Creating an MRI Classification System for Abductor Musculature Atrophy

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INTRODUCTION

- Disease of the hip abductors is increasingly recognized as a cause of greater trochanteric pain syndrome and dysfunction of the joint.
- When conservative treatment measures are unsuccessful, surgical intervention is warranted in the setting of abductor tendon tears.
- A higher degree of pre-operative fatty infiltration negatively affects surgical outcomes including pain, Hip Outcome Score, Modified Harris Hip Score, and patient satisfaction.
- There is no standardized system for grading fatty infiltration in hip abductors.

PURPOSE

- This study aimed to:
  1. Describe a simple, reliable, and reproducible classification system for fatty infiltration specific to hip anatomy using MRI imaging.
  2. Assess the correlation between fatty infiltration grade and existing hip pathology.

METHODS

- We retrospectively identified 100 patients at UW Health who underwent a pelvic MRI with no infection, fracture, tumor, or prior history of hip surgery and collected demographic information and details on their existing hip pathology.
- Using the MRI images, we took various measurements of the bilateral gluteus medius (GMed) and minimus (GMin) for each patient, outlined in Table 1, and recorded the location of fatty atrophy.
- We then graded each GMin and GMed according to our new Blankenbaker/Spiker system, explained in Table 2. We additionally created an open access, online calculator to increase ease of use of our grading system which is linked in Table 2.
- Statistical analysis included mixed model regression to determine age/sex relationships with muscle and fat measurements as well as Wilcoxon rank sums to evaluate for differences in grade values depending on the presence or absence of specific hip conditions.

Table 1: GMin and GMed measurements taken for each hip.

Measurement	Quantity	Source Image
M1	Thickness of muscle	Slice where muscle is the thickest
M2	Thickness of fat	
M3	Thickness of fat	Slice where fat is the thickest
M4	Length of fat	
M5	Thickness of muscle	
M6	Length of muscle	

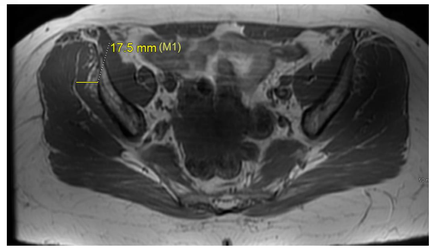


Figure 1: Measurement of thickness of the right GMin (M1).

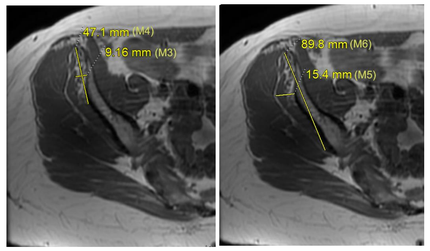
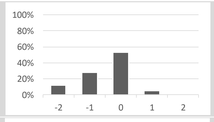
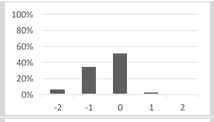
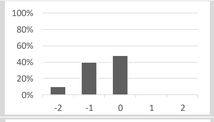
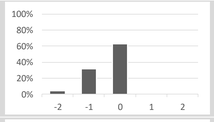
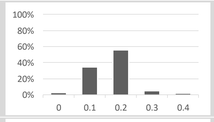
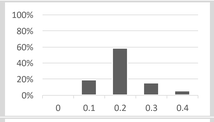
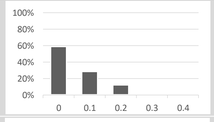
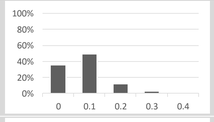
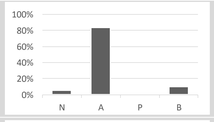
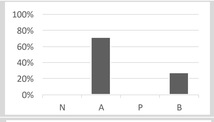
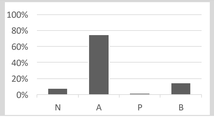
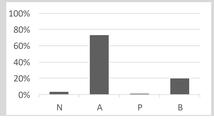


Figure 2: Measurement of thickness and length of fat and muscle in fattiest slice of the right GMin (M3, M4, M5, and M6).

Table 2: Blankenbaker-Spiker Classification system. QR code links to the online calculator.

Muscle Thickness	Fat Content	Fat Localization
-2 = >2.5 SDs below the reference value	0.0 = no fatty atrophy, <6 fatty streaks	A = Anterior portion
-1 = 1-2.5 SDs below the reference value	0.1 = 1-25% fat, 6+ fatty streaks	P = Posterior portion
0 = within 1 SD of the reference value	0.2 = 26-50% fat	B = Both
1 = 1-2.5 SDs above the reference value	0.3 = 51-75% fat	N = Neither
2 = >2.5 SDs above the reference value	0.4 = 76-100% fat	
Reference values: Female = 41.62 mm (GMed), 20.77 mm (GMin) Male = 51.20 mm (GMed), 24.29 mm (GMin)		

Table 3: Distribution of grades for muscle thickness, fat content, and localization between hips without and with pathology in the GMin and GMed.

		Abductors Without Pathology	Abductors With Pathology
Muscle Thickness	GMin		
	GMed		
Fat Content	GMin		
	GMed		
Localization	GMin		
	GMed		

RESULTS

- **Patient population (68 F, 32 M)**
  - Average age = 49 years old
  - Average BMI = 27.99 kg/m^2
  - Pathology:
    - Labral tear = 32.0%
    - Cartilage loss = 34.0%
    - Tendinitis = 30.5%
    - Bursitis = 24.5%
    - Tendon tear = 11.5%
- **Muscle and fat measurements**
  - Muscle thickness: M > F
  - Fat percentage: F > M in GMin, increased with age
- **Grades**
  - Muscle thickness:
    - GMin – 0 (IQR [-1, 0])
    - GMed – 0 (IQR [-1, 0])
  - Fat content:
    - GMin – 0.2 (IQR [0.1, 0.2])
    - GMed – 0 (IQR [0, 0.1])
  - Localization: most often in anterior muscle
- **Correlations**
  - Muscle thickness:
    - Positive association with incidence of tendon tear, tendinitis, and cartilage loss for GMed
  - Fatty atrophy:
    - Positive association with tendon tear, tendinitis, and cartilage loss in both GMin and GMed
    - Positive association with labral tear in GMin
    - Positive association with bursitis in GMed
  - Positive correlation between hip pathology and fat localized to posterior muscle or whole muscle

CONCLUSIONS

- This classification system provides a simple way to grade fatty atrophy in hip abductor muscles.
- It addresses the limitations of subjectivity and specificity to hip anatomy that exists in current systems and correlates with various hip pathologies.
- Future work will include an analysis of the inter- and intra-rater reliability of the system and application of the system to a population of patients who underwent tendon repair to compare pre-operative fatty atrophy scores and post-operative outcomes.

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REFERENCES

- For a reference list, scan the QR code to the right.

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