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Hip revision surgery in cases with acetabular bone loss: PPR rings, homologous bone and platelet gel

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Abstract Hip revision has several objectives: filling the bone defect, restoring the rotational center of the hip, and restoring limb length and hip function. Recently, through tissue engineering, it became possible to consider a fourth objective: to give a graft improved capability to osteointegrate and to restore bone stock as for amount of bone and bone quality (tissue engineering or bioenhancement). Concerning biomechanical and clinical objectives, rings are the most commonly used prosthesis. We used the Partial Pelvic Replacement (PPR) ring and retrospectively analyzed our patients at a mean follow-up of 27.2 months. We found no signs of radiological failure, no radiolucency or osteolysis, nor implant component ruptures. The mean Harris hip score improved significantly from 35.9 preoperatively to 78.1. As for the anatomical objective of hip revision surgery, homologous bone grafts are the most used means to fill a bone defect. We developed a new method to produce platelet gel as a simple and inexpensive way to obtain autologous growth factors, without any discomfort for the patient. We used platelet gel with PPR rings and homologous bone graft; we report our method and describe the first cases treated, with good results.

Key words Bone Loss • Hip • Platelet gel • Revision • PPR ring

Introduction

The importance of bone loss in revision arthroplasty needs little discussion, as it has been widely investigated, from classification issues to biomechanics of the implant [1–3]. Revision surgery used to be a rescue surgery ("act and then think"), while over the years it became anatomofunctional surgery ("think and then act") with growing attention to the following objectives: filling the bone defect (anatomic), restoring the rotation center of the hip (biomechanical), and restoring limb length and hip function (clinical) [4, 5]. Surgeons recently also developed a "biological" focus: through research on growth factors and stem cells, it is now possible to give a graft the capability to osteointegrate and restore a good bone stock regarding both quantity and quality of bone (tissue engineering or bioenhancement systems) [6–10].

Concerning the first two objectives, rings of various shapes are among the most common means to deal with different kinds of acetabular bone loss [11–14]. With type III bone loss according to the Italian Revision Group (GIR) [2] and AAOS [1] classifications, we have used for over 20 years Burch-Schneider rings (more than 200 implants) [13], since they provide good stability for medial-wall bone loss. We did not find these rings suitable, though, when the bone loss was cranial to the acetabulum, because of the shortness of the cranial part. We later experimented with the Partial Pelvis Replacement (PPR) ring (Waldemar Link, Hamburg, Germany).

As for the third objective, homologous bone grafts are the most used means of filling a defect [8, 14–17]. Recently, the use of platelet gel has been introduced in clinical practice to enhance graft osteointegration [6]. Some authors reported the use of bone marrow cells to enhance bone grafts, with both osteoinductive and osteogenic properties [9]. Platelet gel added to the homologous bone graft can improve its ability to be re-colonized by osteoblasts, adding to the osteoconductive properties of the bone the osteoinductive properties of the growth factor. This is a way to also achieve the fourth objective [6]. We developed a method to produce platelet gel, avoiding the use of bothropase as described earlier (since it is no longer possible to use it in Italy and in many other countries), yet keeping this autologous way of providing growth factors simple and inexpensive, without any discomfort for the patient.

We retrospectively analyzed, both radiographically and clinically, patients treated for hip revision with the PPR ring, with bone loss cranial to the acetabulum. Furthermore, we describe the preparation of platelet gel and its use in 2 cases.

Materials and methods

We retrospectively evaluated 18 patients treated between 1996 and 2003 and having at least 6 months of follow-up data. The average age of the patients was 72.5 years; 4 patients were men and 14 were women. All of the patients had type III bone loss (Fig. 1) according to GIR classification [2], or type three bone loss according to the AAOS classification [1]. All the patients had bone loss that was cranial to the acetabulum, with some cranial or cranial-medial migration of the previously implanted cup.

