The Influence of Femoral Neck Shaft Angle and Iliac Wing Width on Hip Abductor Biomechanics: Implications for Gluteal Tendinopathy

Shangcheng Wang[1], Nahir Habet[1]*, Ryan Serbin[1], Kirby Bonvillain[1], K. Durham Weeks[2,3]

[1]Atrium Health Musculoskeletal Institute, Charlotte, NC, USA; [2]OrthoCarolina Sports Medicine, Charlotte, NC, USA; [3]OrthoCarolina Research Institute, Charlotte, NC, USA

Email: Nahir.Habet@atriumhealth.org

Disclosures: Shangcheng Wang (N), Nahir Habet (N), Ryan Serbin (N), Kirby Bonvillain(N), K. Durham Weeks (N)

Introduction: Gluteal tendinopathy characterized by the degenerative changes in the tendinous structures of the hip abductors, manifests as lateral hip pain at the greater trochanter and affects approximately 10-25% of the general populace [1]. Morphological variances, notably a diminished femoral neck shaft angle (NSA) and a reduced iliac wing width to trochanteric width ratio, have been identified as potential risk factors for the onset of this pathology [2,4]. Yet, existing literature offers limited biomechanical insights into how these morphological variations influence the biomechanical milieu of the hip abductors, particularly in the context of muscular tension forces and the compressive force exerted by the IT band. This investigation seeks to elucidate the biomechanical ramifications of these morphological determinants on the hip abductors.

Methods: Utilizing a generic musculoskeletal model, variations in femoral NSAs and iliac wing widths were introduced. The workflow of this study is detailed in Fig. 1. Nine walking cycles, based on data from a healthy adult male, were simulated, and the resultant biomechanics of the hip abductors were systematically analyzed.

Results: The model with an NSA of 143° and IWW of 185mm showcased the most pronounced biomechanical disadvantage, with the shortest average moment arm (GMed, 26mm; GMin, 29mm) and the highest total forces (GMed, 1240N; GMin, 242N). In contrast, the model with an NSA of 108°and IWW of 345mm had the longest average moment arm (GMed, 47mm; GMin, 45mm) and the lowest forces (GMed, 742N; GMin, 145N). Percentage changes of lever arm and muscle force with respect to NSA and IWW were shown in Fig. 2. Linear regression analyses revealed that a reduction of 15° in NSA was associated with an increase of 16% and 14% in the average moment arm and a reduction of 17% and 13% in the total force of the GMed and GMin, respectively. A width ratio reduction of 0.21 was associated with an 11% and 6% decrease in the average moment arm and a 10% and 17% increase in the total muscle force of the GMed and GMin, respectively.

Discussion: The biomechanical implications of a narrowed iliac wing width are evident, leading to diminished lever arms and heightened tension in the hip abductors. This insight is crucial for clinicians, as understanding these biomechanical challenges can guide therapeutic interventions, potentially focusing on strengthening exercises or biomechanical corrections for patients with such morphological characteristics. Conversely, while a decreased femoral neck shaft angle has been clinically linked to gluteal tendinopathy, its biomechanical impact appears to be less detrimental. This suggests that clinical interventions for patients with a reduced NSA might need to consider factors beyond mere hip morphology, such as addressing IT band tension. The compression exerted by the IT band, especially in the presence of a reduced NSA, emerges as a potentially significant factor in the pathogenesis of this condition. Clinicians should be aware of this when assessing lateral hip pain, as targeted therapies addressing IT band compression might offer relief for patients with specific hip morphologies.

Significance: This pioneering biomechanical study offers a foundational insight into the intricate interplay of hip morphology and its biomechanical implications in gluteal tendinopathy. By elucidating the biomechanical role and underlying pathology of hip morphology in the onset of gluteal tendinopathy, it sets a precedent for subsequent investigative endeavors in this domain.

