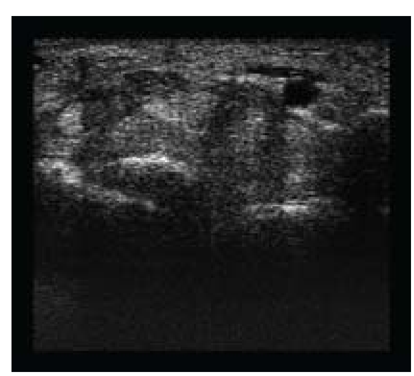


Figure 8: Transverse scan of the anterior wrist. Corresponding drawing.

PATHOLOGY

Ultrasonography has been largely used for the examination of tendons, tendon sheaths and bursae. Due to the improved capability of ultrasonography to demonstrate even small anatomical structures, there is now a wider range of indications, mainly in sports injuries, rheumatic diseases and patients with palpable masses in the soft tissues.

1. Tendons, tendon sheaths and bursae

Tendonitis is inflammation of tendons with no tendon sheath. Ultrasonography shows an enlarged and diffusely hypoechoic tendon. Peritendinous and intratendinous hypervascularization is often displayed on the power Doppler examination. The condition may become chronic (tendinosis), sometimes with intratendinous calcifications. Calcifications are hyperechoic, generally seen as bright reflective structures without through-transmission and with a strong posterior shadowing. Findings may also be focal, e.g. in the upper insertion of the patellar tendon ("jumper´s knee").

Tenosynovitis is inflammation of tendons surrounded by a tendon sheath. The tendon sheath is filled with fluid (anechoic) or synovial tissue (hypoechoic), which is best seen on a transverse scan. Synovial hypervascularization may be detected with a power Doppler examination. With time (subacute and chronic stages), hypertrophy of the tendon itself may develop (e.g. de Quervains stenosing tenosynovitis at the wrist).

Tendon tears should be diagnosed without delay and are seen as a defect in the substance or the outline of a tendon, or as a localized zone of altered echogenicity. Changes may be difficult to describe, as many tears develop in tendons with previous degenerative lesions (tendinosis). It is important to differentiate between small intratendinous microruptures, partial tendon tears and complete tendon tears. Partial tears in tendons with no synovial sheath are big enough to produce a defect in the outline of the tendon. Partial tears in tendons surrounded by a tendon sheath often progress into a longitudinal splitting of the tendon, which may also be hypertrophied (e.g. peroneus tendons at the ankle, long head of the biceps at the shoulder or extensor carpi ulnaris at the wrist). In complete tears, a retraction of the tendon fragments is often present and should be measured in order to plan the surgical treatment. In small complete tears or partial tears, the retraction may be detected or induced by a dynamic examination.

Tears may also be localized at the bony insertion or at the musculotendinous junction (e.g. "tennis leg", which is generally a tear of the insertion of the Achilles tendon on the medial gastrocnemius muscle and diagnosed indirectly by the anechoic/hypoechoic blood collection localized between the medial gastrocnemius and soleus muscles).

Bursitis is detected as a fluid-filled or synovial flat structure in characteristic anatomical sites. Small amounts of fluid may be overlooked if the examination is performed with too much compression or if the patient is not examined in different positions. On a seated patient, small amounts of fluid in the subdeltoid bursa are often localized inferiorly or anteriorly, and the shoulder must always be examined sufficiently in the distal direction.

2. Shoulder

Symptoms of shoulder joint pathology are generally nonspecific and related to many different etiologies (periarticular, articular, osseous), but most patients with shoulder pain have a disease of the periarticular soft tissues (rotator cuff, long head of the biceps and subdeltoid-subacromial bursa).

Figure 9. Calcification in the supraspinatus tendon (longitudinal scan).

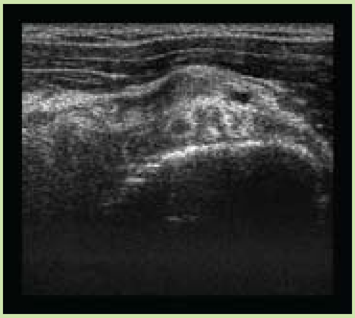


Figure 10. Impingement syndrome: Painful compression of the supraspinatus tendon and subacromial bursa against the coracoacromial ligament during abduction of the arm.

