Histological and Clinical Evaluation of Failed Shoulder Surface Replacement Implants

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Statement of Purpose: Cementless surface replacement of the shoulder using a cobalt chrome implant has achieved popularity as an alternative to conventional shoulder hemiarthroplasty for treatment of many degenerative and painful conditions of shoulder[1]. The potential advantages of humeral surface replacement are: minimal bone resection, short operative time, reduced blood loss and ease of revision [1, 2]. Despite these advantages, failure due to loosening, humeral neck fracture, subacromial impingement pain and stiffness have been reported [3, 4]. The aim of this study was to investigate the hypothesis that distal stem fixation resulted in stress shielding causing decreased bone formation, viability and osseointegration with increased osteoclastic activity, leading to the failure of uncemented resurfacing implants retrieved at revision.

Methods: Following ethical approval, 14 failed resurfacing shoulder implants retrieved from patients at revision surgery were assessed. Seven female and 7 male patients with a mean age of 64.88 (range, 42 – 75 years) were investigated. Retrieved specimens were processed for undecalcified histology and a thin section prepared through the centre of each implant. Prior to analysis, implants were divided into four regions; (i) under the cup, (ii) at the proximal stem, (iii) mid stem and (iv) distal stem (Figure 1). Image analysis techniques (Axiovision 4.5, Carl Zeiss) were used to quantify bone-implant contact, bone area, bone viability and osteoclastic activity within these four regions adjacent to the implant. Bone viability was measured by determining the number of lacunae occupied by osteocytes. The Spearman's rank coefficient was used to assess correlations between pairs and a Mann Whitney-U test used to determine significant differences between regions. In all cases p values < 0.05 were considered significant. All implants were also examined using Backscattered Scanning Electron Microscopy.

Results: Results showed significantly increased bone contact under the cup of the implants (27.77% ± 17.25%), when compared with measurements obtained in the proximal (16.71 % ± 11.83%), mid (20.39 % ± 18.09 %) and distal regions (17.18 % ± 16.85 %) of the stem ($p < 0.05$ in all cases) (Figure 2).

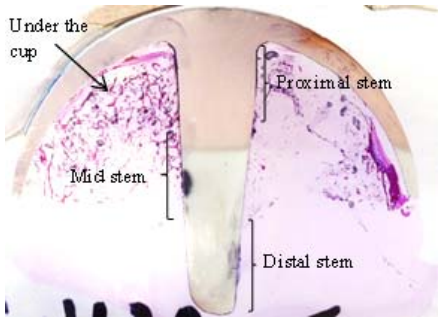

Figure 1: Histological section showing the 4 regions assessed.

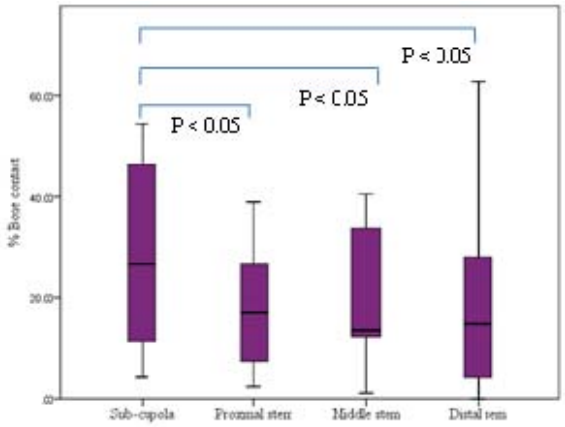

Figure 2. Graph showing percentage bone contact in the 4 regions.

No significant differences were found when the proximal, mid and distal regions of the stem were compared. In addition, significantly increased bone area was measured beneath the cup and adjacent to the proximal region of the stem when compared with the mid and distal stem ($p<0.05$ in all cases). When all implants and regions were combined, results showed a mean bone-implant contact of 21.13% ± 29.71% and a mean bone area of 0.11± 0.08 mm^2. When results for percentage bone viability were compared, results showed significantly higher bone viability in the region under the cup of the implant when compared to bone found at distal stem ($p = 0.038$). No other significant differences were found. When results for all 14 implants were combined, a mean viability of 57.51% ± 19.91% was measured. No significant correlations between bone viability, bone contact, bone area and osteoclast number were found.

Conclusions: This study showed that in failed uncemented shoulder implants, greater osseointegration, bone formation and bone viability occurred beneath the cup of the implant when compared with the stem. These results suggest that stress shielding by the cup may not be the most important contributor to implant failure.

References:

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