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Total Elbow Arthroplasty as a Viable Reconstruction Option for Proximal Ulna Giant Cell Tumor: Case Report

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A B S T R A C T

Introduction: Giant cell tumor (GCT) of bone is a relatively common primary bone tumor, typically benign but known for local aggressiveness and potential for recurrence. It commonly affects the epiphyseal regions of long bones, particularly around the knee. Occurrence in the proximal ulna is rare, accounting for less than 1% of skeletal tumors, posing significant treatment challenges due to the complex elbow anatomy. Treatment aims for complete tumor removal, preservation of function, and prevention of recurrence, with options ranging from curettage to wide resection. Reconstruction after resection, especially involving the joint, is complex. **Case presentation:** We report the case of a 39-year-old female presenting with a painful swelling in her right elbow three months after a fall. Clinical examination revealed swelling, tenderness, and limited range of motion. Radiographs and MRI showed an expansile lytic lesion in the proximal ulna, suggestive of GCT. The patient underwent wide resection of the tumor followed by reconstruction using total elbow arthroplasty (TEA). Histopathology confirmed the diagnosis of GCT. **Conclusion:** At 8-month follow-up, the patient demonstrated excellent functional recovery with a range of motion from 0° extension to 150° flexion, a DASH score of 6.7, and an MSTS score of 26, with no signs of local recurrence. This case illustrates that wide resection combined with TEA is a viable and effective treatment strategy for GCT of the proximal ulna, offering good functional outcomes and local tumor control.

1. Introduction

Giant cell tumor (GCT) of bone, a primary bone neoplasm first detailed by Cooper in 1818, is characterized by the presence of mononuclear stromal cells and multinucleated giant cells resembling osteoclasts. While typically classified as benign, GCTs are known for their locally aggressive nature, the potential for significant bone destruction, relatively high recurrence rates after treatment, and the rare potential for malignant transformation or metastasis, primarily to the lungs. GCT accounts for approximately 5% of all primary bone tumors and around 20% of benign bone tumors. It most commonly occurs in skeletally mature young adults, typically between the ages of 20 and 40, with a slight predilection for females. The most frequent locations are the epiphyseal ends of long bones, especially the distal femur, proximal tibia, and distal radius. The occurrence of GCT in the proximal ulna is distinctly uncommon, representing less than 1% of all primary bone tumors and only 0.45% to 3.2% of GCT cases. Tumors in this location present unique management challenges due to the complex anatomy and biomechanics of the elbow joint. The proximal ulna forms the critical ulnohumeral articulation, provides stability, and serves as the insertion point for the

triceps muscle, the primary elbow extensor. Significant destruction of the proximal ulna by an aggressive tumor like GCT can severely compromise elbow stability and function.[1-4]

The optimal treatment strategy for GCT remains a subject of discussion, balancing the need for complete tumor eradication with the preservation of limb function. Treatment modalities range from intralesional curettage, often combined with adjuvants (such as phenol, liquid nitrogen, high-speed burring, or polymethylmethacrylate (PMMA) cement), to wide en-bloc resection. Curettage aims to preserve bone stock and joint function but carries a higher risk of local recurrence, reported between 15-45%, particularly for large or Campanacci grade III tumors, or when surgical margins are inadequate. Wide resection offers better local tumor control with lower recurrence rates (typically <10%) but often necessitates complex reconstruction, especially when the articular surface is involved or destroyed. Denosumab, a monoclonal antibody targeting RANKL, has emerged as a neoadjuvant or primary treatment option, particularly for unresectable or metastatic GCT, helping to reduce tumor size and facilitate subsequent surgery. Reconstruction following wide resection of the proximal ulna is challenging. Options include arthrodesis, osteoarticular allografts, prosthetic replacement (megaprosthesis or total elbow arthroplasty - TEA), free vascularized fibular grafts, ulnar transposition, or extracorporeal irradiated autografts. Arthrodesis provides stability but results in the complete loss of elbow motion. Allografts carry risks of non-union, fracture, infection, and disease transmission. Biological reconstructions like fibular grafts or irradiated autografts aim to restore bone stock but can be technically demanding with variable functional outcomes.[5-7]

Total elbow arthroplasty (TEA) has become an increasingly utilized option for reconstruction after tumor resection around the elbow, offering the potential for pain relief, stability, and restoration of a functional range of motion, despite historically higher complication rates compared to hip or knee arthroplasty. TEA is particularly considered when significant articular destruction precludes joint preservation or other reconstructive options are deemed unsuitable.[8-10] This study aims to present a comprehensive case report detailing the successful surgical management of a rare and aggressive giant cell tumor involving the proximal ulna. Specifically, it demonstrates the feasibility and efficacy of wide en-bloc resection combined with total elbow arthroplasty as a viable reconstruction strategy, highlighting the excellent functional restoration and satisfactory oncologic outcome achieved in this challenging clinical scenario.

