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The Evolution of the Technique of Impaction Bone Grafting in Femoral Revision Surgery has Improved Clinical Outcome. A Prospective Mid-Term Study

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ABSTRACT

Ninety-three patients (97 hips) underwent impaction bone grafting (IBG) using a cemented tapered femoral stem at our institution. Forty-one hips were operated between 1993 and 1998 (group 1) and 56 hips between 1999 and 2007 (group 2). The use of an extended trochanteric osteotomy and a long stem was more frequent in group 2. Group 2 hips showed a better clinical result. One hip was revised for aseptic loosening and most failures were early periprosthetic fractures. The survival rate for reoperation for any cause was 82.9% for group 1 and 84.3% for group 2. Patients in group 1 had a higher risk for periprosthetic fractures and radiological subsidence >5 mm. Experience and the evolution of the IBG technique have improved the good long-term outcome.

The impaction bone grafting (IBG) technique with a cemented stem presents very low rates in terms of aseptic loosening in femoral revision surgery at the long-term [1]. Different types of cemented stems have demonstrated that it is a reliable technique all around the world [2–4]. Histological studies have shown new bone formation [5,6]; trabecular remodelling was observed in radiographic evaluations from the first reported cases [7]; and positron emission tomography has shown early regeneration of blood flow, interpreted as osteoblastic activation in morselized IBG [8].

Most failures are due to fractures during the early postoperative period [9]. A bone defect can affect clinical outcome and the rate of complications, particularly subsidence and periprosthetic fractures [10], so newer surgical devices have been developed in order to decrease the number of these problems [11,12]. The Swedish Hip Arthroplasty Register reports different results among institutions; nevertheless, the difference is small and the overall non-revised survival rate is very high, so the authors consider that the technique is standarized and can be learned quickly [13].

We hypothesized that patients who underwent revision hip surgery for femoral aseptic loosening with IBG and a double-tapered polished cemented stem had a better result for those operated later than for the first cases done at our institution. The aim of this study has been to assess the long-term results of the technique and the possible differences due to the evolution of the technique. We compared the clinical and radiological outcomes between two groups of patients operated before or 5 years after beginning the use of femoral IBG.

Materials and Methods

Ninety-three consecutive patients (97 hips), operated for femoral revision surgery between 1993 and 2007, were prospectively followed for a minimum follow-up of 5 years. All patients underwent femoral IBG and received a double-tapered polished collarless cemented stem (Exeter–Stryker Corporation, Mahwah, NJ). The indications for this technique at our institution are as follows: age under than 70 years or in older fit and active patients with moderate to severe proximal cortical bone loss, including those with an endosteal canal wider than 18 mm. We do not use it for massive circumferential proximal bone defects larger than 10 cm. Only cases operated for aseptic loosening were included, and septic and periprosthetic fracture cases were excluded from this study. Although no patient has been excluded from the survivorship analysis, a minimum 5-year duration of clinical and radiographic follow-up of unrevised stems was required for inclusion. No hips were lost to follow-up or died from causes unrelated to the operation before 5 years. During the analysis we considered those patients who underwent femoral IBG during the first 5 years from the introduction of this technique at our hospital, and those operated after that time. We compared two groups: group 1 consists of 41 hips operated between 1993 and the end of 1998; and group 2, 56 hips operated after 1998. The mean follow-up was 16.4 years (range, 15 to 19) in group 1 and 8.2 years (range 5 to 14) in group 2. Preoperative data for demographics, original diagnosis for the primary total hip arthroplasty (THA) and femoral bone defect according to the Endoklinik classification

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Table 1
Preoperative Patient Data in Both Groups.

	At Surgery			
	1993–1998	After 1998	Total	*P* values
Age years, mean (range)	61.3 (31–78) ± 12.8	66.1 (40–83) ± 9.2	64.1	0.15[a]
Gender (male/female)	20/21	25/31	41/57	0.68[b]
Side (right/left)	25/16	32/34	57/40	0.71[b]
Original diagnosis				
Primary osteoarthritis	20	41	61	
Congenital hip disease	8	2	10	
Rheumatoid arthritis	5	2	7	
Avascular necrosis	1	7	8	
Postraumatic	3	3	6	
Developmental disease	2	–	2	
Others	2	1	3	
Bone defect				
Grade 2	5	17	20	0.09[b]
Grade 3	23	30	49	
Grade 4	13	9	23	

[a] Mann–Whitney U.
[b] Pearson chi-square test Fisher's exact test.

[14], were similar in both groups (Table 1). Oral and written informed consent were always obtained from all patients and they were informed preoperatively that they might receive an IBG procedure.

