COMPARISON OF SELECTED STRETCH POSITIONS OF THE PIRIFORMIS MUSCLE USING COMPUTED TOMOGRAPHY

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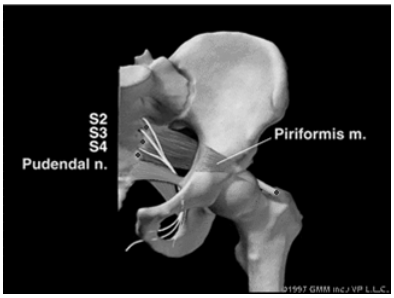

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Background Information

- Function of the piriformis
  - ER of the femur during hip ext[1-3]
  - ABD during hip flex[1-3]
  - IR during hip flex[1,3-6]

Background Information

- Limited research exists on appropriate stretching
- Literature is contradictory
- Clinicians choose stretching method based on clinical experience rather than research

Common stretches

Pilot Study 2006

- Pelvic fluoroscopy performed on skeletal model to determine piriformis stretch
- Positive Results
  - Greatest stretch in upper fibers with 90° Hip Flex and 50° ER
- Limitations
  - Poor radiographic images due to low degree of radiation using fluoroscopy
  - ADD was not addressed in the stretching positions

Research Focus & Question

- Purpose:
  - Comparing commonly used stretch positions of the piriformis using CT scans
    - Common clinical technique involves Flex, ER & ADD
- Question:
  - Which technique demonstrates the greatest piriformis stretch:
    - 90° hip Flex, ADD, ER
      - Stretch ADD
    - 90° hip Flex, ER, ADD
      - Stretch ER

Hypotheses

- A combination of ER and ADD will give a more significant stretch than ER alone
- Stretch ADD will yield a greater stretch than Stretch ER
  - Based on subjective stretching
  - No research supports this hypothesis

Results from database search

- Search Results
  - 17 articles collected
    - 10: relevant information on piriformis muscle
    - 4: relevant information on CT scans
- Databases
  - PubMed
  - Cinhal
  - Medline
  - InfoTrac Onefile

Summary of Lit Review

- **Hip Flex & ADD**
  - 1 review article & 2 textbooks
- **Hip Flex, ADD, IR**
  - 6 articles: 5 review & 1 case study
    - 1 supporting hip flex below 60°
- **Hip Flex, ADD, ER**
  - 3 articles: 1 experimental study & 2 reviews
    - 1 supporting hip flex above 60°
  - **Clinical use of this combination is common**
- Problem: literature has not addressed optimal stretching or the order of the positions of the stretch

Methods

- Instrumentation
  - Computed Tomography
    - General Electric Lightspeed VCT (64 slice machine)
- Subjects
  - 4 female human subjects
    - Supine: 0° hip flex
    - Stretch ADD
    - Stretch ER

Stretching Positions From Supine

- 90° Hip Flex, ADD followed by ER (stretch ADD)

- 90° Hip Flex, ER followed by ADD (stretch ER)

Radiation Exposure

- Lowest possible radiation dose is absorbed by subject using a 64 slice CT machine
- Hamilton Co radiation physicist Don Stone stated: 3 CT scans/person are safe for non-pregnant females[21]

Selection Criteria

- Inclusion
  - Female
  - Aged 20-25
  - Low soft tissue mass
  - Height 5'5" or less
  - Sign consent form
- Exclusion
  - Participation in radiation study within the last year
  - Current or planned pregnancy within 6 months after the completion of the study
  - Current smoker
  - Any known hip pathology

Measurement and Analysis

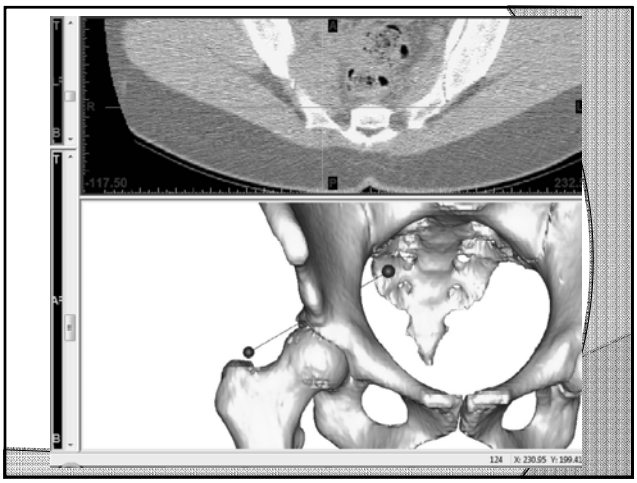
- Protocol for CT scans were assembled by Dr. Marcellin-Little
- CT scan was reconstructed by the LightSpeed VCT and converted to Dicom images
- Dicom images were sent to Dr. Marcellin-Little for analysis and measurement

