

Humeral Shaft Metastases: An Alternative Method of Reconstruction after Surgical Resection

Cappuccio Michele¹, Calabro Teresa^{2*}, De Iure Federico¹, Tigani Domenico³ and Gasbarrini Alessandro⁴

¹Orthopaedic and Trauma Unit-Spine Surgery, Maggiore Hospital, Largo Nigrisoli, 2 40133, Bologna, Italy

²Department of Orthopaedics, University of Bologna, Istituto Ortopedico Rizzoli, Bologna, Italy

³Orthopaedic and Trauma Unit, Maggiore Hospital, Largo Nigrisoli, 240133, Bologna, Italy

⁴Department of Degenerative and Oncological Spine Surgery, Istituto Ortopedico Rizzoli, Bologna, Italy

Abstract

Aim: To retrospectively review our patients with metastasis of diaphyseal humerus by surgical resection and reconstruction with cement, titanium mesh and plate.

Methods: Between April 2008 and December 2012 we treated 6 consecutive patients with humeral metastasis, 4 females and 2 males, with a mean age of 72 years (range 60-78 years) and a mean follow up of 14 months (range 1.3-47.2 months).

Results: We observed one major complication and all patients died of disease. The mean Musculoskeletal Tumour Society functional score at the time of final follow up was 26.8. Limb salvage surgery for malignant tumors of diaphyseal humerus is an operative challenge, where the surgeon has to preserve elbow and hand functions and retain shoulder stability with as much function as possible. Diaphyseal resection allows disease local control, which alleviate tumor-related pain also preserving the shoulder and elbow function.

Conclusions: Treatment with cemented-plate and mesh provided a cheap and reliable option for diaphyseal humerus reconstruction after tumour resection.

Keywords: Humeral shaft; Metastases; Reconstruction; Titanium mesh; Tumour

Introduction

Humerus is the second most frequently involved site after femur for metastatic disease in appendicular skeleton [1,2]. Metastases are more frequent over the age of 40 years [3] and pathological fractures of the humeral shaft occur late in the course of malignant disease [4]. In the latest decades limb salvage has become treatment of choice also in these patients because it offers both functional and cosmetic advantages [5]. In selected cases a resection of the tumor is indicated. Different techniques of reconstruction have been described, included osteoarticular allograft, allograft-prosthesis composite, free vascularized fibula graft, cement nail spacers, clavicle-pro-humerus, the use of intercalary spacers [6,7] and endoprosthetic replacement [5,8-16]. Currently there is no consensus on a gold standard procedure. The aim of reconstruction in patients affected by bone metastasis is both to relieve pain and to restore the functionality of the arm for the remaining life. Usually, metastases affecting humeral diaphysis are managed with intramedullary nailing or plate fixation but, even in case of effective adjuvant therapies, bone healing cannot be expected [17].

Intramedullary nailing is a minimal invasive procedure and allows a large segment of the humerus to be stabilized [18]. However this method brings some potential complications (damage to the rotator cuff, prominence of the nail proximally, inability to achieve rigid fixation due to poor bone quality; no local control of the disease with a high rate of progression of the tumor mass) [19]. As reported by Frassica et al. [18], extensive curettage of the tumor can be helpful to reduce the risk of local progression or local recurrence, and plating augmented with cement can be used for defects reconstruction and to support the internal fixation [18,20]. We report a short series of patients with humeral pathologic fracture due to a metastasis treated by "en bloc" resection and reconstruction with cement spacer, titanium mesh and plate. We describe a simple technique, reliable also in no referred centers, in case of extensive diaphyseal defects or failed internal fixation with nailing or plates. All patients had a "quod vitam" prognosis higher than six months at the time of surgery and were followed and evaluated until death.

