Complex Acetabular Prosthetic Revisions.
Comparison of modern materials in treatment strategies

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Abstract

The increasing number of total hip arthroplasty (THA) operations has inevitably led to an increase in the number of revisions for aseptic, septic or traumatic mobilization. The surgical treatment of these lesions is a demanding challenge for the surgeon: the primary objective is a stable osterexesis of the fracture that allows an early mobilization of the patient, therefore a careful evaluation of the materials to be implanted is also necessary. The aim of our study is to demonstrate the usefulness and limitations of new revision surgery technologies in cotiprosteal fractures. We enrolled 54 patients who underwent hip acetabular revision. The criteria chosen for the evaluation of outcomes: the visual analogue scale of pain in the traumatized hip (VAS); the subjective score of the Harris HIP Score; quality of life measured with The Short Form (12) Health Survey (SF-12); the average time of cup integration and complications. The evaluation endpoint was set at 24 months. The results, assessed with the aforementioned parameters, were on average good. Complications are the same as those described in the literature. The advantages of the new generation of acetabular components are: excellent integration and ductility of materials during revision of hip arthroplasty.

Keywords: Acetabular Revision Surgery; Bone Loss; Outcomes; Paprosky acetabular classification; Tantalium; Custom Made

1. INTRODUCTION

Periprosthetic acetabular fractures represent a growing and serious complication of total hip arthroplasty (THA). The incidence of periprosthetic fractures is 0.07% [1] with 0.2% occurring after implantation of cemented prosthesis [2]. The incidence of postoperative acetabular fractures with pelvic disruptions is 0.9% [3]. Most of the periprosthetic acetabular fractures occur during the intervention of the first installation and / or acetabular revision [4.5]. Factors associated with the increase of periprosthetic acetabular fractures

are attributable to broaden THA indications, the increased use of cementless implants and the growing population of patients receiving revisions [6]. Periprosthetic acetabular fractures, like dislocations, are the third leading cause of revision after aseptic mobilization and infection [7] and are associated with a poor functional outcome, increased morbidity and mortality and a growing economic burden. Tantalum is a pure, inert, robust, flexible, corrosion-resistant and biocompatible metal, which guarantees final stability and long term biological fixing.

2. MATERIALS AND METHODS

From January 2012 to December 2016, at the three Trauma Level I Center: Vito Fazzi Hospital, Lecce, Italy;, Italy; we treated 110 acetabular cup loosining in total hip arthroplasty. From 110 acetabular cup, we enrolled 40 patients suffering by Paprosky's bone defect Type IIIA[8].

Exclusion criteria included: bone defect and cup mobilitation caused by hematological or oncological pathologies; infection diseases, Paproky's bone defects Type I,; trauma; the age less than 65; patients who did not adhere to a minimum follow-up of 12 months.

We divided the patients into two groups.

The three patient groups were formed based on the patient's choice to undergo such treatment and surgeon performing treatment. All patients were informed in a clear and comprehensive way of the two types of treatment and other possible surgical and conservative alternatives. Patients were treated according to the ethical standards of the Helsinki Declaration and were invited to read, understand and sign the informed consent form. The chosen criteria to evaluate the two groups during the clinical and radiological follow-up were: the hip complication after the three types of surgery; the duration of surgery; the objective quality of life and the elbow function measured by Harris Hip Score(HHS)[9] while the subjective quality of life correlated with hip function by the Short Form 12 Health Survey (SF-12)[9]; The hip pain with Visual Analog Scale(VAS). The acetabular stability was misured by X-rays control as the osteointegration and was misured by radiographic Moore's criteria (MC) [11], and postoperative complications. The evaluation endpoint was set at 24 months for both groups.

Descriptive statistics were used to summarize the characteristics of the study group and subgroups, including means and standard deviations of all continuous variables. The t test was used to compare continuous outcomes. The Fisher, in this groups are smaller than 10 patients, exact test were used to compare Categorical variables. The statistical significance was defined as $p<0.05$.

Cohen's kappa coefficient (κ) is a statistic which measures inter-rater agreement for qualitative (categorical) items. We through this parameter we calculated the concordance between different qualitative values of the bone stock and acetabular cup integration from the radiological point of view according MC.

3. RESULTS AND DISCUSSION

We divided the 54 in the three groups: the first one vas the 26 patients treated with revision acetabular cup cage(ACC); the second one was 20 patients treated with Tantalium Acetabular Cup(TAC); and the last one 8 patients treated with Custom Made acetabular Cup(CM).

Null hypothesis between the three populations was rejected.

The surgery lasted an average of 105.9 (±18.6; range 73-172) minutes in ACC while 116.7 (±19.8; range 69-177) minutes for TAC instead 106.7 (±17.5; range 70-169) in(CM), p>0.05.
We had 4 complications in group ACC; 4 in TAC; and 1 in CM, p>0.05

The clinical results according HHS(Fig.1),SF-12(Fig.2) and VAS(Fig.3) show not statistical difference between the three groups at the last follow up.

