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Original article

Revision arthroplasty with megaprosthesis after Girdlestone procedure for periprosthetic joint infection as an option in massive acetabular and femoral bone defects

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Background and aim: To evaluate the clinical outcomes of patients treated with Girdlestone procedure (GP) or excision arthroplasty (EA) for periprosthetic infection with massive bone defects and undergoing revision arthroplasty. *Methods:* All patients treated with EA or GP for hip periprosthetic infection between 2014 and 2017 and sustaining revision arthroplasty (RA) were included in the study. Patients with less than 24 months of follow-up or less than 12 months between GP or EA and RA were excluded. Any sign of implant mobilization or periprosthetic fracture was assessed through X-ray. Patients were evaluated with D'aubignè-Postel hip score before RA and at the last follow-up. Mann-Whitney U test was used to assess differences between pre-RA surgery and last follow-up. P value was set as <0.05. *Results:* Twelve patients meet the inclusion criteria (mean follow-up 58+/-9.72 months). No radiographic sign of implant mobilization or periprosthetic fracture was reported. A significant difference was found for each parameter of the D'Aubigne-Postel score ($p < 0.0001$); none of the patients reached more than fair results in the absolute hip score. The difference between pre and post-operative global status showed a fair improvement. A significant difference was found for leg length discrepancy between pre and post RA ($p<0.0001$). *Conclusions*: Conversion from EA or GP to RA in patients suffering from massive acetabular and femur defects is challenging; conversion procedure is able to reduce patients' disability and to improve walking ability. (www.actabiomedica.it)

Key words: Girdlestone, excision arthroplasty, revision arthroplasty, bone defects, infection.

Introduction

Excision Arthroplasty (EA) and Girdlestone procedure (GP) represent a useful salvage procedure following the complications of failed total hip arthroplasty, especially in septic revision (1–3). Nevertheless, an extensive number of studies reported unsatisfactory clinical outcomes, with prevalence for elderly patients (1,4–6). Since the poor clinical results and subsequent disability, most patients are not willing to accept the procedure as definitive. Often patients are looking for conversion from GP to revision arthroplasty (RA) to obtain pain relief and a better quality of life (7,8).

Infection of the hip prosthesis is very challenging for orthopaedic surgeons, since after infection full functional recovery is very rare. The periprosthetic infection affects both bone and soft tissues making a revision more difficult (9).

The main objective is to completely eradicate the periprosthetic infection, to reduce pain, and to recover joint function as far as possible (10).

GP and EA are very invasive procedures, but with a high success rate (2,11), responsible for a real amputation of the hip joint with extensive debridement of soft tissue(5); some of the main problems are related to the management of bone loss, leg length discrepancy (LLD) and abductor muscle dysfunction (3,12,13). Megaprostheses could be useful to cover bone defects, but the functional outcomes are acceptable but not excellent (14).

In the case of conversion to RA, clinical outcomes are unpredictable(15) and time-dependent, needing to accurately inform the patients about the revision procedure and the expected outcomes.

This study aims to evaluate the clinical outcomes of patients treated with RA following EA or GP for periprosthetic joint infection, with massive acetabular and femoral bone defects.

Materials and Methods

All patients treated with EA or GP for hip periprosthetic infection between 2014 and 2017 were eligible to be included in the study. Patients were all treated and followed by the same surgeon in the same institution. We excluded from our analysis patients who didn't complete 24 months of follow-up, or with less than 12 months between Girdlestone procedure and RA. Conversion from EA to RA was performed following strict laboratory and clinical parameters: normal value of erythrocytes sedimentation rate (ESR) and C reactive protein (CRP), negative cultures and leucocyte count from 3 subsequent fine needle aspirations, good function and status of the same side knee and contralateral hip and knee, and great motivation to undergo a further surgical procedure.

