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Clinical case

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Upper limb salvage with massive intercalary allograft for humeral chondrosarcoma

Recuperación de miembro superior con aloinjerto intercalar masivo para condrosarcoma humeral

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ABSTRACT. Introduction: chondrosarcoma is a high-grade malignant tumor composed of mesenchymal cells with cartilage differentiation. It most frequently appears in the bones of the pelvis, the femur, and the humerus. The main management method is oncological resection with wide margins and function-preserving reconstruction. The prognosis depends on the histologic grade and location of the tumor. **Case presentation:** we present the case of an adult patient with chondrosarcoma in the right humerus managed in our unit with wide resection and massive allograft reconstruction (limb salvage). **Conclusions:** the option of reconstructive surgery could lead to considerable success and minimize the functional, emotional, and aesthetic impairment that an amputation would entail.

Keywords: chondrosarcoma, proximal humerus, reconstruction, limb salvage surgery, allograft.

RESUMEN. Introducción: el condrosarcoma es un tumor maligno de alto grado compuesto por células mesenquimales con diferenciación cartilaginosa. Aparece con mayor frecuencia en los huesos de la pelvis, el fémur y el húmero. El principal método de manejo es la resección oncológica con amplios márgenes y reconstrucción preservando la función. El pronóstico depende del grado histológico y la ubicación del tumor. **Presentación del caso:** presentamos el caso de un paciente adulto con condrosarcoma en húmero derecho, manejado en nuestra unidad, con resección amplia y reconstrucción masiva con aloinjerto (salvamento de extremidad). **Conclusiones:** la opción de cirugía reconstructiva podría conllevar un éxito considerable y minimizar el deterioro funcional, emocional y estético que supondría una amputación.

Palabras clave: condrosarcoma, húmero proximal, reconstrucción, cirugía de salvamento de extremidad, aloinjerto.

Introduction

Chondrosarcoma is a malignant tumor composed of mesenchymal cells with cartilage differentiation. It is the second most common malignant primary bone tumor, and is more common in people over 40 years of age.[1] Its most frequent locations are the bones of the pelvis, the femur and the humerus.[2] There are several subtypes of chondrosarcoma that differ in terms of location, degree of malignancy, origin, treatment and prognosis.

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Chondrosarcoma is the third most frequent malignant primary tumor after osteosarcoma and Ewing's sarcoma; however, it is the most frequent primary bone tumor in the adult population.[3]

Chondrosarcoma can be classified according to its origin as primary or secondary and central or peripheral, as well as according to the histological grade (low or high grade) and histological subtype (mesenchymal, clear cells, etc.), each of which has clear therapeutic repercussions and is associated with prognosis and survival. Dedifferentiated chondrosarcoma is the most malignant type and has the highest metastatic potential.[4,5,6,7]

Central chondrosarcoma represents approximately 60% of patients. It typically presents in adults older than 50 years and is almost absent in children. Males are the most affected sex (2:1).[8]

Histologically, it is difficult to distinguish enchondroma (benign tumor) from low-grade chondrosarcoma; for diagnosis, the location and radiographic characteristics, such as periosteal reactions, cortical destruction, and, often, associated extraosseous soft tissue masses, must be accounted for.[1,2,3]

Chondrosarcoma is slow growing and progressive, with associated pain and formation of a mass. When these tumors occur in axial bones such as the pelvis, ribs, scapula, femur and proximal humerus or when they are fast growing and associated with an extensive soft tissue mass or metastases, they tend to have aggressive behavior with a worse prognosis.[2]

In most patients, a biopsy is required to confirm what may seem clinically and radiologically obvious. This biopsy may be performed by needle, but open biopsy is recommended if the diagnosis is not obvious.[4]

Magnetic resonance imaging (MRI) is the ideal imaging modality for preoperative treatment planning, especially in relation to neurovascular structures and the definition of osteotomy margins.[9]