2. Case Presentation

A 39-year-old female sought medical attention at the orthopedic clinic, reporting a primary complaint of a painful lump on her right elbow, a condition that had been progressively worsening over the three months leading up to her visit. The patient's history revealed that approximately six months prior to her presentation, she had sustained a fall from a motorcycle, resulting in an injury to her right elbow. Initially, following the fall, she experienced only mild tenderness in the elbow, and she was able to continue with her normal daily activities. However, about three months before her clinic visit, she began to notice distinct swelling and enlargement in the proximal region of her right forearm and elbow. Inquiring further into her medical history, the patient denied experiencing any associated systemic symptoms such as fever, night sweats, weight loss, loss of appetite, chronic cough, or any signs suggestive of bloody stools or bloody urine, effectively excluding a range of systemic illnesses and potential metastatic processes. Furthermore, she reported no prior history of tumors, nor was there any family history of bone tumors or similar symptoms. An assessment of her general health status using the Karnofsky Performance Score yielded a score of 80, indicating that while she was capable of carrying out normal activities, she was experiencing some degree of effort and exhibiting some signs or symptoms of her disease. Physical

examination of the patient revealed that she was well-nourished and appeared to be in no acute distress. A focused examination of her right upper extremity highlighted a significant swelling localized over the proximal ulna and the posterior aspect of the elbow. The skin overlying the affected area was intact, although some visible venous distension, or venectation, was noted. Notably, there was no evidence of skin ulceration, sinus tracts, or other signs that would suggest an infection. Upon closer inspection, a slight varus deformity of the elbow was observed. Palpation of the area confirmed the presence of a firm, non-mobile mass originating from the proximal ulna. The mass was approximately 9 cm in its largest dimension, had clearly defined borders, and was associated with tenderness. Distal to the elbow, the neurovascular status of the extremity was intact, as evidenced by palpable peripheral pulses and intact sensation. Both active and passive range of motion of the right elbow were considerably limited, primarily due to pain, which was exacerbated by flexion and extension movements. Additionally, the patient experienced a slight restriction in shoulder range of motion, which was attributed to the pain originating from her elbow. Initial laboratory investigations were conducted to assess the patient's general condition and to rule out any infectious processes. The results of the complete blood count, erythrocyte sedimentation rate (ESR), and C-reactive protein (CRP) tests all fell within normal limits. These findings were significant in excluding an active infectious process as the cause of her symptoms. Imaging studies were crucial in further evaluating the patient's condition. Plain radiographs, including anteroposterior and lateral views of the right elbow, revealed a large, expansile, osteolytic lesion located in the metaphysis and epiphysis of the proximal ulna. The lesion extended close to the subchondral bone, indicating its proximity to the joint surface. The radiographs also demonstrated cortical thinning and expansion, along with areas of apparent cortical breach and a subtle periosteal reaction. These radiographic features were suggestive of an aggressive benign or low-grade malignant bone tumor. Based on these radiographic findings, the initial differential diagnoses included giant cell tumor (GCT), aneurysmal bone cyst, and telangiectatic osteosarcoma. To further characterize the lesion and aid in narrowing down the differential diagnosis, magnetic resonance imaging (MRI) of the right elbow was performed. The MRI sequences included T1-weighted, T2-weighted, and fat-suppressed sequences in sagittal, axial, and coronal planes, both with and without the administration of gadolinium contrast. The MRI revealed a well-defined, solid mass measuring approximately 5 x 3.9 x 3.5 cm, situated within the intramedullary cavity of the olecranon and proximal ulnar metaphysis. The mass appeared relatively homogeneous, exhibiting intermediate signal intensity on T1-weighted images and high signal intensity on T2-weighted images, with avid and largely homogeneous enhancement following the administration of contrast. The MRI also confirmed significant cortical thinning and expansion, with focal areas of cortical destruction, but only minimal extra-osseous soft tissue extension. Some surrounding soft tissue edema was noted. Importantly, no other osseous lesions were identified on the MRI. The collective MRI findings were highly suggestive of a giant cell tumor, and based on the cortical breach observed, it was classified as Campanacci Grade III. In addition to the local imaging of the elbow, a staging chest X-ray or CT scan was performed to evaluate for potential pulmonary metastasis, a standard practice in the workup of GCT. The results of this staging imaging were negative, showing no evidence of pulmonary metastasis. Synthesizing the clinical presentation, physical examination findings, and imaging results, a working diagnosis of giant cell tumor of the proximal ulna was established. The treatment plan was formulated considering the size of the tumor, its aggressive appearance on imaging, specifically the cortical thinning and breach, and its involvement near the articular surface. The chosen treatment approach involved wide resection of the tumor followed by reconstruction with total elbow arthroplasty. The patient was thoroughly informed

