



Ultrasound of the skeletal and muscular system

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ABSTRACT

The skeletal and muscular system includes different types of muscles, each of which plays an essential role in the body's function. The use of musculoskeletal ultrasound in diagnosing the cause of chronic pain in nerves, muscles and joints has many advantages over older diagnostic methods. One of the most important advantages is providing a live image of the body organs without using dangerous radiation. Musculoskeletal ultrasound is an imaging method of muscles, tendons, ligaments, peripheral nerves and joints. With the help of musculoskeletal ultrasound, it is possible to observe the stretching and pressure of tendons and muscles. Also, this imaging method can identify nerve entanglement, arthritis and other problems related to the nervous and muscle system. Musculoskeletal ultrasound is a safe and non-invasive imaging method that does not use dangerous radio waves. Observing the anatomical structures and nerves of the body continuously allows the doctor to carry out the diagnosis and treatment process with sufficient precision and accuracy.

Introduction

Musculoskeletal diseases refer to all diseases and disorders related to bones, joints and muscles [1-3]. It is worth mentioning that the pain caused by all kinds of musculoskeletal disorders will disrupt a person's daily life and activities. In general, the following types of musculoskeletal diseases can be mentioned:

- ✓ Arthritis of joints and spine.
- ✓ Intervertebral disc.
- ✓ Spinal deviation [4].
- ✓ Inflammation of tendons and joints.
- ✓ Fibromyalgia.
- ✓ Myofascial pain syndrome.
- ✓ Carpal tunnel syndrome [5].
- ✓ Types of peripheral myopathies and neuropathies.

Application of musculoskeletal ultrasound

This imaging method helps to diagnose the following:

- ✓ Rupture or inflammation of the shoulder rotator cuff tendon, Achilles' tendon in the wrist and other tendons in the body.
- ✓ Muscle tears, lumps or fluid accumulation.
- ✓ Ligament stretching or tearing.
- ✓ Inflammation or fluid effusion within bursae and joints [6].
- ✓ Early changes in rheumatoid arthritis.
- ✓ Nerve entrapment such as carpal tunnel syndrome or ulnar neuropathy.
- ✓ Benign and malignant soft tissue tumors.
- ✓ Ganglion cysts, Hernia
- ✓ Foreign bodies in soft tissue such as glass.
- ✓ Hip dislocation in babies [7].
- ✓ Fluid in the painful hip joint of children.
- ✓ Examining neck muscle problems in babies.
- ✓ Soft tissue masses in children.
- ✓ Directing joint injections [8].
- ✓ Directing epidural injections.
- ✓ Guided intramuscular injection of Botox in spasticity and dystonia.

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Benefits of musculoskeletal ultrasound

Ultrasound provides real-time images. As a result, the doctor can observe the anatomy of the joint, tendon, ligament and muscle during movement. Radio waves are not used in ultrasound imaging. For this reason, this imaging method is safe for pregnant women and babies. Compared to other imaging methods, ultrasound has better access. Patients who use a pacemaker or other devices implanted in their body can benefit from ultrasound without any worries [9-11].

Preparation for musculoskeletal ultrasound

Wear comfortable and loose clothing. It may be necessary to remove all clothing and jewelry from the area to be examined. Sometimes it is necessary to wear a gown [12].

How to perform musculoskeletal ultrasound

For certain ultrasound examinations of the musculoskeletal system, the patient is asked to sit on an examination table or mobile chair. For other ultrasound examinations, the position should be face up. The radiologist may ask you to move the organ being examined or may evaluate it for you to assess the anatomy and function of the joint, muscle, ligament, or tendon. In the case of infants and children, the child should lie on the back on the examination table, other positions may be necessary (Figure 1).

Complications of musculoskeletal ultrasound

Ultrasound, like CT scan and radiography, does not use X-rays. Therefore, ultrasound is a safe and harmless method and has no side effects [13].

