Original Article

Capsula Eburnea

CURRENT STATUS AND PROSPECTS FOR CONSERVATIVE STEM PROSTHESES IN HIP-REPLACEMENT SURGERY.

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SUMMARY

Enormous progress has been made in the field of hip replacement surgery over the past decades, and challenges once thought insurmountable have been overcome. Alongside a natural evolution of prostheses and surgical techniques, there has been a progressive increase in the number of younger patients undergoing this type of surgery. Given the longer life expectancy of such patients and the high risk of revision associated with hip replacement surgeries, orthopedic surgeons and researchers are increasingly pursuing techniques and devices that can be used with utmost respect for the natural anatomy and biomechanics of the hip. Consequently, short-stem prostheses are being widely recommended. This type of prosthesis allows the preservation of the femoral neck, therefore offering the possibility to use conventional prostheses also in eventual revision surgeries instead of specific revision prostheses, offering multiple benefits for the patient. We report results obtained in eleven patients implanted with conservative Proxima stem implant.

Introduction

Improvements in the quality of life and medical innovation have increased the life expectancy of the population, resulting in an increase in the numbers of relatively young patients needing to undergo hip replacement surgery.

Patients under seventy years old can be considered "young", and are likely to need subsequent revision surgeries given that prostheses, like any mechanical devices, have a limited lifespan after which they must be replaced.

These younger patients are often physically active individuals who expect to be able to resume their normal daily activities, including work, without any residual symptoms; in these cases, both the prosthesis and surgical technique must be able to cope with requirements that are quite different from those in older patients. This notion is confirmed by the contrasting results obtained with traditional hip replacement in different age groups: based on data provided by the Swedish National Hip Arthroplasty Registry, the success rate at 10 years from the original surgery in patients over 75 years old was higher than 97%, but dropped to 94% in patients aged between 55 and 75, and to 87% in patients under 55 years old (figure 1).

The reason for such a high failure rate can be found not only in the increased functional requirements from the prostheses of this category of patients, but also in the greater variance in the conformation of the proximal femur in these patients. Consequently, it is difficult to find a prosthetic device that allows the physiological load to be distributed in a manner that prevents "stress shielding". This is a phenomenon where bone tissue, shielded by the stem from the stress it is normally receives, is slowly and progressively

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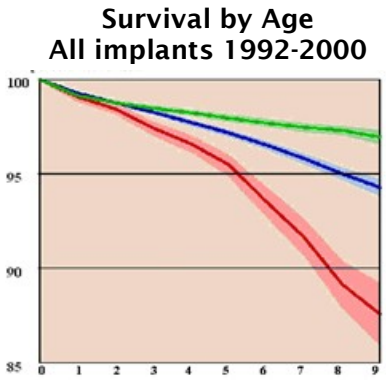

Figure 1: Data provided by the Swedish National Hip Arthroplasty Registry.
Comparison of the longevity of hip prostheses implanted between 1992 and 2000 in patients divided into three age groups: green line: over 75 years old;
blue line: between 55 and 75 years old; red line: under 55 years old. In the youngest patient group, the lifespan of the prosthesis was significantly shorter than in the other groups (reproduced with modifications from www.orhounimib.it). Vertical axis: percentage; Orizontal axis: years postoperatively.

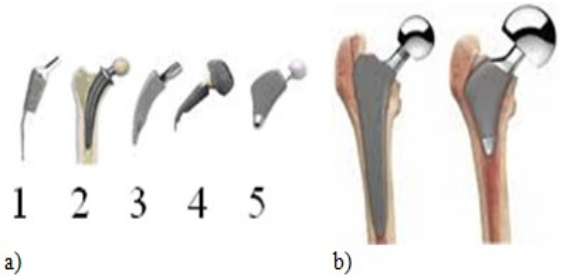

Figure 2: Some examples of currently available conservative prostheses, based on different biomechanical notions (a) (reproduced with modifications from: www.shorthip-surgeons.com); comparison with a traditional prosthesis accentuates the minimal invasiveness of the Proxima stem (b) (reproduced with modifications from: www.doctormarya.com).

resorbed [1-3], decreasing the mechanical support available to the prosthesis and thus increasing the risk of the implant loosening. Aseptic loosening of the prosthesis is a complication that should absolutely not be disregarded, since it represents the main cause of around 80% of revision surgeries [4]. Considering the unsatisfactory results obtained in young patients with traditional prostheses, the increase in the younger population undergoing this type of surgery, the longer life expectancy of such patients, as well as the higher risk of revision, research and production of conservative prostheses has become an urgent necessity. The first conservative implant was designed in the early eighties with the aim of conserving femoral bone stock in keeping with the tissue-sparing surgical principles that aspire to minimize surgical invasiveness with utmost respect for the tissues, in order to optimize the postoperative progression and functional recovery [5].
The main benefit of short-stem prostheses is, in fact, the possibility to preserve bone material both in the neck as well as in the metaphyseal area of the femur, ensuring the availability of sufficient bone stock for an eventual revision surgery. This allows the orthopedic surgeon to use a traditional prosthesis during revision surgery instead of a revision-specific device, offering multiple benefits to the patient in terms of quality of life. Moreover, preservation of the femoral neck seems to be closely correlated with the resistance of the stem to torsional stress [6]. The use of conservative prostheses also permits the use of minimally invasive access routes. This results not only in a shorter scar, but also in decreased periarticular soft tissue trauma, reduced blood loss during the surgery and postoperative pain as well as hastening functional recovery. Several types of short-stem implants are currently available; these are based on different biomechanical theories relative to the stress distribution in the proximal femur (figure 2a).
In this article we report our experience with the Proxima stem (figure 2b), a conservative prosthesis whose design is based on the biomechanical interpretation of the proximal femur by Fetto and colleagues. Taking into account, in addition to the load transmitted directly to the femur according to the classic Koch model [7], the abductor muscle action needed to stabilize the pelvis during the monopodal phase of gait initiation, this research group showed that even the lateral cortex of the proximal femur normally bears compression loads, concluding that an ideal prosthetic stem should have not only medial support, but also rest on the lateral femoral cortex [8, 9]. In keeping with this assertion, the Proxima stem has an ample lateral flare that rests on the lateral metaphyseal cortex.