about the diagnosis, the proposed surgical procedure, the potential risks and benefits, and the available alternative reconstruction options. Following this comprehensive discussion, informed consent was obtained from the patient to proceed with the planned surgical intervention (Table 1).

The treatment approach for this patient with a giant cell tumor of the proximal ulna was carefully planned and executed in several distinct phases, beginning with a thorough pre-operative assessment, proceeding to the surgical intervention, and culminating in a structured postoperative care and follow-up regimen. The pre-operative planning phase was initiated with the confirmation of the working diagnosis of giant cell tumor. This diagnosis was based on a synthesis of clinical findings, radiographic evidence from X-ray imaging, and the detailed visualization provided by Magnetic Resonance Imaging (MRI). The imaging studies played a crucial role in characterizing the tumor's size, location, and extent of involvement within the proximal ulna, which is essential for surgical planning. Following the diagnostic confirmation, a staging process was undertaken to determine if the tumor had spread to other parts of the body. This involved performing chest imaging, utilizing either a chest X-ray or a CT scan, to specifically check for any signs of metastasis, particularly to the lungs, which is a common site for distant spread of bone tumors. Fortunately, in this case, the chest imaging yielded negative results, indicating that there was no evidence of metastasis. The local staging of the tumor was also a critical component of the pre-operative planning. The tumor was classified as Campanacci Grade III based on the imaging findings, specifically the observation of cortical breach. The Campanacci grading system is a widely used method for assessing the aggressiveness of giant cell tumors, with Grade III indicating a more aggressive lesion that has breached the cortex of the bone. This grading is important as it influences treatment decisions and helps to predict the likelihood of local recurrence. With the diagnosis confirmed, and the tumor appropriately staged, the treatment decision was made. The chosen treatment strategy involved a wide en-bloc resection of the proximal ulnar tumor, followed by reconstruction of the elbow joint using total elbow arthroplasty (TEA). Wide en-bloc resection is a surgical technique that aims to remove the entire tumor along with a margin of healthy tissue, reducing the risk of local recurrence. Given the size of the tumor, its aggressive nature as indicated by the cortical breach, and its proximity to the elbow joint, this approach was deemed necessary to achieve adequate oncologic control. Reconstruction with TEA was planned to restore function to the elbow joint after the resection. This complex procedure was carefully explained to the patient, including a thorough discussion of the potential risks and benefits, as well as alternative reconstruction options. The importance of obtaining informed consent was emphasized, and the patient provided her consent to proceed with the planned surgical intervention. The surgical procedure was performed under general anesthesia to ensure the patient was completely comfortable and pain-free throughout the operation. The patient was positioned in the lateral decubitus position, which allowed optimal surgical access to the elbow joint. The surgical approach involved a posterior longitudinal incision made over the elbow, strategically centered over the tumor prominence to allow for adequate exposure and resection of the tumor. A critical step in the procedure was the identification, protection, and anterior transposition of the ulnar nerve. This was essential to prevent iatrogenic injury to the nerve during the tumor resection and reconstruction, as damage to the ulnar nerve can result in significant functional impairment of the hand and forearm. Following nerve management, a wide en-bloc resection of the proximal ulna was performed. This involved the meticulous removal of the tumor along with a margin of healthy bone and soft tissue. The resection included the olecranon, the coronoid process, and the proximal ulnar shaft, encompassing the entire tumor mass. The excised specimen measured approximately 9 cm in length, reflecting the substantial size of the tumor. To ensure complete tumor removal, margins were