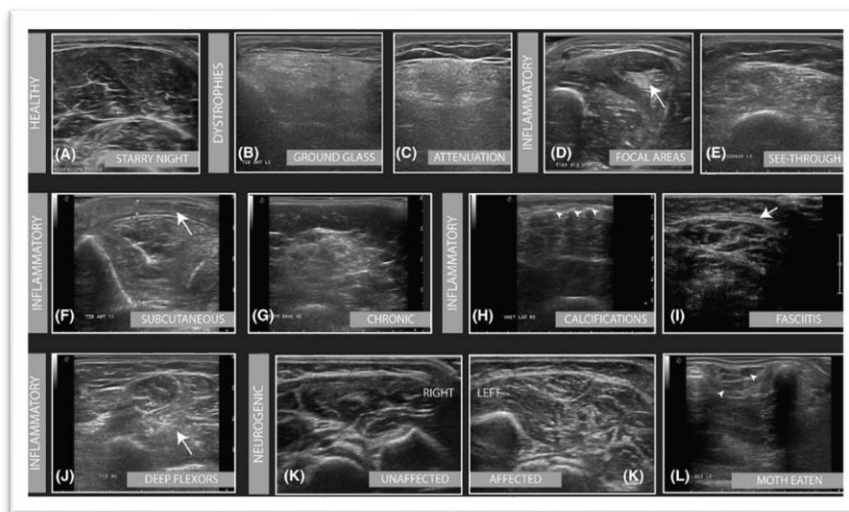


Figure 1. Muscle ultrasound: Present state and future opportunities

Diagnosis of bone and skeletal disorders with ultrasound

Ultrasound images are commonly used to help diagnose problems with skeletal organs:

- ✓ Tendon or tendinitis in the shoulder, Achilles, ankle and many other tendons in the body.
- ✓ Lumps or accumulation of fluid in the joints [14].
- ✓ Rupture of ligaments.
- ✓ Inflammation or accumulation of fluid in the joints, Rheumatoid Arthritis.
- ✓ Nerve damage such as carpal tunnel syndrome.
- ✓ Benign and malignant soft tissue tumors.
- ✓ Ganglion cyst, Hernia
- ✓ Hip dislocation in babies.
- ✓ Abnormalities of neck muscles in infants with torticollis, Lumps and bumps in children [15].

How is ultrasound of the skeletal system performed?

For neuromuscular ultrasound, the patient should be sitting or lying on the bed. The way the patient is positioned depends on where the imaging is performed. The desired surface is smeared with ultrasound gel and the ultrasound probe is guided by

the doctor. Sound waves enter the body through an ultrasound probe. Ultrasound waves pass through or return to any organ [16].

The returning waves are received again by the ultrasound probe and converted into an electrical signal. Then the electrical signals are converted into images by computer algorithms. Finally, the image will be seen on the monitor screen of the device. The sonographer may request the movement of the target organ during the imaging. This movement is to check joint, tendon, ligament and muscle function. Ultrasound of the skeletal system is generally painless. However, if the organ is slightly damaged, its movement causes irritation to the patient.

What are the limitations of muscle ultrasound?

Ultrasound cannot show bone tissue well. For this reason, other imaging methods are used to examine bones in adults. Bone tissue in babies is generally soft and cartilage-like. For this reason, there is a possibility of bone ultrasound in babies, but for children and adults, X-ray photography is needed. Ultrasound cannot provide adequate images of very internal organs. For this reason, ultrasound is not

recommended in structures that are deep. According to the evidence, ultrasound is not suitable for spinal injuries [17].

What are the benefits of muscle and joint ultrasound?

Ultrasound provides real-time images. As a result, the doctor can observe the anatomy of the joint, tendon, ligament and muscle during movement. Also, the patient can describe his pain while moving the limb and help the doctor to make a diagnosis. Radio waves are not used in ultrasound imaging. For this reason, this imaging method is safe for pregnant women and babies. Ultrasound has better access compared to other imaging methods. With the help of portable and handheld ultrasound imaging can be done anywhere and even in the patient's bed [18].

Physical medicine and rehabilitation in the diagnosis, treatment and rehabilitation of diseases of the musculoskeletal system

Physical medicine provides rehabilitation methods for physically and cognitively disabled people of all ages. A doctor specializing in physical medicine and rehabilitation is called a physiatrist [19].

Physiotherapists are highly skilled in diagnosing and treating diseases of the nervous system and injuries of the musculoskeletal system. Physical medicine and rehabilitation specialists are able to diagnose and treat problems such as stroke, brain-spinal cord injuries, muscle cramps, painful and nervous conditions of organs, all kinds of disabilities and physical disabilities. Physical medicine and rehabilitation may treat the patient with a combination of medicine, physiotherapy, massage, exercise therapy, epidural steroid injection, ozone therapy, laser therapy. In general, PMR activity is divided into three branches: physical medicine or musculoskeletal medicine, electrodiagnosis medicine and rehabilitation medicine. Recently, the use of ultrasound of the musculoskeletal system in clinical medical care, especially in the field of physical medicine and rehabilitation, has received attention [20].

What is the role of portable ultrasound devices in ultrasounds of the musculoskeletal system?

