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Survivorship of proximal femoral replacement in neoplastic and non-neoplastic elderly patients

A. ZIRANU[1,2], M.B. BOCCHI[1,2], M.S. OLIVA[3], C. MESCHINI[1,2], F. MESSINA[1,2], S. CALORI[1,2], R. VITIELLO[1,2,4]

[1]Department of Orthopaedics, Fondazione Policlinico Universitario A. Gemelli IRCCS, Rome, Italy
[2]Università Cattolica del Sacro Cuore, Rome, Italy
[3]Department of Orthopaedics, Ospedale San Giovanni Evangelista, Tivoli, Italy
[4]Private Nursing House "Villa Stuart", Rome, Italy

Abstract. – OBJECTIVE: Massive bone loss is a serious problem in the elderly. Joint replacement with modular prostheses represents the most common reconstructive technique after oncological and non-oncological resections. Megaprostheses are broadly available, adaptable and versatile and allow early mobilization and rehabilitation. Although segmental endoprosthetic implants are now widely used and despite innovations, complications remain far high. Our purpose is to establish what happens to megaprostheses of a specific anatomical site in the long term in a population with oncologic and non-oncologic indications treated at a single center solely by a few skilled surgeons.

MATERIALS AND METHODS: We retrospectively reviewed our institutional database. We collected 35 patients who underwent endoprosthetic reconstruction exclusively of the proximal femur for neoplastic and non-neoplastic disease between 2008 and 2021. The minimum follow-up was 12 months. Complications were collected and classified, and also adapted to the non-oncological setting.

RESULTS: Taking into consideration the entire population, 94% of this survived the follow-up at 6 months, subsequently 85% at 1 year and 82% at 2 years. At follow-ups after 5 years, 79% of megaprostheses showed no mechanical failure. Analyzing prosthetic survival in the two groups, this was >50% at 24 months after surgery in both groups, with better survival for the oncological one.

CONCLUSIONS: Proximal femur replacement can be a valid option in treatment of oncological and non-oncological cases. Due to the high complication rate, only selected cases should undergo this kind of surgical procedure.

Key Words:
Megaprostheses, Proximal femur resection, Implant survival, Oncological, Metastases.

Introduction

Massive bone loss is a serious problem in the elderly, especially in patients who have already undergone many surgical procedures[1-5].

Limb salvage surgery has replaced amputation as the treatment of choice for nearly all patients with a primary malignancy of bone. Joint replacement with modular prostheses represents the most common reconstructive technique in case of bone loss after tumor resection, and more[6-11]. These implants, in fact, have also been used to restore osteoarticular defects in prosthetic revision surgery and still traumatic bone defects or recurrent non-union[12-17]. Proximal femoral replacement is broadly available, adaptable and versatile compared with other reconstructive options. These implants provide rapid intra-operative reconstruction and immediate stability which allows early mobilization, rehabilitation, and weight bearing which are critical for a smooth functional recovery, particularly in the elderly[18]. Although segmental endoprosthetic implants are now widely used and, despite implants and materials innovations[19-21], the reported complication rate remains far higher than the one observed for total joint arthroplasties. Complications, which can be mechanical and biological, always require additional treatments affecting patients and implants survival[22-26]. Among biological ones, the most frequent and feared complications are undoubtedly periprosthetic infections, which can occur mainly due to sustained surgeries with wide tissues exposures and dissections in fragile patients[27-32]. Since endoprosthetic replacement is increasingly used, the literature is varied on the subject. Survival data[33-35] are very heterogeneous in many respects starting with year, type and site of implant, surgical indications and finally surgeon experience.

Corresponding Author: Maria Serena Oliva, MD; e-mail: mariaserena.oliva@gmail.com

The purpose of our study is to establish implant survivorship of proximal femur megaprostheses in elderly population with both neoplastic and non-neoplastic patients, treated in a single center solely by fellowship-trained oncological surgeons.

Materials and Methods

We retrospectively reviewed our institutional computerized database. All patients who underwent endoprosthetic reconstruction exclusively of the proximal femur for neoplastic and non-neoplastic disease between 2008 and 2021 were included in this study. Patients had a minimum follow-up of 12 months (mean: 34.5 months; range: 12-144 months). No patients were recalled specifically for this study; all data were obtained from the medical records.

