LUMBAR MULTIFIDUS MUSCLE CROSS-SECTIONAL AREA RELATIONSHIP TO KNEE EXTENSOR AND HIP EXTERNAL ROTATOR ISOMETRIC STRENGTH

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BACKGROUND AND PURPOSE

- Low back pain (LBP) affects 85% of the general population and has a recurrence rate as great as 75%[1]
- The lumbar multifidus (LM) muscle is a key contributor to spine stability and lower extremity (LE) neuromuscular control
- Back extensor endurance has been related to factors influencing dynamic stability of the LE kinetic chain[2,3]
- Having LBP history increases the likelihood of sport-related sprains and strains affecting the back by 3-6 times[4]
- LM atrophy associated with LBP may result in persistent neuromuscular control alterations, despite symptom resolution[5]
- Cross-sectional area (CSA) of the LM is reduced in LBP patients, which is most pronounced at the L4/L5 to L5/S1 levels[6]
- The existence of a relationship between LE muscle performance capabilities and CSA of the LM has not been investigated
- The purpose of this study was to identify a possible relationship between CSA of the LM and isometric strength values for the knee extensors and hip external rotators, and any differences between college students with and without LBP history

PARTICIPANTS

- Participants were recruited on the basis of involvement in other concurrent research projects:
  - Subgroup 1: 21 college students, 22.5 2.2 years
    - 4 males, 1.78 0.07 m, 90.49 10.74 kg; 16 females, 1.68 0.06 m, 70.14 11.71 kg
    - Exclusion criterion: LE Injury within three weeks prior to participation
  - Subgroup 2: 27 college athletes, 20.4 1.5 years
    - 13 males,1.85 0.06 m, 95.41 16.75 kg; 14 females, 1.65 0.04 m, 67.13 10.11 kg
    - Inclusion criterion: 13 subjects selected based on Oswestry Disability Index (ODI) ≥ 10
    - Exclusion criterion: Acute injury affecting the low back or LE

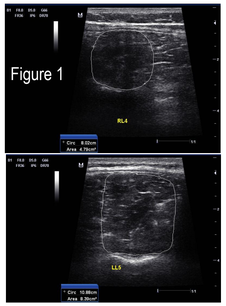

Figure 1

Table 1

Variable	Combined	Subgroup 1	Subgroup 2
ODI score	4.85 6.55	2.76 4.88	6.67 7.19
WSH (sec)	25.73 14.62	17.04 7.92	32.73 15.12
CSA – Avg (cm^2)	6.88 1.25	6.37 1.32	6.37 1.32
CSA - RL4 (cm^2)	6.02 1.59	6.00 1.55	6.04 1.62
CSA - LL4 (cm^2)	6.23 1.62	6.51 1.79	6.08 1.49
CSA - RL5 (cm^2)	6.74 1.38	6.62 1.45	6.78 1.35
CSA - LL5 (cm^2)	6.54 1.54	6.37 1.38	6.64 1.65
HER (kg)	-	6.37 1.32	-
KExt (Nm)	-	-	161.8 38.91

PROCEDURES

- Diagnostic ultrasound (DxUS) images obtained for right (R) and left (L) LM at L4 and L5 levels
  - Prone position with bolster under hips and feet; arms relaxed and head turned to side
  - Spinous process (SP) of L4 and L5 palpated and marked for identification
- Four landmarks identified to define the borders of the LM (Figure 1):
  - Medial - shadow of SP; Lateral - fascial lining between LM and erector spinae; Superior - thoracolumbar fascia; Inferior - laminae
- CSA (cm^2) determined by outlining the circumference of the LM with DxUS system software
  - 3 measurements of each image obtained and averaged; internal consistency of each 3-measure set assessed
- Sub-group 1: Hand dynamometer - isometric force output of hip external rotators (HER; kg)
- Sub-group 2: Isokinetic dynamometer - isometric average torque of knee extensors (KExt; Nm)
- Receiving operating characteristic (ROC) analysis used to establish cut-points
  - Median isometric strength value used to determine cut-points for analysis
  - Sensitivity (Sn), specificity (Sp), Fisher's exact test, odds ratio (OR)

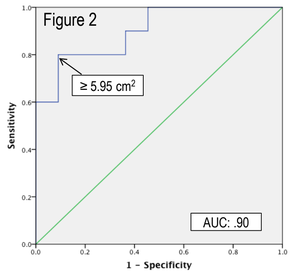

Figure 2

CSA Association with Hip External Rotator Strength		
Positive Factors	HER ≤ 3.6 kg	HER > 3.6 kg
CSA ≤ 5.95	10	2
CSA > 5.95	1	8
Total	11	10
Fisher's Exact One-Sided p = .002		
Sensitivity = .80	Specificity = .91	
+LR = 4.54	-LR = .11	
OR = 4.54 / .11 = 40.00	90% CI: 4.61 – 346.96	

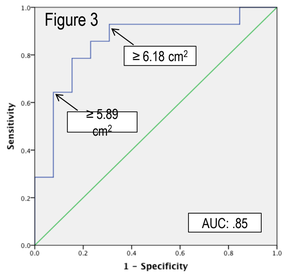

Figure 3

CSA Association with Knee Extensor Strength		
Positive Factors	KExt ≤ 214 Nm	KExt > 214 Nm
CSA ≤ 5.89	12	5
CSA > 5.89	1	9
Total	13	14
Fisher's Exact One-Sided p = .003		
Sensitivity = .64	Specificity = .92	
+LR = 2.59	-LR = .12	
OR = 2.59 / .12 = 21.60	90% CI: 3.10 – 150.66	

RESULTS

- Means and standard deviations for each variable presented in Table 1
- Internal consistency of CSA measurements (Cronbach's α for each 3-measure set) was exceptionally good
  - RL4: .987; LL4: .987; RL5: .977; LL5: .990
- Association of CSA of LM (3-measure average) with hip strength was exceptionally strong; r = .601, p = .004
  - Dichotomized analysis: CSA of LM ≥ 5.95 cm^2 associated with hip external rotator strength ≥ 3.6 kg (≥ 8 lbs)
    - Sn = .80; Sp = .91; p = .002; OR = 40.00
- Association of CSA of LM (3-measure average) with knee strength was exceptionally strong r = .626, p <.001
  - Dichotomized analysis: CSA of LM ≥ 5.89 cm^2 associated with knee extensor strength ≥ 214 Nm (≥ 158 ft-lbs)
    - Sn = .64; Sp = .92; p = .003; OR = 21.60
      - Alternate cut-point ≥ 6.18 cm^2: Sn = .79; Sp = 85; p = .001; OR = 20.17
- Association of CSA of LM with WSH duration less substantial, but potentially meaningful
  - Dichotomized analysis (both datasets): CSA of LM ≥ 6.50 cm^2 associated with WSH duration (≥ 24 sec)
    - Sn = .52; Sp = .71; p = .095; OR = 2.65 (90% CI = .97 – 7.26)

CLINICAL RELEVANCE

- DxUS can provide reliable CSA values for the LM, which may provide valuable information about an individual's multi-segmental neuromuscular performance capabilities and his or her susceptibility to sport-related injury
  - CSA of LM may provide a means to document a positive adaptation produced by therapeutic exercise
- The strong association between CSA of LM with both hip and knee strength suggests that optimal function of LM plays an important role in mediating neural mechanisms associated with integrated muscle activation patterns
  - HER and/or KExt weakness may relate to a relative lack of LM facilitation of motor neuron excitability
- Prevention of injury (or re-injury) to the low back and LE may be highly dependent on optimal LM function

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