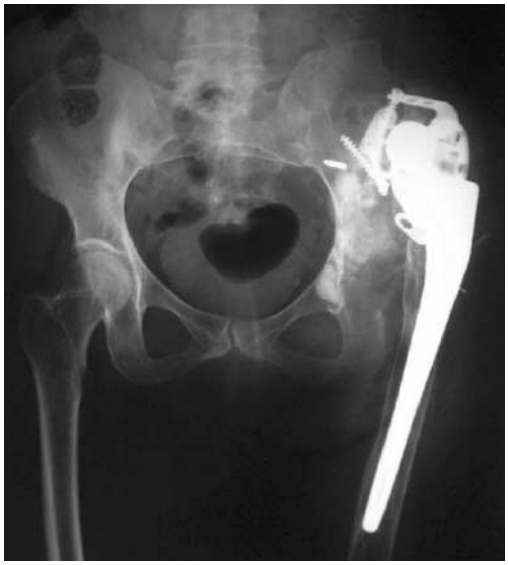

Fig. 1 Preoperative pelvis radiograph shows aseptic loosening of the former implant and type III bone stock loss cranial to the acetabulum

Patients were clinically evaluated with the Harris hip score [18] preoperatively and at last follow-up. At the same time, we performed a radiographic evaluation with the use of plain radiographs.

The implant

The Partial Pelvis Replacement (PPR) ring (Waldemar Link, Hamburg, Germany) is a hemispherical steel ring, with two long proximal flanges, capable of bearing up to ten screws. Screws can also be put inside many holes on the ring cup surface. The ring apparatus is completed by a distal hook. First, the cranial part of the PPR is bent to be close to the bone surface shape. Then, the flanges are fixed with bone screw. Subsequently, screws are placed inside the caudal section. The obturator hook is hooked to the cranial border of the obturator foramen by means of a clamp, and connected tightly with a screw. Subsequently, the screw lock is placed over the head of the screw. After fixation of the ring, a polyethylene acetabular component is cemented in the usual manner.

Operative technique

We used the Gibson-Moore access modified to draw a straight line posterior to the greater trochanter. We prolonged the incision some centimeters distally and longitudinally, and some centimeters proximally towards the posterior iliac spine, with a curved incision, when needed. The mean operation time was 130 minutes. Attention was paid to the restoration of the rotational center of the hip, which was radiographically reached at all times, with a maximum deviation of 2 cm on postoperative radiographs, and an average deviation of 0.40 cm.

Care was taken as for the position of the proximal flanges of the ring, since the inferior branch of the superior gluteus nerve crosses their paths cranially to the acetabulum rim. It is enough to insert the flanges carefully under the soft tissues, close to the bone, avoiding to stress the nerve fibers. The flanges can be bent to fit the bone shape. The ring does need to be in contact with some medial wall or at least inferior rim, not having any other means of holding in the inferior pole. In the absence of this bone, the ischium hook can be used. We practiced impaction grafting to fill the bone loss with homologous bone graft after positioning the ring and fixing it with a proximal screw. We later positioned screws through the graft and then we cemented the cup to the ring.

Platelet gel preparation

Platelet gel is usually prepared by mixing platelets (concentrated by centrifugation up to 6 times) with a variable amount of cryoprecipitated blood, bothropase and calcium gluconate. Since it is

no longer possible to use bothropase in Italy, we mixed 5 ml cryoprecipitate and 2 ml calcium gluconate, 45 minutes before use. During that time, clot forms and separates from serum that is rich in autologous thrombin. Thereafter, 2 ml of this serum is added to 5 ml cryoprecipitate, 5 ml concentrated platelet and 2 ml calcium gluconate, to make the in 2–3 min. To assess the ability of thrombin to catalyze gel formation, we compared this protocol to a simular protocol except for the presence of thrombin. Without the thrombin, the gel formed at a mean time of 15 min; without the thrombin there was also a broad variation of the physical characteristics of the gel, leading to unpredictable viscosity, dyshomogeneous aspect and sometimes failure of the gel to form.

The preparation of platelet gel does not cause any distress to the patient, since it is performed using blood obtained 48 h prior to surgery. Two bags of blood are necessary, one for concentrated platelets, another for the cryoprecipitate. In our hospital, standard bags contain 420 ml of blood.

All patients gave informed consent to participate in the study. The study was conducted in accordance with the ethical standards of the 1964 Declaration of Helsinki.