A general anesthesia was performed in all cases. All patients received Cephazolin 2 g intravenous as antibiotic prophylaxis before surgery, if not contraindicated. A urinary catheter was placed in all patients and removed within 72 h after the surgery. Patients were placed in lateral decubitus position. A lateral approach was used. After bone exposure, an en block resection was performed, cementless silver-coated megaprosthesis was implanted according to the manufacturer technique (Mutars, Implantcast, Rome, Italy)[36]. Silver-coated megaprosthesis was preferred in order to reduce risk of post-surgical infections. No acetabular components were implanted in oncological patients. The myodesis through the Trevira Tube© (Implantcast, GmbH, Buxtehude, Germany) completed the surgery[37]. One intra-articular closed-suction drainage was placed and then removed 48 h after surgery. Mechanical, intermittent compression stockings were used for deep vein thrombosis prophylaxis along with anticoagulants.

All patients followed the same post-operative rehabilitation protocol: at 48 h after surgery patients were seated with their feet out of bed; at 72 h, they were allowed to progressive weight bearing with walker frames. Walking without aids was achieved in two months. Routine total hip precautions were followed for 3 months. Patients were regularly followed-up at 2 and 4 weeks after surgery and then every 3 months for the first two years, then yearly. Starting 4 weeks after surgery, an X-ray was performed at each clinical evaluation. Complications, according to Hendersen et al[22] and adapted to the non-neoplastic setting[38], were divided as follow:

Mechanical Complications

- Type I - "Soft tissue failure": these include in particular dislocations and tendon ruptures; delayed wound healing was also included in this category;
- Type II - Clinical or radiographic evidence of aseptic mobilization;
- Type III - Structural failure, associated with periprosthetic fractures, or failure of the prosthetic components themselves.

Non-Mechanical Complications

- Type IV - Periprosthetic infection;
- Type V - Tumor progression with prostheses contamination.

Implant failure refers to those cases in which it was deemed necessary one or more of the following procedures:

– Prosthetic component exchange/repair or revision including exchange of polyethylene components and replacement of part or all of the prosthesis;
– Fixation of a periprosthetic fracture;
– Reconstruction of the periprosthetic soft tissues including superficial soft tissue irrigation and debridement, skin grafting, and muscle flap creation or revision, but also deep soft tissue revision including synovectomy, arthrotomy, removal of pseudomembrane;
– Removal of the prosthesis;
– Amputation or disarticulation of the limb.

Complications were calculated for the entire population and then separately for the two groups of patients. The time of survival of the reconstruction implants was calculated from the date of initial surgery to the date of failure or the last follow-up. The implants survival was determined according to the method of Kaplan-Meier. Statistical analysis was performed using Microsoft Excel.

Results

We collected 35 patients, 12 (34%) males and 23 (66%) females, who were then divided into two groups based on the reasons for implanting the megaprostheses. Group 1 consisted of 11

patients who underwent surgery for non-oncological reasons: 7 had periprosthetic fractures, 2 had intramedullary nail synthesis failures, 1 showed a prosthesis stem breakage and 1 got infection outcomes. Group 2 consisted of 24 oncological patients instead, all cases were metastatic malignancies secondary to: breast carcinoma (8), lung carcinoma (4), kidney carcinoma (2), prostate carcinoma (2), thyroid carcinoma (1), uterine leiomyosarcoma (1), lymphoma (3) and multiple myelomas (3).

The mean age was 74 years (SD 8): in group 1 was 78 years while in group 2 was 72 years.

In the study population, 27 patients (77%) had no complications until their last follow-up, while 7 (23%) had developed at least one (Figure 1).

Going specifically, in the non-neoplasm group 5 patients (45.5%) have experienced complications as in (Figure 2).

It should be noted that 2 patients had originally a mechanical complication, a dislocation of the implant (Type I), but an underlying infection (Type IV) was later diagnosed.

Similarly, we observed the same for one patient in group 2 in which in general 3 patients (12.5%) experienced complications (Figure 3). Furthermore, in this latter group we observed a Type 5 non-mechanical complication, in particular a progression of the metastatic disease with progressive involvement of the entire femur.

Finally, failure of the implant was observed in 8 patients (23%) that requested: 2 partial and 2 total revisions of the megaprostheses, 2 removals of the implant and antibiotic spacer replacement, 1 conversion to total femur megaprostheses and 1 arthrodesis.

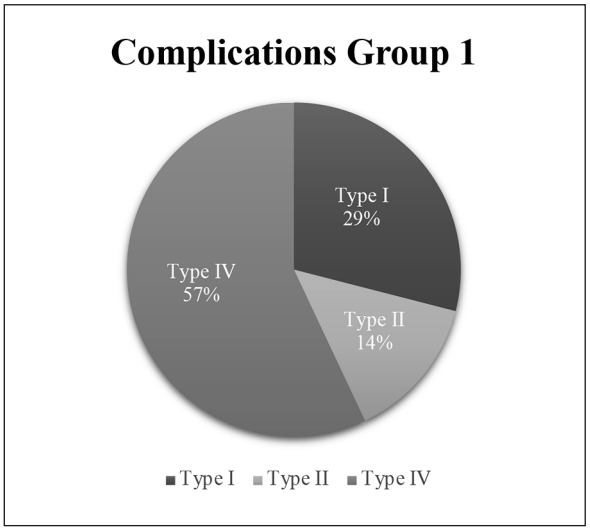

Figure 2. Complications in Group 1.

