Hamstring Muscle Architecture Using Wide Field Of View Ultrasound: A Reliability Study

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INTRODUCTION

Hamstring strains are the most prevalent muscle injuries incurred by athletes participating in field sports [1]. The geometric distribution of muscle fascicles within a muscle determine its mechanical function and influences its maximal force output and contraction velocity. Shorter muscle fascicles contain less sarcomeres in series, which will result in a reduced maximal shortening velocity, which could increase the risk of injury [2].

Ultrasound (US) is the most used medical imaging modality to assess the architectural characteristics of skeletal muscle. Most of the published research using B-mode US to measure the architectural characteristics of the hamstring muscles has used a relatively limited field of view (<5cm), which necessitates the use of extrapolation methods to quantify muscle fascicle lengths (Figure 2).

These extrapolation methods, which predominantly use linear approximations based upon muscle thickness and pennation angles, do not account for muscle fascicle curvature and are subsequently prone to error [3].

AIM

To establish the reliability of a new method "Wide Field Of View" to assess the hamstring muscle architecture.

MATERIALS & METHODS

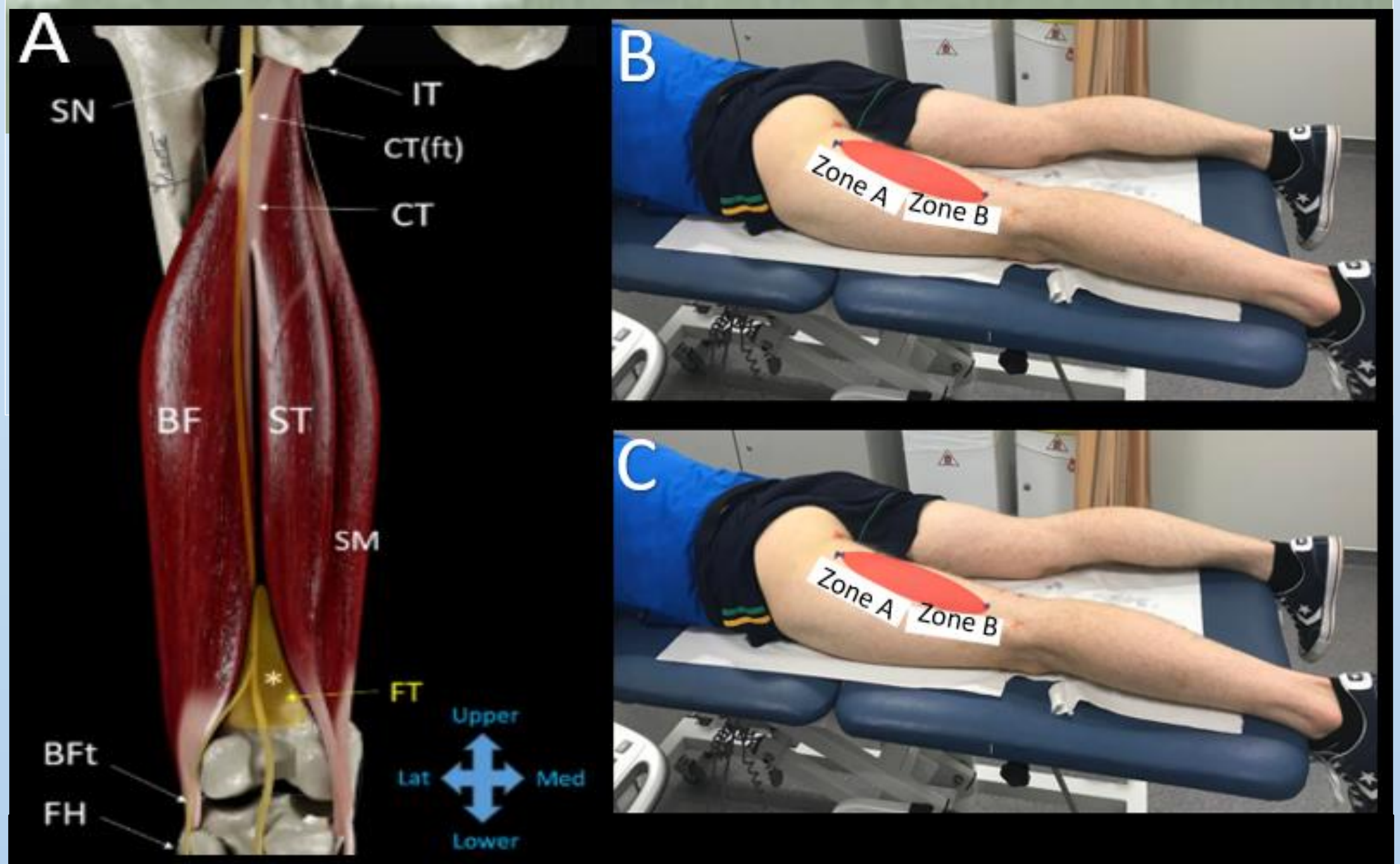

Figure 1: A: Diagram of the hamstring muscles (Balius et al., 2019). **B:** Session 1 (test) set up, where the architectural characteristics of the hamstring muscles were sonographically assessed in Zone A (proximal muscle) & Zone B (distal muscle). **C:** Session 2 (re-test) set up.

