remained isovolumetric across different contraction intensities and progressively shortened along its line of action as contraction intensity increased. This caused the muscle to progressively bulge centrally, as expected. However, the bulging was shown to occur in the thickness dimension at lower contraction intensities, and then in the width dimension at higher contraction intensities. This indicates that changes in muscle thickness (which drive changes in muscle gearing) are dominant at low contraction intensities.

Discussion: The results provide the first evidence of how human muscles bulge during contractions and indicate that contraction intensity influences the direction that muscles bulge and the subsequent stretch of the internal series elastic tissue. Further research is required to examine whether factors such as muscle-tendon length can influence force transmission due to variable muscle bulging.

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Using ultrasound to investigate sarcopenia in foot muscles

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Introduction: Sarcopenia (age-related muscle loss) is a global phenomenon that is worsening due to our aging population. Hence, preserving the independence and physical function of older population should be a primary health priority. Although often neglected, the foot muscles are vital to maintaining physical functioning, whereby toe muscle weakness is an independent predictor of falls in older people. Muscle atrophy has been detected in numerous muscles of the lower limb in older adults, including the tricep surae muscle group. It is speculated that muscles within the feet, including those that control the toes, also suffer from atrophy with ageing. However, there is a paucity of literature characterising foot muscle morphology in older people. Therefore, the purpose of this study was to compare the muscle size of the toe flexor muscles of older adults relative to their younger counterparts.

Methods: Forty-one young adults (18–50 years) and 43 older adults (60+ years) were recruited to participate in the study. The abductor hallucis, flexor digitorum brevis and quadratus plantae muscles in the foot and the flexor digitorum longus muscle in the shank were imaged using a Venue 40 musculoskeletal ultrasound system (GE Healthcare, United Kingdom) fitted with a 5–13 Hz (maximum depth 6 cm) linear transducer. Muscle thickness (mm) and cross-sectional area (CSA; mm^2) were measured using ImageJ software (National Institute for Health, USA). ANCOVA tests were then used to determine whether muscle size differed between the Young and Old participant groups with gender and BMI used as co-variates.

Results: The older adults had a significant reduction in thickness and CSA of most intrinsic foot muscles in comparison to the younger adults. For example, a 25% and 17% reduction in thickness and CSA of the flexor digitorum brevis muscle was evident ($p < 0.001$).

Discussion: This study confirms that the size of the muscles that perform toe flexion is reduced in older people compared to their younger counterparts. It is possible that this leads to an imbalance between toe flexor and extensor muscles, and is perhaps the cause the increased prevalence of toe deformities in older people. Sarcopenia appears to affect the size of the smaller foot muscles. This could contribute to reduced toe flexion force production and have a profound effect on the ability of older people to walk safely. Interventions aimed at reversing foot muscle atrophy in older people require further investigation.

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A markerless motion capture technique for sport performance analysis and injury prevention: Toward a 'big data', machine learning future

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Background: Sport biomechanists face a number of unique challenges rarely encountered by clinical or lab based biomechanical researchers. Sporting manoeuvres occur at high speeds with athletes utilising multiple joint degrees of freedom. Subsequently, sport related motion capture, analysis and reporting, requires cutting edge technological solutions for the reconstruction and analysis of high speed complex three-dimensional (3D) motion. From an applied perspective, an ideal solution to 3D sports biomechanical analysis lies in participant specific non-invasive markerless motion capture, enhanced by additional 3D scanning and imaging techniques.

Methods: The developed markerless methodology comprises two phases. In the offline calibration and initialisation phase, a static t-pose is acquired of the athlete using a high resolution 3D scanner to create a subject specific reference shape. A skeleton comprising a number of articulated bones and joints is fitted to the 3D model to create a reference rigged template. In the online motion capture phase, a minimum of six 2D video cameras are configured and calibrated to record multi-view 2D videos. A background segmentation algorithm extracts 2D athlete silhouettes in each video frame, which are merged to reconstruct a low fidelity 3D visual hull. Optimisation algorithms extract geometrical data of the visual hull and identify, and segment, each body part. Global joint kinematics are estimated by fitting the reference skeleton to the identified body parts of the curve skeleton. Constrained mesh deformation functions are fed by the global joint kinematics and the resulting error between the surface of deformed model and the visual hull is employed, to adapt and refine the accuracy of the initially estimated joint kinematics.

Results: The overall mean error between the 3D scan (reference) and the resulting surfaces (absolute mean of the difference between closest points) varied between 12 cm to 16 cm across three different postures selected for analysis. This error is reasonable when matching two meshes of 5000 vertices each. The validity of the developed markerless approach was concurrently assessed against a current gold standard marker based using a constant model in OpenSim with lower limb, hip and knee joint angles differences of $<2^\circ$ in all planes.

Discussion: The overall differences between the aligned reference model and the visual hull confirm that the developed markerless system is capable of estimating accurate joint kinematics in diverse blind body pose estimation scenarios (i.e. sporting activities) and provides an exciting and promising foundation for the non-invasive on-field measurement of athletes during match play.

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