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Original article

Evaluation of the results of the treatment of Vancouver B1 periprosthetic fractures and proposed indications for the use of cortical allograft as part of the osteosynthesis

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ABSTRACT. Currently there is limited information on the indications for the use of cortical allograft for the treatment of periprosthetic fractures on a stable stem. The purpose of this study was to retrospectively evaluate the treatment and the results obtained in this type of fractures and propose a series of criteria for the use of cortical allograft. Between 2003 and 2008 a total of 31 periprosthetic femur fractures were treated at our institution. Twelve of them were classified as B1: 6 were treated with a Dall-Miles (Stryker®) system plate and 6 with the same plate supplemented with a structural cortical allograft over the medial cortex of the femur (DM and DM-Allo groups, respectively). An evaluation of the clinical and radiologic results was performed in the latest follow-up available. A patient in the DM-Allo group had rupture of a screw and 10° varization; the fracture healed despite this and the patient had a satisfactory clinical course. The Oxford Hip Score was 9 points lower in the DM group compared with the DM-Allo group, and the EQ-5D health scale was 0.10 better for the DM group. The DM-Allo group had a longer hospital stay and more transfusion-related requirements. We think that the patients with clinical or radiologic criteria of osteoporotic bone may benefit from the use of a cortical allograft to favor healing and increase the bone stock. However, those advantages should be weighed considering the higher risk of surgical-related morbidity associated with the surgical insult.

RESUMEN. Actualmente existe escasa información sobre las indicaciones del uso de aloinjerto cortical para el tratamiento de las fracturas periprótesicas sobre un vástago estable. El propósito de este estudio fue evaluar en forma retrospectiva el tratamiento y los resultados obtenidos en este tipo de fracturas y proponer una serie de criterios para el uso de aloinjerto cortical. Entre 2003 y 2008 se presentaron un total de 31 fracturas periprotésicas de fémur tratadas en nuestra institución. De ellas, 12 se clasificaron como B1: 6 fueron tratados con una placa de fijación del sistema Dall-Miles (Stryker®) y 6 con dicha placa suplementada con un aloinjerto cortical estructural sobre la cortical medial del fémur (Grupos DM y DM-Alo respectivamente). En el último seguimiento disponible, se realizó una evaluación de los resultados tanto clínicos como radiológicos. Un paciente del grupo DM-Alo presentó la ruptura de un tornillo y varización en 10º; a pesar de ello la fractura consolidó y el paciente presentó una evolución clínica satisfactoria. La puntuación en Oxford Hip Score fue 9 puntos inferior en el grupo DM respecto al grupo DM-Alo y la escala de salud EQ-5D fue una décima mejor para el grupo DM. El grupo DM-Alo presentó una estancia hospitalaria superior y mayores requerimientos de complementos transfusionales. Consideramos que los pacientes con criterios clínicos o radiológicos de hueso osteoporótico se pueden beneficiar del uso del aloinjerto cortical para favorecer la consolidación y aumentar la reserva ósea. Sin embargo,

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dichas ventajas se deben sopesar con el riesgo de una mayor morbilidad asociada a una cirugía que supone una mayor agresión quirúrgica.

Palabras clave: fractura, fractura periprotésica, tratamiento de fractura periprotésica.

Introduction

The incidence of periprosthetic hip fractures has progressively increased in the past few years. There is consensus on the need for prosthetic exchange in fractures involving stem loosening, with the possibility of linking it to other fixation systems such as plates, wire cerclage or cortical allograft plates. On the other hand, the treatment of choice of fractures without prosthetic loosening is open reduction and plate fixation.[1,2]

However, there is controversy over the need to use or not to use cortical allograft in fractures without prosthetic loosening and the literature does not provide the necessary criteria to determine in which cases they can be used.

We present herein a retrospective study evaluating the results obtained in the treatment of periprosthetic hip fractures around a fixed stem (Vancouver B1).[3] Moreover, we propose a series of indications for the use of cortical allograft combined with fixation.

Material and methods

A retrospective study was conducted in patients with a diagnosis of Vancouver B1 periprosthetic fracture treated with the Dall-Miles (DM) (Stryker®) system with or without cortical allograft, operated on between January 2003 and January 2008 at Hospital Clinic in Barcelona. They were divided into two groups based on the surgical treatment provided: the first group (DM-Allo group) was composed of the patients treated with a DM plate and cortical allograft. The other group (DM group) was composed of the patients treated exclusively with the DM plate.

The variables studied were: Age, gender, comorbidity assessed according to the ASA (American Society of Anesthesiology) index, type of hip arthroplasty, operative time (minutes), need for transfusion, and length of hospital stay (days). The profound and superficial infection rate and the fixation failure rate were calculated. All cases were followed-up until fracture healing. Moreover, the mortality rate at 3 months and at the end of the follow-up period was determined.