assessed intraoperatively. This often involves sending tissue samples to the pathology department for frozen section analysis, where a pathologist examines the tissue under a microscope to confirm that the surgical margins are free of tumor cells. Achieving clear margins is crucial for minimizing the risk of local tumor recurrence. Following the resection, reconstruction of the elbow joint was performed using a cemented, linked total elbow arthroplasty (TEA) system. This involved preparing the humeral and ulnar medullary canals to receive the prosthetic components. The appropriate-sized prosthetic components were then cemented into place, carefully restoring the joint alignment, stability, and biomechanics. Particular attention was paid to the reattachment and tensioning of the triceps mechanism, which is essential for elbow extension. The triceps was securely reattached to the prosthetic ulnar component or the remaining bone to ensure adequate elbow function. The surgical wound was closed in layers over a drain. The drain was used to prevent the accumulation of fluid in the surgical site, which can reduce the risk of infection and promote healing. The excised specimen, comprising the resected proximal ulna containing the tumor, was sent for histopathological examination. The histopathology report confirmed the diagnosis of Giant Cell Tumor of bone. The tumor was characterized by sheets of mononuclear stromal cells interspersed with numerous, uniformly distributed osteoclast-like giant cells, which is the hallmark histological feature of GCT. Importantly, the histopathological examination revealed no features of malignancy, and the surgical margins were reported as clear, indicating complete tumor resection. The postoperative care phase commenced immediately following the surgery. The patient received routine postoperative care, including pain management to ensure comfort and prophylactic antibiotics to prevent infection. Drain management was also a part of the immediate postoperative care. Elbow mobilization was initiated cautiously, adhering to a structured rehabilitation protocol. This typically involved early passive motion exercises, followed by a gradual progression to active motion. The rehabilitation program was carefully designed to protect the repaired triceps mechanism while promoting healing and restoring elbow function. The follow-up phase is crucial for monitoring the patient's recovery, assessing the functional outcome of the surgery, and detecting any potential complications or tumor recurrence. In this case, the follow-up period discussed in the report was 8 months. At the 8-month follow-up, the patient reported a significant improvement in both pain levels and overall function of the elbow. Clinical examination revealed a well-healed surgical incision, indicating successful wound healing without complications. The patient had achieved an excellent functional range of motion in the right elbow. She demonstrated full extension (0 degrees) and flexion up to 150 degrees. Pronation and supination of the forearm were also within functional limits, although specific measurements were not provided in this report. Imaging assessment at the 8-month follow-up involved radiographs of the right elbow. These radiographs showed that the TEA components were well-positioned and well-aligned. There were no signs of implant loosening, subsidence, or osteolysis, which are potential complications associated with joint replacement surgery. Crucially, there was no radiographic evidence of local tumor recurrence, indicating successful oncologic control. To objectively assess the functional outcome of the treatment, patient-reported outcome measures were utilized. The Disabilities of the Arm, Shoulder, and Hand (DASH) score was 6.7 out of a possible 100, where a lower score indicates less disability. This low DASH score reflects minimal functional limitation in the patient's upper extremity. The Musculoskeletal Tumor Society (MSTS) score for the upper extremity was 26 out of a maximum of 30. This high MSTS score corresponds to an excellent functional result with only minor disability. The patient also expressed satisfaction with the results of the treatment. Based on these positive outcomes, the patient's oncologic status at the 8-month follow-up was considered favorable, with no clinical or radiographic evidence of

local recurrence. Furthermore, no complications were reported during this follow-up period. Despite the successful outcome at 8 months, the importance of continued regular follow-up was emphasized. This is crucial for long-term monitoring of the implant and ongoing surveillance for any signs of local recurrence or distant metastasis, as late recurrences can occur even several years after treatment of giant cell tumors (Table 2).

Table 1. Summary of patient's clinical findings.

