# - Musculoskeletal Ultrasound: Applications on the Sportsfield

## 2008 Beijing Summer Olympic & Paralympic

Sonography played an important role in the initial diagnostic assessment (e.g., abdominal pain, musculoskeletal pains) for 759 patients (athletes, coaches, team officials and volunteers) in the 29th Olympic and Paralympic Games in Beijing.<sup>36</sup>



1 - abdomen, 2 - musculoskeleton, 3 - gynecology, 4 - heart, 5 - small parts, 6 - vessels

#### 2016 Rio de Janeiro Summer Olympic

The National Olympic Committee medical teams detected the tendon abnormalities of the athletes using the ultrasound, and some National Olympic teams utilized their own ultrasound scanners.<sup>37</sup>

#### Distribution of tendon abnormalities by ultrasounddetected severity of abnormality<sup>37</sup>

Modality	Most commonly injured tendon (N)	Other tendons (N)	Total
Complete tear	Peroneus brevis (1)	N/A	1
Partial tear	Adductor longus (1), infraspinatus (1), iliotibial band (1), hamstring (1)	N/A	4
Tendinosis	Achilles (11)	Hamstring (2), common flexor (1) and extensor (1) at the elbow, extensor carpi ulnaris (1), infraspinatus (1), parellar (1), rectus femoris (1)	19
lsolated fluid around tendon	Peroneus longus (3)	Peroneus brevis (2), tibialis posterior (2), tibialis anterior (1)	8

# 2016 Brazil São Paulo Soccer Championship

Using an electronic questionnaire previously developed by the Medical Committee of the Paulista Soccer Federation, ultrasonography was requested for 28.2% of the injuries out of 259 injuries throughout 361 games in 2016 São Paulo soccer championship.<sup>38</sup>

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# Coming to you, Now



# Musculoskeletal ultrasound

Ultrasound imaging appears black and white based on the formations of basic musculoskeletal structures, and echogenicity and pattern are used to understand the anatomical structure and lesion.12

• Longitudinal tendon image: Endomysium showing a regular arrangement of echogenic linear bands

• Transverse tendon image: Muscle bundles appearing short and curved with a speckled appearance, and the muscle parenchyma appearing hypoechoic, leading to white spots or curved shapes standing out in contrast

• Appearing like an echo similar to muscle tissue. Unlike muscle tissue, not containing a septum inside

#### Cortical bone<sup>1</sup>

• Normal cortical bone appearing as a hyperechoic continuous line with a black shadow below the cortical bone by attenuated ultrasound (posterior acoustic shadowing)

#### Periosteum<sup>1</sup>

• In case of bone tissue damage, inflammation, and tumor, periosteum is observed in the superficial layer of the cortical bone with a hyperechoic thin line is observed running parallel to the superficial layer of the cortical bone

## Tendon<sup>1</sup>

• Normal tendon tissue appearing as a hyperechoic linear band with varying thickness depending on its location.

Being anisotropic, a tendon fiber can be clearly observed when the probe is positioned longitudinally

## Ligament<sup>1</sup>

• Normal ligament fiber appearing as hyperechoic linear structure whose components show more various echoes than ligaments, depending on the contents of collagen, elastin and fibrocartilage within them

## Peripheral nerve<sup>1</sup>

• The structures inside the peripheral nerves appearing as high echoes surrounded by adjacent hypoechoic lines

• Bursa inside a normal intra-articular tissue appearing as hypoechoic and thin line of less than 2 mm. In case of inflammation, multiple hyperechoic lesions may float within the bursa or appear like spider webs.

# Applications of musculoskeletal ultrasound

SONON has a wide rage of clinical applications in the diagnosis, treatment and procedure of musculoskeletal diseases. As Doppler function that detects the degree of inflammation for measuring the disease activity, is feasible, SONON could be utilized in various fields of medicine including sports medicine.











Portable Ultrasound

# • Applications of musculoskeletal ultrasound: **Upper extremities**

• Utility of Ultrasound: Shoulder ultrasound is a useful modality for patients with shoulder pain, i) enabling a convenient and accurate diagnosis following a history taking and physical examination, and ii) having a variety of usages for treating peri-shoulder diseases.<sup>3</sup>

#### Ultrasound assessment

- Application: Long head of biceps tendon, subscapularis tendon, supraspinatus tendon, infraspinatus tendon, acromioclavicular ioint<sup>3</sup>
- Securacy: Ultrasound demonstrated comparable sensitivity or specificity for detection of partial- and full-thickness rotator cuff tear compared with arthrography or MRI, showing its benefit as a screening test modality.4
- Patient satisfaction: The patients' satisfaction score was higher for sonography and the patients preferred the sonography over MRI in the satisfaction surveys by patients with shoulder pain and clinically suspected rotator cuff tear.