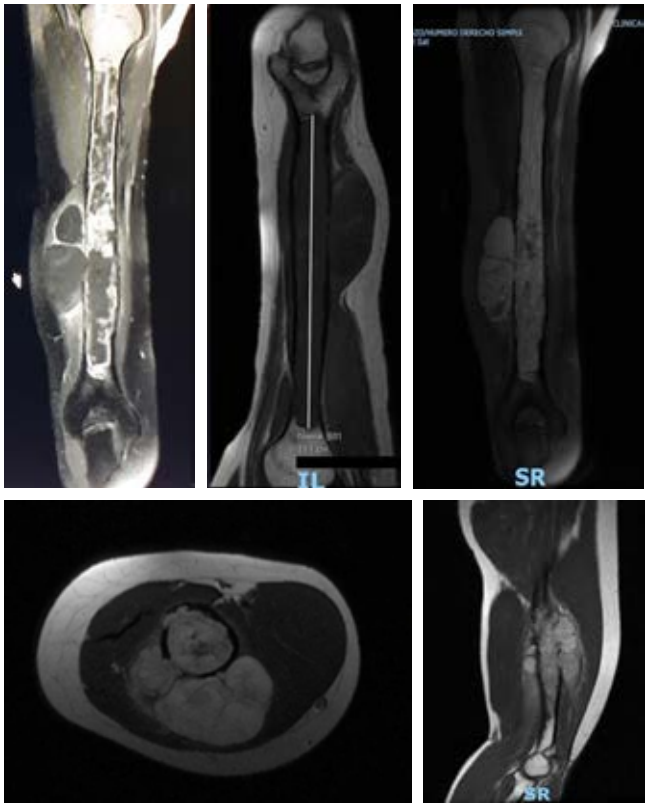

Figure 2: Different magnetic resonance imaging views showing complete diaphyseal involvement with extensive bone lysis and soft tissue involvement.

Surgical management includes en bloc resection with wide margins, including the biopsy scar as part of the surgical specimen, followed by reconstruction with prostheses, structural allografts or alloprosthetic compounds.[10,11]

Case presentation

With the required informed consent, this study presents the case of a 36-year-old female patient referred for evaluation by Oncological Orthopedics at the Sebastián de Belalcázar/Colsanitas Clinic, Cali, Colombia, where she had established a clinical history of a mass in the right arm that had increased volume and sensation over the previous six months without a history of trauma or other relevant antecedents. Physical examination revealed a palpable, circumferential, fixed mass between the middle and distal thirds of the right arm, with pain on palpation and preserved ranges of mobility in the shoulder and elbow. Examination by X-ray imaging of the right arm showed a lytic lesion in the humeral shaft with poorly defined edges, cortical thinning, a periosteal reaction and a mass effect with compromise of the soft tissues *(Figure 1)*.

Contrast-enhanced MRI showed an infiltrative, diffuse endosteal lesion affecting the humeral shaft extending

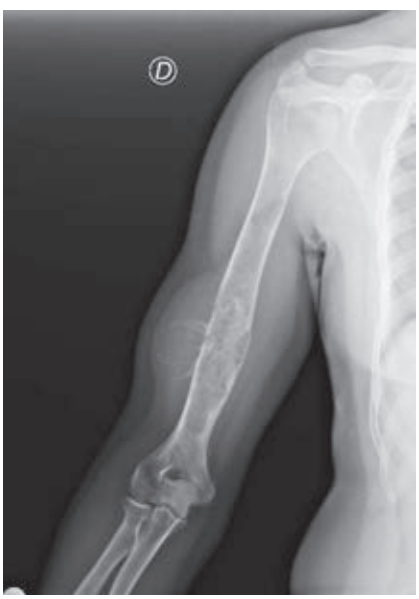

Figure 1:

Lytic lesion of the right humerus with diaphyseal involvement.

19 cm longitudinally from the humeral neck to the supracondylar region, infiltrating and destroying the cortex in the lateral margin of the middle third of the diaphysis. The scan also revealed a soft tissue mass involving the deep muscle groups on the posterolateral aspect of the arm that measured approximately 7.8 × 4.9 × 2.6 cm in diameter (lateral*anteroposterior*transverse). The tumor signal was predominantly high on the T2 sequences, with hemorrhagic content and a focal juxtacortical tumor component toward the posterior and medial margins measuring 2.4 cm and presenting with marked diffusion restriction and contrast enhancement, suggesting a large tumor component in this segment. Peripheral enhancement of the tumor lesion was also observed, and there were no displaced or angled fractures. Tumor involvement was not observed in the proximal or distal epiphysis of the humerus. The humeral vascular bundle running along the medial aspect of the arm did not demonstrate signs of tumor infiltration, but branches supplying the tumor were observed emerging from the distal brachial artery.

The dimensions for surgical planning were confirmed on MRI following an assessment of bone extension and soft tissue involvement on the different planes *(Figure 2)*.

An incisional biopsy was performed for histopathology and immunohistochemistry, yielding results compatible with chondrosarcoma *(Figure 3)*.

During outpatient follow-up, extended studies were performed for staging; the chest and abdomen were normal on computed tomography (CT), and a bone scan showed uptake solely at the level of the humeral mass.

According to the surgical staging systems for musculoskeletal tumors (i.e., the Enneking and Musculoskeletal Tumor Society [MSTS] systems), the mass in this patient corresponded to stage IIb (high grade, extracompartmental).[12,13]

As this was a grade II humeral chondrosarcoma involving the proximal and distal epiphysis, it was decided to perform limb salvage surgery with complete and wide resection of the lesion and subsequent reconstruction with a massive intercalary allograft and proximal and distal osteosynthesis in the right humerus. The patient was then admitted for hospitalization and preoperative preparation.

