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Case report

Chondrosarcoma of the proximal radius treated by wide resection and reconstructed by 3D printed implant: A case report and description of surgical technique

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ABSTRACT

Introduction: Chondrosarcoma is the second most common primary malignancy of bone that can occur in multiple locations in the skeleton. It has been rarely reported in the proximal radius. While surgical resection is the primary treatment modality for individuals with localized disease, reconstruction can be challenging in the elbow joint due to its complex anatomy. 3D printing technology can be used in such complex cases to restore the normal anatomy after resection.

Case presentation: We present a case of mesenchymal chondrosarcoma in a 33-year-old male occurring in the proximal radius, restricting his elbow motion. That was resected and reconstructed using 3D modeling. Restoring a functional range of motion without instability.

Discussion: Many surgical options for chondrosarcoma presented over the years including en bloc resection, resection with or without reconstruction, or amputation. Usage of 3D modeling in the orthopedic surgery field is relatively new and it can be used in pre-operative planning and shortens surgical time. 3D printing in our case helped in obtaining a full range of motion (flexion, extension, pronation, and supination) for the patient.

Conclusion: It's important to reconstruct elbow joint support structure and function after resection of such a large malignant tumor in young patients. We used 3D printed implant to maintain a functional limb and it was an excellent alternative treatment.

1. Introduction

Chondrosarcoma is a cartilage forming neoplasm, which is the second most common primary malignancy of bone [1]. Acral lesions are unlikely to metastasize, regardless of grade, while axial or more proximal lesions are more likely to metastasize than tumors found in the distal extremities with equivalent histology [1]. Proximal radius is a very rare location for chondrosarcoma to occur and up to our knowledge, there is only one case reported [2]. Chondrosarcoma has many types ranging from indolent, low-grade tumors to aggressive or high-grade forms [3]. Malignant cartilage tumors are classified as classical chondrosarcoma (grade I–III), dedifferentiated chondrosarcoma (grade IV), mesenchymal chondrosarcoma, and clear cell chondrosarcoma [3].

Surgical resection represents the primary and preferred treatment modality for individuals with localized disease [1]. The treatment of advanced, metastatic disease is particularly challenging, given the recognition that conventional chemotherapy has proven to be largely ineffective [3]. Surgical options for reconstruction of the elbow are challenging due to the complicity of the anatomy and often have disabling effects [2].

The technology of three-dimensional (3D) printing uses specific materials and digitalized models to print out the structure [4–5]. Although it was created in the 1980s, only in recent years has been widely utilized in military, architecture, and medical fields [6–7]. 3D modeling usage has been increased recently in many fields from medicine to industry [8–9]. It improves management options for various diseases and provides a great benefit especially for medical imaging and dental imaging as it allows printing precise personalized implants

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[10–13]. Few reports have described its advantages and applications [4–7,14].

In this case, we are presenting a patient with chondrosarcoma of proximal radius restricting elbow movement and affecting daily activities. The tumor was resected and reconstructed using 3D implantation. The procedure was done by main author Hisham Alsanawi (Upper-Extremity trained fellowship) without any complications and restoration of his elbow range of motion was achieved. This case shows the benefit of using 3D implantation technology in restoring elbow structures.

This study was reported in line with the SCARE 2020 criteria [22].

2. Case presentation

A 33-year-old male known case of Hodgkin's lymphoma was diagnosed in 1997 and was managed with chemo-radiotherapy. He also suffered from spinal sarcoma and underwent a tumor debulking procedure with decompression followed by adjuvant chemotherapy. The patient self-presented in the emergency department (ED) of the King Saud University Hospital, Riyadh, Saudi Arabia after he heard an audible click in his left elbow when he lifted a heavy object, followed by pain and inability to move his elbow. On clinical examination, BMI was 20 (normal weight), the patient's elbow was swollen and a firm and tender mass measuring 5 cm × 3 cm was palpable on the dorsolateral aspect of the proximal radius. Elbow range of motion was limited due to pain and the distal neurovascular exam was normal. Radiographs taken in the ED (Fig. 1A) showed a spiral fracture over a lytic lesion that extends from the radial head to the proximal diaphysis of the radius. Computed tomography (CT) scan showed an aggressive sclerotic bony lesion in the proximal radius measuring 7.6 × 2.1 cm with a sunburst periosteal reaction Fig. 2. The patient was immediately admitted for further work-up and investigations.