Category/Parameter	Details
Demographics	
Age	39 years
Gender	Female
Anamnesis (History)	
Chief complaint	Lump on the right elbow
History of present illness	- Lump developed 3 months prior to admission. - History of a fall injuring the right elbow 6 months prior to admission. - Initial mild elbow tenderness after fall, still able to perform normal activities. - Noticed right elbow swelling and enlargement starting 3 months prior to admission. - Progressive enlargement reported.
Associated symptoms	-Pain associated with the lump and limited motion. - No associated abscess or sinus symptoms.
Systemic symptoms	Denied weight loss, night pain, loss of appetite, chronic cough, bloody stools, or bloody urine. No fever reported.
Past medical history	Not explicitly mentioned beyond the inciting fall.
Family history	No family history of similar symptoms or other tumor types reported.
Performance status	Karnofsky Performance Score: 80 (Normal activity with effort; some signs or symptoms of disease).
Physical examination	
General	Well-nourished, no acute distress (inferred). Abnormalities confined to the right upper extremity.
Local examination (Right Elbow)	**Inspection:** Obvious swelling over proximal ulna/posterior elbow; Skin intact; Slight varus deformity noted; Visible lump; Venectation (visible veins) present; No ulceration. **Palpation:**Tenderness present; Firm, hard, palpable mass; Clearly defined border; Estimated largest diameter approx. 9 cm (from intraoperative finding). Neurovascular: No signs of neurovascular decompression (NVD). Distal pulses palpable, sensation intact (inferred from "no NVD"). **Range of Motion (ROM):** Elbow flexion/extension limited due to pain; Shoulder ROM slightly limited due to elbow pain.
Laboratory findings	
Hematology	White Blood Cell (WBC) count: Normal. Total Blood Count: Normal. Differential Count: Normal.
Inflammatory markers	Erythrocyte Sedimentation Rate (ESR): Normal. C-Reactive Protein (CRP): Normal.
Imaging findings	
Radiography (X-ray)	Expansile osteolytic lesion in the metaphysis and epiphysis of the proximal ulna; Extended up to subchondral bone; Cortical thinning and expansion; Subtle periosteal reaction; Suggestive of GCT, Aneurysmal Bone Cyst, or Unicameral Bone Cyst.
Magnetic resonance imaging (MRI)	T1, T2, Fat-Sat sequences (Sagittal, Axial, Coronal), pre- and post-contrast. Solid mass in intramedullary olecranon/proximal ulna. Size approx. 5 x 3.9 x 3.5 cm. Relatively homogeneous, circular shape, well-defined borders. Signal: Intermediate on T1, High on T2 (inferred). Enhancement: Avid, largely homogeneous contrast enhancement (inferred). Cortical thinning and expansion, partial cortical destruction. Surrounding soft tissue edema. No other osseous involvement apparent. Conclusion suggestive of a benign primary bone tumor, likely GCT.
Chest imaging	Chest X-ray / CT scan performed for staging, results were negative for metastasis.
Clinical diagnosis	
Working diagnosis	Giant Cell Tumor (GCT) of the right proximal ulna (Campanacci Grade III).
Final diagnosis	Confirmed Giant Cell Tumor (GCT) of bone via histopathological assessment post-resection.

Table 2. Summary of treatment procedure and follow-up.

Phase/Parameter	Details
Pre-operative planning	
Diagnosis confirmation	Working diagnosis of GCT based on clinical presentation, radiography, and MRI.
Staging	Chest imaging (X-ray or CT) performed, negative for metastasis. Tumor staged locally as Campanacci Grade III based on imaging (cortical breach).
Treatment decision	Plan for wide en-bloc resection of the proximal ulnar tumor followed by reconstruction with Total Elbow Arthroplasty (TEA). Decision based on tumor size, aggressive features (cortical breach), and joint proximity. Patient informed consent obtained.
Surgical procedure	
Anesthesia	General anesthesia.
Patient position	Lateral decubitus position.
Surgical approach	Posterior longitudinal incision over the elbow.
Intraoperative steps	- Ulnar nerve identified, protected, and transposed anteriorly. - Wide en-bloc resection of the proximal ulna including the tumor. - Resection included olecranon, coronoid process, and proximal ulnar shaft containing the tumor. - Excised specimen size approx. 9 cm. - Margins assessed intraoperatively. - Reconstruction performed with cemented, linked Total Elbow Arthroplasty (TEA) system. - Humeral and ulnar medullary canals prepared and components cemented. - Triceps mechanism reattached. - Wound closure in layers over a drain.
Histopathology	
Specimen	Resected proximal ulna containing tumor.
Definitive diagnosis	Giant Cell Tumor (GCT) of bone.
Margin status	Surgical margins clear (negative).
Postoperative care	
Immediate post-op	Routine care including pain management and prophylactic antibiotics; Drain management.
Mobilization/rehabilitation	Elbow mobilization initiated cautiously (passive followed by active motion) according to surgeon's protocol.
Follow-up	
Duration	8 months.
Clinical assessment (at 8 months)	- Patient reported significant improvement. - Well-healed surgical incision. - Excellent functional range of motion achieved: - Extension: 0° (Full). - Flexion: 150°. - Pronation/Supination: Within functional limits.
Imaging assessment (at 8 months)	Radiographs (X-ray) of the right elbow showed: - TEA components well-positioned and well-aligned. - No signs of implant loosening, subsidence, or osteolysis. - No radiographic signs of local tumor recurrence.
Functional outcome (at 8 months)	- Disabilities of the Arm, Shoulder, and Hand (DASH) score: 6.7 / 100 (Minimal disability). - Musculoskeletal Tumor Society (MSTS) score (upper extremity): 26 / 30 (Excellent result, minor disability). - Patient satisfied with results.
Oncologic status (at 8 months)	No clinical or radiographic evidence of local recurrence.
Complications	No complications reported during the 8-month follow-up period.
Long-term plan	Continued regular follow-up for implant monitoring and tumor surveillance recommended.

