Shoulder Arthroplasty

Jaime Candal Couto
Osteoarthritis

“Improvement of self assessed health status after TSR (Total Shoulder Replacement) is comparable to that of Total Hip replacement and Coronary Artery Bypass Graft”

– Boorman et al, JSES 2003
1: The surgeon
Shoulder arthroplasty: incidence
(100,000 population/year)

- US: 21.55
- New Zealand: 4.2
- UK: 3.6
- Norway: 2.8 (1994) - 4.7 (2005)
100-150 prosthesis / year
New Zealand Shoulder Arthroplasty register

- 3 m population
- 160 orthopaedic surgeons
- 4 years 2000-2003
- 686 primary prosthesis

J Candal-Couto, BOA 2005
Surgeons workload: Shoulder arthroplasty cases/4 years
THE OXFORD SHOULDER SCORE (OSS)

12 questions; score 1(best)-5(worst)

1. Worst pain from shoulder
2. Trouble with dressing
3. Trouble with transport
4. Using a knife and fork
5. Doing household shopping alone
6. Carrying a tray of food
7. Brushing/combing hair
8. Usual level of shoulder pain
9. Hanging clothes in wardrobe
10. Washing under both arms
11. Work interference due to pain
12. Pain in bed at night

Excellent: 12-18
Good: 19-26
Fair: 27-36
Poor: 37-60

## SURGEON’S WORKLOAD & Oxford Shoulder Score (12-60)

*J Candal-Couto, BOA 2005*

<table>
<thead>
<tr>
<th>Outcome (%)</th>
<th>ALL CASES</th>
<th>High volume surgeon</th>
<th>Low volume surgeon</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent</td>
<td>34.3 %</td>
<td>27.6 %</td>
<td></td>
</tr>
<tr>
<td>Good</td>
<td>30.3 %</td>
<td></td>
<td>28.9 %</td>
</tr>
<tr>
<td>Fair</td>
<td>24.5 %</td>
<td></td>
<td>23.9 %</td>
</tr>
<tr>
<td>Poor</td>
<td>10.7 %</td>
<td></td>
<td>19.4 %</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Number of cases</th>
<th>221</th>
<th>224</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean score</td>
<td>23.8</td>
<td>26.4</td>
</tr>
</tbody>
</table>

\[ p = 0.0038 \]

\[ p < 0.0001 \]
Surgeons who do >5 cases per year also have...

- Lower complication rates
- Lower Mortality
- Shorter Hospital Stay

- Jain at al, JBJS-A 2004
- Hammond et al, JBJS-A 2003
2: The Prosthesis
Shoulder arthroplasty: historical background.  

*Pean, 1893*
1951 Neer’s Vitalim prosthesis
1970’s Neer Total Shoulder

Neer, et al, JBJS 1982
Humeral Stem
Second Generation: 1980’s
Anatomy of the humerus and prosthetic design

- Surprisingly not Studied in detail till 90’s!
- Normal proximal Humeral anatomy Highly variable
- Variability between individuals and also right & Left
Basic Concepts: Normal anatomy

- Head-Shaft angle
- Retroversion
- Offset
- Radius of Curvature and height
Basic concepts: Implant Considerations

- Humeral head size
- Humeral Head osteotomy
- Head-Stem relationship
1: Head – Shaft Angle

- Difficult measurement
  - Base of articular surface is a plane not a line
  - Humeral shaft is tubular

Range 30°-55°
2: Retroversion

- Markedly variable
- RANGE $0^\circ - 55^\circ$
3: Offset

- Distance of Center of rotation to central axis of humeral canal
- **CORONAL:** 4 to 14 mm MEDIAL
- **SAGITTAL:** -2 to 10mm POSTERIOR
Radius of Curvature
20-30mm
Head Height

\( \frac{3}{4} \) of RC
Surface Arc
150°
4: Radius of Curvature and Head Height

- Radius of Curvature (RC): 20-30mm
- Head Height: always ¾ of RC
- Surface Arc 150°
Implant Considerations

- Head Size
- Head-Stem Relationship
- Osteotomy
1: Head Size

- Too small or too large will change centre of rotation and alter dynamics of Rotator cuff
- Joint “Stuffed” vs “Slack”
- Surface Arc affected
- Mechanical Impingement
  - Tuberosity-Acromion
  - Humeral head-glenoid
2: Head Stem relationship: Offset
3: Humeral Head Osteotomy

2 different philosophies:

- Cut the bone to match the prosthesis
  
  *Eg: Bigliani-Flatow (Zimmer)*

- Cut the bone anatomically and adjust the prosthesis to match the osteotomy
  
  *Eg: Anatomical Prosthesis (Zimmer)*
Fixed neck-shaft angle
Adjust to retroversion
“3rd Generation” & Anatomical Humeral Prosthesis

- Aim to recreate normal anatomy
  - Restore/maintain dynamics of rotator cuff
  - Avoid impingement
- Modular heads
  - Height
  - Diameter
  - Offset
- Anatomical 3 dimensional variable angle
HUMERAL STEMMED COMPONENTS

3\textsuperscript{RD} GENERATION/ ANATOMICAL DESIGNS

- Logical
- Superior results in laboratory
- Technically much easier and reliable to reproduce normal anatomy
- Very good short term-medium term clinical results

- \textit{Godeneche et al, JSES 2002}
- \textit{Phahler et al, Act Chir Belg, 2009}
Severe avascular necrosis
The humeral Component: a different approach...