In our experience, out of the total number of patients with complications, all the patients had a complication which led to prosthetic failure.

Taking into consideration the entire population, 94% of this survived the follow-up at 6 months, subsequently 85% at 1 year and 82% at 2 years. At follow-ups after 5 years, 79% of megaprostheses showed no mechanical failure.

Analyzing the non-neoplastic population alone, the survival of megaprostheses at follow-ups of 6,

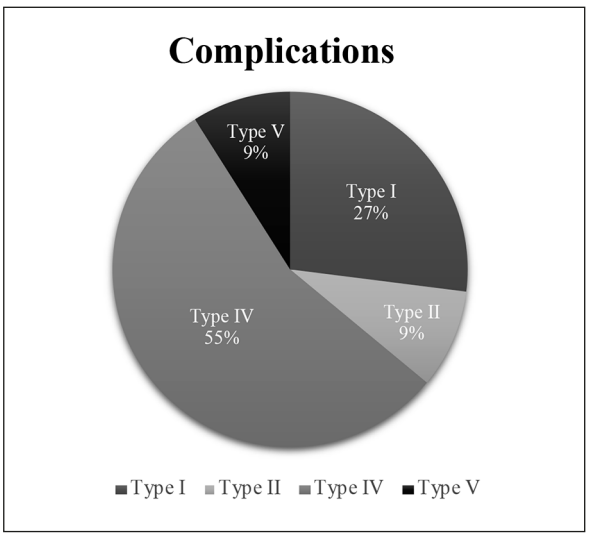

Figure 1. Overall complications.

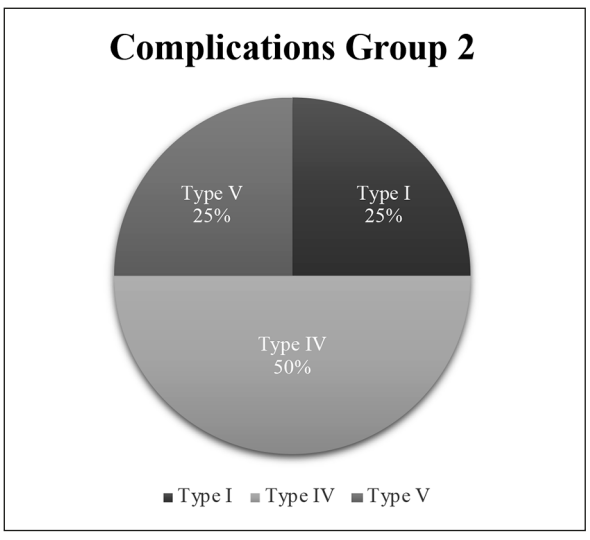

Figure 3. Complications in Group 2.

12, 24 months respectively were 82%, 64%, 55%, while over 5 years there was a survival rate of 55% (Figure 4).

Analyzing the neoplastic population, the survival of megaprostheses at follow-ups of 6, 12, 24 months respectively were 100%, 96%, 96%, while over 5 years there was a survival rate of 91% (Figure 4).

Discussion

The proximal femoral replacement (PFR), also known as megaprosthesis, is one of the surgical techniques not only for the treatment of oncological lesions, but also for revision arthroplasty or cases of complex traumatology[39,40].

Instability, type 1 according to Hendersen et al[22], is one of the most common complications after PFR and occurs up to 1/3 of patients[41]. The dissection of soft tissues, the removal of muscle and tendon tissue that is operated during cancer surgery, or the presence of scars and adhesions for previous operations in the case of non-neoplastic patients, is certainly a known risk factor for instability. To avoid this latter complication, it is possible to use hemiprostheses which have been shown to be useful in decreasing the dislocation rate by up to 67%[41]. If the use of hemiprostheses is a valid alternative in cancer patients, especially metastatic ones, it cannot be said for non-cancer patients who have a longer life expectancy.