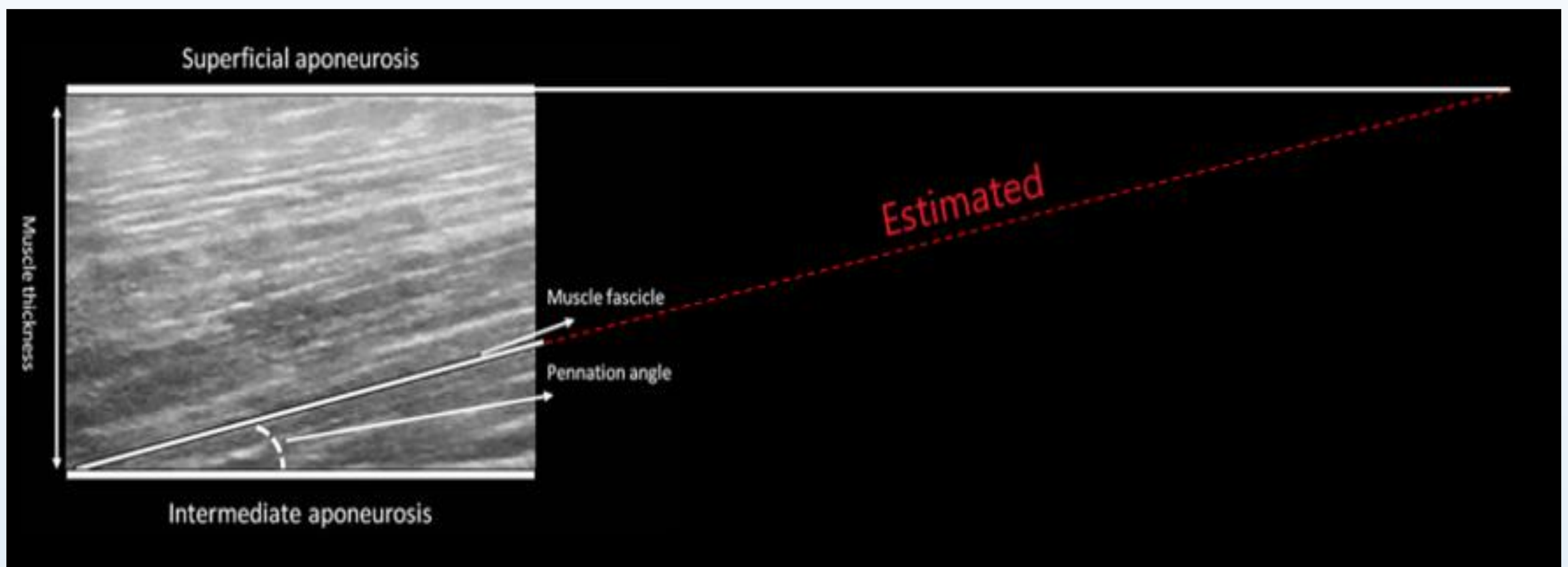

Figure 2: A sonogram of the Bicep Femoris long head muscle utilising a field of view smaller than the fascicle length (Timmins et al., 2016).

