Perimuscular Fascia Remodeling in a Porcine Movement Restriction Model Relevant to Human Low Back Pain

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BACKGROUND The pathophysiology of chronic low back pain (cLBP) is poorly understood. However, it has become evident that cLBP is a dynamic, fluctuating condition with multifactorial etiology and complex pathogenesis. Connective tissue remodeling due to pain-related fear and avoidance of movement is a potentially important mechanistic factors contributing to cLBP. We hypothesize that 1) in the pig, movement restriction using a hobble (harness attaching the hind limb to a chest strap limiting hip extension) produces connective tissue remodeling in the major fascial planes of the back and 2) human subjects with chronic low back pain (cLBP) have decreased displacement of the spine and pelvis during quadruped gait similar to that produced by the hobble.
METHODS 1) Porcine model: We conducted a preliminary study of 3 motion-restricted and 3 unrestricted pigs. In restricted animals, a harness attaching the hind limb to a chest strap was used to limit hip extension. After one month, the pigs' thoracolumar fascia was imaged with ultrasound followed by sacrifice and tissue excision for *ex vivo* high resolution C-scan ultrasound imaging and histology. 2) Human experiments: Seven human subjects, 3 with cLBP and 4 without LBP (No-LBP), were tested by walking in quadruped gait in a straight line for 20 feet both at their own pace (3 trials) and at a standard speed (0.6 Hz, 3 trials). Thoracic and pelvic motion was recorded using two wireless orientation sensors (Microstrain, Inc) mounted over the middle of the sacrum (S1 level) and the spinous process of T10.
RESULTS In all 3 non-restricted pigs the fascia had prominent striations due to separations between collagen fiber bundles that were visible on gross samples and palpable. In contrast, the fascia in all 3 restricted pigs was uniform without visible or palpable striations. Restricted pigs had a marked decrease in loose connective tissue separating dense connective tissue bundles in restricted pigs. Fourier analysis of C-scan ultrasound images showed a decreased magnitude of peaks at spatial spacing>0.2 mm but similar peaks for spacing< 0.2 mm. Mean ± SD peak amplitude at spacing>0.2 was 0.20 ± 0.1 for restricted vs. 1.5 ± 0.2 for controls. In the human quadruped gait analysis mean±SE peak intersegmental angle (degrees) was 21.8±3.7 for cLBP compared with 27.5±3.6 for No-LBP for self-paces trials and 21.4±4.5 vs. 27.5±3.5 for cLBP and No-LBP respectively for standard speed trials. A similar decrease in thoracopelvic intersegmental motion was observed in a control subject wearing the hobble.
CONCLUSIONS These preliminary results suggest that, in pigs, movement restriction of the pelvis and back causes changes in connective tissue architecture (remodeling) in the thoracolumbar fascia that can be quantified with C-scan ultrasound. These results also suggest that quadruped gait analysis may be a useful tool to examine movement patterns and connective tissue abnormalities in humans with cLBP.
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