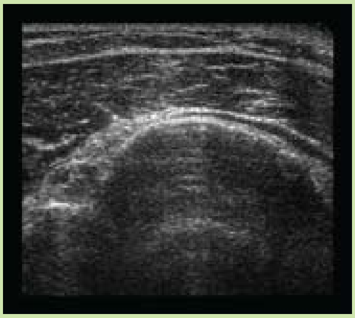


Figure 11. Transverse scan showing fluid in the subacromial bursa and the tendon sheath of the long head of the biceps.

Ultrasonography has therefore shown to be an outstanding first line examination modality.

Rotator cuff pathology (subscapularis, supraspinatus and infraspinatus tendons) may be associated with acute tendinitis, partial-thickness tendon tear, full-thickness tendon tear or intratendinous calcification. Tendinitis and tendon tears are most frequently found in the supraspinatus tendon (Figure 6), which is due to the exposed anatomical position of this tendon during abduction (subacromial impingement). It should be kept in mind that degenerative changes (tendinosis) are commonly present in the supraspinatus tendon and increase with age.

Intratendinous calcifications may be symptomatic (pain, impingement) and are mostly found in the supraspinatus tendon and seen as hyperechoic with a strong posterior shadowing when hard (Figure 9), or without a posterior shadowing when smooth. Smooth calcifications may be treated by ultrasound-guided needle aspiration.

The dynamic ultrasound examination of the shoulder is of great value and may objectively show pathological conditions like the impingement syndrome (painful arc during compression of the supraspinatus tendon and subacromial bursa against the coracoacromial arc during abduction of the arm) (Figure 10).

Figure 13. Ultrasound-guided steroid injection in the subdeltoid bursa of the shoulder.

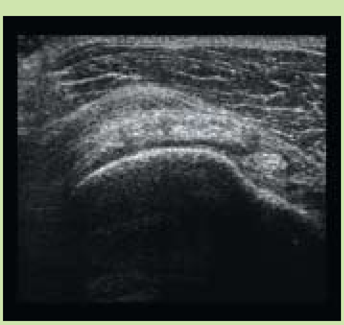


Figure 12. Chronic subacromial bursitis with thickening of the synovial wall (transverse scan).

Pathology of the long head of the biceps. Effusion in the tendon sheath is not in itself a sign of tenosynovitis as it is related to shoulder joint effusion (communication between the joint and the tendon sheath) (Figure 3). Changes in the tendon may be due to tenosynovitis (thick tendon with fluid in the tendon sheath), tendinosis (thick tendon), partial tendon tear (sometimes with splitting of the tendon) or complete tendon tear (empty bicipital groove, retracted tendon parts, if chronic atrophic hyperechoic muscle). Luxation of the long head of the biceps is clinically difficult to diagnose but easy to detect ultrasonographically (empty bicipital groove with medially located tendon).

Subdeltoid-subacromial bursa: traumatic bursitis with fluid in the bursa (Figure 11) or chronic thickness of the synovial walls (Figure 12). Bursitis in inflammatory joint diseases with often marked, hypoechoic synovial hypertrophy and hyperemia. Treatment by steroid injection in the bursa may be safely and efficiently performed when ultrasound-guided (Figure 13).

Diseases of the acromio-clavicular joint may mimic diseases of the rotator cuff (arthrosis, arthritis, subluxation).

In patients with a direct shoulder trauma, ultrasonography may differentiate between rotator cuff tear, rotator cuff tendinitis, subdeltoid-subacromial bursitis, fracture of the greater tuberosity (which may be missed with plain radiography), capsule or ligament lesion of the acromio-clavicular joint (with or without luxation).

3. Knee

MRI is an established imaging technique which provides a complete examination of the knee. Ultrasonography is unsurpassed for the assessment of the periarticular soft tissues (tendons, bursae, collateral ligaments,

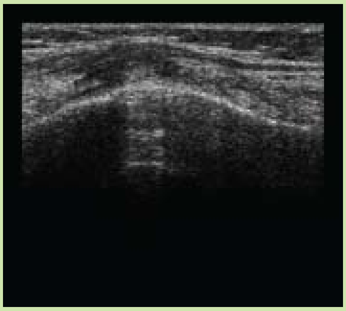


Figure 14A. "Runner´s knee" with bursitis between the thickened iliotibial band and the lateral femoral condyle (longitudinal scan).

