The effect of mono- and multifilaments on primary stability of cementless femoral revision hip components

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INTRODUCTION:
Bone loss in the proximal femur around a failed hip stem is a complex problem and makes a revision more difficult. The concept of a femoral window or even an extended proximal femoral osteotomy allows the surgeon to visualize the bony bearing and to improve the removal of well-fixed cementless or cemented components.

Once removal has been completed, cerclage wires are the treatment of choice (used in 33% of revision cases). They should secure a solid fixation of the osteotomy providing an appropriate tension of abductors and achieving primary stability of the new stem. Especially this point is the most important requirement for a successful bony ingrowth and therefore the longevity of a cementless revision stem.

Until now, studies refer to the advantages of multifilaments (cable wires) compared to monofilaments (tension wires) in general, whereas the traditional method with monofilaments seems to dominate hip revisions. Because of their widespread use, this experimental and comparative study was designed to take a closer look on the effect of both, mono- and multifilaments on primary stability of cementless revision hip components.

Therefore, we aimed to determine (1) the effectivity of wiring an extended proximal femoral osteotomy in general, (2) the differences achieved with each method, and (3) whether one method has advantages concerning different fixation principles of revision hip stems (metaphyseal and diaphyseal fixation concept).

METHODS:
The investigated cerclage wires were a titanium monofilament (1.5mm, Peter Brehm GmbH, Weisendorf, Germany) and a CoCrWNi multifilament (1.6mm Dall Miles Cable, Stryker Orthopaedics, New Jersey, USA). The MHP*-stem (Biomet Germany GmbH, Berlin, Germany) represented the metaphyseal and the Wagner-SL®-stem (Zimmer Inc.,Warsaw, USA) the diaphyseal fixation concept. Each revision hip stem was implanted three times into synthetic femoral models (composite bones second generation (#3106), Pacific Research Laboratories, Inc., Vashon, USA) following an established protocol.

Prior the defined implant setting in a material testing machine a standardized extended proximal femoral osteotomy was performed in the anterior cortex of each femur. The distal semicircular transverse cut was set according to the segmental femoral AAOS Type II defect (110mm below the lesser trochanter) and the medial and lateral extended cuts were longitudinal oriented in accordance to the femoral coordinate system of Bergmann et al. using a height gage and an oscillating saw blade (Fig. 1).

A high-resolution measuring device was modified to explore spatial micromovements of the bones and stems at multiple locations under cyclic application of axial torques. The generation of movement graphs subjected to measured locations of both the stem (P1-P4) and the synthetic bone (F1-F5) defining the relative movements (\( \Delta \alpha / TZ \)) and save costs.

RESULTS:
Friedman’s test revealed reproduced fixation modi in all measurements for both stems (p=0.01).

1) The analysis of variance showed that in comparison to the unstabilized extended proximal femoral osteotomy the mono- as well as the multifilaments effected a major change of relative micromovement for both stem designs (p=0.03) (Tab. 1).

2) In particular the cylindrical MHP*-stem showed a significant increase of its primary rotational stability in the proximal main fixation area through both wire systems. As well with the mono- as with the multifilament even a proximal fixation behaviour of the conical Wagner-SL®-stem, normally fixing diaphysially, could be reached.

3) A significantly better restabilization could be observed for the MHP*-stem using multifilaments (p=0.04). This result became clear through the reduction of the overall relative micromovements reached through monofilaments (16.6 mdeg/Nm) and multifilaments (11.1 mdeg/Nm). The conical Wagner-SL®-stem showed no differences in primary stability between mono- and multifilament treatment (p=0.29).

Table 1: Results of the overall relative micromovements [mdeg/Nm]

<table>
<thead>
<tr>
<th></th>
<th>metaphyseal fixing</th>
<th>diaphyseal fixing</th>
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<tbody>
<tr>
<td></td>
<td>mean</td>
<td>SD</td>
</tr>
<tr>
<td>unstabilized</td>
<td>41.9</td>
<td>32.6</td>
</tr>
<tr>
<td>monofilament</td>
<td>16.6</td>
<td>2.7</td>
</tr>
<tr>
<td>multifilament</td>
<td>11.1</td>
<td>1.8</td>
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DISCUSSION:
In the case of a revision with an extended proximal femoral osteotomy both, the mono- and multifilaments are capable of supporting the newly inserted revision hip stem in bridging the artificial defect. In particular for the MHP*-stem, micromovements could be reduced with large extend.

Nevertheless, in the combined use with metaphyseal fixing revision hip stems, multifilaments seem to be advantageous with regard to femoral osteotomies. Preventing a possible osseous femoral anaemia through circular constriction, the use of multifilaments, however, should be impeded in combination with diaphyseal fixing components (Wagner-SL®). Comparable and reproducible results with both filaments could be reached, so that none of the wiring systems showed any advantages in this situation. We attribute this to the main fixation area of the conical Wagner-SL®-stem. It is located distally of the semicircular transverse cut whereas the wires are usually placed at the proximal osteotomy.

In conclusion, the decision of using a wiring system should be made depending on the fixation concept of the implanted revision hip stem. Our results about mono- and multifilaments in revision hip surgery may help the orthopaedic surgeon to optimize their use, reduce complications and save costs.

Figure 1: Survey of the standardized extended proximal femoral osteotomy (a) and wiring in sagittal (b) and frontal (c) plane.