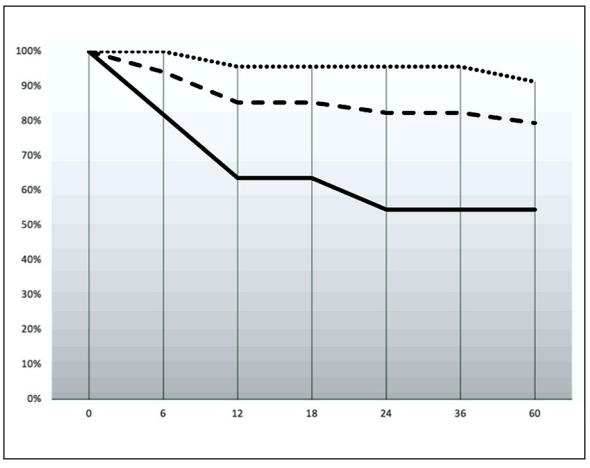

Figure 4. Implants survival Analysis: Kaplan-Meier estimate – dotted line: implant survival in the oncological population (Group 2); dashed line: implant survival in the non-oncological population (Group 1); solid line: implants survival in the overall population.

In these cases, it is possible to use direct anchors on the megaprosthesis or meshes that act as insertion for the muscle components in order to give greater stability to the implant[11].

Another possibility is the use of a dual mobility which could reduce the risk of dislocation, even if there are no long-term studies[42]. In our series there were 3 cases of dislocation, of which 2 in the non-neoplasm group and 1 in the group 2. The two cases in the non-neoplasm group turned out to be cases of instability over prosthetic infection.

Aseptic loosening, Henderson type 2 is also a common failure mode in PFRs and may occur in 0-11%[43]. It is still debated whether cemented or uncemented coated stems provide the best long-term survival, but a recent review suggests a higher risk in cemented ones[7].

In our series, composed by all uncemented prostheses, there were only one case of aseptic loosening occurred in a patient with a broken stem from a previous hip replacement.

Hendersen type 3, structural fail, is reported to be the less frequent complication (0-3%)[41]. This has also been confirmed in our series, occurring in a patient 12 years after the operation of megaprostheses.

The rate of infections, Henderson type 4, in the PFR is quite variable in literature, ranging between 6 and 19.5%[43]. In neoplasm patients, this type of complication is the most frequent, due to the resection of the soft tissue, long operating times, large metal surfaces and potential impact of neo-adjuvant and adjuvant treatment, such us radiation and chemotherapy[41]. On the other hand, in non-cancer patients, previous interventions must be considered, together with the presence of a scar tissue and any alterations in the vascularization. To limit these complications, silver-coated prostheses are increasingly used, since they are useful in reducing the incidence of early infections[44,45].

The presence of local recurrence, Henderson type 5, is a very variable (3-7%) complication, depending on the population examined (primary tumors, metastasis, etc.)[46-48].

Despite these complications, numerous authors[43] describe very promising limb salvage rates in oncologic patients, with values reported between 92% and 100%.

According to Capanna et al[49] research overall survival rate in oncological patients was 75.9% and 66.2% at 5- and 10-years follow-up (excluding Henderson type 5).

Other studies reported 5 years survivorship to be between 55% and 90.7% [59, 65-68], between 55 and 86% at 10 years [61, 68, 69] and 56% at 20 years [70][43]. Concerning non-neoplasm patients, the implant survival rate is higher, accounting for 76.6%[39].

Limitations

Our research has several limitations. Firstly, when analyzing the survival of a population, it is assumed that the risk is homogeneous throughout the population. Having analyzed an oncological population, it is clear that this has a reduced life perspective than non-neoplasm ones; then, using new surgery as outcomes, there is no doubt that the survival curve of neoplasm patients is distorted by this assumption. Probably the trend in the first two years is more reliable, in accordance with the survival of the patients, while subsequently it becomes less truthful. Secondly, it is an observational and retrospective study. Thirdly, the sample is small. Fourthly, it is difficult to talk about this type of intervention and standardize the procedure (exposure, soft tissue resection, etc.), diagnosis and type of patient (radiation, chemotherapy, previous surgery, etc). On the other hand, our study has several strengths: it was carried out at a single institution, in a short period of time, the surgeries were carried out by only 3 surgeons' expert in the field. Furthermore, the same megaprosthetic implant, cementless, silver-coated, was always used and the same reconstructive technique was employed.

Conclusions

According to our study, Megaprosthetic implants show fairly good implant survival. Considering the high complication rate, most frequent in the first years after surgery, megaprostheses represent a reliable surgical option in studied and selected cases.

Conflict of Interest

All authors have completed the ICMJE uniform disclosure form. The authors have no conflicts of interest to declare.

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Authors' Contribution

Conception and design: Ziranu A. and Vitiello R. Administrative support: Vitiello R. Provision of study materials or patients: Bocchi MB. and Oliva MS. Collection and assembly of data: Meschini C., Calori S. and Messina F. Data analysis and interpretation: Bocchi MB. and Vitiello R. Manuscript writing: All authors. Final approval of manuscript: All authors.

Ethics Approval

The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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