CONTRACTILE FEATURES OF HUMAN LUMBAR FASCIA

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Purpose

To compare the mean density of contractile fibroblasts (myofibroblasts) in human lumbar fascia (LF) with other human fasciae, as well as with the LF in quadrupeds. To calculate the potential contraction force of human LF based on in vitro contraction tests with human fascia.

Relevance

Human LF has been shown to play a substantial role in force transmission of muscular forces influencing vertebral stability. LF stiffness can also contribute to lumbar compartment syndrome, a potential cause of low back pain. Previous animal studies from our group suggested an ability of LF to actively contract, due to the presence of myofibroblasts. A better understanding of the potential impact of fascial tonicity on lower back biomechanics in humans would therefore be useful.

Methods

We performed an immunohistochemical analysis for the myofibroblasts marker alpha-smooth mucle actin with tissue samples of LF, fascia lata and plantar fascia from 32 human bodies, and with LF tissue samples from rats (n=10), mice (n=4) and pigs (n=4).

Additionally mechanographic force registrations were conducted with biopsy pieces of human fascia lata. These were performed in a superfusion bath under isometric strain in response to stimulation with the myofibroblasts agonists mepyramine, histamine and oxytocin, as well as in response to the smooth muscle relaxant glyceryl trinitrate. Unviable fascia tissues were similarly investigated to elucidate the cellular contribution.

Analysis

Immunhistochemistry: Digital quantification of myofibroblasts density was performed based on the percentage of stained areas in 15 randomly chosen photomicroscopic images of each tissue sample.

Mechanography: Force differences between maximal tissue contraction and relaxation were hypothetically applied to the cross sectional area of all lumbar fascia at the level of L4/L5 in an average human body. The potential biomechanical impact was calculated with inclusion of intramuscular fasciae of paraspinal musculature.

Results

Immunohistochemistry: Human LF revealed a higher myofibroblasts density than human plantar fascia or fascia lata ($p<0.05$). Myofibroblast density of LF in humans was significantly higher than in rats ($p<0.05$), and mean values of LF in mice and pigs were also lower than in humans.

Mechanography: The max. observed force difference (3.6 mN/mm2) applied to the cross sectional area of lumbar fasciae predicts a total contraction force of 5 N. Higher values could be expected with in vitro tests from LF, based on its higher MF density. Nevertheless, this force magnitude is already above the reported thresholds for mechanosensory stimulation and for influencing gamma-motor regulation.

Conclusion

The capacity for fascial contraction appears to be particularly expressed in human LF, when compared with quadruped animals as well as with other human fasciae. The density of myofibroblasts in human LF seems sufficient to allow an impact on musculoskeletal dynamics.

Implications

Temporary or chronic changes in fascial tone may be able to influence low back stability in humans. Additional studies incorporating ultrasound based elastography are recommended to examine LF stiffness in vivo.

Keywords

Lumbar fascia, fascial contractility, back stability, myofibroblasts.