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F. Bellomo
L. Bertignone
L. Morino
P. Milano
E. Schiavone
M. Barale

MP-Link cementless distal fixation modular prosthesis for revision total hip arthroplasty

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F. Bellomo • L. Bertignone (✉) • L. Morino • P. Milano • E. Schiavone • M. Barale
First Division of Orthopaedics and Traumatology, C.T.O. Othopaedic Hospital, Via Zuretti 29, I-10126 Turin, Italy
Tel.: +39-011-740659
Fax: +39-011-6540420
E-mail: lucabertignone@yahoo.it

Abstract The aseptic loosening of the femoral stem may require different treatments due to the complex problems related to the bone resorption (qualitatively and quantitatively): a minimum bone stock loss may result in a periprosthetic resorption that is so severe to make the fixation of the revision prosthesis extremely difficult. The revision surgery of a loosened hip prosthesis is often characterized by a complex reconstruction due to such severe loss of femoral bone tissue. We illustrate our experience with MP-Link modular stem (Waldemar Link, Hamburg, Germany) in cases of severe bone loss of the metaphyseal area and of the proximal third of the femoral shaft, assessing the technological developments (materials and design) over the years and examining the pros and cons of cementless distal-fixation modular stems versus the traditional Wagner's stem.

Key words Revision • Femoral loosening • Modular stem

Introduction

The increasingly widespread use of revision total hip arthroplasty (800 000 hips/year worldwide) has involved and will involve the need to cope with the related complications. Among these, the most frequent is the aseptic loosening of components. This may involve different problems related to bone resorption (both quantitatively and qualitatively): a minimum bone-stock loss may result in a periprosthetic resorption that is so severe to make the fixation of the revision prosthesis extremely difficult.

The factors that influence the long-term outcome of an implant are related to age, gender, body weight, original diagnosis, previous surgeries, and use of the prosthesis; local factors may also be added:

- *Material properties.* The mechanical combination of prosthesis, cement and bone, having different elasticity properties, causes various problems that lead to an ongoing study about the stem shape and material.
- *Local tissue reaction,* characterized by the presence upon the aseptic bone resorption of many cell elements producing prostaglandin E2, interleukins, tumor necrosis factor and proteases causing the formation of fibrotic tissue at the prosthesis-bone and cement-bone interfaces;
- *Prosthetic design,* especially in cementless implants, where the larger contact area between the prosthesis and bone cause a good bone ingrowth and avoid stress-shielding.

Materials and methods

At the First Orthopaedic Division of the Turin C.T.O. Orthopaedic Hospital, we have been using different stems for the femoral component: primary implant stems, with and without cement and requiring the use of the bone bank, and long stems (S-Rom, Wagner, Kira, MP-Link, etc.). We focused our attention on the MP-Link, by assessing the technological developments (materials and

design) over the years and by examining the pros and cons of cementless distal-fixation modular stems versus the traditional Wagner stem. Consequently, we have reviewed a case series consisting of 14 patients who were implanted with 14 MP-Link stems at our center from January 1997 to June 2000. Implantation was performed after aseptic loosening of the femoral component, with specific indication of severe bone loss of the metaepiphyseal area and of the proximal third femoral shaft with defects of grades II, III and IV according to the classification of the Italian Reimplantation Group [2]. In all cases, the surgical approach has been the direct lateral approach (Hardinge type); it was never necessary to perform trochanteric osteotomy. In four cases of severe osteoporosis we have also used bone chips (bone bank, in order to fill the defects). In four cases we performed preventive cerclage of the stem diaphyseal fixation area, by minimizing the removal of periosteum from the shaft. The average follow-up was 2 years and 2 months, with clinical and radiographic controls (anteroposterior and axial views) made at 3, 6, 12 months and, subsequently, on an annual basis. The clinical evaluation was made by means of Merle d'Aubigne's score card [3] that takes into consideration the measures of pain, motility and motion with decreasing scores from 6 to 1.

Results

Due to the small number of cases, we do not deem our results statistically significant, however our experience with MP-Link stem allows us to illustrate our philosophy and express our feelings about the clinical data.