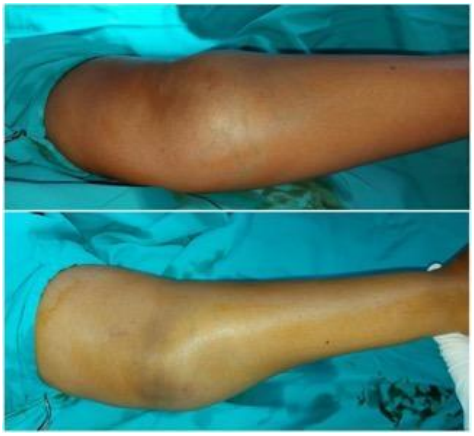

Figure 1. The patient's right elbow is clearly swollen, skin intact, with varus deformity, lump, venectation, but no ulcer in the clinical photos.

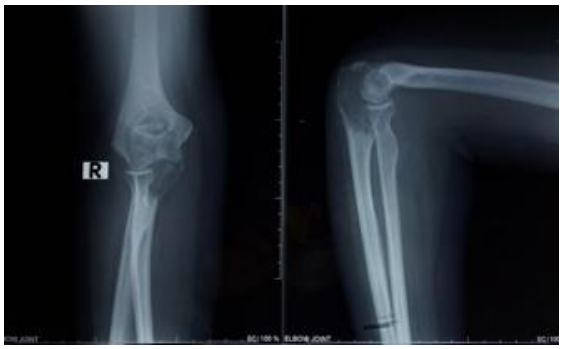

Figure 2. A pre-operative radiograph showed an osteolytic expansile lesion in the metaphysic extending up to the subchondral bone and periosteal reaction.

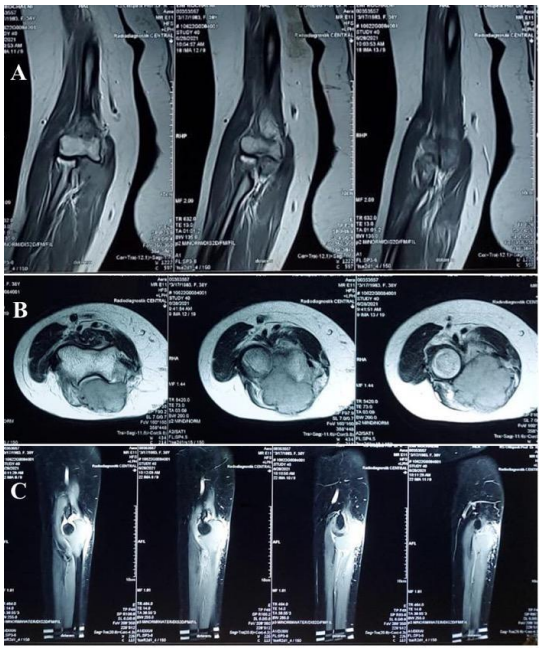

Figure 3. A) Sagital T2; B) Axial T1 + C; C) Sagital T1 + C; Solid mass in the intramedullary olecranon of the ulna, approximately 5x3.9x3.5 cm, is relatively homogeneous, circular in shape, well-defined, and edematous in the surrounding soft tissue. This mass is most likely a primary bone tumor (GCT), as it thins the cortex and swells, partially destroying it; Other OS involvement is not apparent.

