IS REMOVAL AND REINSERTION OF CEMENTED FEMORAL STEMS DURING REVISION HIP ARTHROPLASTY A MECHANICALLY SAFE PROCEDURE?

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INTRODUCTION

Removal of a well fixed cement mantle during revision hip arthroplasty is a technically demanding procedure, usually associated with prolonged surgical time, higher morbidity and several complications such as bone loss and intra-operative femoral perforations or fractures (Fig 1).

As early as in the 1970s Smith Petersen and Sir John Charnley had already suggested removal and reinsertion of non-infected well cemented stems in order to obtain better exposure during acetabular revision surgeries (Fig. 2).

Later in 1978 Greenwald and colleagues, and Efthekar, working independently, proposed stem removal and cementing a new stem on the old cement mantle left in situ. This procedure has been popularized as cement-in-cement technique.

Although clinical mid-term results may support the retention of a well fixed cement mantle during revision hip arthroplasty, biomechanical studies are scarce, conflicting and most of them restricted to interface strength analysis (Table 1).

MATERIALS & METHODS

In this study we analyzed the pattern of load transmission to the cement mantle and to the outer surface of 6 composites submitted to the implantation, extraction and reimplantation of 3 different designs of polished tapered stems (Fig. 3).

Strain distribution in the cement mantle was measured with 4 uni-axial strain-gauges, and in the outer surface of the composite with 5 uni-axial and one tri-axial strain-gauges, before and after implantation of 2 specimens of each stem design.

Femoral stems were implanted according to the technique described by the manufacturer, after the appropriate size selection with the aid of templates (Fig. 4).

A specifically designed pressurizer was developed in order to apply a load of 1,300 N to the cement mantle for all specimens.

The loading condition, simulated a single-leg stance of 3.25 body weight for a 708N subject. Static loads were applied to the intact composites, after implantation, after cyclic loads of 1 million cycles and after reimplantation of the stems (Fig. 5).

Strains in the cement mantle and outer surface of composites in such loading circumstances, were confronted in linear regression.
After clearing the shoulder of the prosthesis from cement remnants, the removal of the stems was carried out with the use of an extractor device, in order to prevent rotational moments.

Three hours later, after checking for the sensors status, the stem was carefully reimplanted in the cement mantle with the use of a heavy hammer (Fig.6).

Frontal and lateral radiographs were obtained for the intact composites, after stem implantation, after cyclic tests and after reimplantation of the stems, in order to evaluate the quality and thickness of the cement mantle and to detect qualitative defects location with respect to the Gruen zones (Fig.7).

RESULTS

Linear regression analysis of the strain values obtained by the sensors in the cement mantle following reinsertion plotted with regard to the strains obtained initially by the same sensors before and after cyclic loading, showed a strong positive correlation (with coefficients of 0.95; 0.91, and a slope of 1.12 and 1.03 respectively, Figs. 8-9).

And if we look at the figures for the static strain of all sensors after reimplantation, plotted with regard to values of initial static strain we can see a highly significant positive correlation with a coefficient of 0.98, and a slope of 0.96, Fig.10).

CONCLUSIONS

1. Reinsertion of same design and size polished, tapered stems may not alter the pattern of load transmission and stability at the interfaces between stem/cement, and to the outer surface of bone.

2. The mechanical conditions at the interfaces are restored with no need for additional cement during reinsertion if the cement envelope is preserved. The same mechanical principle that maintains the stability of the stem during subsidence for “force-closed” fixation, may keep the stability of the interface following reinsertion.

3. This procedure may not be applicable to designs with texturing or precoating, and cylindrical-collared designs because in such conditions (“shape-closed “fixation) the mechanics of stem/cement interface may not be restored.