No intraoperative fractures or immediate neurovascular complications were observed in the treated cases. Among the late complications we had one case of deep vein thrombosis (DVT) that healed after appropriate medical treatment, with no consequences for the patient and one case of surface infection, treated by targeted antibiotic therapy. So far, no radiographic signs of loosening were observed and no dislocation occurred; consequently, no revision surgery was required. We must point out five cases of heterotopic ossifications of grades I and II according to the Authors, with no objective relevance. Clinically, the results seem promising, with a preoperative average pain score of 2.3 and a postoperative pain score of 5.1, for motility of 2.5 to 4.7 and for gait of 2.1 to 4.1. The patients' subjective scores have basically been good.

Discussion

The revision surgery in a loosened hip prosthesis often involves a serious problem of reconstruction due to a severe femoral bone-stock loss. With a clinical and radiographic picture of stem aseptic loosening, it is necessary to classify the periprosthetic bone loss to have a correct surgical indication. Currently, the classifications mostly referred to in order to define a femoral bone loss are the following:

- Engelbrecht [1]
- Gustilo and Pasternack [4]
- Gruppo Italiano Reimpianti [2]

The revision techniques are many and require a specific knowledge. For example, in case of revisions with low bone-stock loss and osteoporosis, it is possible to use primary implants with adequate size assuring initial stability and good fixation over time in the future. Such results can be achieved by cementing the implant, to be done especially when the removed prosthesis was not cemented, or without cementing if there is a possibility for enough bone ingrowth and good initial stability [5]. Revisions with bone stock loss and osteoporosis are much more complex. There are many feasible solutions proposed by the authors that may be basically grouped into two methods. The first one is based on the use of bone grafts and congruous prostheses [6]; the second one is based on the use of long stem prostheses with adequate size to achieve a diaphyseal fixation, thus not using the femoral proximal end, where the bone loss occurred, for the mechanical fixation [7]. In the latter group there has been a gradual and continuous development of shapes and design, in order to try to satisfy the needs for the assurance of a successful revision.

The most well-known, and possibly the first stem to be designed with this philosophy is Wagner's [8]. This prosthesis is cementless, with fixation in the medullary canal, and it uses stems with variable length ranging from 190 to 305 mm, with a variable diameter measuring 14 to 25 mm (with 1 mm increments), and a 145° cervicus-diaphisary (CCD) angle. Moreover, the stem has a tapered shape with a 2° anteversion angle; it is provided with eight sharp, longitudinal fins, also tapered, that assure antirotational stability to the implant. The wedge-shaped geometry of the prosthetic stem has been studied in order to ensure, in case of minimum bone resorption, spontaneous stabilization of the prosthesis; this principle must not be confused with the clinically relevant subsidence caused by a wrong choice of the stem size. The choice of the 145° cervicus-diaphisary angle (CCD) angle made by Wagner has been explained by the intention to decrease the torque movement transmitted to the stem by the patient when he stands up or climbs up stairs. Wagner's prosthesis managed to solve difficult cases of loosened stems; however, when the bone defect is important, it may require a very aggressive surgical technique, with wide exposure of the femur, relevant blood loss and complex postoperative course for the patient. Moreover, when endosteal osteolytic lesions with osteoporosis occur, we observe large changes in the parameters of the femoral canal with consequent discrepancy of the internal diameters between the femoral metaphyseal and the diaphyseal

regions. In these cases, which are quite frequent, the adjustment of large prostheses like Wagner's may lead either to stem undersizing in the femoral canal or to the fixation of the stem in a relatively short portion of the femoral shaft. Furthermore, the complete distal fixation is sometimes responsible for subsidence and stress-shielding and may cause thigh pain. Wagner's prosthesis does not allow the restoration of a correct joint offset. Moreover, a very accurate surgical technique is required, as by means of a distal fixation prosthesis like Wagner's it is not possible to change the femoral neck anteversion angle. Some authors [9, 10] fill the gap between such prostheses and the bone with cement that, however, in these cases does not assure the fixation due to the lack of cancellous bone in the host femur, at the proximal component level, and prevents the bone ingrowth.

