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REVIEW ARTICLE

Application of Ultrasound in Sports Injury

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The ability to make correct ultrasonographic diagnosis in sports injuries is improving as advancing technology allows for high-resolution images in contemporary medical ultrasound. Ultrasonography demonstrates tissue structure with two-dimensional grayscale images. Blood flow in the tissue can be rapidly depicted with color and power Doppler technique. Furthermore, ultrasonography is the preferred imaging modality to study soft tissue lesions dynamically. With high-resolution images afforded by ultrasonography, injuries of the muscle, tendon, ligament, bursa, bony structure, cartilage, and subcutaneous tissue can be accurately diagnosed if the examiner is well trained. A panoramic view makes the ultrasonographic images better understood by the sports clinicians. The advanced technique of sonoelastography examination, which facilitates understanding of stiffness in the soft tissue, is also a potential tool in diagnosis of sports injuries. Recently, compact ultrasound machine machines are becoming increasingly available, leading to prompt ultrasonographic diagnosis of sports injuries on the field. In this brief review, we will discuss common sports injuries of these structures, their clinical implications, and ultrasound key points.

Introduction

The resolution of ultrasound images has improved rapidly in recent years. Ultrasound machines with high-frequency (12–15 MHz) linear array transducers provide better image resolution and are widely used to evaluate superficial soft tissue structures such as muscle, tendon, ligament, and bursa. They are therefore commonly referred to as musculoskeletal ultrasound (MSUS) machines. Grayscale techniques provide anatomic pictures for target lesions, while color and power Doppler detect soft tissue vascularity. Panoramic images depict extended fields of view that can demonstrate the whole vision of lesions and their relationship with adjacent structures. The availability of compact portable ultrasound machine makes it possible for physicians to perform real-time assessment for patients. On the event field, sports practitioners can now perform

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prompt scanning, draft an exact treatment protocol, and start treating the injured athlete immediately [1]. Indeed, MSUS is recommended as the first line imaging tool to evaluate sports injuries [2].

In this article, applications of MSUS to common sports injuries will be reviewed. The limitations and possibilities of further development of MSUS will also be briefly discussed.

Application of MSUS to the muscle in sports injuries

About 30% of sports injuries occur in the muscles [3]. Most acute muscle injuries occur from violent eccentric muscle contractions or a direct blow to the muscle, and usually occur at the myotendinous junction [4,5], especially for the muscles crossing two joints [6]. Magnetic resonance imaging (MRI) provides accurate diagnosis to an acute muscle injury but the equipment is usually reserved for medical use [7]. MSUS provides compatible resolution to visualize the normal and injured muscle structures and is available on the field to assess the severity and extent of injury.

Muscle injuries can be classified into three degrees according to their severity [3]:

1. First degree injury: In this class, muscle injury is subtle, and loss of muscle function is insignificant. Nevertheless, there are changes of echogenicity and integrity of the perimysium under ultrasound examination. Loss of normal pennate pattern of the perimysium (Fig. 1A) can be detected if the transducer is properly placed. Comparison of the muscle lesion to the sound side is recommended for grading the severity of the injury.
2. Second degree injury: In this class, parts of fibers in the muscle belly are torn and are usually diagnosed as a partial muscle tear. The function of target muscle is affected clinically to a variable extent. Ultrasound is extremely useful in localizing and measuring the size of partial tears. Localized hypoechoic or anechoic area can be depicted in such partially torn muscles (Fig. 1B). Subtle ruptures of muscles can by asymptomatic clinically. However, the gap of fibers may be widened and becomes evident in ultrasonography especially when the affected muscle contracts. Thus, dynamic ultrasonographic study with active movement of the affected muscle should be routinely performed in suspicion of muscle injuries.
3. Third degree injury: In this class, full-thickness rupture of the muscle happens (Fig. 1C) and loss of function can be significant. Ultrasound is useful in both determining the extent of injury and finding the torn ends of the muscle for surgical repair.

Hematoma usually develops later within the torn muscle. It always causes functional compromise of the involved body part. Serial sonographic follow-ups help in understanding the process of healing. In follow-up examinations, this study found that the injured muscle may be replaced by fibrotic tissue, which reduces in its elasticity and strength. For elite athletes, ultrasound provides valuable information about healing of muscle injuries and help physicians to determine appropriate timing for returning to fitness [8].

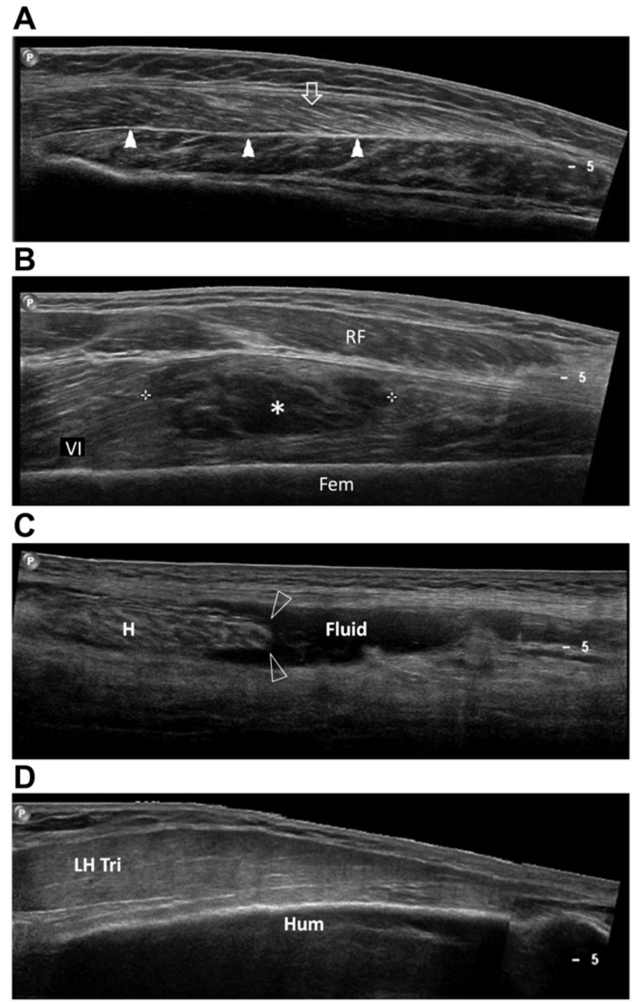

Fig. 1 Ultrasound pictures from various pathologies of the muscles. (A) Normal sonographic picture of the muscle. The perimysiums depict parallel echogenic lines (open arrow) and the fascial (arrowheads) between the muscles. (B) Partial tear of the muscle showing hypoechoic area (*) in the vastus intermidialis muscle (VI) between rectus femoris muscle (RF) and femoral bone. (C) Complete rupture of right hamstring muscle (H). Margin of ruptured muscle (open arrowheads) can be seen in the anechoic fluid. (D) Rhabdomyolysis of long head of triceps muscles (LH Tri) showing diffused echogenic change of the muscle. The perimysiums in the muscle are hard to identify.

Sports-related rhabdomyolysis is a severe and potentially life-threatening condition [9]. Exertional rhabdomyolysis usually follows prolonged or strenuous exercise such as marathon running [10,11] and body building [12,13]. Exercise in a high-temperature environment leading to hyperemia is also a cause of rhabdomyolysis [14]. Without prompt treatment, acute renal failure may develop. Clinical presentations as well as laboratory data and MRI establish good diagnosis for this disease. However, ultrasound provides direct visualization of the echogenicity change and perimysial breakdown of the affected muscle (Fig. 1D).