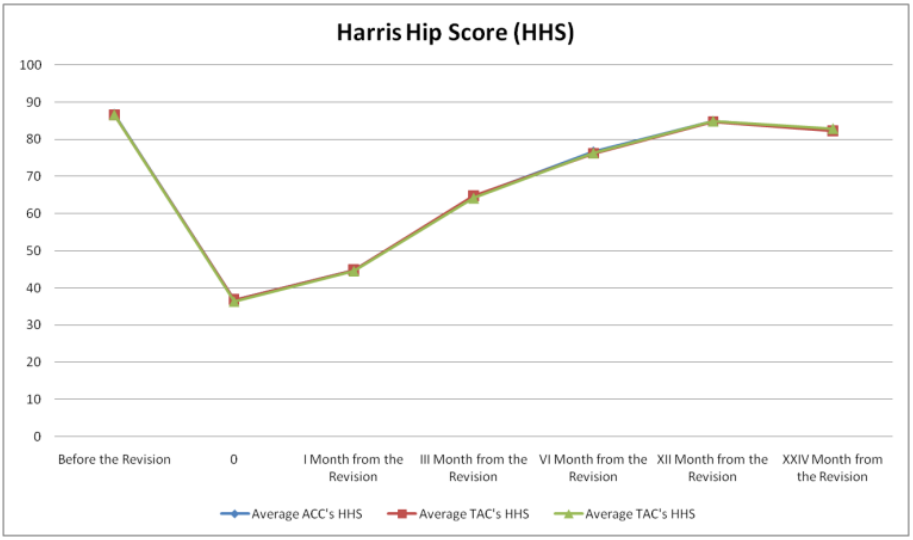

Fig. 1: Trend of Harris Hip Score (HHS) pre and at 2 year after the revision surgery event. At 24th month, there was not a statistically differences (p>0.05).

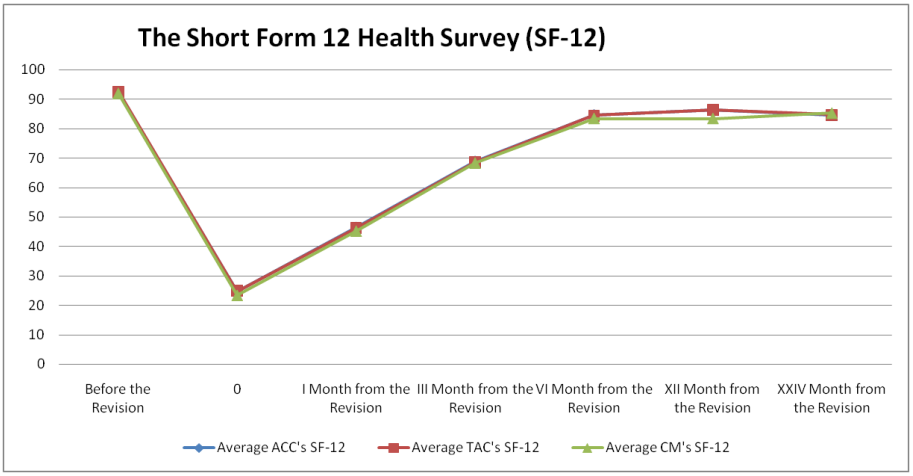

Fig. 2: Trend of Subjective quality of life measured by Short Form 12 Health Survey (SF-12) pre and at 2 year after the revision surgery event. At 24th month, there was not a statistically differences (p>0.05).

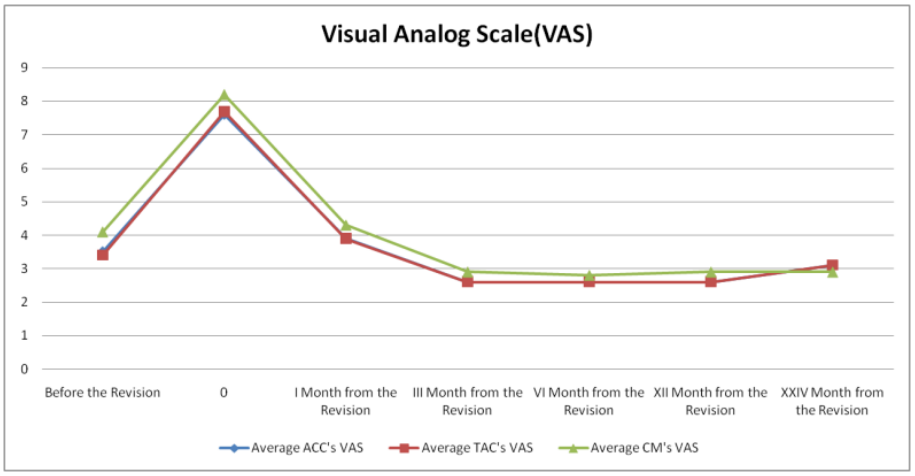

Fig. 3: Trend of Pain measured by VAS pre and at 2 year after the revision surgery event. At 24th month, there was not a statistically differences ($p>0.05$).