#### Ultrasound-guided procedure

O Application: Glenohumeral joint injection, subacromio-subdeltoid bursal injection, acromioclavicular joint injection, calcific tendinitis treatment, suprascapular nerve block<sup>3</sup>

#### Ultrasound assessment

• Application: Diagnosis of pathological conditions at the tendon insertion (e.g., lateral and medial epicondylitis), articular surface, synovial surface and peripheral nerve (e.g., ulnar nerve)<sup>48</sup>

Securacy: Ultrasonography diagnosed the medial epicondylitis with high sensitivity and specificity.

mparison tween the		Clin	nical Diagnosis			Ultrasonoaraphy
nical and rasonographic	Ultrasonographic Diagnosis	Medial Epicondylitis (n=21)	No Medial Epicondylitis (n=25)	Total (n=46)	<b>_</b>	Sensitivity: 95.2%
agnosis	Medial Epicondylitis	20	2	22	-	Specificity:
nealaí icondvlitis <sup>7</sup>	No Medial Epicondylitis	1	23	24		5278

#### • Ultrasound-guided procedure

- S Application: Anterior/Posterior bursal injection and intra-articular injection<sup>46</sup>
- O Accuracy: Ultrasound-guided intra-articular injection showed 100% injection success rate for the steroid injection in the patients with elbow osteoarthritis, and its success rate was significantly higher than that of the palpation guidance (77.5%).8

## Wrist and Hand

#### Ultrasound assessment

O Application: Inflammatory disease (e.g., tenosynovitis), tumor and tumor-like disease (e.g., ganglion cyst, epidermoid), traumatic disease (e.g., tendon abnormalities, button hole deformity)<sup>9</sup>

#### Ultrasound-guided procedure

O Application: Metacarpophalangeal and interphalangeal joint injection, radiocarpal joint injection, scaphotrapeziotrapezoidal and trapeziometacarpal joint injection<sup>10</sup>

# Applications of musculoskeletal ultrasound: Lower extremities

## Ankle and Foot

- thin subcutaneous fat layer with superficial tendons and ligaments, making ultrasound imaging easier and a small probe could be used to examine the toe areas in detail.<sup>11-13</sup> Ultrasound assessment
- O Application: Distal tibiofibular joint, talocrural joint, subtalar joint<sup>4</sup>
- O Accuracy: Ultrasound evaluation detected the foot and ankle fractures with high sensitivity and specificity, implying its applicability in the emergency department for diagnosing foot or ankle fracture.1516

Sensitivity		Clinical Diagnosis			Tabal		
and specificity			Fracture (-)	Fracture (+)	Total	Ultrasound scannin	
ate of	US					Sensitivity:	
Iltrasound	Fracture (-)	n	110	0	110	100%	
or diagnosing		%	99.1	0	84	Specificity:	
ankle fracture <sup>15</sup>	Fracture (+)	n	1	20	21	99.1%	
		%	0.9	100	16		
	Total	n	111	20	131		
		%	100	100	100		

diagnosed with ultrasound in case of a new trauma.<sup>15</sup>

#### Ultrasound-guided procedure

be done accurately.<sup>18,19</sup>

#### Ultrasound assessment

- synovial fluid sensitively.20
- O Accuracy: Musculoskeletal ultrasound achieved a significantly higher diagnostic sensitivity and specificity for meniscal pathology and knee osteoarthritis, compared with MRI and x-ray.<sup>18,19</sup>

viagnostic pecificity and	Modality	Sensitivity	Specificity	PPV	NPV	CCR	LR+	LR-
ensitivity of neniscal	Ultrasound	91.2%	84.2%	94.5%	76.2%	89.5%	5.78	0.10
bathology for MRI vs ultrasound <sup>18</sup>	MRI	91.7%	66.7%	84.6%	80.0%	81.1	2.75	0.13

#### Ultrasound-guided procedure

S Application: Intra-articular knee injection<sup>21</sup>

accurately compared with blind injections.<sup>21</sup>

#### Hip and Hamstring

- fibers and the degree of retraction is feasible.<sup>22</sup>
- Ultrasound assessment
- ment with atypical symptoms.23
- Ultrasound-guided procedure
- S Application: Lesions inside the joint and the hamstring<sup>25</sup>



• Utility of Ultrasound: Ankle and foot, one of the most frequently injured joints in the body, have a

Patient satisfaction: 95% of patients underwent ultrasound scanning stated that they would prefer to be

Sepplication: Tibiotalar joint injection, posterior subtalar joint injection, midfoot and forefoot joint injection