The problems caused by Wagner-like prostheses were partially overcome by using modular prostheses. The MP Reconstruction Link prosthesis [11] is the final development of the cementless prostheses designed by Lubinus [12] in 1999. The uncemented tapered stem made of a biocompatible porous-coated titanium alloy in four different lengths (210, 250, 290, 330 mm), with variable diameters ranging from 14 to 25 mm, assures a stable distal fixation (press-fit). Moreover, there is a cortical grip through the 8–10 fins that guarantee the implant's antirotational stability. The proximal stem has a 3° curvature that reduced the need to make shaft osteotomies, often necessary when longer straight stems are used. The head-neck segment, made of cobalt-chromium alloy, has a cylindrical shape with two different CCD angles (126° and 135°). The two components are maintained together by means of a 38-mm locking screw provided with anti-unscrewing device and also by means of a toothed system. The system modularity is completed by the presence of two wedges made of cobalt-chromium alloy, measuring 10 and 20 mm, allowing to increase the total length of the prosthesis by up to 30 mm (stem plus head-neck segment).

The theoretical advantages [13, 14], also confirmed by us, may be summarized as follows:

- Less invasiveness in some cases;
- Better metaphyseal bone-prosthesis fit;
- Possibility to change the anteversion angle when the stem is stabilized;
- Possibilities to restore the proper leg length;
- Choice of the desidered offset.

The theoretical disadvantage of modular prostheses is a higher risk of mechanical fractures.

The short follow-up and the low number of cases do not allow us to draw final conclusions, however the patients' evaluations show positive clinical and radiological results. It is absolutely necessary to make a correct classification of the periprosthetic bone loss to make the most appropriate choice of materials and surgical technique (Fig. 1). Our philosophy is to use the prosthetic system that seems most adequate to solve the type of loosening and bone loss we have to deal with (Fig. 2).

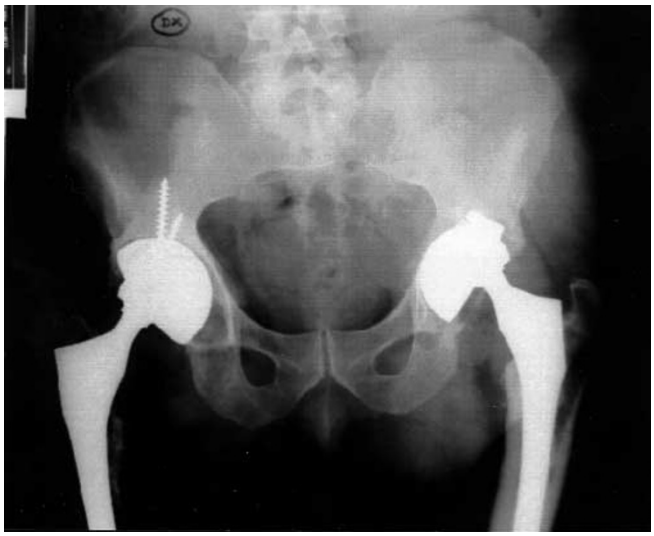

Fig. 1 Femoral stem aseptic loosening and rupture of the polyethylene acetabular component insert 9 years after primary replacement