Magnetic resonance imaging (MRI) showed an expansile proximal radius lesion measuring 4 × 4.3 × 10 cm in anterior-posterior, transverse and craniocaudal dimensions respectively with an extension to the articular surface. Routine blood tests, as well as inflammatory markers including ESR, CRP, and Procalcitonin, were within the normal range. A CT-guided percutaneous biopsy was performed and showed a biphasic appearance of small, round blue cells. That confirms the diagnosis of mesenchymal chondrosarcoma. Initially, conservative management in the form of cast immobilization and pain medication was offered. Three months later, he was still complaining of pain with restriction of his elbow motion which affects his daily living activities. A follow-up x-ray showed a malunited proximal radius over the lesion without changes in tumor size (Fig. 1B). After presenting the case to the hospital tumor board followed by a lengthy discussion with the patient, the best plan was to reconstruct the proximal radius using a 3D printing technology. The patients' main intention was to restore his elbow range of motion to have a functional limb. He is a non-smoker patient with no drug allergy and no family history of cancer.

3. Surgical technique

Pre-operative planning was initially done by obtaining a bilateral forearms CT imaging. Following that, the contralateral (normal) side was used as a reference to make the 3D model (Fig. 3). After designing the 3D model and reversing it to match the affected side, a mold, to contain the bone cement, was printed and sent to the hospital's central sterilization unit. The procedure was done under general anesthesia and performed by the senior author Hisham Alsanawi (upper-extremity trained fellowship). After receiving the proper prophylaxis antibiotic (cefazolin), the patient's left upper limb was prepared and draped. The posterolateral approach for the proximal radius was chosen. Posterior interosseous nerve (PIN) was carefully identified and protected. Based on the preoperative surgical planning and the 3D printed mold, a 7 cm bone segment of the proximal radius was resected. Cement was injected slowly in the model shaper (Fig. 3). The bone cement was then carefully removed and fixed to the remaining distal radius using a 3.5 dynamic compression plate (Fig. 4). Intraoperative elbow range of motion was tested and was found to be full without restriction. Irrigation of the wound with sterile saline was done, Skin was closed, and a dry dressing was applied. Three prophylactic doses of cefazolin antibiotic were given postoperatively. Post-operative X-rays (Fig. 5). The patient was allowed to have an immediate range of motion as tolerated. A hinged elbow brace was placed for 4 weeks. The final three months follow-up showed satisfactory outcomes and stable fixation and no resorption seen (Fig. 6).

4. Discussion

We have been utilizing 3D modeling for most malunion cases of upper extremity fracture by using 3D reconstruction computed tomography (CT) of the contralateral side to match the patient's normal anatomy and eliminate the risk of difference among the population. Although others use orthogonal X-rays, 3D CT reconstructed scan is more accurate to match the exact geometry of the bone [14].

Usage of 3D modeling in orthopedic surgery field is relatively new, its main advantage lies in understanding patient's anatomy, academic teaching, research, and surgical planning of tumor resection, complex fractures, or deformities [6,7,14]. The use of 3D modeling in such cases helps in pre-operative planning and shortens surgical time [15,16].

Chondrosarcoma rarely presents in the proximal radius [2]. Many surgical options were presented over the years including en bloc resection, resection with or without reconstruction, or amputation [17]. Each surgical option has its own complication; however, literature did not offer much on resection of the mass with reconstruction using 3D models to decrease the risk of wrist pain, proximal migration of the radius, and deformed appearance that can happen with the other surgical options especially in this younger age group who would like to maintain their functionality [2–9,17].

To our knowledge, there are limited reported cases in the literature regarding proximal radius migration, subluxation, or wrist pain after proximal radius resection without reconstruction [18]. Al-Juhani W et al. reported two cases of proximal radius migration following

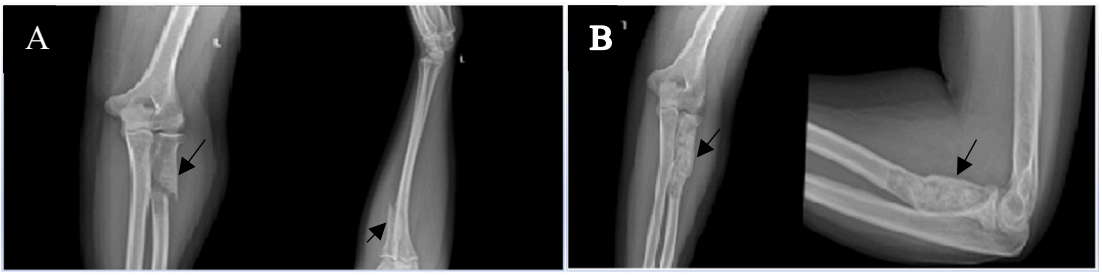

Fig. 1. A. AP and lateral X-rays of the left forearm showing a pathological fracture over lytic lesion of proximal radius (arrow). B: AP and lateral X-rays of the left forearm showing same lesion 2 months later with intra-lesion mineralization and malunited fracture (arrow).

