MUSCLE ATTACHMENTS OF THE LUMBAR FASCIAE

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SUMMARY
Selected muscular attachments of the middle and posterior layers of lumbar fasciae were examined in four unembalmed cadavers. Tension was applied to these muscles via clamps attached to a spring balance and forces of 10-40N applied. Fascial tension in response to applied muscle tension was measured at L3 using a buckle strain gauge and also by movement of fascial markers (recorded photographically). Results indicate that traction on latissimus dorsi produces most tension in the lumbar fascia (at L3) followed by transversus abdominis. Both muscles transmitted tension to fascia across the length of the lumbar spine, whereas the external and internal obliques (EO & IO) and gluteus maximus (GM) tended to generate fascial tension to a lesser extent above (EO) or below L3 (IO & GM). Of the anterolateral abdominals TA withstood the greatest applied tension before failure. The findings provide an indication of the relative capacity of these muscles to influence the lumbar spine via middle & posterior layers of lumbar fascia.

INTRODUCTION
The lumbar fasciae are reported to have important roles in supporting the spine via their numerous muscle and vertebral attachments. These have been variably reported in dissection and tension[1] studies on embalmed cadavers, but not well documented in unembalmed specimens. The effect of applied traction to anterolateral abdominal muscles on the lumbar fasciae has not been previously documented. This study aims to document and compare the relative transmission of tension to the middle and posterior layers of lumbar fascia when traction was applied to latissimus dorsi (LD), gluteus maximus (GM), external and internal oblique (EO, IO) and transversus abdominis (TA) muscles in unembalmed cadavers.

MATERIALS & METHODS
On 4 unembalmed cadavers (2F, 2M; mean age 75 years, range 73-82; refrigerated since death 7-30 days) the back and posterior abdominal wall muscles were progressively dissected then each cadaver firmly secured to the table at T6 and S4 levels. When exposed, the spinous then transverse processes and full extent of posterior then middle layers of fascia (respectively) were marked with dots using a permanent marker. A buckle strain gauge was calibrated then threaded through the fascia to measure horizontal tension just adjacent to the L3 spinous (then transverse) process. LD, GM (superficial fibres

between S2 & S4), EO, IO & TA were each gripped adjacent to their (lumbosacral) fascial attachments using two 23cm Doyen intestinal clamps fixed together using cable ties. Tension was applied to this gripping system via a metal chain hooked to the cable ties proximally and to an electronic hand held spring balance distally. 10-30N of tension was applied in the direction of the attaching muscle fibres, with photographs and tension measures being taken; the latter at 1N intervals and repeated 3 times on each side. Photographs were also taken during tension measures from a fixed height with a 50mm scale-bar positioned parallel to the fascia. These (in 3 of 4 cadavers) were later aligned and analyzed in Adobe Photoshop 5.0 by drawing an arc across the most distal visible site of marker movement towards the grip site (and away from more distal markers). The average distance from this arc of movement (in response to a 10N force) to the grip edge was compared between muscles. Vertebral levels & side(s) on which fascial movement occurred were also noted for each muscle tested.

RESULTS

Buckle strain gauge readings were less consistent (with applied tension) than distance measures. Those readings not demonstrating a sequential increased output with increased tension were excluded from analysis. Strain gauge readings indicated that (at 10N applied tension) LD transmitted most tension to L3 via the posterior layer of lumbar fascia (far greater than TA, IO or EO respectively). Fascial strain readings in response to tension on TA, IO & EO were higher in the middle than posterior layer, with TA transmitting most tension to L3 (transverse process).

Distance measures however indicated that tension on LD and TA moved almost equidistant fascial markers on the posterior layer, bilaterally and across all lumbar vertebrae (TA to S1 level). IO and GM transmitted tension below L3 level (to S1 & S2 respectively; GM consistently bilaterally and IO in most cases). EO transmitted to a lesser extent, to fascia between L1 and L3 (ipsilateral only in most cases). Movement of fascia in response to tension on LD & GM was found to be greater than that in studies performed on embalmed cadavers, yet these unembalmed specimens tended to tear at lower loads.

The middle layer photographic measures similarly showed traction on TA produced more extensive fascial displacement than on the obliques (IO below L3 and EO above L3). Transmission was in all cases unilateral.

LD and GM could withstand forces of up to 40N before tearing at the grip site, while TA, EO & IO were only tested to capacity at the middle layer where they withstood maximum applied traction of 30N, 20N and 15N respectively.

CONCLUSION

Unembalmed cadavers provide a good medium for assessing and comparing the muscular attachments of the lumbar fasciae, achieving large fascial displacements with low applied loads. Results indicate that traction on LD and TA transmit tension to fascia most effectively across the length of the lumbar spine, EO to a lesser extent above L3 and IO & GM below L3. Each anterolateral abdominal muscle is capable of acting via both middle and posterior layers of lumbar fascia and of these TA has the greatest capacity to withstand tension. The relative tensile capacities of attaching muscles have implications in assessing their proposed roles (via the fasciae) on the lumbar spine.

REFERENCES

1. Vleeming et al 1995: Spine 20: 753-58