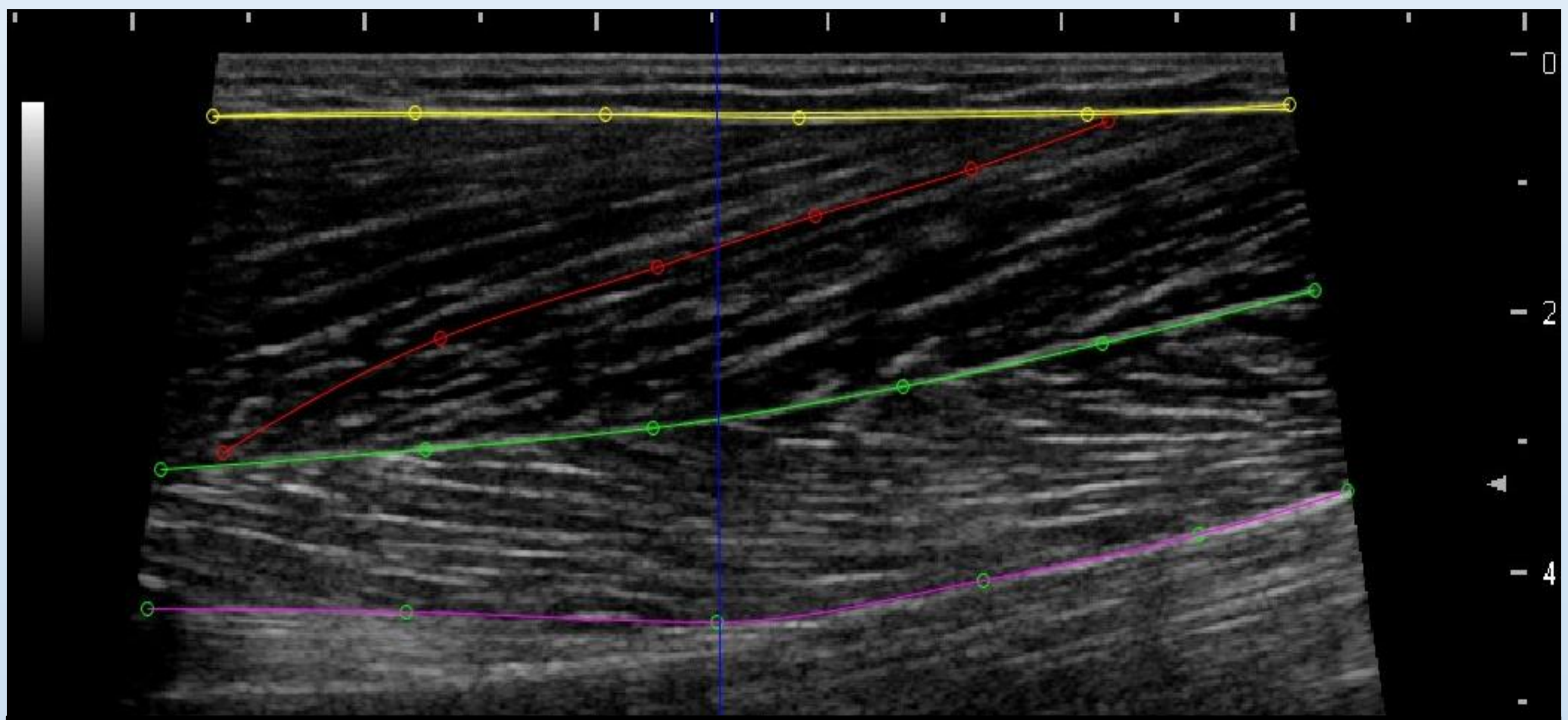

Figure 3: An sonogram of the Bicep Femoris long head muscle utilising a field of view wider than the fascicle length (Cronin et al., 2021).