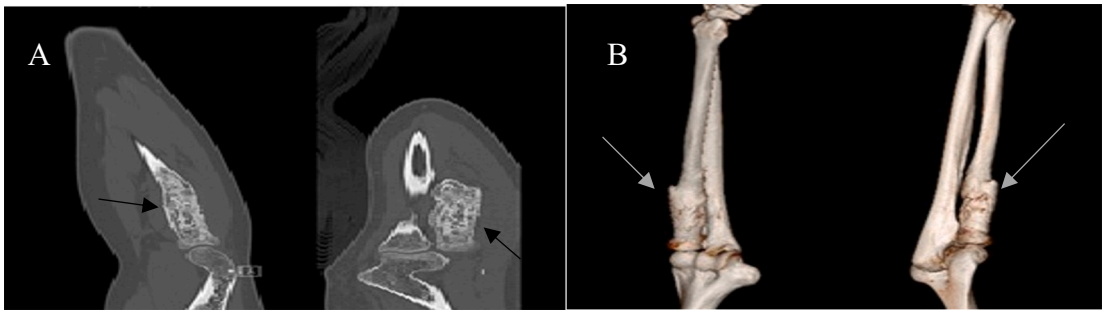

Fig. 2. A. Showing coronal and sagittal view of the left elbow computer tomography scan showing aggressive sclerotic bony lesion in the proximal radius with sunburst raction (arrow). B: Showing three-dimensional computed tomography scan of the left forearm showing the size of proximal radius lesion (arrow).

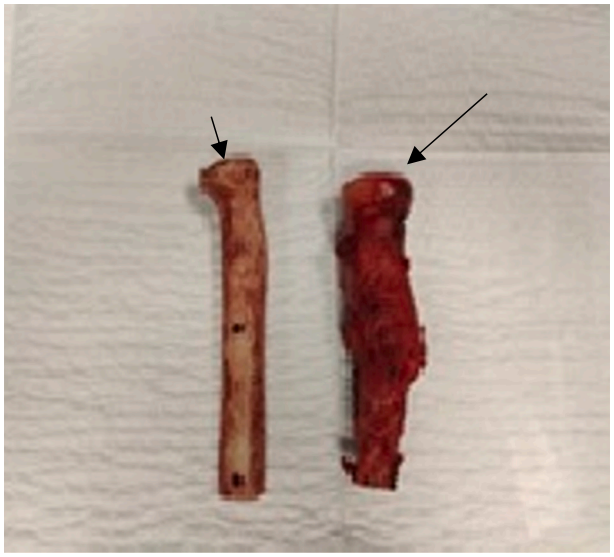

Fig. 3. Original resected proximal radius (long arrow) versus, 3D printed model proximal radius (short arrow).

resection of radial head for Ewing sarcoma [18]. Liu et al. reported a high rate of complications with en bloc resection of giant cell tumors of the radius [19]. These complications included arthritis (13–50%) and subluxation (12–67%). However, Vander Griend et al. reported that carpal bones were more susceptible to subluxation. He reported also one patient who complained of wrist pain and instability after 2 years of follow-up [20]. Schiffern A et al. reported posterior and medial drift of the proximal radius that was greater when more than 2 cm resection was done in a study of thirteen patients who had undergone radial head resection [21].

In this case, we were able to obtain a full range of motion (flexion, extension, pronation, and supination). During the time of follow-up, the patient showed superior outcome, with a satisfactory range of motion, had no complaints of wrist pain or instability. No obvious deformity was noted and no signs of infection were observed during early follow-up visits. We are reporting this case to encourage other surgeons to start using this method for managing their patients and report long-term outcomes. As our case has only a short period of follow-up, longer follow-ups are recommended to report long-term outcomes and prognosis.

5. Conclusion

It's important to reconstruct elbow joint support structure and function after resection of such large malignant tumor in young patients. We used 3D printed implant to maintain a functional limb and it was an excellent alternative treatment.