Measurement and Analysis

- Images were imported into *Mimics*
  - *A* biomodeling software program
- Thresholding was performed
  - To minimize artifacts from beam hardening & CT noise
- 3D reconstructions were assessed for musculoskeletal alignment
- One-way ANOVA corrected for repeated measures was used to compare the stretching positions

Measurement of Piriformis

- Muscle length was calculated by *Mimics* using the distance between 2 spheres which represented the proximal and distal bony attachments of the piriformis
  - Proximal – centered over the 3rd sacral vertebra midway between the sacral nerve foramen and the lateral border of the sacrum
  - Distal – medial aspect of the proximal border of the greater trochanter



Stretch Positions (Goniometric Measurements)

Subject 1

- supine
- 1 (stretch ADD): hip Flex 90° ADD 50° ER 35°
- 2 (stretch ER): hip Flex 90° ER 65° ADD 37°

Subject 2

- supine
- 1 (stretch ER): hip Flex 90° ER 67° ADD 35°
- 2 (stretch ADD): hip Flex 90° ADD 52° ER 33°

Length Measurements

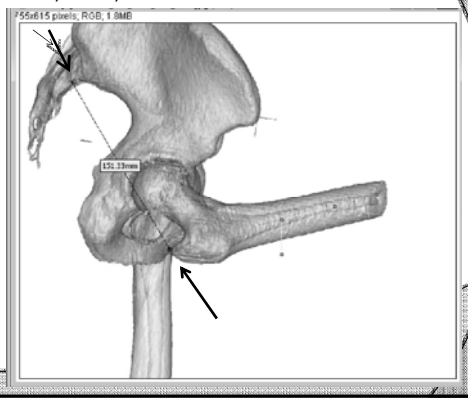
Subject 1

- Supine length: 124 mm
- **Position 1: 156 mm**
  - **26% difference**
    - **Stretch ADD**
- Position 2: 151 mm
  - 22% difference
    - Stretch ER

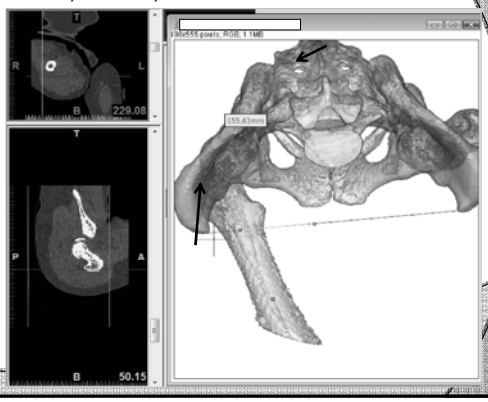
Subject 2

- Supine length: 126 mm
- Position 1: 156mm
  - 24% difference
    - Stretch ER
- **Position 2: 159 mm**
  - **26% difference**
    - **Stretch ADD**

Flexion, ER, ADD = 151.33mm



Flexion, ADD, ER = 155.63mm

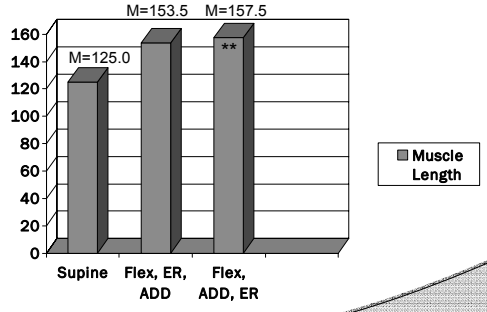


Statistics

Position	P value (p < 0.05)
Supine → Flex, ADD, ER	0.029
Supine → Flex, ER, ADD	0.100
Stretch ADD → Stretch ER	0.468

- Power analysis revealed that 6 subjects would be sufficient to reduce standard error and demonstrate significance for stretch ER

Change in Piriformis Length



** Statistically significant from supine (p= 0.029)

Summary of Results

- In the two subjects
  - Both stretch positions resulted in an increase in piriformis length from supine
  - Stretch ADD from supine showed statistical significance
  - Stretch ER from supine was not significant
    - Due to small sample size and a large standard error

Study critique

Strengths

- Use of CT & Mimics to analyze piriformis length
- Similar results found within & between subjects
- Findings support what is seen clinically

Limitations

- Small sample size
- Data of other 2 subjects not yet analyzed
- Difficulty maintaining the position during the scan
- Homogeneous sample 2° diameter of the CT opening

Conclusion

- Hypothesis #1: supported
  - A combination of ER and ADD gave a more significant stretch than ER alone
  - 26% vs. 13.35% noted from pilot study
- Hypothesis #2: supported
  - Stretch ADD gave a greater stretch than Stretch ER

Recommendations

- Larger sample size
- Include male & female subjects
- Trial run for subject "fit" in CT machine
  - Without radiation
  - Femur length
  - Mvmt of LE during CT scan 2° LE hitting side of machine
- Extrapolate data using *Mimics* software
  - Include hip flex < 60°, ADD, and IR

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QUESTIONS ?