The Average Correlation bone stock-acetabular cup integration accordin Moore's criteria was high according Cohen κ: 0.84±0.09 for ACC while κ: 0.83±0.10 for TAC and 83±0.09 for CM, $p>0.05$.

Periprosthetic acetabular fractures are not common, and therefore, their treatment requires a long learning curve and a good surgical strategy. In 2004, Helfet et al. [5] produced an algorithm for the treatment of this pathology. We observed the following main aspects to take the right decision: the type of fracture, the bone quality, the stability of arthroplasty, the location of the fracture considering the prosthetic implant and how to create a time- and stress resistant implant.

A good preoperative planning with proper radiological XR and CT imaging should always be done before surgery [11]. A simple X-ray can give us precious indications through 4 landmarks [11]. Therefore, the chosen treatment depends on the fracture complexity and on the acetabular prosthesis stability. Surgical treatment for an unstable acetabulum should stabilize the columns of the acetabulum, provide bone grafting of defects and maintain an adequate bone stock for the replacement of a stable acetabular implant. To achieve the union of the acetabular columns and provide a stable environment for reimplantation of an acetabular component, during the surgery it is required a rigorous adherence to the principles of fracture [1 disk]. An exception is made for the pelvic discontinuity because it can be divided into two major classes: acute and chronic. In the first case, the fracture should be treated as described for traumatic fractures with an unstable component. In chronic discontinuity, the pelvis is much stiffer; we thus recommend the use of the acetabular cup reconstruction to allow discontinuity distraction and adequate implant stability[11]. Among the various possible trabecular metal bone substitutes on the market, we have chosen those manufactured in tantalum, as it is: pure, inert, very robust, fexible, corrosion-resistant and biocompatible. It is also extremely inert in vivo and is considered one of the most biocompatible elements used in implantology, even compared to titanium [12]. Trabecular tantalum guarantees pores of 400–500-μm size and a porosity up to 80%, that is, 18 percentage points more than other materials on the market [13]. The fully interconnected tantalum trabecular pores are designed to promote a bone growth signifcantly higher than the one displayed by conventional porous coatings. From the

biomechanical point of view, tantalum has a friction coefcient on the cancellous bone of 0.98, higher than the one shown by other materials used in implants [14]. ACC with Gription augments (97% at 60 months) was comparable to that with TM augments, associated to cemented cups or not[15]. Whether modular or customized, all are high-porosity materials intended to reproduce trabecular bone structure, with high friction coefficients with respect to the bone, and biocompatibility. TM is derived from tantalum, and the others from titanium[15]. To our knowledge, no precise cost assessment has been made comparing these metallic reconstructions to allografts with reinforcement cage. In THA revision, the implants themselves were important cost factors, but they did not specifically assess metallic reconstructions[15]. Metallic reconstruction reduces the risk of iterative loosening, especially in the most severe cases of Paprosky types 3A and 3B; the level of evidence, however, is low and the advantage of metallic reconstruction is clear only in case of pelvic discontinuity (Table 3). Metallic reconstruction shows higher rates of revision for dislocation, probably due to the difficulties in using Dual Mobility. A comparative trial could confirm this association between TM and dislocation, based on retrospective data or case-control studies. Follow-up of metallic reconstruction is always shorter than for allograft with reinforcement cage, and any claim of superiority needs to be taken with caution. One marginal advantage is that operative time and blood loss are lower with metallic reconstruction.

The present study answered the 5 questions it sought to address(1.What materials are available and can be used with DM designs?; 2. Can the cost of these materials be estimated and compared to allograft with reinforcement cage? 3. Do metallic materials ensure better survival than allograft+cage, according to severity of bone loss? 4. What are the advantages and drawbacks of modular and custom metallic reconstructions? 5. In what indications are these materials irreplaceable), notably with a lower rate of iterative loosening with metallic reconstruction, and especially the absence of the resorption that leads to long-term failure of allografting. There also seems to be a trend, although with low level of evidence, in favor of TM reconstruction as compared to uncemented cups [15]. Progress can obviously be expected in modular designs, and especially with DM, which reduce, without entirely eliminating, dislocation [15]. The results are according scientific literature[15].

4. CONCLUSIONS

Periprosthetic fractures of the acetabulum with bone loss are a rare but potentially disastrous complication of total hip prostheses. Their management and therapeutic choice will test the ability of the orthopedic surgeon. The use of a hemispherical cementless acetabulum in combination with tantalum augments, or a Jumbo acetabulum with stabilization of the fracture distraction, is also achievable even for the acetabular revision with marked bone loss in periacetabular fractures in the presence of THA. Further studies are needed to understand the real potential of custom made in this type of surgery. The take home message is: modular reconstruction requires no preoperative 3D planning, but incurs the risk of complications inherent to modularity; custom implants can treat more extensive defects, but involve a production phase and are difficult to implant when large, with risk of neural lesion particularly if revision is limited to the acetabulum; modular reconstruction parts can be ablated using the cup extractor; no such solution is available for monoblock metallic custom components.

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