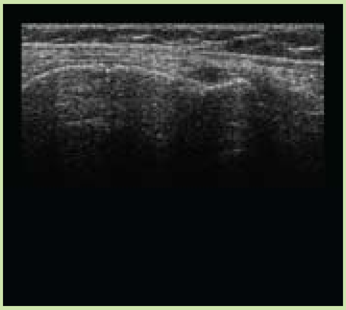


Figure 14B. Contralateral normal side.

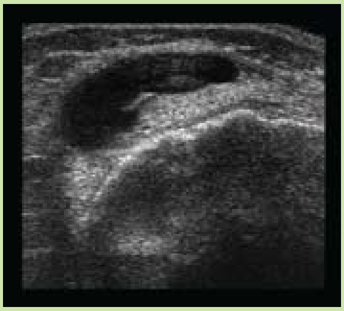


Figure 15. Transverse scan of the medial aspect of the knee, showing a ganglion cyst connected to the joint capsule and overlying the medial collateral ligament.

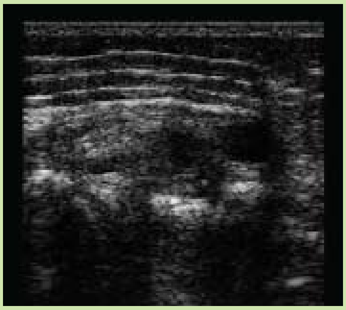


Figure 16. Meniscal cyst of the medial aspect of the knee, connected to a tear through the hyperechoic meniscus.

patellar retimaculum), but evaluation of the important intra-articular structures of the knee (menisci and cruciate ligaments) is difficult, requiring a specific technique and an experienced examiner.

Signs of joint effusion and/or synovitis are searched for in the suprapatellar recess. If there is any doubt in differentiating these findings, compression of the recess with the transducer is easy to perform. Bony, or even radio-negative cartilaginous loose bodies may be detected in all recesses or in a Baker´s cyst.

Tendon pathology in the extensor mechanism (two big patellar and quadriceps tendons) or other tendons generally consists of tendinitis, jumper´s knee or tendon tear (most frequently at the distal part of the quadriceps tendon about one or two cm from the bony insertion). In patients with jumper´s knee, an intratendinous focal hypoechoic zone is seen at the upper insertion of the patellar tendon. This lesion often appears hypervascularized on power Doppler examination and calcifications frequently develop.

In "runner's knee", an overuse condition in runners with anterolateral knee pain, ultrasonography shows a hypoechoic mass (bursa) between the iliotibial band and the lateral femoral condyle (Fig. 14). The iliotibial band may be thickened at the level of femoral condyle or at the tibial insertion.

Masses around the knee may be Baker´s cysts (pathological distension of the semimembranosus-medial gastrocnemius bursa), bursitis (most commonly prepatellar, infrapatellar, iliotibial in runner´s knee), ganglion cysts (generally anechoic, in relation to the knee joint capsule or the superior tibiofibular joint, and containing a thick, gelatinous material when punctured) (Figure 15), meniscal cysts communicating with a meniscal tear (Figure 16), hematomas, abscesses, and soft tissue tumors.

In patients with a mass in the popliteal fossa, Baker´s cysts, tumors, popliteal aneurysms and hematomas may be identified properly. Baker´s cysts are identifiable by their location and visualization of the communication between the cyst and the knee joint. In patients with an acute edematous leg, differentiation between a Baker´s cyst rupture with the presence of subfascial fluid in the leg and compression or thrombosis of the popliteal vein may be obtained.

MRI is still the gold standard for demonstrating meniscal lesions, but ultrasonography may detect a great number of them, especially in the posterior horn of the medial meniscus, which is particularly well demonstrated using a posterior approach and a dynamic examination (flexion/extension of the leg). Lesions are seen either as hyperechoic lines or–if the meniscus fragments are displaced and fluid present in the joint–as hypoechoic/anechoic clefts.

Lesions of the collateral ligaments are easy to diagnose, but lesions of the cruciate ligaments are best demonstrated by MRI. Nevertheless, an acute lesion of the anterior cruciate ligament may be detected indirectly by the presence of a hematoma at the upper, femoral insertion of the ligament.

Other lesions that may be displayed are lesions of the medial patellar retinaculum (acute or chronic) or signs of Osgood-Schlatter disease (cartilage thickening and bony fragmentation in the tibial tuberosity, patellar tendinitis and bursitis).

