Impingement syndromes of the shoulder & hip: Evaluation using ultrasound

David Robinson
Monash University, Clayton

Academic Supervisor
A/Prof Michal Schneider
Dept. of Medical Imaging & Radiation Sciences
Faculty of Medicine, Nursing and Health Sciences
Monash University
Clayton

Clinical Supervisors
Dr Steven Lee MBBS FRANZCR
The Avenue X-ray & MRI
Windsor

Dr Paul Marks MBBS FRANZCR
Imaging Associates
Box Hill
Impingement syndromes

- A mechanical encroachment upon or collision between two objects
- May affect tendons, nerves, arteries veins and bony surfaces across joints, particularly the shoulder & hip
- Methods of diagnosis commonly rely on clinical presentation, electromyography, X-ray, Computed Tomography (CT) and Magnetic Resonance (MR)
- Delays in diagnosis can result in irreversible damage to the structure affected
Quadrilateral Space Syndrome QSS

- Compression neuropathy of the axillary nerve in the quadrilateral space

- Detected with MR Angiography of the posterior circumflex humeral artery (PCHA)

Source: Williams PL, Warwick RE (Ed.s.) Grays Anatomy 36th Ed.
QSS (cont.)

Source: David Robinson The Avenue X-ray & MRI
QSS – Ultrasound of the PCHA

Results:

- 50 asymptomatic volunteers recruited – no shoulder pathology
- Mean (±Sdev) age 35 (± 14 yrs)
- Scan from posterolateral approach
- PCHA observed in all cases in neutral and ABER
- Ultrasound can be used to reliably visualize the PCHA.
- WFUMB Sydney 2009
- Published JMIRO 54 (2010) 219-223
**QSS – 2. Occlusion & Stenosis of the PCHA: Detection with ultrasound**

Doppler ultrasound evaluation of PCHA blood flow in asymptomatic shoulders (n/N (%))

<table>
<thead>
<tr>
<th>PCHA flow</th>
<th>n/N(%)</th>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>78/93 (83.87%)</td>
<td></td>
</tr>
<tr>
<td>Abnormal</td>
<td>15/93 (16.13%)</td>
<td></td>
</tr>
<tr>
<td>Occluded on ABER</td>
<td>8/15 (53.33%)</td>
<td>No detectable Doppler signal</td>
</tr>
<tr>
<td>Stenosed on ABER</td>
<td>2/15 (13.33%)</td>
<td>ABER PSV &gt; 2 times neutral PSV</td>
</tr>
<tr>
<td>Delayed acceleration</td>
<td>5/15 (33.33%)</td>
<td>AT &gt; 80 msec without evidence of aTOS</td>
</tr>
</tbody>
</table>

Impingement syndromes of the shoulder & hip: Evaluation using ultrasound

16 August 2014
QSS –2. Occlusion & stenosis of the PCHA: Detection with ultrasound

- Table 2: Doppler ultrasound characteristics of the PCHA according to arm position

<table>
<thead>
<tr>
<th></th>
<th>Neutral</th>
<th>ABER</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSV Dominant arm</td>
<td>29.58 (±8.69) cm/sec</td>
<td>29.81 (±19.76) cm/sec</td>
</tr>
<tr>
<td>PSV Non-dominant arm</td>
<td>28.99 (±9.38) cm/sec</td>
<td>25.79 (±16.80) cm/sec</td>
</tr>
<tr>
<td>Resistive Index</td>
<td>0.92 (±0.07)</td>
<td>0.93 (±0.14)</td>
</tr>
<tr>
<td>Acceleration time</td>
<td>37.73 (±9.34)</td>
<td>49.51 (±31.38)</td>
</tr>
</tbody>
</table>

PSV = Peak Systolic velocity
ABER = Abduction and External Rotation
Occlusion or stenosis of the PCHA on ABER is an uncommon finding in an asymptomatic population.

Axillary neurovascular compression is unlikely if colour doppler ultrasound does not show PCHA compromise during ABER.

Published JMIRO 55 (2011) 479–484
Femoroacetabular Impingement (FAI)

- The femoral head-neck junction at the hip may impinge upon the acetabular labrum at terminal motion (flexion & internal rotation)

- A non-spherical, extra-articular extension of the femoral head impacts the labrum causing damage a may lead to osteoarthritis (OA)
FAI (cont.)

"CAM" Effect

FAI (cont.)

- Femoral head asphericity objectively assessed using an “alpha angle “

- Current imaging techniques for hip FAI are problematic….