According to the surgical plan, the procedure was performed as follows. First, an expanded deltopectoral approach was performed, including the previous biopsy within the tumor lesion, curving toward the side and in the posterior and longitudinal directions over the olecranon. Subsequently, the tumoral lesion was dissected with wide lateral, middle and distal margins; at this level, the margin was close to the radial nerve, which was controlled along its entirety with neurolysis. Then, the deltoid muscle was dissected, exposing the axillary nerve, followed by tenotomy at the insertion points of the latissimus dorsi and pectoral muscles with complete dissection of the humerus, preserving the biopsy scar as part of the surgical specimen. Finally, osteotomy of the proximal humerus was performed at the level of the lower edge of the subscapularis muscle, and osteotomy of the distal supracondylar humerus was performed at the level of the olecranon fossa *(Figure 4)*. Based on the MR images, adequate margins were obtained; then, frozen samples from the proximal and distal ends were examined and found to be negative. The defect was

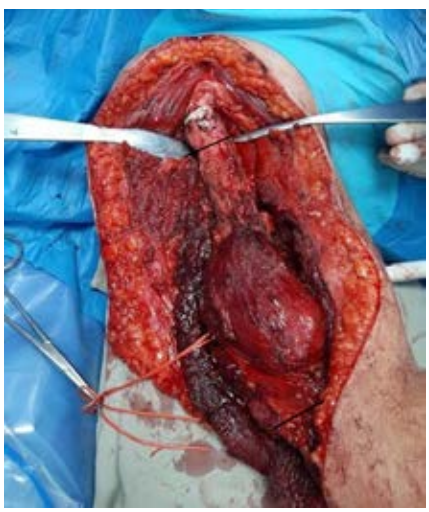

Figure 4:

Proximal and distal osteotomy with margins defined for complete and wide resection.

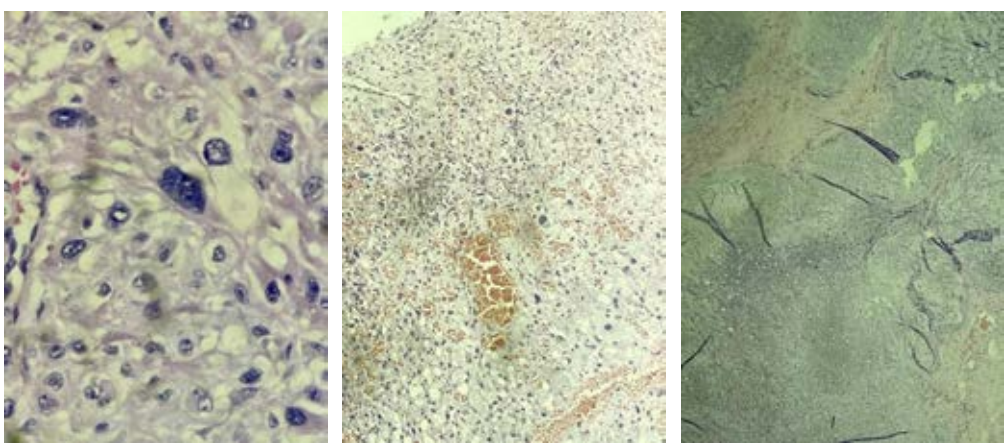

Figure 3:

Histopathology images compatible with chondrosarcoma of histological grade 2/3, described as consisting of lobes with abundant cartilaginous matrix and chondrocytes in lacunar spaces permeating the intertrabecular spaces.

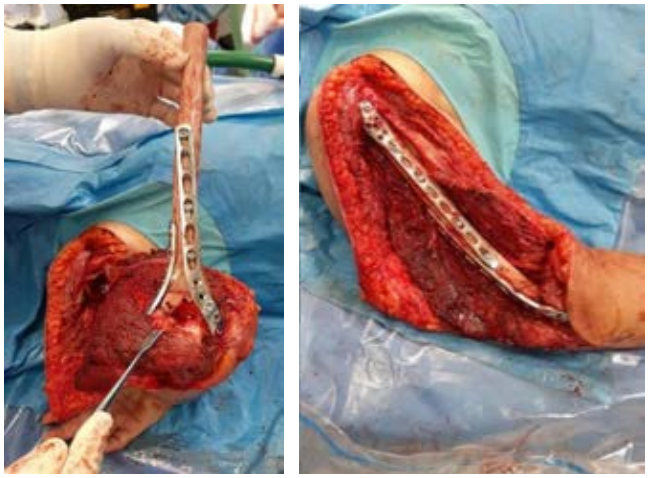

Figure 5: Proximal and distal osteosynthesis with a structural allograft.

reconstructed with a massive allograft of the proximal humerus from the bone bank and proximal and distal fixation with plates and screws for osteosynthesis under adequate fluoroscopic control *(Figure 5)*. Soft tissue reconstruction was performed by flap rotation and hemostasis followed by layered wound closure and skin stapling.