The structural allograft was provided by the Tissue Bank at our hospital and was obtained from multi-organ donors. Donor selection was done according to the EATB (European Association of Tissue Banks) and AEBT (Spanish Association of Tissue Banks)[4,5] standards. The allograft was obtained by a group specializing in stringent aseptic techniques. Bacteriologic cultures were taken from each of the bones obtained excluding those proven to be contaminated. The bones were stored at a temperature of -80°C in dedicated freezers. Additional complementary sterilization measures were not used.

All patients were treated according to the same protocol with prophylactic antibiotics consisting of an initial dose of cefuroxime 1.5g and teicoplanin 800mg during the anesthetic induction, followed by a second dose of cefuroxime 1.5g at two hours.

In all cases a lateral approach, retro-vastus lateralis, was used to clean the fracture site and reduce it anatomically. The fixation was performed with the DM metallic plate system and wire cerclages. Five- and 11-hole plates were used depending on the length of the fracture line and the surgeon's preferences. In all cases the plate was placed on the lateral cortex of the femur. As it is recommended in the literature,[6] the metal plate was longer in the case of long spiral or oblique fractures, and at least 3 cerclages or screws proximal or distal to the fracture site were placed, using preferably cerclages or unicortical screws in the zone of the prosthetic stem and bi- or tricortical screws (in cases of the DM-Allo group) in the distal zone. In the cases in which an allograft counterplate was used, the latter was placed over the femoral medial cortex.

The functional status of all the patients who were still alive was assessed at the end of the follow-up period. The Oxford Hip Score[7] and the EQ-5D scale[8] were used. The Oxford Hip Score[7] is a short 12-question questionnaire designed to evaluate the functional outcomes in patients who underwent primary or revision hip arthroplasty.

The score ranges from 12 to 60; the best scores are the lowest ones.

The EQ-5D is a standardized and simple measure that allows estimating the quality of life of any patient. We used the version that was validated for the Spanish population.[9]

Results

During this period a total of 31 periprosthetic femur fractures related with hip arthroplasty were identified. A total of 12 Vancouver type B1 fractures were included.

The first 6-patient group (DM-Allo group) was composed of the patients treated with a DM plate and cortical allograft. The other 6-patient group (DM group) was composed of the patients treated exclusively with the DM plate.

The gender distribution was identical in both groups: 4 females and 2 males. Mean age was 82.3 years and was 4 years older for the DM-Allo group. 58.3% of the fractures (7 patients) occurred around hemiarthroplasties: 5 uncemented monopolar, 1 cemented monopolar, and 1 cemented bipolar. In 4 cases the fractures occurred over a cemented total hip prosthesis (THP) and in one case in an uncemented THP. In all cases the mechanism of fracture was of low energy. The baseline physical status based on the ASA score was 2.65, and was slightly higher for the DM-Allo group, in which all cases were found to be ASA 3.

Tibial allograft was used in 5 of 6 cases in the DM-Allo and femur allograft in the remaining ones.

The only case of the series with an open fracture was given an additional dose of IM cefonicid 2g at the time of admission, according to the open fracture antibiotic protocol at our center.

By the end of the follow-up 5 patients had died and 7 could answer the questionnaires.

No fixation failures were detected in any of the cases, with the exception of a patient of the DM-Allo group who had screw rupture with a 10° varus angulation of the stem *(Figure 1)*. This radiologic finding had no clinical consequences and the patient remained pain free. No patient required reoperation.

A minimum radiologic follow-up of 6 months was possible in 10 patients; in the remaining 2 it was not possible because one died within one month of surgery and the other one within 5 months (one patient in the DM-Allo group and one in the DM group, respectively). Mean follow-up in the DM-Allo group, excluding the death, was 1.4 years (0.63-2.79). Mean follow-up in the DM group, excluding the death, was 1.08 years (0.5-1.75). Radiologic fracture healing was observed in all 10 cases. In all patients in the DM-Allo group graft integration was observed.

There was only one case of infection in the entire series (DM-Allo group), which corresponded to the only open fracture (type I according to the Gustilo classification). It was a superficial infection caused by *Enterobacter cloacae* that was resolved with IV antibiotic therapy without the need for surgical lavage. The mean length of stay, the transfusion needs and the mortality were greater for the DM-Allo group. The operative time, in turn, was lower for the DM-Allo group compared to the DM group (mean of 117 and 148 minutes, respectively). The EQ-5D health scale was one tenth better for the DM group; the Oxford Hip Score was 9 points lower in the DM group compared with the DM-Allo group *(Table 1)*.

Discussion

The incidence of periprosthetic fractures has increased in recent years and the most frequent ones are those located

Table 1. Characteristics of the patients in the series.

