Improved positioning of the femoral stem with a centralizing device

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Two series of patients operated on with total hip replacements for arthrosis are reported. The same prosthesis and operative and cementing techniques were used in both series, except that in Series 2 a centralizing device consisting of four triangular fins passed over the tip was also used to improve the positioning of the femoral stem. It was found that the position of the tip was more central in Series 2. No drawbacks were associated with the use of the device. We concluded that the centralizing device facilitated the positioning of the femoral stem tip.

It has been shown that a varus or an excessive valgus position of a cemented femoral component gives a higher failure rate (Beckenbaugh and Ilstrup 1978, Paterson et al. 1986, Russotti et al. 1988). With a femoral component without a collar, proximal flanges, or grooves, the stresses on the cement and interface increase distally (Fowler et al. 1988, Huiskes 1988). Several studies have shown that a thin mantle medially or lack of cement around the prosthetic tip will increase the failure rate (Beckenbaugh and Ilstrup 1978, Kristiansen and Jensen 1985, Roberts et al. 1986, Goldie 1987, Poss et al. 1988). Varus position is commonly but not always associated with a lateral position of the tip. The valgus position, on the other hand, may bring the tip into direct endosteal contact medially. Little attention has been paid to the position of the tip in the sagittal plane.

In an attempt to improve and facilitate the positioning of the femoral component, a centralizing device was developed for more precise centering of the tip. The effect on the positioning of the total hip arthroplasties is presented.

Patients and methods

The postoperative radiographs of two series of total hip replacements were assessed in one series (Series I) without and in one series (Series II) with the use of a centralizing device. Series I consisted of 17 males and 15 females (aged 69 [15–83] years) were consecutively operated on during 1985, and Series II consisted of18 males and 18 females (aged 68 [39–88] years) who were consecutively operated on during 1987.

All the patients received a primary arthroplasty (Scan Hip®) for arthrosis. An intramedullary plug of HDPE was used after reaming the femoral cavity with a 250-mm-long flexible reamer. The reaming was carried out until endosteal contact with 1-mm increments. A 1-mm larger plug with a marker was placed 20 mm below the tip. The plug used had stiff threads, but it still allowed air and cement to be pressed into the upper threads.

After cleaning the bone surface with a brush and high-pressure irrigation, gentamicin-containing bone cement (Palacos®), chilled to 4 °C and mixed under a vacuum (Lidgren et al. 1987), was injected distally with a manually driven gun. As an oxidant disinfectant and to reduced surface bleeding (Turner 1983, Hankin et al. 1984), hydrogen peroxide (0.75 percent) was used for irrigation.

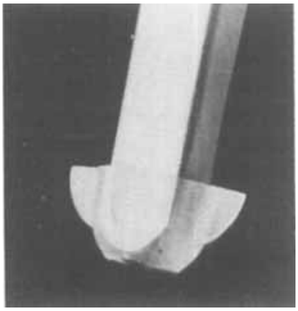

Figure 1. The centralizing device, with four fins.

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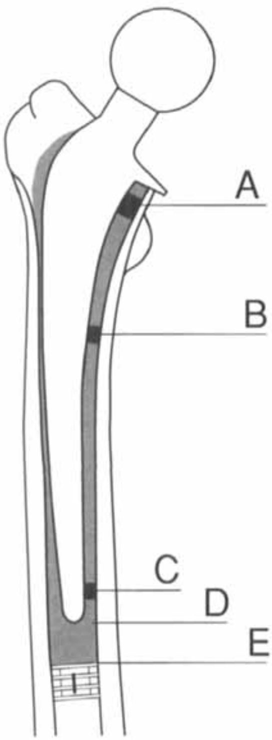

Figure 2. The parameters measured on the radiographs. The width of the medullary cavity and the thickness of the cement at the medial aspect of the stem at the level of the minor trochanter (A), and 50 mm distally (B). The distance between the midpoint of the tip of the stem and the medial aspect of the medullary cavity (C) and the total width at this level (D). Displacement of the tip was expressed by D/2–C. Similar measurements of the position of the tip were performed on the lateral radiographs. The cement distal from the tip of the femoral stem to the femoral plug (E).

Figure 3. Femoral stem inserted without centralizing wings showing displacement of the tip in a 61-year-old male.

Figure 4. Total hip replacement in a 66-year-old female. The femoral stem with centralizing wings show good cement filling.

A proximal egg-shaped sealer of silicon rubber used over the nozzle allowed for filling of the proximal part of the femoral cavity under pressure. During the first period (Series 1), all the surgeons aimed at placing the stem in a neutral position. The femoral prosthesis in Series 2 was inserted with a centralizing device (Figure 1) consisting of four triangular fins passed over the tip (Mitab, Sweden). The prosthesis was held firmly until setting, which took place after about 10 minutes.