A control radiographic image was taken in the immediate postoperative period showing adequate congruence of the allograft with the host bones and fixation with the osteosynthesis material in the right humerus *(Figure 6)*.

Clinical follow-up continued, with acceptable postsurgical evolution, including allograft consolidation at three months *(Figure 7)*. Physical examination of the upper right limb showed hypoesthesia and an interosseus motor deficit in the 5th finger, which progressed to complete improvement. The range of motion of the shoulder reached 150 degrees of flexion, 90 degrees of abduction, and 45 degrees during external rotation and adduction, while that of the elbow reached 10 to 110 degrees of flexion-extension with complete pronosupination *(Figure 8)*.

According to the MSTS upper extremity rating scale, the patient currently has a score of 29/30, corresponding to 96%.[14]

Discussion

Chondrosarcoma is a malignant tumor composed of mesenchymal cells with cartilage differentiation, ranging in classification from low grade with little metastatic potential to high grade with aggressive behavior and early metastasis. Among the initial case reports, amputation and radical surgery are fundamental pillars in the management of this tumor.[15,16,17] Subsequently, surgical management involving reconstruction with prostheses, structural allografts or alloprosthetic compounds has emerged as an option for limb preservation.[18,19,20,21,22]

Most recently documented reports describe chondrosarcoma of the humerus occurring in the proximal area, with subsequent wide resection and reconstruction with joint stents.[23,24,25,26] Reconstructive surgery after wide tumor resection in a different location of the humerus presents a challenge for preserving the limb itself and the function of the limb while minimizing the aesthetic impact that an amputation would entail. Among the chondrosarcoma management options, including prosthesis and/or allograft reconstruction with or without the addition of a vascularized fibular autograft,[27] the best option for this patient was considered and chosen. As there was no compromise of the humeral head or the epicondyles according to the extent documented on imaging, resecting only the diaphyseal area became the main objective, with the goal of preserving the articular function of the shoulder and elbow, for which

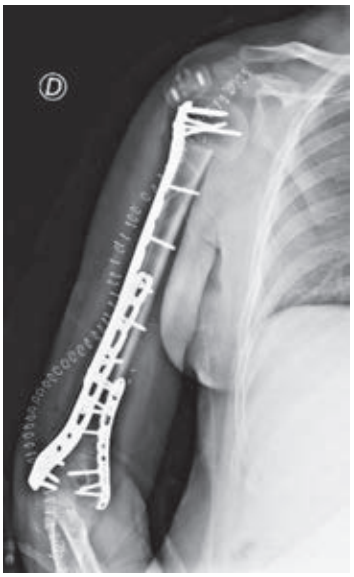

Figure 6:

Immediate postoperative radiograph showing reconstruction of the humerus with osteosynthesis and a structural allograft.

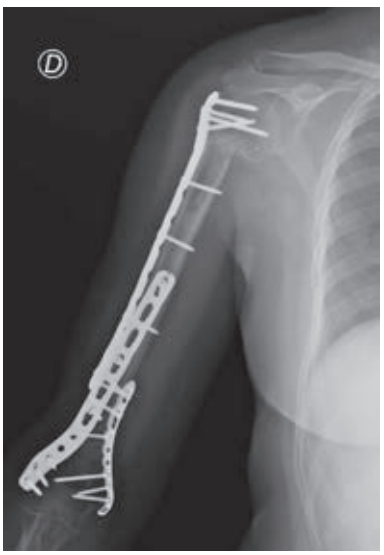

Figure 7:

Radiographic evidence of allograft/host bone consolidation at 3 months.

Figure 8: Range of motion of the elbow and shoulder at six months postoperatively. **A)** Flexion of the elbow. **B)** Extension of the elbow. **C)** Flexion of the shoulder. **D)** External rotation of the shoulder.

the allograft was used. According to a report by Errani C et al., who investigated 60 patients under 16 years of age who underwent diaphyseal resection and reconstruction with an intercalary allograft for femoral osteosarcomas, the outcomes did not differ between patients who did and did not undergo vascularized fibular autografting. Thus, they recommended the use of an autograft only for the management of complications such as nonunion or associated fractures.

In the short follow-up period, the postoperative course of this patient has been very favorable, as she has thus far shown no evidence of relapse and is satisfied with the functional result.

Surgical treatment of malignant bone tumors should focus on complete resection and functional preservation of the limb. The option of reconstructive surgery could lead to considerable success and minimize the functional, emotional, and aesthetic impairment that an amputation would entail.

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