Results

The 18 patients of the retrospective analysis were reviewed at a mean follow-up time of 27.2 months. At follow-up, the mean Harris hip score [18] had improved from the 35.9 preoperatively to 78.1 (p=0.001). Furthermore, at follow-up no patient showed signs of osteolysis, radiolucency, mobilization or component rupture (Figs. 2, 3).

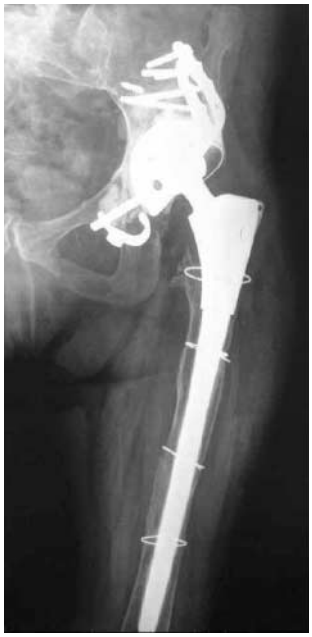

Fig. 2 Postoperative radiograph shows the implanted ring and homologous bone graft to fill the bone defect

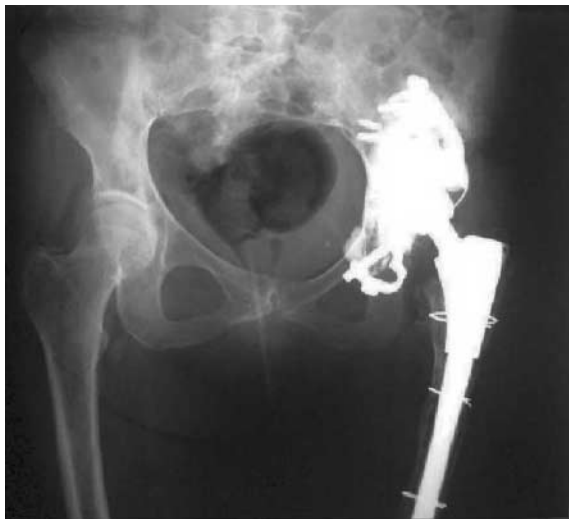

Fig. 3 Postoperative radiograph shows restoration of the rotational center of the hip

As for the platelet gel, we found that our method was not only simple, but also reliable, without broad variation in time for preparation. The gel was absorbed by the bone graft, in a mean time of 10 seconds. After 30 seconds, the gel started retracting, keeping morcellized bone tight but still plastic enough to be positioned under the ring, and impacted. After 2–3 minutes, the mixture of gel and bone was solid enough to stay in place by itself, keeping the bone graft firmly together, as a continous bone wall. The impaction grafting procedure was facilitated by the absorbed gel. The radiographic appearence of two patients was good postoperatively. We are waiting for longer term controls and creates number of cases to assess the biologic advantage of the growth factor provided, although we expect them to be similar to that reported in the literature [6].

Discussion

We believe that our good result at this medium-time follow-up is due to the ring characteristics, which allow this implant to be easily positioned to bridge a cranial acetabular bone loss. Screws through the cranial flanges insure stability, and additional screws placed in the bone graft help avoid micromovement, a well known way to obstacle graft osteointegration. A weakness of the study may be the lack of a control group. The presence of nerve branches in the field was never a surgical problem, provided the implant was close to the bone: a task easier in force of the plasticity of the flanges.

The platelet gel enhancement of bone graft was successful in keeping the morcellized bone graft together,

making it easier to stuff it into the bone holes. Waiting 2–3 minutes, the impacted graft was fixed by the gel, which gave it the appearence of continuous bone wall. Autologous hemoderivation showed in our experience a good compliance to the patients, who often dislike the idea of recombinant product use. Autologous growth factors have a milder, self-limiting action, more similar to natural repairing processes [6]. Platelet gels are a way to provide growth factors by a method that is also inexpensive (€ 100 per patient), while the use of recombinant human morphogenic protein not only has several contraindications but is also expensive.

We believe that a randomized clinical trial would be useful to quantify the benefits in terms of increased osteointegration speed and increased graft quality, eventually leading to both a better quality bone stock in the case of a new reintervention, as well as longer "life" of the implant.

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