Figure 3: This figure illustrates the load distribution of the Proxima stem in the proximal femur. The lateral flare can be used to provide additional support also on the lateral metaphyseal cortex (reproduced with modifications from: www.slideshare.net).

Materials and methods

Between 2008 and 2009, we implanted 11 Proxima stem prostheses in five male patients and six female patients, aged between 49 and 68 years. The average height of the patients was 172 cm and the average weight 71 kg.

The mean follow-up period was two years, and the preoperative diagnosis was coxarthrosis for all subjects.

The clinical evaluation of the patients was based on the Harris Hip Score (HHS) [10], while the radiological evaluation was carried out with preoperative and postoperative check-ups; the latter were performed at one month, six months, one year and two years from the initial surgery.

Stem alignment was considered "neutral" where no deviation from the axis of the femoral diaphysis was detected; "varus" or "valgus" if axis deviation was less than 5°; "severely varus" or "severely valgus" with a deviation greater than 5°.

Results

In our experience, clinical results were quite satisfactory. The most notable finding was a rapid functional recovery with a very low incidence of postoperative complications. The Harris Hip Score evaluation produced a mean score of 97/100.

None of the patients experienced the so-called "thigh pain" phenomenon, typically caused by stress concentration near the tip of a conventional stem implant.

One patient experienced slight groin pain that resolved spontaneously after a few months.

No cases of infection, deep vein thrombosis or pulmonary embolism were detected.

Stem alignment resulted neutral in eight patients, varus in two and valgus in one, while no cases of severely varus or severely valgus stem alignment occurred.

Distal migration of the stem or development of secondary varus tilting were not detected in any of our patients.

Representative radiographic images of a 59 year old female patient are shown in the figures section (fig.4).

Discussion

The success of the Proxima stem derives from its respect for the biomechanics of the proximal femur. In this respect, the addition of the lateral flare seems to be of particular importance, since thanks to the added support on the lateral cortex, this device allows a physiological stress distribution on the proximal femur, also helping to preserve bone mass and increase periprosthetic bone stock [11, 12]. These data have been confirmed by previous studies where DEXA scan, that is considered to be the most reliable tool to assess bone remodeling, was applied [13]. Moreover, the possibility to obtain a circumferential contact between the implant and the femoral metaphysis ensures an excellent torsional stability [14].

From a technical point of view, the location of the osteotomy site needs to be carefully considered, since it seems to affect prosthetic stability significantly: medial resection should begin at the level of the femoral head-neck junction, proceed distally and laterally in a manner such as to create an ample access for the stem. The presence of the pronounced lateral flare implies a new stem insertion method. The surgical technique currently in use is called "round the corner", and consists of an initial insertion of the broach at a 30° angle to the long axis of the femur and then progressively aligning it to the axis of the

Figure 4: 59 year old female patient. Preoperative radiographs (a, b); postoperative radiographs obtained at one month (c, d) and one year (e, f) from surgery.

femur. The correct alignment is initially checked with a specific guide, and eventually verified by fluoroscopy [15].

Preoperative planning, and in particular bone quality assessment, play an essential role in the choice of the prosthesis size, and in general in the decision of whether or not to utilize a conservative implant. Cortical index evaluation may be used among other methods; this index is the ratio between the outer diameter of the femur and the diameter of the medullary canal at the isthmus, observed with an anteroposterior femoral x-ray [16]. In patients with a score of less than 3, considered the poor bone quality, a cemented implant is recommended. An oversized stem can be used in patients with a score between 3 and 4 to obtain a good initial stability. In these cases, in fact, better fill is preferred given the low resistance of osteoporotic cancellous bone. Finally, with a score greater than 4, a normal size stem can be used [15].

Conclusions

The Proxima stem implant ensures excellent bone stock preservation, whilst guaranteeing exceptional stability and physiological stress distribution in the bone to optimize integration and bone remodeling. The encouraging clinical results obtained so far show that the use of this device leads to more than satisfactory outcomes, in particular in patients with good initial bone stock. Therefore, the Proxima stem can be considered an optimal hip prosthesis, subject to rigorous patient selection, as well as accurate preoperative planning. However, further studies with a longer follow-up period are necessary to better analyze the evolution of radiological results and eventually confirm the longevity of the clinical outcomes observed.

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