Operative Technique

We performed the femoral IBG technique according to the Exeter principles [7]. After removal of the previous stem, the femoral canal was completely cleared of all debris, cement (if any) and fibrous membrane before starting IBG. Intraoperative bone defect was confirmed and recorded at this time. Samples were sent for histological and bacteriological analysis. Morselized bone allograft was used in all hips; a bone mill (LereBone Mill; Johnson & Johnson, DePuy, Warsaw, IN) prepared unwashed cancellous chips measuring 2 to 5 mm in diameter from fresh-frozen femoral head, previously retrieved during surgery for primary THAs at our institution, and vigorously impacted with a trial prosthesis from X-Change instruments (Stryker Corporation). All segmental defects in the cortex or calcar were reconstructed with metallic meshes and cerclage wires designed to contain allograft in this technique (X-change; Stryker Corporation). A collarless double-tapered polished Exeter stem was cemented using antibiotic-loaded bone cement (Palacos with gentamicin; Merck, Darmstadt, Germany). The cement was injected in a retrograde manner and then pressurized with a proximal seal. The surgical procedure was different in the two groups (Table 2). We began using a posterolateral approach, but because of the difficulty of removing cement or osseointegrated uncemented stems, an extended trochanteric osteotomy (ETO) was more frequently used in the following years. Although more femoral heads were employed in group 2, with the number of hips available there were no statistical differences between groups (Table 2). The use of metallic meshes for uncontained defects was similar in both groups since the main surgical indication has not changed. An Exeter standard-length stem has been used in most cases (82 hips), however, since 1998 an Exeter long-length stem has been used more frequently in cases with severe distal bone loss in order to bypass the distal bone deficiency and avoid possible periprosthetic fractures (15 hips). This long stem was used more frequently in group 2 (Table 2).

Table 2
Operative Data and At Surgery.

	At Surgery			
	1993–1998	After 1998	Total	*P* value
Approach				
Posterolateral	39	44	83	0.038[a] exact
Extended trochanteric osteotomy	2	12	14	
Mesh				
Yes	18	18	36	0.24[a]
No	23	38	61	
Number of Femoral Heads				
1	-	4	4	0.06[a]
2	31	28	59	
3	9	21	30	
4	1	2	3	
Stem type				
Standard	39	43	82	0.021[a] exact
Long	2	13	15	

[a] Pearson chi-square test Fisher's exact test.

Postoperative management regarding functional recovery has changed since our early patients, who had bed rest for 14 days [7], to a more rapid bed–chair sitting, beginning in 1997, now, after 5 days in bed with the leg in abduction, and depending on intraoperative bone quality and the resulting reconstruction of the femur (and frequently the acetabulum), they are encouraged to walk with partial weight-bearing using crutches or a walker at 6 weeks with a gradual return to full weight-bearing after 3 months. Most patients are relatively young (mean age in this series was 64.1 years old) and had no neurological impairment for this postoperative management. The number of patients before 1997 was insufficient to allow any statistical analysis. Antibiotic prophylaxis (1 g cefazolin every 6 hours, in non allergic patients) was discontinued at 48 hours. Subcutaneous heparin was used as a routine preventive measure for thromboembolic problems until the patients were fully mobile (6 weeks in most cases).

Clinical and Radiological Analysis

A clinical and radiological evaluation was done at every follow-up interval: 6 weeks, 12 weeks, 6 months, 1 year, and annually thereafter. Clinical evaluation assessed pain, function, and motion following the Merle D'Aubigné and Postel (MAP) scale (range 1–6) [15]. Clinical failure was defined as rerevision or removal of the stem for any cause, pain (level 4 or worse), or both. We related thigh pain to femoral stem problems when the patients complained at rotation of the hip, with the straight leg raising test and/or on weight bearing [16]. We also assessed the complications observed, the number of patients who needed a cane or crutches for walking outdoors, the number of patients who had a visible limp, and leg length discrepancy as measured by blocks under the operated feet at the first postoperative year examination, in both groups.

Standard anteroposterior and lateral radiographs of the pelvis were made for all patients immediately after surgery and at every follow-up examination. All postoperative and follow-up radiographs were made at our institution following the same protocol [17]. The position of the stem was defined as neutral, valgus (lateral deviation of 3 mm or more), or varus (medial deviation of 3 mm or more). Grades of initial packing and cement filling were classified according to Gie et al as excellent, good, fair, poor, and defective [7]. We also graded the later appearance of the grafts according to Gie et al as no change, progress of radiolucent lines, localized resorption, cortical repair, and trabecular remodeling. Stem subsidence was measured according to the method of Fowler et al using the tip of the greater trochanter as the reference point [18]. Radiographic failure was defined as a circumferential radiolucent line in all seven Gruen et al zones on the anteroposterior view [19]. All measurements were corrected for magnification using the known dimensions of the femoral head.

Statistical Analysis

Qualitative data are expressed as counts and percentages and quantitative data by mean ± standard deviation or range. Qualitative data for hips operated after or before 1998 were compared using the chi-square test or Fisher's exact test and quantitative data were compared with the use of the Mann–Whitney U test. Kaplan–Meier survivorship