The Effect of Surface Roughness and a Collar on Fixation of Cemented Femoral Stems in vivo

by

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Thesis Summary

The use of polished surfaced femoral stems of hip replacements has been reported
to decrease aseptic loosening and osteolysis (Fowler et al.1988), but others report
that loosening is initiated by debonding of the stem in the cement and recommend
increasing this bond (Jasly et al.1991).

This thesis investigated the effect of femoral stem surface roughness and a collar on
the fixation of cemented hip hemi-arthroplasty femoral stems in an in vivo sheep
model up to nine months following implantation. Plain radiography, micromotion
between prosthesis and bone during mechanical testing and histology were used.
The primary hypotheses tested were:

At nine months after implantation a polished surfaced prosthesis will show
radiographic evidence of subsidence at the prosthesis-cement interface whereas
a matt surfaced prosthesis will not.

At nine months after implantation, there is less axial micromotion between a
polished surfaced prosthesis and bone than between a matt surfaced prosthesis
and bone.

At nine months after implantation, subsidence of a polished surfaced femoral stem
within the cement mantle was not seen and there was no difference in prosthesis-
cement subsidence between a polished and a matt surfaced femoral stem (p = 0.3).

At nine months after implantation, there was no difference in axial prosthesis-bone
micromotion between polished and matt surfaced stems (p = 0.6). Axial prosthesis-
bone micromotion was no different between implant types (p = 0.3) but taken as a
whole the micromotion immediately after implantation was greater than at nine
months (p < 0.001). The representative middle value of axial prosthesis-bone
micromotion was 37 μm immediately after implantation and 23 μm at nine months.

For medio-lateral and antero-posterior prosthesis-bone micromotion and axial,
medio-lateral and antero-posterior prosthesis-cement micromotion, the differences
between the three prosthesis types immediately after implantation compared to at nine months, were small and not considered important.

Immediately after implantation, there was excellent interdigitation at the c-b interface. However, there were small c-b gaps that were filled with blood and bone debris and these were less than 300 μm. Debonding was not seen in the histological sections, small p-c gaps were seen immediately after implantation arid at nine months due to cement mantle voids and were probably present at the time of implantation. At nine months after implantation there was evidence of bone remodelling with filling of the c-b gaps that were seen immediately after implantation; the result being increased stability of the stem. Small areas of fibrous tissue at the c-b interface did not affect the mechanical stability of stem.

Trabecularization of the distal femoral cortex and the formation of a neocortex was a common finding at nine months after implantation. Radiolucent lines at the c-b interface were found to represent this remodelling of the conical bone rather than the presence of a complete fibrous interface which was not seen.

The fixation of cemented femoral stems studied in this in vivo sheep model was not influenced by the surface roughness of the stem or the use of a collar. This is important and has not previously been shown. There were no radiographic or histological findings to suggest implant loosening. Also, the results of this study suggests micromotion between cemented femoral prostheses and bone may decrease over time, resulting in improved fixation. This study has shown that a polished stem does not have significant p-c micromotion and the use of a matt surface finish with or without a collar does not improve bonding of the stem to the cement.