The Effect Of Applying Tension To The Lumbar Fasciae On Segmental Flexion And Extension

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Introduction

Transversus abdominis has been proposed to influence intersegmental movement by generating tension in the posterior and middle layers of lumbar fasciae (MLF, PLF).

Background & purpose

Cavaderic studies indicate that tensile force (eg. from muscles) may be transmitted via the lumbar fasciae to the lumbosacral spine (Vleeming et al 1995, Barker et al 2004). Studies on human & porcine spines (Tesh 1986, Hodges et al 2003) indicate that fascial tension may influence lumbar intersegmental movement, however the loading methods and force magnitudes used varied from those common in-vivo. The purpose of this study was to document the effects of tensile force through the lumbar fasciae (simulating moderate contraction of transversus abdominis) on lumbar segmental loads and on displacement during flexion and extension.

Materials and methods

Seventeen lumbar segments from 9 unembalmed cavaderic spines (4 elderly and 5 middle-aged) were used to compare compressive loads applied (3cm from the segment centre of rotation) to produce flexion and extension moments, with and without tension through the MLF and PLF. Specimens were set in dental plaster, preconditioned and loaded using a Mecmesin Imperial™ 1000 test machine with 20N fascial tension applied to the lateral raphe during alternate tests.

Two series of tests were conducted: 1. 'Static' tests, applying a set initial compressive load (1-200N) then recording multiple load measures with fascial tension on and off. 2. 'Cyclic loading' tests, applying 0-450N compressive load to flex/ extend the segment, while monitoring load and displacement throughout movement and applying fascial tension on alternate tests. At the completion of both series, the PLF was incised to determine the proportion of applied (20N) tension being transmitted through each layer of fascia.

Paired t-tests were used to compare load measures from static tests with fascia on/ off. Effects of fascial tension were noted (from a set zero point) on displacement at zero applied compression (including the neutral zone) and at 450N compression (including the entire range of motion) for cyclic loading tests. Effects of fascial tension on segmental stiffness were calculated at various points throughout range (25-400N)

Results

During static tests, fascial tension increased resistance to applied compression producing flexion by on average 9.5N, increasing stiffness at all lumbar segments and resisting smaller (<8N) loads completely, loads of <3N over 4 times. The increased resistance was statistically significant ($p < 0.01$) at all flexion loads and all segments. Fascial tension decreased resistance to applied extension loads, reducing the applied compressive load by on average 6.6N. This was significant ($p < .05$) at <100N in all segments and at 100-200N in 15/17 segments.

Results of cyclic loading tests were more variable but indicated that in most (13/17) segments, fascial tension during flexion decreased the segment's movement, particularly at low compressive loads. The average reduction across all segments was 26% (+/- 20) at zero compression and 2% (+/-3) at 450N compression. During extension, fascial tension generally had the opposite effect, increasing the displacement at zero compression in 10/17 segments by an average of 23% (+/-27). However, overall displacement of the segment was slightly decreased in extension (by 1% +/-3) at 450N compression). Stiffness was on average increased by 1.2-6.3N/mm in flexion, particularly in earlier range (~6N/mm at 25-50N). This represented mean increases in segmental stiffness of 28% at 50N and 44% at 25N. In extension, stiffness was decreased by 1.6-2.1N/mm, representing mean decreases in segmental stiffness of 5% at 50N and 8% at 25N. At all segments, the majority of fascial tension (>85%) was transmitted through the MLF.

Conclusion

Tension on the lumbar fasciae simulating moderate contraction of TrA significantly affects segmental forces and motion, particularly towards the neutral zone. Fascial tension increases the segment's stiffness to flexion moments and generally reduces its initial stiffness to extension moments. This has implications for a potential protective role of transversus abdominis via the middle layer of lumbar fascia during flexion.

References

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