3. Discussion

Giant cell tumor of bone, while histologically classified as benign in the majority of cases, presents a complex clinical picture due to its inherent potential for locally aggressive behavior. This tumor is characterized by a unique cellular composition, featuring mononuclear stromal cells interspersed with multinucleated giant cells that bear a resemblance to osteoclasts, the bone-resorbing cells. This cellular makeup contributes to the tumor's capacity to progressively destroy bone tissue, leading to significant structural compromise if left untreated. The clinical management of GCT is further complicated by its propensity for recurrence, even after seemingly successful initial treatment. Recurrence rates can vary substantially depending on the treatment modality employed and the specific location and characteristics of the tumor. In some instances, GCTs can undergo malignant transformation, although this is a relatively rare occurrence. Furthermore, while infrequent, GCTs possess the capacity for metastasis, with the lungs being the most common site of distant spread. GCTs typically manifest in skeletally mature individuals, with the peak incidence occurring in young adults between the ages of 20 and 40 years. There is a slight predominance of GCTs in females compared to males. The tumor exhibits a predilection for the epiphyseal regions of long bones, which are the areas adjacent to the joints. The most frequent sites of involvement include the distal femur, proximal tibia, and distal radius, all of which are in close proximity to major joints such as the knee and wrist. The proximal ulna, the location affected in the case presented, is an uncommon site for GCT development. Tumors in this location account for a small fraction of all primary bone tumors and an even smaller percentage of GCT cases. The unique anatomical and biomechanical features of the elbow joint introduce specific challenges in the treatment of GCTs arising in the proximal ulna. The elbow joint is a complex articulation that allows for a wide range of motion, including flexion, extension, pronation, and supination. The proximal ulna plays a crucial role in the stability and function of this joint, forming a critical part of the ulnohumeral articulation. It also serves as the insertion site for the triceps muscle, the primary extensor of the elbow, which is essential for activities such as pushing and lifting. Therefore, significant destruction of the proximal ulna due to a tumor like GCT can lead to substantial impairment of elbow function, affecting stability, range of motion, and strength. The rarity of GCT in this location, combined with the functional importance of the elbow, necessitates a carefully considered and individualized treatment approach.[11,12]

The overarching goals in the treatment of giant cell tumor of bone are threefold complete eradication of the tumor to prevent recurrence, preservation or restoration of optimal limb function, and minimization of treatment-related morbidity. Achieving these goals often requires a delicate balance, as the most effective treatment for tumor eradication may not always be the most function-preserving. The treatment armamentarium for GCT encompasses a range of surgical and medical modalities, each with its own set of advantages and disadvantages. The choice of treatment is influenced by several factors, including the size and location of the tumor, its aggressiveness as determined by imaging and histological features, and the patient's overall health and functional demands. Intralesional curettage is a surgical technique that involves the removal of the tumor from within the bone. This approach aims to preserve as much of the surrounding bone and joint structures as possible, which can lead to better functional outcomes compared to more extensive resections. To enhance the effectiveness of curettage and reduce the risk of recurrence, it is often combined with adjuvant therapies. These adjuvants can include chemical agents such as phenol, which is used to kill any remaining tumor cells, cryotherapy using liquid nitrogen to freeze and destroy tumor tissue, high-speed burring to mechanically remove residual tumor cells, and the use of polymethylmethacrylate (PMMA) cement to fill the defect and provide structural

support. Despite these efforts, curettage is associated with a relatively high risk of local recurrence, with reported rates ranging from 15% to 45%. The risk of recurrence is particularly elevated in cases involving large tumors, tumors classified as Campanacci grade III (indicating cortical destruction), or when surgical margins are inadequate, meaning that some tumor cells are left behind. Wide en-bloc resection is a more radical surgical approach that involves the removal of the entire tumor along with a margin of healthy tissue surrounding it. This technique aims to achieve complete tumor eradication and minimize the risk of local recurrence. Studies have demonstrated that wide resection generally results in lower recurrence rates compared to curettage, typically less than 10%. However, wide resection often necessitates the sacrifice of significant bone and soft tissue, which can lead to substantial functional deficits. Reconstruction following wide resection is frequently complex, especially when the tumor involves or destroys the articular surface of a joint. In recent years, denosumab, a monoclonal antibody that targets RANKL (receptor activator of nuclear factor kappa-B ligand), has emerged as a valuable treatment option for GCT. Denosumab acts by inhibiting osteoclast formation and activity, thereby reducing bone resorption and tumor growth. It has been particularly useful in the treatment of unresectable or metastatic GCT, where it can help to control tumor progression and alleviate symptoms. Denosumab can also be used as a neoadjuvant therapy prior to surgery, with the goal of reducing tumor size and making surgical resection easier. The selection of the most appropriate treatment strategy for GCT requires a careful assessment of the individual patient and their specific circumstances. Factors such as the tumor's location, size, and aggressiveness, as well as the patient's age, functional demands, and overall health, must be taken into account to optimize the balance between oncologic control and functional outcome.[13,14]