4. Ankle and foot

Achilles tendon diseases are frequent indications for ultrasonography. The symptoms may be due to tendinopathy, peritendinitis, tendon rupture, enthesopathy or retrocalcaneal bursitis.

In tendinopathy (acute tendonitis and/or chronic tendinosis), a diffuse or focal hypoechoic tendon thicken-

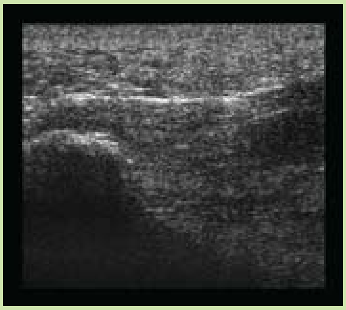


Figure 17A

Figure 17B

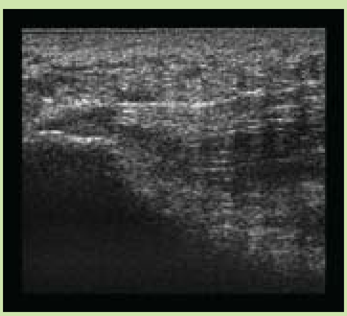


Figure 17C

Figure 17. Plantar fasciitis.
A: Thickened and hypoechoic plantar fascia at the calcaneal insertion (longitudinal scan). B: power Doppler examination showing hyperemia in the thickened plantar fascia. C: Calcaneal insertion of the contralateral normal plantar fascia.

ing with preservation of the fibrillar tendon structure is found. The tendon is rounded on a transverse scanning plane, with a convex anterior border (Figure 5). With power Doppler examination, peri and intratendinous hyperemia is often present. Microruptures and calcifications may develop. Peritendinitis is seen as a hypoechoic thickening of the epitendineum, with or without signs of tendinopathy. Signs of enthesopathy may be seen in patients with overuse or inflammatory joint diseases.

Achilles tendon rupture (partial or complete) generally occurs in tendons with underlying tendinopathy, generally 6 to 10 cm from the insertion on the calcaneus. In complete rupture, the importance of the tendon retraction is measured preoperatively. The tendon defect may be filled with fluid, blood, invaginated fat or, when chronic, granulation tissue. A dynamic examination is very useful in difficult cases (chronic ruptures or postoperative reruptures).

In "tennis leg", the rupture is localized at the musculotendinous junction of the medial gastrocnemius muscle. A fluid collection is detected between the medial gastrocnemius and soleus muscles. Over time, a hypoechoic fibrous residual mass may develop.

In retrocalcaneal bursitis, an enlarged, fluid or synovial filled bursa is seen in the angle between the Achilles tendon and the calcaneus. Hyperemia is often detected in or around the bursal wall with the power Doppler examination. Inflammation of the adjacent part of the Achilles tendon or erosions on the calcaneus may be present. Ultrasound-guided puncture may be performed for fluid analyses or steroid injection.

Anterior, lateral or medial tendons have tendon sheaths, and ultrasonography is outstanding for demonstrating tenosynovitis, tendon rupture or tendon luxation. In tenosynovitis, there is fluid and/or synovial proliferation in the tendon sheath. In partial tendon tear, a splitting of the tendon may develop (most frequently in the peroneus brevis or tibialis posterior tendons). In a complete tendon tear, the exact extent of the tendon retraction is visualized. Power Doppler is used to detect vascular activity, and ultrasound can be used to guide interventional procedures. Ultrasonography may show luxation of the peroneus tendon over the edge of the fibula. A dynamic test (eversion/dorsal flexion of the foot) may be necessary to detect difficult cases.

Signs of joint effusion, synovitis and/or loose bodies are detectable in the anterior, lateral or medial recesses, but the posterior recess is more difficult to analyze.

Ligament lesions (anterior talofibular, calcaneofibular, anterior tibiofibular or medial collateral ligament) may be detected in detail, especially in patients with chronic problems (anterior "impingement" due to granulomatous tissue at the anterolateral joint line).

Diseases of the plantar fascia are easy to demonstrate with ultrasonography: plantar fasciitis (thickened and hypoechoic calcaneal insertion) (Figure 17); rupture (several cms distal to the calcaneus); plantar fibromatosis (soft tissue tumor in the plantar fascia).

Morton´s neuroma is a pseudotumoral lesion of the plantar interdigital nerve (perineural fibrosis), most frequently seen in the 3rd interstitium. With ultrasonography, a small, hypoechoic mass with irregular margins is found between the metatarsal heads.