- Young asymptomatic populations - unnecessary radiation (CT, X-ray)

- Cost and availability - MRI and CT scanning

Source: Notzli HP et al. The contour of the femoral femoral head-neck junction as a predictor for the risk of anterior impingement. JBJS(BR) 2002 84-B
Impingement syndromes of the shoulder & hip: Evaluation using ultrasound
16 August 2014
FAI – Difference in alpha angles using two methods

Source: Beaule PE et al. Three-dimensional computed tomography of the hip in the assessment of femoroacetabular impingement. JBJS(BR) 2005 84-B
FAI – Difference of alpha angles using two methods

Source: David Robinson and David Kortmann, The Avenue X-ray & MRI
Difference in alpha angles when using two commonly described methods for CT assessment of FAI

Aims:

- Calculate femoral head-neck alpha angles on a group of patients having 3DCT at our institution (Beaule - CT method)
- Recalculate the femoral head-neck alpha angles using the method originally described by Notzli et al (2002).
FAI - Difference in alpha angles using two methods

- Twenty three patients included in the study. Eleven bilateral (N=34).

- Age range 19 - 74 years - average 38.9 years (± 14.5) years).

- The mean alpha angle Beaule was 61.59 (± 14.3) degrees (range 37.7 – 90.9).

- The mean calculated alpha angle Notzli was 54.01 ± 13.1 degrees (range 37.6 – 79.2).

- Wilcoxon signed rank test
FAI - Difference in alpha angles using two methods

Wilcoxon Signed rank Test

- Calculated Alpha angle

Beaule Method vs. Notzli Method
FAI - Difference in alpha angles using two methods

- The mean difference between the two measurements was 7.6 degrees (95%CI 4.9 – 10.2) (p < 0.0001).

- The two commonly used methods of calculating femoral head-neck alpha angle are not directly comparable - Beaule method higher value

- Study submitted for publication (MSKR) June 2014 – Rejected July 2014

- E-poster CSM September 2014
Aims:

- determine the intra-observer reliability of repeated measurement of the femoral head-neck alpha angle using ultrasound as the imaging modality.
FAI – Inter-observer error in calculation of alpha angle using US

- Eleven (11) healthy asymptomatic volunteers (5F 6M) N=22

- Age range 22 – 50 years (mean 31 years)

- Both hips imaged in longitudinal plane with respect to the femoral neck

- Volunteers imaged a second time several days later.

- Measurements of the alpha angle taken three times for each hip and the subsequent mean compared between the two time points.

- Intra-class correlation coefficient calculated for right and left hips
Statistical Results: ICC – Intra-Class Correlation Coefficient for one sonographer when measuring the femoral head-neck alpha angle using ultrasound (Total N = 11).

<table>
<thead>
<tr>
<th>Side</th>
<th>Variation across 6 repeated measures</th>
<th>ICC (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>p</td>
<td>f</td>
</tr>
<tr>
<td>Left</td>
<td>0.314</td>
<td>1.268</td>
</tr>
<tr>
<td>Right</td>
<td>0.253</td>
<td>1.438</td>
</tr>
</tbody>
</table>
Calculations of femoral head-neck alpha angles using ultrasound have high intra-observer reliability.

Submitted for publication European Journal of Radiology September 2013

Rejected April 2014
FAI. Ultrasound calculation of the femoral head-neck alpha angle.

Aims:

- Use established imaging modalities 3DCT and MRI to for alpha angle
- Use ultrasound to image the hips of patients with FAI and calculate the femoral head-neck alpha angle using the same method.
- Determine the correlation between ultrasound calculation of the femoral head-neck alpha angle and that calculated by established modalities.
47 volunteers recruited

22 volunteers underwent CT (10 bilateral)  23 volunteers underwent MRI

2 combined CT and MRI

57 hips for analysis

Results to be analyzed
### Timeline

<table>
<thead>
<tr>
<th>Period</th>
<th>Task</th>
</tr>
</thead>
<tbody>
<tr>
<td>July – September 2014</td>
<td>Rewrite 2 rejected articles for resubmission to other journal(s)</td>
</tr>
<tr>
<td></td>
<td>Begin analysis of ultrasound alpha angle data</td>
</tr>
<tr>
<td>September 2014</td>
<td>CSM meeting (e-poster - comparison of alpha angle measurements)</td>
</tr>
<tr>
<td>October – December 2014</td>
<td>Write up results of ultrasound of alpha angle &amp; submission for publication</td>
</tr>
<tr>
<td>December 2014 – April 2015</td>
<td>Complete analysis and write-up of results for all studies</td>
</tr>
<tr>
<td>April 2015 - 2016</td>
<td>Write up thesis</td>
</tr>
</tbody>
</table>