RESURFACING ARTHROPLASTY

- Historically early loosening.
- Copeland prosthesis: satisfactory 10 year results
  - HA coating + design avoid loosening

Levy & Copeland, JSES, 2004
2 designs
Copeland’s resurfacing

- Widespread use in the UK
- Successful and reliable 10 year results
- Joint “overstuffing” causes problems
My experience

- 36 prosthesis
- 8 rheumatoid
- 2 cuff arthropathy
- 26 OA
- 34 satisfied
- 2 glenoid erosion-1revised
- 1 early infection
- 1 late infection-revised
- ? No loosening
The Glenoid

anatomy
The Glenoid

anatomy
The Glenoid

- **Upper**: 23mm
  - (18-30)
- **Lower 29mm**
  - (21-35)
37.9mm
31.2-50.1mm
Glenoid inclination

Superior incline 4°
Glenoid version
Glenoid version

2° anteversion-9° retroversion
Basic concepts

- Glenoid erosion/wear
- Radial missmatch
- Componnt design
1: Posterior glenoid erosion in OA
Posterior glenoid erosion in OA
Glenoid wear

- Eccentric reaming to correct >10° will make the glenoid surface significantly smaller and compromise arc of motion.
- Grafting may compromise fixation of glenoid component.
“Radial Mismatch”
“Radial Mismatch”
“Radial Mismatch”
“Radial Mismatch”
“Radial Mismatch”
Conformity vs “Radial Mismatch”

- Physiological translation

- Cadaveric studies: 4mm mismatch best replicates normal glenohumeral kinematics
  - Karduna et al, JBJS A 1997

- Clinically, mismatch of 6-7mm provides best clinical outcome with low incidence of post operative radiolucent lines
  - Walch et al, JBJS A 2002
3 Glenoid component Designs and methods of fixation

- Endless number invented & abandoned!
- Modern glenoids: Areas of recent controversy
  - Cemented / uncemented / hybrid
  - All plastic / metal-back
  - Keeled / peg fixation
  - Flat back / curved back
WHICH GLENOID?

- Biomechanical and early clinical clearly favours:
  1. Pegged
  2. Curved Back
  3. Cemented, all plastic
  4. Radial mismatch 4-7mm

Strauss et al, JSES 2009
Alternatives to glenoid prosthetic replacement?

- Allograft
  - Meniscal
  - Achilles tendon
- “Ream & run”
- Microfracture

– MAY BE CONSIDERED IN THE YOUNG
3: The Patient
# INDICATIONS AND TYPE OF ARTHROPLASTY

<table>
<thead>
<tr>
<th>Pathology</th>
<th>HHA</th>
<th>TSA</th>
<th>“Reverse Shoulder”</th>
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<tbody>
<tr>
<td>Osteoarthritis</td>
<td>138</td>
<td>213</td>
<td>3</td>
</tr>
<tr>
<td>Rheumatoid arthritis</td>
<td>68</td>
<td>35</td>
<td>1</td>
</tr>
<tr>
<td>Other inflammatory arthritis</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Acute proximal humeral fracture</td>
<td>94</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Old trauma</td>
<td>37</td>
<td>10</td>
<td>2</td>
</tr>
<tr>
<td>Post recurrent dislocation</td>
<td>3</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Avascular Necrosis</td>
<td>21</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Cuff tear/ Cuff tear arthropathy (44) (*)</td>
<td>36</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>Other</td>
<td>3</td>
<td>4</td>
<td>0</td>
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</table>

(*) cuff tear does not exclude of other pathology. 8 cases had a second diagnosis: 3 OA, 1 RhA, 2 AVN and 2 “old trauma”.
## INDICATIONS & OSS

<table>
<thead>
<tr>
<th>Pathology (n of cases)</th>
<th>Mean Score</th>
<th>t-test</th>
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</thead>
<tbody>
<tr>
<td>Osteoarthritis (246)</td>
<td>22.4</td>
<td>P&lt; 0.0001</td>
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<tr>
<td>Rheumatoid arthritis (75)</td>
<td>26.7</td>
<td></td>
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<tr>
<td>Other Inflammatory (6)</td>
<td>29.1</td>
<td></td>
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<tr>
<td>Acute Fracture Proximal humerus (42)</td>
<td>31.4 *</td>
<td>P&lt; 0.0001</td>
</tr>
<tr>
<td>Old trauma (31)</td>
<td>29.8 *</td>
<td>P&lt; 0.0001</td>
</tr>
<tr>
<td>Avascular necrosis (15)</td>
<td>25.5</td>
<td></td>
</tr>
<tr>
<td>Cuff tear/ CT arthropathy (31)</td>
<td>29.6</td>
<td></td>
</tr>
<tr>
<td>Post recurrent Dislocation (3)</td>
<td>27.3</td>
<td></td>
</tr>
<tr>
<td>(*)Acute fractures vs old trauma p=0.51 (N.S)</td>
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**INDICATIONS AND TYPE OF ARTHROPLASTY & OSS**