5. Hip

Most ultrasonographic examinations of the hip are performed to detect signs of arthritis (joint effusion and/or synovial hypertrophy) and to perform ultrasound-guided needle puncture when infectious or cristal arthropathy is suspected. Intra-articular steroid injection may also be performed by the same technique. Other indications are lateral pain (suspicion of trochanteric bursitis or gluteus medius tendinitis) or anterior pain (suspicion of adductor or iliopsoas tendinitis, hernia, ileopectineal bursitis).

In patients with a painful snapping hip, the dynamic examination may

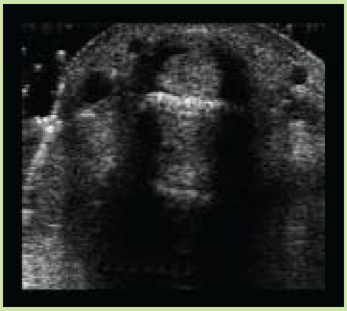


Figure 18A

Figure 18B

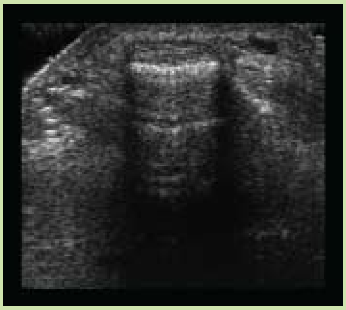


Figure 18C

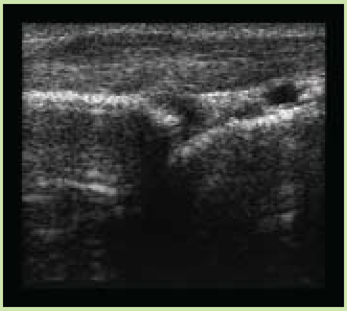


Figure 18D

Figure 18.
de Quervain´s tenosynovitis with thickening of tendons and tendon sheath seen in transverse (A) and longitudinal (B) scans of the wrist. Transverse (C) and longitudinal (D) scans of the contralateral normal tendons.

objectively detect conditions that are difficult to diagnose: external snapping of the iliotibial band over the greater trochanter, anterior snapping of the iliopsoas tendon over the femoral head.

6- Wrist and hand

Tenosynovitis (most tendons around the wrist have a tendon sheath) may easily be diagnosed by ultrasonography. Most frequent is de Quervain´s tenosynovitis, which is a subacute stenosing tenosynovitis related to overuse (Figure 18), and the flexor tendons tenosynovitis which may lead to carpal tunnel syndrome. In patients with infection, ultrasonography may detect infectious tenosynovitis or foreign bodies. Ultrasound-guided puncture may be performed for aspiration when infection is suspected, or steroid injection when infection is ruled out (Figure 19).

Tendon rupture is also well demonstrated and the level of the retracted proximal tendon communicated to the surgeon. Dynamic tests may help to detect tendon luxation (extensor carpi ulnaris).

Signs of tendinopathy and entesopathy are seen in tendons without tendon sheath (flexor carpi ulnaris).

Effusion, synovitis and/or bone erosions of the wrist, carpal joints or finger joints are important findings in inflammatory joint diseases (rheumatoid arthritis).

In carpal tunnel syndrome, entrapment of the median nerve is directly visualized (thickening proximal to the flexor retinaculum, flattening at the level of the retinaculum and bulging of the retinaculum). The cause of an extrinsic compression may be detected (e.g. ganglion, flexor tendon tenosynovitis, wrist synovitis).

All types of masses around the wrist, most frequently ganglion cysts, may be diagnosed properly. Ganglions are generally anechoic lesions connected to joint lines or tendon sheaths.

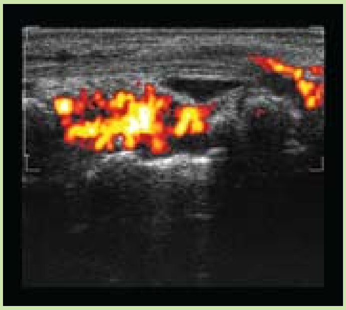


Figure 19A

Figure 19B

Figure 19C

Figure 19.
Longitudinal (A) and transverse (B) power Doppler scans in a patient with tenosynovitis of the wrist. C: Ultrsound-guided steroid injection with the tip of the needle inside the tendon sheath (transverse scan).