Disability was evaluated with D'Aubignè-Postel hip score(16) before RA and at the last follow-up. It is an 18 points scale evaluating pain, mobility, and ability to walk for the affected hip, where 0 is the minimum and 6 is the maximum for each parameter. The absolute hip score taking into consideration pain and mobility (first 2 parameters) lower or equal to 7 is classified as bad, 8 as poor, 9 as fair, 10 as good, and 11-12 as very good. A difference between preoperative and postoperative status evaluating all 3 parameters lesser or equal to 2 is reported as a failure of treatment; a difference of 3-6 point a fair improvement, a difference from 7 to 11 points a great improvement, and more or equal to 12 points a very great improvement. Bone defects were evaluated through X-ray of the pelvis according to Paprosky classification for acetabulum (17) and proximal femur (18). Follow-up X-rays were evaluated at 1,3, 6 months, and then yearly, to highlight any sign of loosening, described as a lucent zone of more than 2 mm at bone-cement interface or prosthesis migration, or periprosthetic fracture.

Residual LLD was also recorded at the last follow-up.

All participants provided written informed consent to participate in this study. This study was conducted under the principles of the Declaration of Helsinki. The study design protocol was ap-proved by the local Institutional Review Board of University of Campania "Luigi Vanvitelli" (IRB-SUN–2014–03/026).

Surgical technique and rehabilitation

An anterior incision through a Smith Petersen(19) modified Wagner(20) approach was preferred in all cases to better visualize both upper acetabular and femoral bone defects. For the acetabular reconstruction, a hemispherical uncemented cup (Revision Shell TMT, Zimmer – Biomet Inc.) and bone graft were used. Bone graft was prepared from frozen femoral head and growth factors in smaller bone defects; in bigger defects, metallic meshes or augment were used. On the femoral side, due to the high prevalence of extensive bone defects, cemented megaprostheses (GMRS proximal femur LSPK41, Stryker Ma NY) were used in all cases.

Physiotherapy protocols were individualized according to the entity of bone defects and pain control; in general, weight-bearing was avoided for the first month after surgery, while there was no restriction for joint passive and active mobilization, with attention for luxation movements. Then, progressive weight-bearing was allowed for the next 2 months, till complete weight-bearing and achievement of a good range of motion.

Statistical analysis

Continuous variables were reported as mean and standard deviation (SD). Categorical data were reported as rate. Mann-Whitney U test was used to assess differences between pre-RA surgery and last follow-up. P value was set as <0.05.

Results

From 19 patients treated, according to inclusion and exclusion criteria, only 12 patients were eligible to be included in the study. Demographical data are shown in table 1.

Mean follow-up was 58+/-9.72 months (range 44-72 months). The time between EA and RA was 28.25+/-12.35 months (range 15-51 months).

In all Paprosky IIIA defects and one Paprosky IIIB debridement, bone graft from fresh frozen femoral head, and revision cup were used with or without screws; in all other cases, metallic meshes or augments were used.

A significant difference was found for each parameter of Merle D'Aubigne score p < 0.0001), but none of the patients had more than 10 points in the absolute hip score, mean 9.25 +/- 0.87 which is scored as fair results. The difference between pre and post-operative global status reaches a mean of 6.75+/-1.54 points and it was scored as a fair improvement. All patients at final follow-up suffered from limping with various degrees of walking speed due to LLD or weak abductor muscles.

Pre-RA LLD was 4 +/-0.95cm (range 3 – 6.5cm), while at the end of follow up was 1.75 +/- 0.75cm (range 1 – 3cm) (p<0.0001).

D'Aubignè-Postel parameters were reported in table 2.

All implants were considered stable during follow-up, with no radiological sign of mobilization or loosening of the implants (100%); at the same time, no patients suffered from periprosthetic fracture (0%). The survival rate of GP or EA conversion to RA was 100%.

Discussion

Originally, GP and EA were indicated for the treatment of septic arthritis of the hip (6,11). Over the last 20 years, GP became a very useful tool in the hand of orthopaedic surgeons in case of persistent infection, when all other options failed(3). By time, Girdlestone resection became also a successful tool in case of failed prosthesis such as periprosthetic fracture with poor bone stock and poor general conditions and especially in patients with dementia (21). Although very destructive, about 50% of patients were able to retain some walking ability (1).