References: [1] Segal et al., 2008. Arthritis Res Ther 10: R62; [2] Fearon et al. 2012 Br. J. Sports Med. 46, 888-892. [3] Birnbaum et al., 2010. J. Pediatr. Orthop. Part B 19, 140-149; [4] Viradia et al., 2011. Am J. Orthop. 40, E159-162

Figures:

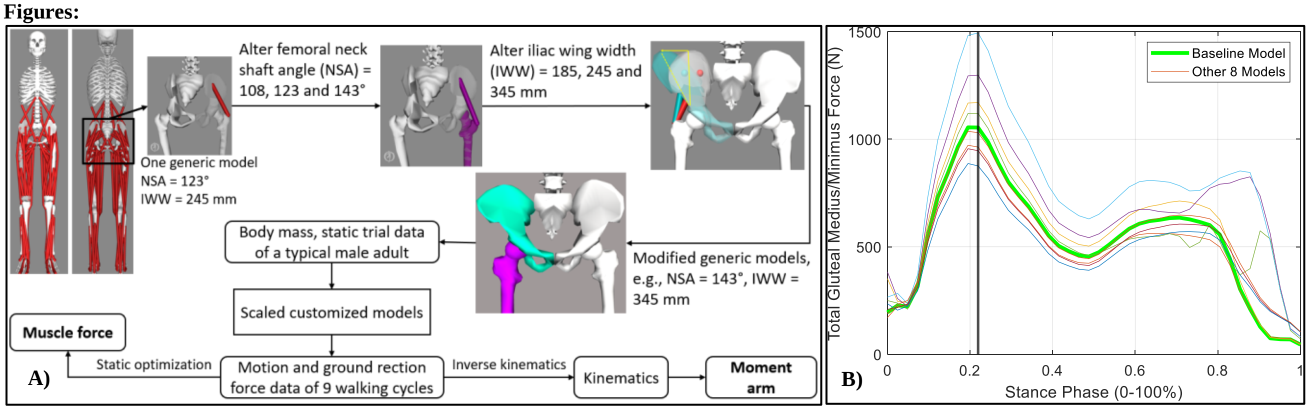

Fig. 1 Workflow of this study A) and the ensemble average waveforms of the total trochanteric abductor force during the stance phase of level walking B)

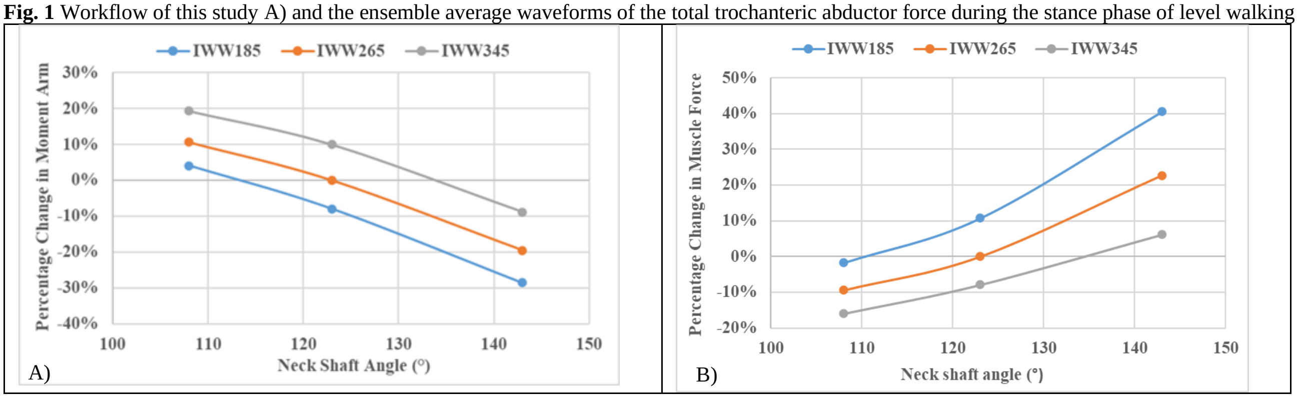

Fig. 2 Percentage change in the average moment arm for trochanteric abductors with respect to iliac wing width (IWW) and neck shaft angle A); Percentage change in the total trochanteric abductor force with respect to IWW and neck shaft angle B).