Some ligament lesions of the wrist and fingers may benefit from ultrasonography. Lesions of the ulnar collateral ligament of the first metacarpophalangeal joint, generally seen in skiers, may lead to chronic instability of the thumb if untreated. Surgery is mandatory if the proximal part of the ligament is luxated dorsally to the adductor fascia (Stener´s lesion), which is seen on an ultrasound as a small hypoechoic mass.

7. Elbow

Ultrasonography of the synovial recesses (anterior, posterior and annular at the radial neck) may show signs of joint effusion (Figure 20), synovitis or loose bodies (bony or even radio-negative cartilaginous).

The biceps tendon is a difficult structure to examine, due to its obliquity at the insertion on the radial tuberosity. Complete tear of the biceps tendon is generally clinically evident, but ultrasonography may be helpful in difficult cases. In patients with anterior pain, ultrasonography may differentiate between biceps tendinitis or partial tear and bicipitoradial bursitis. Lesions of the triceps tendon are not frequent. Olecranon bursitis are easy to document but generally clinically evident.

Ultrasonographic signs of inflammation of the tendon insertion at the lateral (tennis elbow) and medial (golfer's elbow) humeral epicondyle are those seen in all types of enthesopathy (hypoechoic tendon thickening, microruptures, calcifications and/or bone irregularities) (Figure 21).

8. Joint diseases

Ultrasonography of joints cannot provide a full examination of all anatomical areas, but most joint diseases (e.g. inflammatory, degenerative or tumoral joint diseases) are associated with changes in the synovial recesses, which are generally accessible to the ultrasonographic examination. Patients with joint inflammation develop non-specific signs of joint effusion and/or synovial thickening.

Joint effusion is easy to detect with ultrasonography, even when the clinical examination is difficult (hip). Even a small amount of fluid may be detected and localized in certain recesses (anterior recess in the hip and the ankle, suprapatellar recess in the knee, tendon sheath of the long head of the biceps in the shoulder). Ultrasound-guided needle aspiration of the joint fluid may lead to an immediate relief of the pain (in patients with high intracapsular pressure), and to the diagnosis of septic or cristal arthritis.

Synovial thickening may be seen directly on ultrasonography and measured precisely: thick hypoechoic synovial tissue connected with the joint line, sometimes with villous formations or a pseudotumoral aspect (rheumatoid pannus). Differentiation between effusion and synovitis may be made by compression with the transducer

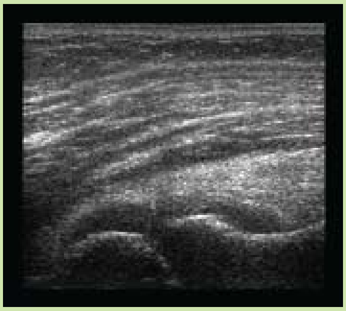


Figure 20A

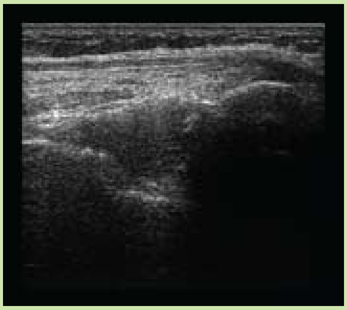


Figure 20B

Figure 20C

Figure 20.
Joint effusion seen in the lateral aspect of the elbow in a longitudinal scan (A) and the posterior recess (B: longitudinal, C: transverse).

Figure 21A

Figure 21B

Figure 21C

Figure 21.
Tennis elbow. A: Longitudinal scan of the thickened and hypoechoic tendon insertion on the lateral epicondyle.
B: Same scan with power Doppler examination showing intratendinous hyperemia. C: Normal contralateral tendon insertion.

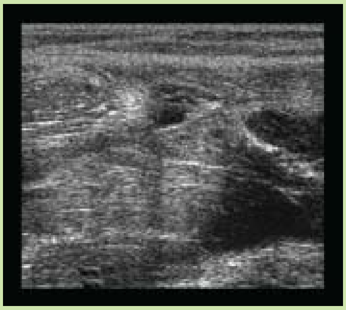


Figure 22A

Figure 22B

Figure 22.
A: Complete tear of the rectus femoris muscle at rest (longitudinal scan).
B: Same scan during muscle contraction with the defect in the muscle more clearly seen.