Reconstruction of the elbow following wide resection of the proximal ulna presents a formidable challenge to the orthopedic surgeon. The primary goals of reconstruction in this setting are to restore stability to the elbow joint, preserve or restore a functional range of motion, and achieve adequate strength for daily activities. The optimal reconstructive technique should also be durable, minimize complications, and provide a satisfactory long-term outcome for the patient. Several reconstructive options are available, each with its own advantages, disadvantages, and potential complications. The choice of reconstruction depends on the extent of the resection, the patient's functional needs, and the surgeon's experience and preference. Arthrodesis, or fusion, of the elbow joint is one reconstructive option. This procedure involves surgically fusing the humerus and ulna bones together, eliminating motion at the elbow joint. Arthrodesis provides excellent stability and can be a reliable option in cases where stability is the primary concern, such as after extensive resections or in patients with significant soft tissue damage. However, a major drawback of arthrodesis is the complete loss of elbow motion, which can significantly impact the patient's ability to perform activities of daily living that require elbow flexion and extension. Osteoarticular allografts, which involve transplanting bone and cartilage from a deceased donor, represent another reconstructive alternative. Allografts can be used to replace large segments of resected bone and restore the articular surface of the elbow joint. However, allografts carry several potential risks and complications, including non-union (failure of the bone to heal), fracture, infection, and disease transmission. Additionally, the long-term survival of allografts can be limited, and they may require revision surgery. Biological reconstructions, such as free vascularized fibular grafts or extracorporeal irradiated autografts, utilize the patient's own bone tissue for reconstruction. Free vascularized fibular grafts involve transplanting a segment of the fibula bone from the leg to the elbow, along with its blood supply, to restore bone stock. Extracorporeal irradiated autografts involve resecting the tumor-bearing bone, irradiating it to kill any remaining tumor cells, and then reimplanting it. These biological reconstructions aim

to provide durable and potentially long-lasting solutions. However, they are technically demanding procedures with variable functional outcomes. They may also require prolonged immobilization and rehabilitation, and there is a risk of complications such as non-union, fracture, and infection. Prosthetic replacement, using either a megaprosthesis or total elbow arthroplasty (TEA), is another reconstructive option, particularly when the articular surface of the elbow joint is involved or destroyed. Megaprostheses are custom-designed implants used to replace large segments of bone, while TEA involves replacing the entire elbow joint with artificial components. These options can provide immediate stability and allow for early mobilization, offering the potential for a more predictable return to function compared to some other reconstructive techniques.[15,16]

Total elbow arthroplasty (TEA) has traditionally been employed for the treatment of end-stage elbow arthritis, particularly in cases of rheumatoid arthritis, or for the management of complex elbow trauma. In these settings, TEA has demonstrated its effectiveness in alleviating pain, improving stability, and restoring a functional range of motion. However, the role of TEA has expanded in recent years to include the reconstruction of the elbow joint following tumor resection. This evolution is driven by the need for reliable reconstructive options after wide resection of tumors around the elbow, which can result in significant bone and soft tissue loss. While TEA offers the potential for pain relief and functional restoration in this context, it is important to acknowledge that it is a complex procedure with its own set of challenges and potential complications.[17,18]

The assessment of functional outcomes following TEA is crucial for evaluating the success of the procedure and guiding patient management. These outcomes are typically evaluated using a combination of clinical assessments, range of motion measurements, and patient-reported outcome measures. Clinical assessments involve evaluating the patient's pain level, stability of the elbow joint, and ability to perform daily activities. Range of motion measurements quantify the extent of flexion, extension, pronation, and supination achieved after surgery. Patient-reported outcome measures are questionnaires that assess the patient's perception of their functional limitations, pain, and overall satisfaction. Several validated patient-reported outcome measures are commonly used in the evaluation of upper extremity function, including the Disabilities of the Arm, Shoulder, and Hand (DASH) score and the Musculoskeletal Tumor Society (MSTS) score.[19,20]

4. Conclusion

In conclusion, this case report illustrates the successful management of a rare and challenging case of giant cell tumor in the proximal ulna. The treatment approach, involving wide resection of the tumor followed by reconstruction with total elbow arthroplasty (TEA), demonstrated excellent functional outcomes and effective local tumor control at the 8-month follow-up. The patient achieved a remarkable range of motion, with full extension and 150° of flexion, and reported minimal disability as evidenced by low DASH and high MSTS scores. This outcome supports the viability of TEA as a reconstructive option in such cases, offering the potential for significant functional restoration. While long-term follow-up is crucial to monitor for recurrence and implant-related complications, the early results presented here are promising. This case contributes valuable evidence to the literature, highlighting a treatment strategy that can be considered for this uncommon and complex clinical scenario.

5. References

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