Unacceptable Reliability of FAI Radiographic Parameters – Renewed Emphasis for Physical Exam Diagnosis and 3D Advanced Imaging

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Background

• Femoroacetabular impingement (FAI) is a common cause of hip pain in young adults
• Correlation of clinical examination and imaging is cornerstone of successful patient selection
Background

• Initial examination of plain radiographs may dictate further advanced imaging
• Image analysis based on multiple factors:
  • Reader (surgeon, radiologist)
  • Platform (digital vs hard-copy)
  • Image (chosen images, technique)
• Multifactorial nature of image interpretation introduces variable reliability
Purpose

• To determine the inter-observer and intra-observer reliability of FAI radiographic parameters
Methods

• IRB-approved study
• Plain radiographic assessment of 50 consecutive adult subjects that underwent hip arthroscopy for indicated procedures related to FAI, labrum, and capsule
  • 5 subjects’ images inadequate (tilt, rotation), leaving 45 hips for analysis
Methods

- Two reviewers:
  - Orthopaedic surgeon (fellowship-trained Sports Medicine, hip preservation)
  - Orthopaedic surgery resident (PGY-4)
- Independent review of all images (two-week interval between reading #1 and #2)
Methods

• 3 images reviewed:
  • Standing anteroposterior (AP) pelvis
  • Supine Dunn 90 degree
  • Standing false profile
Methods

- AP pelvis
  - Lateral CEA
- False profile
  - Anterior CEA
  - Alpha angle
  - Anterior HNO
  - Posterior HNO
  - HNO ratio
- Dunn 90
  - Alpha angle
  - Anterior HNO
  - Posterior HNO
  - HNO ratio
  - Ant-post HNO ratio
  - Femoral head max diameter
Statistical Analysis

• Reliability calculated using two-way mixed intraclass correlation coefficient (ICC) for single measures
• Acceptable reliability defined as ICC $\geq 0.6$
Results

• 45 subjects (29 right hips, 16 left hips)

• Inter-observer reliability acceptable for:
  • Lateral CEA (ICC 0.892)
  • Anterior CEA (ICC 0.933)
  • All other measurements (ICC < 0.6)
Results

• Intra-observer reliability acceptable for:
  • Both reviewers
    • Lateral CEA
      • ICC 0.980, 0.824
    • Anterior CEA
      • ICC 0.981, 0.868
    • Posterior HNO
      • ICC 0.736, 0.725
  • One reviewer
    • Alpha angle (Dunn)
      • ICC 0.909
    • HNO ratio (false profile)
      • ICC 0.642
    • HNO anterior (Dunn)
      • ICC 0.709
    • HNO posterior (false prof)
      • ICC 0.832
Discussion

- Current investigation findings are consistent with:
  - Carlisle, Clohisy, et al; *Iowa Orthop J* 2011
    - Excellent intraobserver reliability of lat CEA, ant CEA
    - Poor interobserver reliability of all other FAI data
  - Clohisy, et al; *Clin Orthop Rel Res* 2009
    - Poor interobserver reliability for FAI, DDH
  - Mast, et al; *Clin Orthop Rel Res* 2011
    - Direct measurements (femoral head diameter) more reliable than estimated (alpha angle) measurements
Why poor reliability?

- **Individual measurer**
  - Surgeon vs radiologist
  - Treating clinician vs independent
  - Years experience
  - Judgment of x-ray adequacy (tilt, rotation)

- **Imaging technique**
  - Use of spherical marker of known size
  - Standing vs supine views
  - Actual images obtained (Dunn, cross-table, frog-leg)
  - Tube-to-film distance

- **Software manipulation**
  - Size of screen
  - Amount of image zoom or magnification
  - Adjustment for pelvic tilt / alignment
  - Assignment of Mose circle
  - Assignment of pelvic tilt
  - Assignment of “out-of-round” location for alpha angle
  - Direct vs estimated measurement
Limitations

- Quantitative (continuous data) parameters only
- Omitted categorical data (present/absent)
  - Crossover sign
  - Ischial spine sign
  - Posterior wall sign
  - Tönnis classification (arthritis)
  - Coxa profunda
  - Protrusio acetabuli
- Only two reviewers
Conclusions

• Acceptable inter-observer reliability for only two parameters (lateral and anterior CEA)
• Acceptable intra-observer reliability for only three parameters (lateral and anterior CEA, Dunn posterior HNO)
Conclusions

- Underscores necessity of thorough history and physical examination to diagnose symptomatic FAI
  - “Treat the patient, not the X-ray”
- Advanced imaging, such as 3D CT and MRI may more reliably characterize FAI pathomorphology
References