In general, ultrasound devices are divided into three categories: furnished, portable, and very small portable or handheld. Furnished devices are designed to perform advanced ultrasounds by radiologists. These devices have many features and their price range is around tens of thousands of dollars. Considering that in physical medicine and rehabilitation clinics, physiatrists only need ultrasound of the musculoskeletal system, the use of furnished ultrasound devices is not economical.

In physical medicine offices and clinics, portable ultrasound devices are usually used for ultrasound of the musculoskeletal system. Portable devices have a

more reasonable price than furnished devices and provide good quality images of the musculoskeletal system. In the last decade, portable and lightweight handheld ultrasound devices have entered the field of clinical medical care, which have been well received by the physiatrist community. Pocket ultrasound machines have the lowest price of ultrasound machines. The weight of these devices is very light and the doctor can easily carry them for a long time [21-23].

How does the ultrasound machine work?

The ultrasound imaging method uses the same principles of sonar that bats and ships use. When sound waves hit an object, they echo. By measuring these echoes, it is possible to estimate how far away the object is, how big it is, and what its shape is, and how stable it is [24].

It can also be estimated whether the object is solid or liquid. Doctors use ultrasound to find changes in the structure of organs, tissues and heart vessels and to find abnormal appendages such as tumors. In ultrasound, the probe sends both the waves and receives the return echoes. When the probe is placed on the skin, it sends silent high-frequency pulses into the body. As the waves bounce off internal organs, fluids, and tissues, the probe's sensitive receiver records tiny changes in the pitch and direction of the sound. The computer immediately measures these waves and displays them in the form of video images on the monitor. The expert usually saves one or more moments of moving images as a still image. It may also record short, back-and-forth videos of images.

Musculoskeletal applications

As the name suggests, ultrasound is a method for recording images of different tissues of the body. Musculoskeletal ultrasound is also one of the diagnostic methods that can be used to diagnose various musculoskeletal diseases. The basis of this method is to detect the dimensions, size and conditions of tissues and internal organs of the body, including muscles and tendons [25]. Although many musculoskeletal diseases can be diagnosed through this type of ultrasound, but still in some cases, people need to get help from other methods for diagnosis.

Among the applications of this diagnostic method are

- ✓ Diagnosis of tendon rupture or inflammation.
- ✓ Diagnosis of Achilles tendon diseases in wrists and other body tendons.
- ✓ Diagnosis of rupture of muscles and different organs.
- ✓ Identifying masses and liquids accumulated in these masses.
- ✓ Diagnosis of rupture or stretching of all types of ligaments and tendons [26].

- ✓ Diagnosis of inflammation or accumulation of fluid in the bursae and joints of the body.
- ✓ Diagnosis of joint rheumatism, especially in the early stages.
- ✓ Diagnosis of nerve entrapment such as carpal tunnel syndrome.
- ✓ Diagnosis of benign and malignant soft tissue tumors.
- ✓ Observing and examining the position of foreign bodies in soft tissues.
- ✓ Diagnosing pelvic dislocation in infants and children, Diagnosis of hernia.
- ✓ Examining the types of neck muscle problems in babies (Figure 2).