The first postoperative radiographic examination was performed within 24 hours and included anteroposterior and lateral radiographs of the hip and the proximal part of the femur. The two views were perpendicular to each other. An additional anteroposterior view of the pelvis was obtained. The parameters measured on the radiographs are shown in Figure 2. The distances obtained were adjusted for differences in magnification by the actual diameter of the prosthetic femoral head. At the level of the tip of the 150-mm stem, the femoral cavity was considered circular using the formula: $TD = (FD^2 + LD^2)$. FD is the displacement in the anteroposterior and LD in the lateral projection.

The Student's t-test was used for the statistical analysis.

Table 1. Displacement (mm) of the tip of the stem in 68 cemented hip arthroplasties. Mean *SD* (range)

Series	Wings	Total[1]	A-P	Lateral
I (n 32)	–	3.6 *1.6* (1–7.7)	2.5 *1.5* (0–5.0)	2.1 *1.7* (0–7.5)
II (n 36)	+	1.8 *0.9* (0–4.0)	1.2 *0.9* (0–3.0)	1.0 *0.9* (0–4.0)
P		< 0.001	< 0.001	= 0.008

[1] For explanation, see Figure 2.

Table 2. Cement distribution (mm)around the femoral stem in 68 cemented hip arthroplasties. Mean *SD* (range)

Series	Medial (A)[1]	Medial (B)	Distal (E)
I	7.3 *3.2* (3–15)	4.1 *1.4* (2–11)	23 *13.1* (1–80)
II	4.8 *2.7* (1–14)	3.7 *1.8* (1–6)	18 *17.6* (4–65)

[1] For explanation, see Figure 2.

Results

There were no significant differences between Series 1 and 2 in the width of the femoral cavity at any of the three levels measured. The mean width at the level of the minor trochanter was 40 mm, 50 mm below the minor trochanter it was 20 mm, and at the level of the tip it was 16 mm. The positioning of the tip of the stem, i.e., centering in both planes was improved by using the centralizing device (Table 1). The size of the displacement is given in absolute figures, but occurred in all the directions with a slight tendency against the medioventral part of the shaft.

Discussion

It has been shown that the revision rate is less than 6 percent after 10 years in patients over aged 60 years if a good prosthetic design is used (Ahnfelt and Herberts 1988). Several studies reported a reduction of radiographic loosening with improved implantation and cementation techniques (Poss et al. 1988, Ranawat et al. 1988). Russotti et al. (1988) reduced the radiographic failure rate from 24 to 1.2 percent and the revision rate from 5 to 0 percent for the femoral stem at 5 years. They regarded cementation technique, proper alignment, and optimal size of the femoral component of particular importance.

An association of lysis to a thin cement shield distally eventually caused by crushing forces on the cement between the femoral hip and the cortical bone has been reported (Carlsson et al. 1983, Huddleston 1988).

It is certainly difficult to select one single factor responsible for the improvement in cemented THA. When a technical parameter such as positioning is evaluated, surgical experience will always influence the result. It is unlikely that this could cause the differences in our study, because the patients were operated on by many surgeons who strove to obtain a neutral shaft position. The same prosthesis and the same cementing technique had routinely been used for many years.

The use of a distal plug is now well established and leads to a stronger bone-cement interface (de Waal-Malefijt 1988). It is important that the distal plug allows for residual air and blood to be extruded in the upper threads or through a special venting hole (Weber 1982, Draenert 1988) in order to get a good distal filling. Either a flanged stiff plug with various diameters or a plug that expands with pressure must be used if it is to stay in position during cement injection (Noble et al. 1987). It is interesting to compare our cement column distal to the tip (on an average 20 mm) with what advocates of plugs achieved (Amstutz et al. 1988). They found that after introducing the plug in 1976, the cement distal to the tip decreased on the average from 48 mm to 37 mm.

Centralizing devices for femoral components have been introduced earlier, initially in metal, but lately also in HDPE and acrylate (Noble et al. 1987, Fowler et al. 1988). No studies have, however, measured the efficacy of a centralizing device in a clinical situation.

Our study shows that it is possible to centralize the stem. The improved position of the femoral tip will lead to slightly thinner cement medially (mean 4.8 mm) in the proximal part, which should still be sufficient to withstand the stresses anticipated (Kwak et al. 1979, Noble et al. 1987).

One important question is whether or not the use of the thin HDPE fins could have any drawbacks. In the cement viscosity phase, no voids caused by the pins are to be expected at the insertion of the prosthesis, and were also not observed when this was analyzed earlier in our laboratory. If a bone cement with a higher viscosity is used or if the insertion is carried out at a later stage, this may change. Another possible drawback could be motion between the cement and bone causing fragmentation of the acrylic, as well as of the polyethylene polymer. The same situation is present around acetabular components where flanges and pods of HDPE have long been used as spacers to achieve a more uniform cement layer, so far without this complication.

That the improved positioning of the femoral stem in itself will reduce mechanical loosening can only be shown by a randomized study where all the other factors are kept unchanged, and probably by using more refined measurements of prosthetic micromovement, such as stereophotogrammetry.

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