Inner Psoas Tri-axial Deformation Under Tensile Load Corresponds to Superficial Dense Connective Tissue Morphology.

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BACKGROUND: Direct contact and stretching are used in manual therapies to apply loads across tissues. Resulting forces are attenuated by deformation through passive viscoelastic elements and active muscle resistance [1]. Deformed surfaces and tissue interfaces transmit local forces as radiating, hydrostatic compression and axial tension [2, 3]. Quantitative force distribution to targeted deep structures is unknown. This study evaluated psoas deformation and strain under axial tension and its distribution related to surface dense connective tissue (DCT) morphology.
METHODS: Isolated porcine psoases were tested in horizontal configuration on smooth surface. Muscle ends were fixed by compound grips using penetrating spikes. A Mcmessin materials testing applied 30% strain gage-length at 8.33 mm/sec. DCT apex, a tendon continuation on caudal ventrolateral surface, served as landmark. A triad of acupuncture needles (0.25X75 mm) penetrated muscle transversely at apex (β), equidistant caudal (α) and cephalic (γ). Morphologic behavior to passive tensile force was monitored by photography. Dimensions and needles' angular deviation were recorded. Inner deformations were monitored by ultrasound elastography. 1cm cross-sections at α,β,γ were photographed for morphological assessments.
RESULTS: Muscle averaged 17.43±1.0 cm, apex diameter of 5.03±0.56 cm. Changes in angle of transverse needle in the coronal plane were smaller (0.79°±6.49°) on ipsilateral side to the DCT than contralateral angle (13.68°±2.07°; $p=0.001$). In transverse plane, axial rotations were 2.79°± 2.23° (ipsilateral) and 14.03 ±1.87° (contralateral; $p=0.027$). Poisson's ratio at each cross-section showed anisotropic response $\alpha>\beta>\gamma$ ($0.0178<p<0.0215$). Overall, mean Poisson's ratio for coronal deformation was -0.365 ± 0.182 and anteroposterior +0.473 ± 0.126 ($p < 0.0000$). Superficial DCT cross-sectional area was higher ($p<0.00001$) than intramuscular at all landmark levels: α (2.3% ± 0.97%); β (1.09 ± 0.64%); γ (0.11% ± 0.22%). No significant differences were seen for intramuscular DCT cross-section areas.
CONCLUSIONS: Deformation of relatively homogenous psoas under tensile load is not uniform either along the length, across its breadth or width. Intramuscular deformations appear related to the superficial fascia rather than intramuscular DCT. This behavior may contribute to insitu intermuscular load sharing; topic of future study—explain applied load distribution patterns [1].
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