• Utility of Ultrasound: As knee joint diseases could lead to a decline in health and quality of life by limiting the patients' mobility, the diagnosis and determining type and timing of treatment should

S Application: A diagnostic value of ultrasound is high for extra-articular lesions (e.g., tendon, synovium, collateral ligament, tumor lesion), and ultrasound could detect the increase of articular fluid and proliferation of

CCR, correct classification rate; LR+, positive likelihood ratio; LR-, negative likelihood ratio, NPV, negative predictive value; PPV, positive predictive value

## O Accuracy: Ultrasound-guided knee injections enable the needle to be placed at the anatomical sites more

• Utility of Ultrasound: Ultrasound is commonly used for identifying hamstring injuries along with MRI, and it has advantages that a dynamic assessment of the site of injury, any discontinuity of muscle

Application: Ultrasound had high sensitivity and specificity in the diagnosis of femoroacetabular impringe-

All in One Portable Ultrasound

# Ultrasound in the Sports injuries: Applications

- The frequency of sports injuries is increasing as an income level rises and the general population becomes more and more active in sports.<sup>24</sup>
- The importance of clinical imaging in sports medicine is growing with the increasing need for scientific management by professional sports practitioners, objective assessment of the degree of performance loss and prediction of rehabilitation periods.24
- The American Medical Society for Sports Medicine developed a musculoskeletal ultrasound curriculum for sports medicine fellowships and it is being regularly updated.<sup>25</sup>
- Ultrasound is used for initial diagnoses and therapeutic decision of physical contact injuries in the overhead sports (e.g., baseball, golf), ball games (e.g., golf, basketball, badminton, soccer), as well as kendo and snowboarding.<sup>26,27</sup>

## Major sports injuries

## Tennis elbow (lateral epicondylitis)

- Typically occurring in athletes associated with throwing and tennis (particularly older than 35 years)<sup>31</sup>
- The result of injury to the common extensor tendon, causing elbow pain<sup>31</sup>
- Ultrasound imaging is done to identify the degree of extensor damage when the symptoms are severe, refractory to therapy or the diagnosis is uncertain<sup>6, 28</sup>
- Ultrasonographic findings: Thickened extensor tendon with hypo-echogenicity, loss of the amount of microfiber. Hyperemia detected via power Doppler and the tear of the extensor tendon.<sup>6, 28</sup>

## **Rotator cuff tear**

- Typically occurring in overhead throwing athletes (e.g., baseball) and swimmers<sup>28,29</sup>
- Supraspinatus tendon lesion is frequently reported, and it is divided into partial or full thickness tear based on the thickness of damaged tendon<sup>26</sup>
- Ultrasound is used for diagnosis by examining the degree of supraspinatus tendon damage and post-operative rotator cuff assessment for evaluating the recovery.30
- Ultrasonographic findings: A loss of tendon with hypoechoic fluid in the area wehre the supraspinatus tendon should be located. The fluid observed as hypoechoic or detecting hyperechoic floaters.<sup>26</sup>

#### Ankle sprain and Achilles tendon injury

- Typically occurring during running and playing soccer, tennis and badminton<sup>31</sup>
- Ankle sprain: A rupture of lateral ligament is mostly caused by inversion injury, and a special attention with accurate diagnosis and sufficient treatment is required not to lead to chronic pain, muscular atrophy and instability<sup>31</sup>
- Achilles tendon injury: Occurring when ankle plantar flexion is suddenly ankle dorsi flexion or when the posterior part of the ankle is directly damaged. Ultrasound is much easier to detect the Archilles tendon injury than MRI.<sup>31,32</sup>
- Ultrasonographic findings: Loss of ligament continuity by hypoechoic gap along with detection of fiber avulsion (Moderate ankle sprain). Partial loss of fiber appearance at the long-axis image along with the well-defined and hypoechoic area inside the tendon (Archilles tendon partial tear). Damaged fiber structure and division of the fiber into 2 segments (Archilles tendon full tear)31

# • Musculoskeletal ultrasound in the Sports medicine: Advantages

• As sports practitioners can now perform prompt scanning and draft an exact treatment protocol of the injured athletes due to the improvement of ultrasound resolution and development of compact ultrasound machine, musculoskeletal ultrasound is recommended as the first line imaging tool in the sports injuries.33



#### Portability

A portable ultrasound can be used for real-time diagnoses of the mountainside injuries (e.g., snowboarding, skiing) without the need of long-distance transport the patient to the nearby local hospital.27

## Application

In the 2006 World Cup, the Cameroon soccer team's medical staff used a portable ultrasound for injury diagnoses during their games and training sessions leading up to the games.<sup>35</sup>





All in One Portable Ultra	
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