(suprapatellar recess), power Doppler examination (synovial activity), or ultrasound-guided puncture. Bone destruction may be found (tumor, rheumatoid arthritis).

Cartilaginous changes in patients with arthritis or osteoarthritis may be detected in regions available to ultrasonography (not covered by bone): heterogeneous echostructure, irregular surface, focal defect or a thinning of the cartilage.

9. Muscles

Ultrasonography is useful for the diagnosis of traumatic changes. The real extension of a lesion is best studied after one or two days. Contusions (hyperechoic areas) and partial/complete tears (localized blood collections) may be diagnosed. In difficult cases, a dynamic examination may be helpful (Figure 22). Infected muscles may be enlarged and hypoechoic (myositis). Bacterial infection may lead to pyomyositis and abscess (collection). Ultrasound-guided needle puncture of even small fluid collections provide immediate and safe detection of abscesses (pus) and hematomas (blood) (Figure 23). The microbiological diagnosis of abscesses may be obtained without delay and the patients treated by ultrasound-guided catheter drainage.

Ultrasonography may give information about the localization, size and anatomical relations of soft tissue tumors, but cannot make a definite diagnosis of malignancy or benignity. Some tumors may nevertheless be relatively easy to recognize (lipomas, hemangiomas, neurinomas, some sarcomas, and so on). A preoperative histological diagnosis is nearly always mandatory and should be performed before all diagnostic imagery (MRI). In many centers, it is obtained as an ultrasound-guided needle biopsy, which is less traumatic than an open surgical biopsy.

Ultrasonography is a very reliable technique for the detection of foreign bodies in the soft tissues (hyperechoic structure, with or without shadowing, sometimes surrounded by some hypoechoic tissue). Removal may be performed with ultrasound-guided surgery.

10. Nerves

Some soft tissue masses arise from or connect tightly to a nerve and these may be displayed by ultrasonography (neurinomas, neurofibromas, neuromas, ganglion cysts).

In patients with nerve entrapment - carpal tunnel syndrome (median nerve), cubital tunnel syndrome (ulnar nerve at the elbow), Guyon tunnel syndrome (ulnar nerve at the wrist), common peroneal nerve at the fibular neck, tarsal tunnel syndrome (tibial nerve), intermetatarsal space (Morton´s neuroma)–an extrinsic cause of compression may be found: tenosynovitis, synovitis, ganglion cyst, soft tissue tumor, osteophytes, foreign body.

Luxation of the ulnar nerve may be assessed dynamically during flexion of the elbow.

11. Bones

Changes that affect the bone surface are detectable by ultrasonogaphy: fractures, exostoses, destructions in patients with bone metastases or rheumatoid arthritis, osteomyelitis with subperiosteal abscess formation.

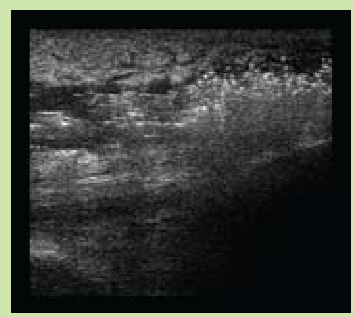


Figure 23A

Figure 23B

Figure 23.
Abscess of the posterior aspect of the elbow. A: Hypoechoic fluid collection with air bubbles in the subcutaneous tissue over the triceps tendon. B: Ultrasound-guided needle puncture.

CONCLUSION

B-K Medical provides a number of high frequency linear array transducers that are optimized for musculoskeletal applications. For physicians, the benefits are high-resolution imaging with good penetration during near-field small-part scanning at a reasonable price.

Transducers from B-K Medical can perform dynamic ultrasound examinations; they are equipped with high Doppler sensitivity and are optimized for steered Doppler examination.

Interventional procedures, such as biopsies and therapeutic applications, are made easy and straightforward.

Physicians can see even small structures, such as those in the hand and wrist, with exceptional clarity. Transducers from B-K Medical exploit the resolution of very high frequencies so that the contrast and resolution they provide are excellent for detailed examinations, where the ability to detect small structures is crucial (Figures 1 and 2).

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With more than 30 years of commitment to ultrasound innovation, BK Medical specializes in the development, manufacture and distribution of dedicated ultrasound solutions. B-K Medical has its headquarters in suburban Copenhagen, Denmark, and has offices and distributors throughout the world.

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