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ORIGINAL STUDY

Effect of a distal centralizer on the positioning of an anatomical stem

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Femoral stem centralizers were originally designed for double tapered, straight stems. In a slightly modified configuration, the PMMA centralizer is plugged in a hole in the tip of the ABG II femoral prosthesis®. The purpose of this study was to determine the effect of the centralizer on the position of the anatomical ABG II stem®.

Thirty-nine cemented ABG II stems® with a centralizer were compared with thirty-nine stems without a centralizer.

We evaluated positioning of the tip of the stem according to a standard selection of criteria, using conventional AP and lateral X-ray imaging.

The centralizer supplied with the ABG II® was found to have no additional value in guaranteeing optimal varus-valgus positioning. If a stem was not placed neutral, generally it was placed in a slight valgus position. The number of deficient cement mantles was not influenced by the three-fin centralizer. Furthermore, the distal centralizer of the ABG II prosthesis® adds a length of 27 mm to the stem, and the distal cement plug found in stems with centralizer was almost twice as long on average.

The ABG II centralizer® was found in this study to provide insufficient guiding of this anatomical stem and to add excessive length to the distal cement plug.

Keywords : total hip arthroplasty ; cemented femoral stem ; distal centralizer ; ABG.

INTRODUCTION

Stem survival depends on several factors, including stem positioning and cement mantle thickness.

Centralizers are designed to guarantee central positioning of a femoral stem in the cement. They were originally designed for double tapered straight stems. In the Exeter type prosthesis® (Stryker Howmedica, Allendale, NJ., USA), the centralizer is a hollow device with three fins that fit over the tip of the prosthesis (*1,2,5*) (fig 1).

In a slightly modified configuration the PMMA centralizer is plugged in a hole in the tip of the ABG II prosthesis® (Stryker Howmedica, Allendale, NJ., USA). This stem is an anatomically shaped, short and proximal fitting stem (fig 2).

MATERIAL AND METHODS

Thirty-nine cemented ABG II stems® with a centralizer were compared with thirty-nine stems without a centralizer, in patients operated in 2003 in a prospective setting.

We evaluated positioning of the tip of the stem according to a standard selection of criteria, using con-

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Fig. 1. — Cemented Exeter prosthesis®

Fig. 2. — Cemented ABG II prosthesis®

ventional AP and lateral X-ray imaging. For AP images, an oblique view of the femoral component was evidenced by an apparent shortening of the prosthesis collar. The AP image was considered acceptable when the apparent collar size of the prosthesis was not reduced more than 10%. In a true lateral view, the collar of the prosthesis should appear to extend symmetrically, both anteriorly and posteriorly, about the prosthesis. For lateral images, an asymmetry in the apparent collar size greater than 15% was considered unacceptable *(1,2,4)*.

If radiographs did not meet the criteria mentioned above, other representative films taken during later follow-up, within six months after operation, were taken under the condition that no radiological changes were observed. This replacement by another image was considered acceptable because changes such as subsidence or rotation are rarely seen within 6 months.

The stem position was noted, as well as the thickness of the cement mantle at the tip of the prosthesis and the length of the distal cement plug. A cement mantle of at least 2 mm thickness around the distal stem was considered desirable *(3,4,5)*. In the AP and lateral images the thickness of medial, lateral, ventral and dorsal cement mantles was measured in millimeters at the tip of the stem, in a plane perpendicular to the anatomical femoral axis. The valgus-varus alignment was scored at the distal one third, straight segment of the prosthesis stem. A line was drawn parallel with the prosthesis stem until it angled with the anatomical axis of the femur. Alignment was divided into three groups : valgus alignment (> 3° valgus), neutral (3° varus to 3° valgus) and varus (> 3° varus) *(6,7)*.

All stems were placed with a polyethylene glycol Optiplug® (Biomet, Warsaw, IN, USA) distal cement restrictor.

The measurement of alignment in the lateral images was considered inaccurate due to the curvatures of the prosthesis and proximal femur. Instead the position of the tip of the stem within the medullary canal was recorded.

The length of the distal cement plug was measured in millimeters from the tip of the prosthesis. The optimal length of a distal cement plug is approximately 10-20 mm *(3,7,8,9)*.