RESULTS

Table 1: Muscle length of the hamstring muscles (session 1 *vs.* session 2)

Muscle	Session 1	Session 2	ICC (95% CI)	SEM
BFlh	323.5 ± 19.0	323.25 ± 19.7	0.99 (0.99 - 0.99)	4.3
BFsh	253 ± 24.8	251.3 ± 26.5	0.99 (0.98 - 0.99)	5.7
SM	317.5 ± 22.7	317.5 ± 23.1	0.99 (0.99 - 0.99)	5.1
ST	329.5 ± 30.0	329.75 ± 30.2	0.99 (0.98 - 0.99)	6.6

Table 2: Architectural comparisons of the hamstring muscles (session 1 *vs.* session 2)

Parameter	Session 1	Session 2	ICC (CL)	SEM
Fascicle Length (mm)				
BFlh Zone A	74.3 ± 5.3	74.8 ± 4.5	0.92 (0.79 - 0.97)	1.1
BFlh Zone B	64.2 ± 10.4	64.8 ± 9.8	0.98 (0.94 - 0.99)	2.3
Semimembranosus Zone A	56.6 ± 10.8	58.2 ± 10.7	0.98 (0.92 - 0.99)	2.4
Semimembranosus Zone B	48.5 ± 9.3	48.5 ± 8.3	0.95 (0.87 - 0.98)	2
Muscle Thickness (mm)				
BFlh Zone A	34 ± 4.1	34 ± 5.1	0.91 (0.76 - 0.96)	1
BFlh Zone B	33.3 ± 4.0	33.1 ± 4.2	0.93 (0.81 - 0.97)	0.91
BFsh Zone A	19.9 ± 4.7	19.9 ± 2.9	0.85 (0.61 - 0.94)	0.84
BFsh Zone B	19.4 ± 3.9	18.7 ± 3.1	0.92 (0.80 - 0.97)	0.79
Semimembranosus Zone A	35.1 ± 6.2	35.2 ± 6.5	0.96 (0.91 - 0.99)	1.4
Semimembranosus Zone B	35.5 ± 5.2	36.7 ± 5.6	0.92 (0.80 - 0.97)	1.2
Semitendinosus Zone A	25.8 ± 3.7	26.6 ± 3.7	0.88 (0.71 - 0.95)	0.82
Semitendinosus Zone B	26.3 ± 4.1	27.7 ± 4.1	0.90 (0.67 - 0.97)	0.92
Pennation Angle (⁰)				
BFlh Zone A	24.4 ± 4.6	23.4 ± 4.4	0.77 (0.41 - 0.91)	1
BFlh Zone B	24.2 ± 5.5	24.2 ± 5.9	0.87 (0.66 - 0.95)	1.3
Semimembranosus Zone A	26.2 ± 6.4	25.9 ± 7.6	0.88 (0.67 - 0.95)	1.6
Semimembranosus Zone B	24.9 ± 7.2	25.4 ± 7.0	0.83 (0.56 - 0.94)	1.6

CONCLUSIONS

Our results indicate that our wide field of view is a reliable method for the quantification of the architectural characteristics of the hamstrings.

PRACTICAL IMPLICATIONS

Our US technique is a reliable method that quantifies hamstring muscle architecture and may assist athlete management susceptible to hamstring strain injury and/or reinjury

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