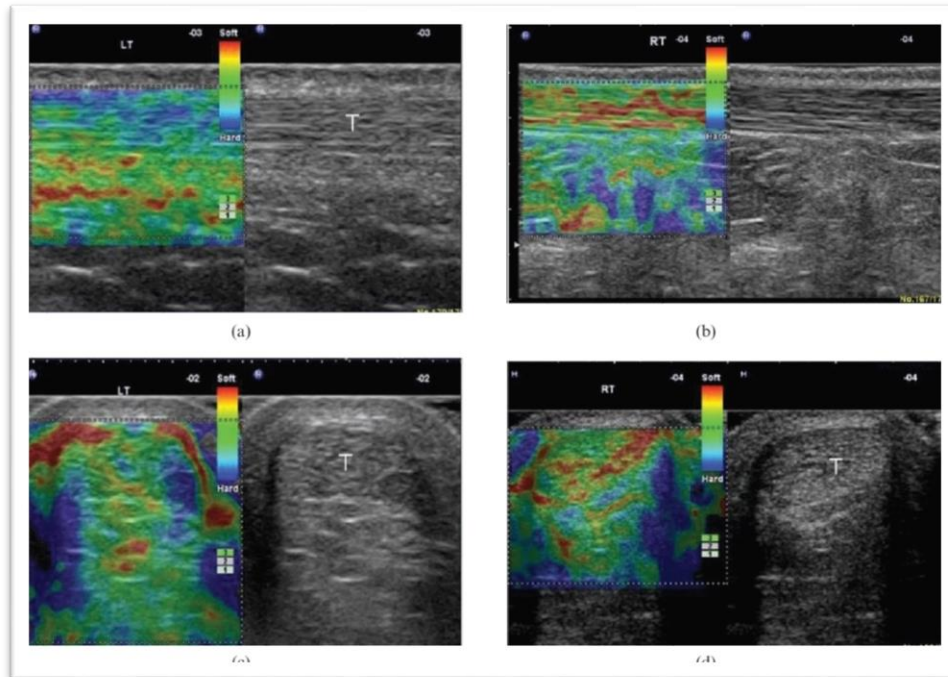


Figure 2. Ultrasound elastography for musculoskeletal applications

The use of MSUS in muscle in sports injuries

About 30% of sports injuries occur in muscles. Most acute muscle injuries occur as a result of vigorous eccentric muscle contractions or direct trauma to the muscle and usually occur at the myotendinous junction, especially for muscles crossing two joints. Magnetic resonance imaging (MRI) provides accurate diagnosis of acute muscle injury, but the equipment is usually reserved for medical use. MSUS provides adaptive resolution for visualizing normal and injured muscle structures and is available for assessing the severity and extent of injury in the field [27-29].

Muscle injuries can be classified into three degrees according to their severity:

1- First-degree injury: In this category, the muscle damage is subtle and the loss of muscle function is negligible. However, there are echogenic changes and integrity of the perimysium under ultrasound examination. If the transducer is placed correctly, it is possible to detect the loss of the natural pattern of the panormium. To assess the severity of the injury, it is recommended to compare the muscle lesion with the sound side [30].

2- Second degree injury: In this category, parts of the fibers of the muscle belly are torn and usually a partial tear of the muscle is detected. Target muscle function is clinically somewhat affected. Ultrasound is very useful in localizing and measuring the size of partial tears. A local hypoechoic or anechoic area can be visualized in such partially torn muscles. Subtle muscle tears can be clinically asymptomatic. However, it is possible that the gap between the fibers is increased and can be seen on ultrasound, especially when the affected muscle contracts. Therefore, a dynamic ultrasound study with active movement of the affected muscle should be routinely performed if muscle injuries are suspected [32-35].

3- Third-degree injury: In this category, full-thickness muscle tear occurs and the loss of function is significant. Ultrasound is useful both in determining the extent of the injury and in locating the torn end of the muscle for surgical repair [36--38]. A hematoma usually develops later in the torn muscle. This always compromises the function of the affected part of the body [39-41]. Serial ultrasound follow-ups help to understand the healing process. In subsequent investigations, this study showed that the damaged muscle may be replaced

by fibrotic tissue, which reduces its elasticity and strength [42-44]. For elite athletes, ultrasound provides valuable information about the recovery of muscle injuries and helps doctors determine the right time to return to fitness. Sports-related rhabdomyolysis is a severe and potentially life-threatening disease [45].

Sports rhabdomyolysis usually occurs after prolonged or intense exercise, such as marathon running and bodybuilding. Exercising in a high-temperature environment, which leads to hyperemia, is also one of the causes of rhabdomyolysis. Without prompt treatment, acute kidney failure may occur. Clinical observations as well as laboratory data and MRI provide a good diagnosis for this disease. However, ultrasound provides direct visualization of the change in echogenicity and peripheral decomposition of the affected muscle [46].

Conclusion

Our human body consists of many different tissues, including bones and soft tissues such as tendons, muscles, and ligaments. Any of these tissues may be torn and injured due to improper care or performing a series of unprincipled movements. In order to detect the damages caused to the skeletal-muscular tissues, different methods can be used such as M. R. Oh you. X-ray imaging is used, but a completely safe method that does no harm to the human body is ultrasound. Musculoskeletal ultrasound, which is called musculoskeletal, is a safe method for diagnosing musculoskeletal tissue problems. This diagnostic method is based on ultrasound waves that are radiated to the internal tissues of the body, and by receiving the reflected information, the size, dimensions and conditions of different tissues can be recognized. Although there are various other methods for diagnosing musculoskeletal diseases, musculoskeletal ultrasound is a completely safe and non-invasive method. With this method, there is no need for radio waves and X-rays to diagnose musculoskeletal diseases. For this reason, this method can be performed for all age groups such as children and adults.

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Authors' Contributions

All authors contributed to data analysis, drafting, and revising of the paper and agreed to be responsible for all the aspects of this work.

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