The technique itself has some consequences: LLD, limitation of range of motion, and high mortality which is connected with the poor general condition of the patients. For all these reasons, it should be used wisely and only as last resort (21).

Table 1. Main demographic characteristics of patients included in the study.

Patients (n=12)	
Gender	7 males 5 females
Age (years)	69,33 +/- 3,94
Type of infection	6 Staphylococcus aureus 1 Providencia stuartii 1 Pseudomonas aeruginosa 1 Streptococcus faecalis 1 Staphylococcus epidermidis 1 Escherichia coli 1 Acinetobacter baumanii
Number of surgical interventions before excision arthroplasty	5,25 +/- 1,14
Paprosky acetabular defects	IIIA (7/12) IIIB (5/12)
Paprosky femoral defects	II (5/12) IIIA(6/12) IIIB (1/12)
Mean follow up (months)	58 +/- 9,72

Table 2. Pre and post-operative D'Aubignè-Postel hip score with statistical analysis. The level of significance is set at p<0,05

	Preoperative	Postoperative	p
Pain	2,83 +/- 0,72	5 +/- 0,43	< 0,0001
Mobility	1,92 +/- 1	4,25 +/- 0,62	< 0,0001
Ability to walk	1,83 +/- 1,19	4,08 +/- 1	< 0,0001
Absolute Hip Score	4,75 +/- 0,87	9,25 +/- 0,87	< 0,0001
Global Hip Score	6,58 +/- 1,62	13,33 +/- 1,56	< 0,0001
Leg Lenght Discrepancy	4 +/- 0,95	1.75 +/- 0,75	< 0,0001

Due to these premises, conversion from GP or EA to RA is reserved to very selected cases.

The conversion procedure is also a surgically demanding procedure, especially after several years(22); the main problems are related to soft tissue retraction and subsequent LLD, and poor bone stock.

After GP or EA, some Authors reported the LLD ranging from 4 to more than 7 cm(23,24). This means that tissue retraction is more important in patients with major LLD and the possibility of a complete correction of the leg length is not always possible due to a possible risk of nerve injury(25). In our study, we were not able to reach a complete correction of LLD; however, we were able to achieve satisfactory results after revision arthroplasty with a mean LLD of 1.75cm (range 1 to 3 cm), which were consistent with the results of Sigmund et al. (23).

Bone defects are also crucial factors for successful revision arthroplasty (26), but also bone quality (27) and prosthesis design (28) could play an important role.

According to Ganhem et al. (29) in case of massive acetabular bone defects, such as Paproski type III acetabular defects but where is still possible a 3-point fixation, the Authors proposed to perform a cementless spherical cup plus augmentation part and allogeneic cancellous bone. If the 3-point fixation was not possible, the acetabular cup with a cranial strip with or without iliac stem and an allogeneic cancellous bone or cup-cage system should be preferred. In our experience, we were able to achieve a good bone stock, with good implant stability using femoral head to fulfill the acetabular defects along with augments and hemispheric cup, and only in 4 cases a metallic mesh or augment was needed to gain sufficient stability.

In the case of poor femoral metaphyseal bone stock, a diaphyseal grip stem should be used(28). To solve the problem of massive femoral defects, we opted to utilize a megaprosthesis stem, to increase the contact between stem and diaphyseal bone and increase the stability of the implant (figure 1 and 2).

Mega prosthesis, especially for the proximal femur, are burdened with a higher rate of infection and dislocation than a conventional prosthesis. In particular, the rate of infection in proximal femur megaprosthesis is reported to be about 7%, while the rate in primary arthroplasty is significantly lower (about 1%)(30,31).