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>Hemiarthroplasty</th>
<th>Total Shoulder Arthroplasty</th>
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<tbody>
<tr>
<td></td>
<td>Number of cases</td>
<td>Average Score</td>
</tr>
<tr>
<td>Osteoarthritis</td>
<td>88</td>
<td>25.4</td>
</tr>
<tr>
<td>Rheumatoid Arthritis</td>
<td>47</td>
<td>28.3</td>
</tr>
<tr>
<td>Avascular Necrosis</td>
<td>11</td>
<td>27.2</td>
</tr>
<tr>
<td>Trauma (acute + old)</td>
<td>64</td>
<td>31.6</td>
</tr>
<tr>
<td>Cuff Tear/ CT arthropathy</td>
<td>25</td>
<td>31.2</td>
</tr>
<tr>
<td></td>
<td>5 (*)</td>
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(*) These 5 cases had a Reverse Shoulder Arthroplasty
Osteoarthritis

- TSR Vs HHA?
- Resurfacing option?
Osteoarthritis

- TSR results significantly superior to hemiarthroplasty alone
  - *Edwards et al, JSES 2003*

- But alternative view that HHA alone gives “acceptable” results
  - *Norris et al, JSES 2002*
Radnay et al, JSES 2007

- Largest Meta-analysis (23 studies)
  - 1952 patients (OA only)
  - 4 year follow up
  - 1966-2004
  - TSR significantly better that HHA:
    - Pain Relief
    - Forward elevation
    - Gain in forward elevation
    - Gain in external rotation
    - Patient satisfaction
But which option gives better long-term results?
Failure mechanisms:

HHA: Glenoid erosion
TSR: Glenoid loosening
Revision TSR for glenoid loosening

- 76% glenoid loosening at 15 years, Neer-2 TSR
  - Sperling at al, JSES 2004

- Revision at 4 years: 6.4%
  - Radnay et al, JSES 2007

- Large variations in reported literature: prosthetic design
  - Aequalis prosthesis >95% survival at 10 years
    - T Bunker, Bess 2008
Revision TSR for glenoid loosening

- Difficult surgery
- Bone graft
- 1-2 stage revision

Both re-implantation of glenoid and conversion to hemiarthroplasty improve pain and function but reimplantation of glenoid better

*Deutsh et al. JSES 2007*
Revision HHA to TSR for glenoid erosion

- More likely if preoperative glenoid arthrosis, particularly if posterior glenoid wear
- In non-concentric wear, risk of poor results >40%
  - Levine et al, JSES 1997
- Even if concentric wear, TSR provides superior results
  - Gartsman et al, JBJS-A, 2000
Revision HHA to TSR for glenoid erosion

- 10% revision at 4 years
  - Radnay et al, JSES 2007

- Glenoid erosion in 72% cases at 15 years
  - Sperling et al, JSES 2004

- Results of HHA revision to TSR not universally good and never as good as primary TSR
TSR vs HHA
*Sperling at al, JSES 2004*

- >15 year retrospective study (1976-1985)
- Patients age < 50
- Neer-2
- 78 HHA - 36 TSR

<table>
<thead>
<tr>
<th></th>
<th>10 year survival</th>
<th>20 year survival</th>
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<tbody>
<tr>
<td>HHA</td>
<td>82%</td>
<td>75%</td>
</tr>
<tr>
<td>TSR</td>
<td>97%</td>
<td>84%</td>
</tr>
<tr>
<td></td>
<td>HHA</td>
<td>TSR</td>
</tr>
<tr>
<td>---------------</td>
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<td>------</td>
</tr>
<tr>
<td>Excellent</td>
<td>10%</td>
<td>21%</td>
</tr>
<tr>
<td>Satisfactory</td>
<td>30%</td>
<td>31%</td>
</tr>
<tr>
<td>Unsatisfactory</td>
<td>60%</td>
<td>48%</td>
</tr>
</tbody>
</table>
My practice

- Young: resurface
- Old: TSR if possible
Rheumatoid Arthritis

- TSR > HHR
- Glenoid deformity may not allow replacement
- DEFICIENCY OF ROTATOR CUFF DICTATES POOR FUNCTION
Rotator cuff arthropathy
Thank you
POST TRAUMATIC CONDITIONS

- Difficult!!
- Outcome unpredictable
- Osteotomy of GT probably best avoided
  - Boileau et al 2001
- “Double Bubble”