We considered a length of more than 20 mm unfavourable.

A power calculation was performed *(10)*. With a 2-sided significance level of 0.05, a sensitivity of 0.90, and an estimated standard deviation of 18 mm, this gave 39 patients per group.

For the differences in cement plug length a Student's t-test was performed. The significance level was set at $p < 0.05$.

Fig. 3. — The radiograph shows a displaced distal centralizer. The cement mantle however is still sufficient.

Table I. — Alignment was divided in three groups : valgus alignment (> 3° valgus), neutral (3° varus to 3° valgus) and varus (> 3° varus)

Alignment	Neutral	Valgus (> 3°)	Varus (> 3°)
+ Centralizer	28	8	3
- Centralizer	27	10	2

Table II. — Cement mantle thickness measured at the tip of the prosthesis. Values are shown as absolute values in millimeters

Cement mantle thickness/SD (mm)	Medial thickness	Lateral thickness	Ventral thickness	Dorsal thickness
+ Centralizer	4/ 1.8	6/ 1.8	6/ 2.1	7/ 2.2
- Centralizer	3/ 1.5	6/ 2.1	5/ 2.3	7/ 2.6

RESULTS

In both groups the tip of the anatomical stem was found in the medial-ventral position. The varus-valgus alignment is shown in table I. We found sufficient cement mantle thickness around the prosthesis tip. However, three stems in the centralizer group and five stems in the control group had a medial cement mantle of less than 2 mm. In one case the dorsal cement mantle thickness was less than 2 mm in the group without centralizer. The mean values for cement mantle thickness are shown in table II. One case had a displacement of the distal centralizer, but a sufficient amount of cement around the distal prosthesis tip (fig 3).

The distal cement plug had an average length of 40 mm (SD 18) in the centralizer group and 23 mm (SD 18) in the group without centralizer. Analysis of this data by Student's t-test yielded a highly significant difference between these results ($p < 0.001$). The maximum length of a distal cement plug with a centralizer was 80 mm versus 55 mm without a centralizer (fig 4).

DISCUSSION

In this study we have shown that the centralizer supplied with the ABG II® has no additional value in guaranteeing optimal varus-valgus positioning within the range of 3° from neutral. If a stem was not placed neutral, it was generally placed in a slight valgus position. The number of deficient cement mantles was not influenced by the three-fin centralizer (*11*).

The optimal length of a distal cement plug is approximately 10-20 mm (*3,7,8,9*).

A longer distal cement plug is non-functional and undesirable in case of revision. The distal centralizer of the ABG II prosthesis® adds a length of 27 mm to the stem and the distal cement plug found in stems with centralizer was almost twice as long on average.

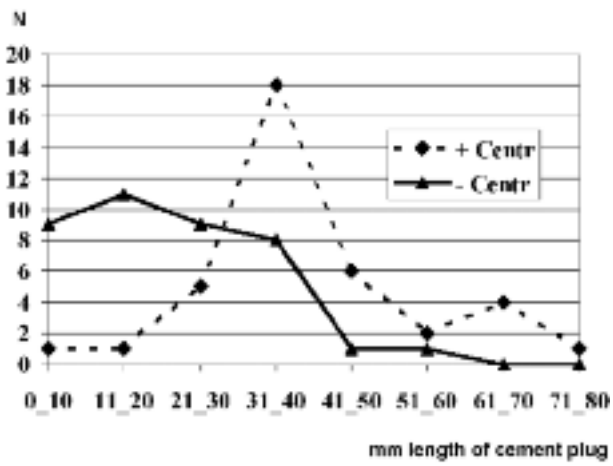

Fig. 4. — The distribution of cement plug length in intervals of 10 mm

Whereas the distal cement plug with the Exeter prosthesis® is essential to guarantee central subsidence into the cement (*12,13,14*), anatomical stems are guided by a correct reaming procedure and their proximal anatomical fitting. We even observed deformation of one centralizer.

In summary, the ABG II centralizer® was found to provide insufficient guiding of this anatomical stem and to add excessive length to the distal cement plug.

Due to these results we discontinued the use of the centralizer in combination with the anatomical ABG II total hip stem® in our department.

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