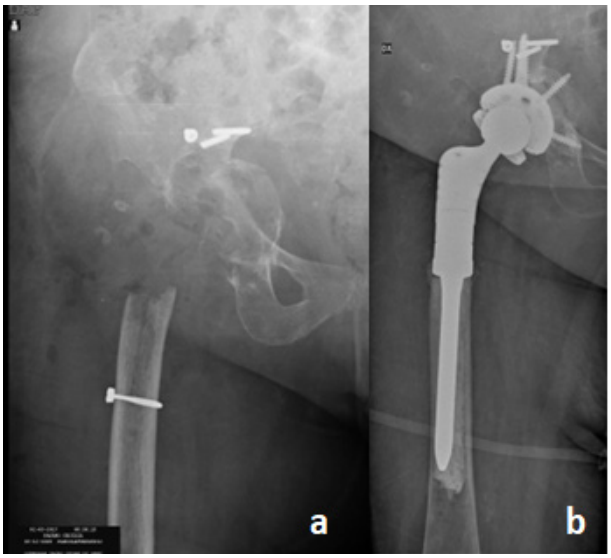

Figure 1. A) anteroposterior view of excision arthroplasty with massive bone loss due to periprosthetic infection B) postoperative anteroposterior view of successful revision arthroplasty with megaprosthesis.

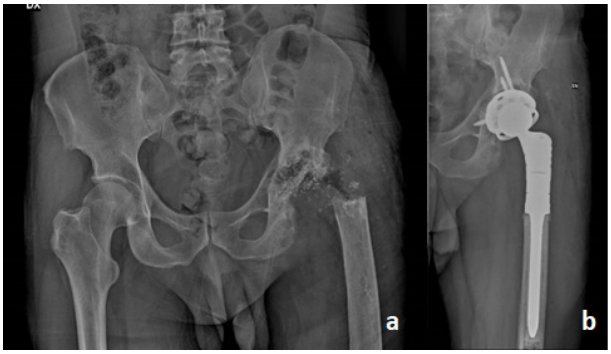

Figure 2. A) massive periprosthetic infection treated with excision arthroplasty B)postoperative x-ray of successful revision arthroplasty with megaprosthesis.

On the other hand, the rate of infection in oncological patients is still higher, surpassing the rate of 10% (32). In the last 6 years, some authors proposed the use of mega prosthesis in very selected cases of severe bone loss, where the therapeutic options are limited (33,34). Their results showed that megaprostheses are available options in these conditions with good clinical results for the restoration of function but a higher incidence of periprosthetic infection and dislocation must be taken into account(35). Corona et al. (14) found a rate of reinfection of 17.2% for both proximal and distal femur while it decreased to 14.3% for the proxi-

mal femur. However, it must be noted that Corona et al used a temporary spacer while we performed a GP; moreover, no details were retrieved about the time of the second stage from spacer insertion. In our series, we used megaprosthesis after periprosthetic infection, but we didn't record any case of reinfection. Although the low number of patients could be in some way an explanation, we strongly believe that our protocol with a minimum of 12 months from GP to RA, negative value of ESR and CRP, and 3 consecutive negative aspirations before RA could be the influencing factor that reduces the risk of reinfection.

Low data are available for the survival rate of this kind of prosthesis since the majority of studies has no more than 5 years of follow-up and are focused on neoplastic excision. For what concern proximal femur mega prosthesis, Vaishya et al. found a survival rate of 80%, which supported the conclusion of Korim et al. who found in their systematic review a global survival rate of 76%(31,34). In our series we didn't perform any revision; however, it must be acknowledged that few patients reached 5 or more years of follow-up.

Several limitations must be acknowledged. Major limitations are related to the study design and its retrospective nature. Moreover, the low number of patients and the not homogeneous follow-up, which in most of the cases didn't reach 5 years, could affect the survival rate.

Conclusions

Conversion from EA or GP to RA in patients suffering from massive acetabular and femur defects is a challenging procedure for orthopaedic surgeons. The conversion procedure can reduce patients' disability and improve walking ability. It is possible to reduce LLD with acceptable results; however, a complete correction is not always possible due to tissue retraction and the risk of nerve injury.

Conflict of Interest: Each author declares that he has no commercial associations (e.g. consultancies, stock ownership, equity interest, patent/licensing arrangement etc.) that might pose a conflict of interest in connection with the submitted article

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