Materials and Methods

We retrospectively reviewed the hospital records of 6 patients with a pathologic fracture at the humeral diaphysis due to a metastasis from solid tumor treated with wide resection in our department between April 2008 and December 2012. All patients had multiple metastases at the time of surgery and local progression despite chemo and radiotherapy. Nevertheless the oncologist reported a "quoad vitam" prognosis higher than six months in all cases. They were managed by resection of the diaphyseal humerus and reconstruction with plating, titanium mesh and antibiotic cement, gentamycin-polymethylmethacrylate (PMMA) (Figure 1). In one case we also used an opposed allograft to increase the mechanical stability. Before surgery, all patients underwent staging studies, including plain radiographs and contrast enhanced computerized tomography (CECT) or MRI of the limb, computerized tomography scans of the chest and whole-body isotope bone scan. MRI was used to define the extent of the lesion, the involvement of the soft tissues, its relation to the neurovascular bundle and the level of involvement of the bone. The primary goal of surgery was complete wide excision of the tumor mass, with preservation of the limb functions.

The lesions were approached by an extended deltopectoral anterolateral incision in beach-chair position. Once the tumour was excised, the remaining humeral canal was reamed and the PMMA was injected proximally and distally using cement gun with a flexible nozzle. To restore the correct length of the arm in large resections,

***Corresponding author:** Teresa Calabro, Department of Orthopaedics, University of Bologna, Istituto Ortopedico Rizzoli, Bologna, Italy, Tel: 0039 3381845257; E-mail: tercalabro@gmail.com

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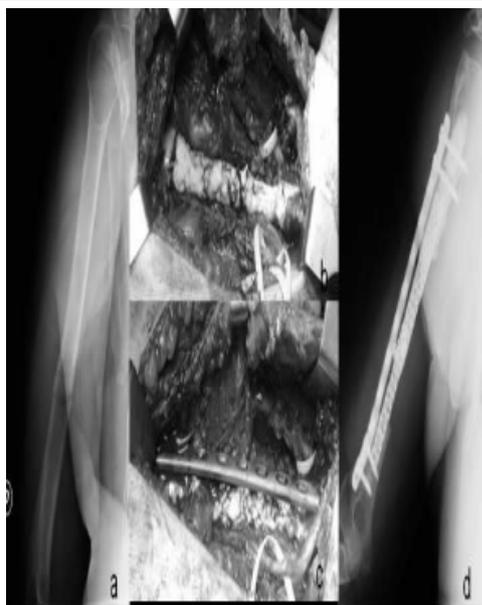


Figure 1: A 72-year-old patient with breast carcinoma reported diffuse pain and functional limitation within his right arm and no previous trauma. X-ray showing a pathological fracture in the distal third of the humeral shaft (A). Intraoperative pictures showing cement and plate positioning (B, C). X-ray at 8 months of follow up (D).



Figure 2: X-ray of a 60-year-old patient with renal carcinoma previously treated with intramedullary nail (A). Local progression of the disease one year after first surgery (B). X-ray at 3 years after surgical procedure (C).

an intramedullary titanium mesh was positioned into the canal, and the remaining semisolid cement was molded into the mesh. In short resections the mesh was positioned around the cement to provide shape and volume. Then a plate was positioned on the lateral surface of the humerus, and fixed with cortical screws. Postoperatively the arm was placed in an arm chest bandage, gentle range of movement exercises of the hand, wrist and elbow were allowed immediately. Rehabilitation by active and passive mobilization started 3 weeks after surgery. Patients were then followed up at regular intervals and were assessed for local control, function and complications related to the implant. Survival time zero was considered the date of surgery and end points

were considered implant failure requiring revision or patient death. Functional assessment at the time of final follow up was done using the Musculoskeletal Tumour Society (MSTS) functional scores [21]. Statistical analysis was performed using the MedCalc Software Version 11.1 (MedCalc Software Broekstraat 52, Mariakerke, Belgium).

Results

We treated 6 patients (4 women, 2 men) with a mean age of 72 years (range, 60-78) at the time of surgery. The primary tumor was lung carcinoma in 3 patients, followed by kidney, liver and breast carcinoma in any of the other cases. All lesions progressed after preoperative radio- and/or chemo-therapy. The mean length of surgery was 135 minutes with a range of 90-215 minutes. All resection margins were histologically free of disease on intra operative frozen sections and final analysis. The mean length of resected bone was 10 cm (range 7-14 cm). One patient with renal carcinoma had been treated elsewhere one year before with intramedullary nailing for a pathological fracture of her right humerus, and presented to our institute for recurrent pain and swelling despite radio and chemotherapy. An embolization of the lesion was performed the day before surgery to reduce the risk of bleeding. This patient developed temporary radial nerve palsy postoperatively, and, 3 years later, a mechanical failure that required surgical revision (Figure 2).