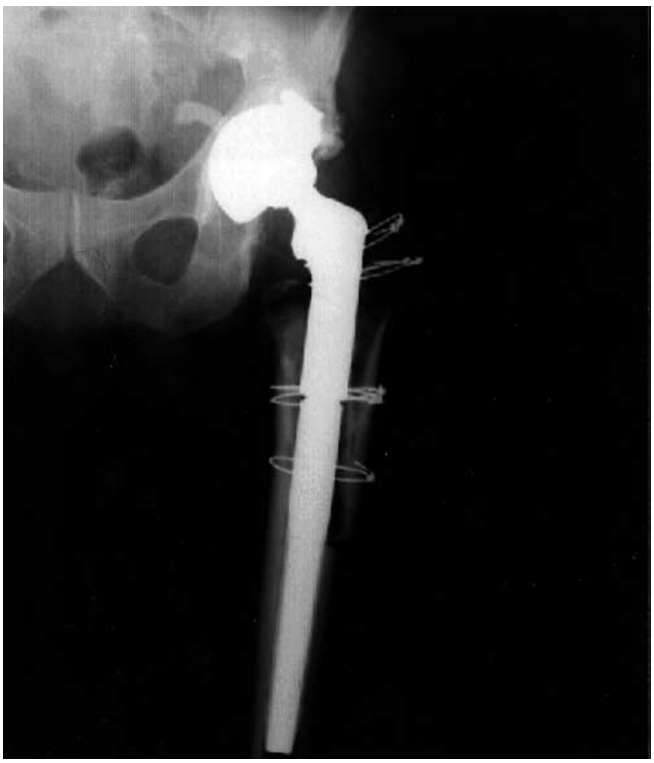

Fig. 2 X-ray control 6 months after revision

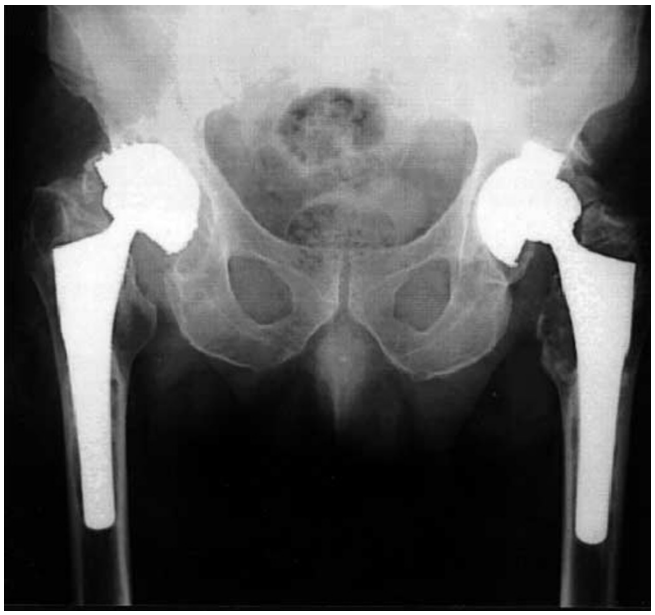

Fig. 3 Aseptic loosening of cementless total joint arthroplasty 8 years after primary replacement

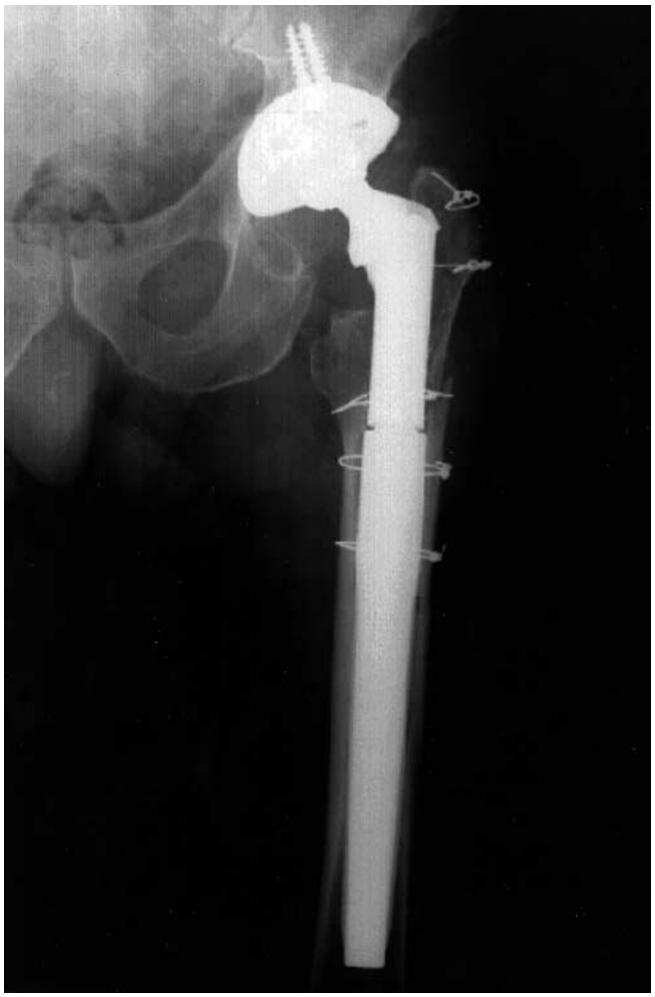

Fig. 4 Postoperative radiographic control 1 year after revision

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