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(G) Three-Dimensional Ultrasound for Investigating Synovial Blood Flow Changes with Exercise in Thumb Osteoarthritis

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Introduction: Inflammation of the joint lining, or synovium, is an important aspect of osteoarthritis (OA) and contributes to disease pathogenesis and symptoms. The basal thumb joint is a common site of OA and is important for hand function. Physical therapy treatments aim to improve patient pain and function. However, the vascular changes and response to exercise are not fully understood in thumb OA. Ultrasound (US) imaging provides soft tissue and joint visualization, and Doppler US technologies can detect and visualize blood flow. Previous synovial blood flow investigation has been limited to two-dimensional visualization, lacking the comprehensive three-dimensional (3D) visualization of the synovial vasculature. This work aims to assess synovial blood flow changes with exercise in thumb OA patients using a 3DUS imaging system.
Methods: A 3DUS system was developed with Doppler imaging technologies to detect and visualize blood flow. The 3DUS device translated a US transducer across a linear region of interest. 3DUS images were acquired over a five-centimetre length using a 14L5 linear transducer and a Canon Aplio i800 US machine with superb microvascular imaging (SMI) Doppler technology. Thirteen thumb OA patients were imaged with 3DUS SMI before and after completing resistance thumb exercises. The synovial volume was manually segmented pre- and post-exercise and the coloured voxels were automatically counted with software. Synovial blood flow volumes and fractions were calculated.
Results: 3DUS SMI images acquired pre- and post-exercise detected and visualized synovial blood flow in thumb OA patients. The absolute mean change in US-detectable synovial blood flow volume with exercise was 1.31 mm^3 ± 2.59 mm^3 and 1.70 mm^3 ± 2.87 mm^3 for the thumb OA patients with detectable blood flow within the region of synovial inflammation.
Conclusion: This study demonstrated the ability of a novel 3DUS imaging device to investigate and measure the effect of exercise on US-detectable synovial blood flow in thumb OA. This work implemented a novel method of quantifying changes in blood flow to gain insight into the response of the synovial vasculature and its role in the disease process. This novel 3DUS device can provide a new method of measuring active joint inflammation and monitoring changes and responses to treatment.

Keyword-1

Medical Imaging

Keyword-2

Ultrasound

Keyword-3

Musculoskeletal Imaging

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