Wrist and shoulder movement were preserved in all patients except one, although elbow extension was limited in the early postoperative months and gradually improved to almost full extension with physiotherapy. All the patients were able to perform their daily activities and routine work. The mean MSTS score was 26.8 (range 25-28) with the mean overall functional rating of 89% (range 83-93%). All patients died for the disease at a mean follow up of 14 months after our surgical procedure (range 1.3-47.2 months, median 6.6 months). None of the patient included in this study developed local recurrence. None of the patient received postoperative radiotherapy because they had maximum dose before surgery.

Discussion

In the last few decades, limb salvage surgery has become the treatment of choice for metastatic tumors of the humerus, as it offers both functional and cosmetic advantages compared to other less aggressive techniques. The goals of surgical treatment are often focused on pain reduction, functional outcome, durability, and nursing care improvement. After surgical resection, the use of allograft in patients with bone metastasis is often contraindicated for the need of postoperative radiotherapy as well as because of the risk of non-union, fracture and infection. Vascularized fibular grafts specifically require microsurgical expertise and entail longer operating time and increased blood loss without an improved functional outcome. Furthermore, it adds morbidity to the donor site [10]. Endoprosthesis needs a definite amount of residual host bone to achieve an adequate fixation of the stem after resection, and this is a limiting factor in such cases [22]. The final decision relies on different variables such as patient's age, functional condition, stage of tumor, degree of soft tissue involvement and experience of the surgeon. Cemented mesh spacer offers a cost-effective limb salvage procedure with preservation of elbow and shoulder function. The low cost of the implant makes it a good alternative option of treatment in these selected indications.

Bone metastases are an expression of a systemic disease; they therefore require a multi-disciplinary treatment, integrating radiotherapy, chemotherapy and surgery. Many factors must be taken into account when choosing the most appropriate surgical technique:

the patient's general conditions, the histotype of the primary tumour and its sensitivity to adjuvant treatments and the spread of the disease. According with the Italian guide line in the treatment of metastatic lesions [23], we prefer the use of IM nailing to stabilize pathological or impending fracture in patient with multiple localizations and short life expectancy, or in lesions sensitive to adjuvant therapy; resection surgery and reconstruction are reserved to solitary or multiple metastases from less aggressive histotypes, such as kidney or thyroid cancer, or in cases of progression of disease despite chemotherapy or radiotherapy. In our experience reconstructing diaphyseal defects using cemented mesh spacer is an inexpensive and effective method, which gives adequate shoulder and arm immediate stability and ensures excellent hand and elbow function. The operative time is relatively short, and the procedure is technically less demanding. The use of antibiotic cement provides higher concentration of local antibiotic and helps in combating local infection especially in patients submitted to chemotherapy. The functional, psychological, emotional and cosmetic results were acceptable in all our patients and far better than those that have been reported after amputation and use of external prostheses [24]. This technique of reconstruction provides immediate stability and relief from pain with unrestricted return of function without the need for bony union. Our rate of complications was similar from that of other series in the literature, our incidence of palsy of the radial nerve (one case, 16.6%) was lower than in other series [7,19].

In our series the only complication is reported in a patient previously treated surgically elsewhere. In a similar study reported by Weiss et al. [25] post-operative survival was 61% (95% CI 50 to 75) at six months, 42% (95% CI 31 to 57) at 12 months, 28% (95% CI 18 to 44) at two years and 12% (95% CI 5 to 28) at five years. A total of five patients underwent revision for locally progressive disease, one for infection and one for mechanical failure of the construct. Overall, there were 14 (22.2%) other complications. As oncological treatments continue to improve, life expectancy of patients with metastatic disease constantly increases, so maintaining the quality of life in these patients becomes everyday more important. The technique we described meets the treatment goals for patients with metastatic bone disease and should be considered in the surgical management of impending fractures or pathological fractures of the humerus in patients with a short expectancy of life, non responding to common systemic therapy. Furthermore is effective and cheap compared to more complex prosthetic replacement procedures?

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