	DM (6 cases)	DM-Allo (6 cases)
Age * (years)	80,3 (63-97)	84,3 (78-90)
ASA score *	2,33 (2-3)	3 (3-3)
Length of stay (days) *	16 (9-17)	20 (8-47)
Transfusion (packed RBCs)	4 de 6	6 / 6
Infection	0 de 6	1 / 6
Oxford Hip Score *	40,25 (24-50)	31,66 (20-43)
EQ-5D *	0,5674 (0,4846-0,7435)	0,4256 (0,1416-0,6038)
3-month mortality	0 de 6	1 / 6
One-year mortality	2 de 6	3 / 6

*Variables expressed with the mean and the range

Figure 1. Radiographic images showing the resulting varus in one of our patients with signs of graft integration and fracture healing.

in the stem zone (Vancouver type B).[10] If the fracture occurs on a stable stem, it is classified as B1. Fractures with a loosened stem correspond to type B2 and those with poor bone quality or low bone stock are classified as B3. However, the classification does not consider the fractures with a stable stem but with poor bone quality, in which it could be interesting to place a cortical allograft counterplate. The purpose of treatment should be fracture healing and early mobilization; there have been multiple methods recommended in the literature: various fixation plates,[11-14] allografts,[15] or a fixation plate with an allograft;[16] the first and the last options are the most frequently advocated in the literature.

There are several papers warning about the poor outcomes obtained with the use of an isolated fixation plate. In this respect, Tsiridis[17] concludes in his series of periprosthetic fractures managed with a DM plate alone, that such construct does not provide enough safety for the treatment of these fractures and recommends their combination with other complementary fixation systems to increase stability. Thus, it is reasonable to think that in patients with osteoporotic bone, the allograft counterplate provides a stable support upon anchoring the screws that support the fixation. Moreover, there are comparative biomechanical studies showing that a construct with a metal plate and an allograft counterplate is more stable that the one with a single metal plate.[18]

However, on the one hand, there are no comparative studies in the literature that clearly state whether adding a structural allograft counterplate has any clear clinical or functional advantages and/or involves a higher surgical risk or risk of infection; and, on the other, authors like Ricci,[19] Old[10] and Sandlhu[20] consider that it is enough to stabilize these fractures with a fixation plate without adding an allograft, and they have shown good outcomes in their series with healing rates of 100%, 95% and 95%, respectively.

We should also consider that the future role of angular stability plates for the treatment of these fractures has not been determined yet, particularly in patients with poor bone quality. Up to now several series have been published with contradictory results.[21,22]

This series analyzed the use of a fixation plate with or without an allograft (DM-Allo and DM groups, respectively). The transfusion and overall mortality rates at the end of the follow-up were higher in the DM-Allo group. Despite the fact that it is difficult to draw conclusions from a comparison of two groups with such a small number of cases, it has been proven that both groups had a favorable course towards fracture healing. In fact, we think that the patient in the DM-Allo group who had screw rupture and varization of the fracture site would have possibly required a reoperation had it not been for the allograft.

If we observe the characteristics of the DM-Allo group, we see that these are older patients with a higher ASA score; this population has a higher chance of having osteoporotic bone. Even though no objective test was used to determine the presence of osteoporosis preoperatively, the trend at our hospital was to use an allograft supposing there was bone fragility due to the age, the history of fracture, the degree of physical activity (disuse osteopenia), and signs of osteopenia in the X-rays and/or in the observation of thinned cortices.

It is difficult at times to determine the characteristics of the patient who will benefit from an allograft, and in clinical practice there is no objective test quantifying the amount of bone before the intervention. This led us to preparing a proposal of the indications for the use of allograft, shown in *table 2*. We currently consider that previously known osteoporosis or bone fragility seen at the time of the intervention constitute indication criteria for the use of a structural allograft. However, we consider that in elderly patients with multiple comorbidities the benefit of a greater stability and guaranteed healing should be weighed versus the risk of more bleeding and the potentially deleterious consequences of this, especially in elderly patients with a high comorbidity rate.

The limitations of this series are the small number of patients and a short follow-up period. However, excluding the deaths, the follow-up exceeds one year and includes X-rays until healing was confirmed, and it is important to highlight the fact that the high mortality rate in both groups of the series is closely related with the patients' old age. The one-year mortality rate observed in our series (5/12) is similar to the one reported in the literature.[23] It must be pointed out that the deaths were secondary to an underlying disease that became acute again or worsened and that there were no hospital deaths nor deaths caused by the surgical treatment.

The strengths of this series include the fact that it analyzed exclusively BI fractures treated with the same fixation plate model; many of the papers published in the literature analyze the results with and without allograft including other fracture types and various fixation plate models.

Conclusions

We think that the good results obtained from the perspective of the healing rates in both groups are due to the proper selection of patients for the use of allograft.

Table 2. Proposed indications for the use of a structural allograft combined with a fixation plate in Vancouver B1 periprosthetic fractures.

Indications
- Poor bone quality:
- Densitometric diagnosis of osteoporosis
- History of osteoporotic fracture.
- Proof of bone fragility during the intervention.

Relative indications
- Patient with risk factors predisposing to greater bone fragility, like alcoholism, antiseizure treatment or corticoid therapy.
- Risk of early loading: patients with a cognitive disorder preventing them from complying with the postoperative instructions.

More studies with more patients and a longer follow-up are needed to confirm whether these proposed indications provide the best outcomes in Vancouver B1 periprosthetic fractures. On the other hand, it is desirable to have a practical and simple tool to quantify the periprosthetic bone quality to stratify the results obtained with different treatment methods.

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