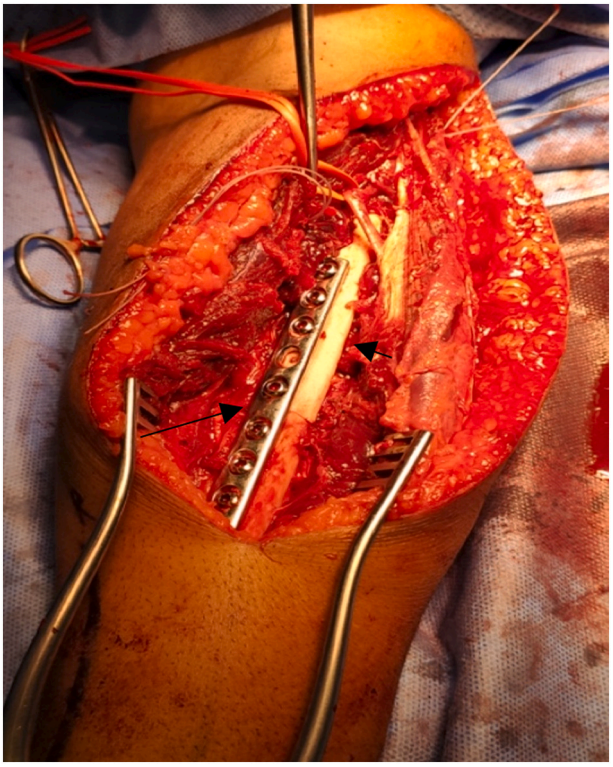

Fig. 4. Intraoperative image taken after application of the implant (short arrow), fixed with 3.5 mm DCP to the distal part of the radius (long arrow).

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Ethical approval

N/A.

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Consent

Written informed consent was obtained from the patient for publication of this case report and accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal on request.

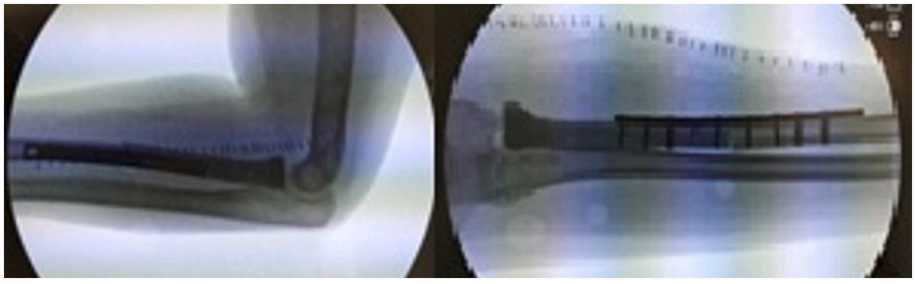

Fig. 5. Shows immediate anterior-posterior and lateral radiographs of the left elbow after application and fixation of the implant.

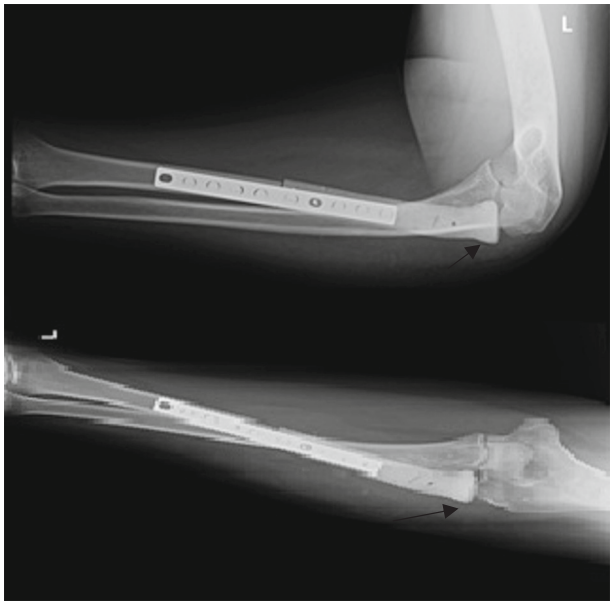

Fig. 6. Anterior-posterior and lateral radiographs of the left forearm 3 months after the surgery showing stable construct and no change in shape of radial head with a congruent joint (arrow).

Research registration number

Not applicable.

Author contribution

Hisham Alsanawi: primary surgeon, case idea, and major writing role.

Waleed Albishi: writing the paper, final approval.

Mohammed AlDhaheri: literature review.

Turki AlMugren: writing the paper.

Naif AlAmer: literature review, reviewing the paper.

Guarantor

Hisham Alsanawi.

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Declaration of competing interest

All authors declare no conflict of interest.

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