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Primary total shoulder arthroplasty in the setting of a benign enchondroma

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Benign bone tumors are noncancerous but still have potential to cause symptoms by compressing on surrounding tissues.[4] Enchondromas constitute one type of benign bone tumor and are commonly found in short tubular bones, although they can also be present in long bones.[10] It is often difficult to differentiate these benign tumors from chondrosarcomas, which are malignant in nature. Diagnostic imaging, including radiography, magnetic resonance imaging, and computed tomography scans, as well as subjective symptomatology can help differentiate these types of bone tumor. Enchondromas are regularly found in the humerus, femur, or tibia and are the second most common benign, cartilaginous tumor.[10,11] However, these tumors are often asymptomatic and therefore may be even more common than previously thought. A study involving 477 magnetic resonance imaging scans of shoulders found enchondromas present in 2.1% of patients, with most detected in the humerus, and it was concluded that shoulder enchondromas were the most common bony abnormality.[7]

Because enchondromas are often asymptomatic, they may be discovered because of unrelated, yet adjacent, soft tissue or bony maladies.[10] In a study of patients with proximal humerus enchondromas who presented with shoulder pain, 82% were found to have other pathologies which could explain the pain apart from the bone tumor.[9] The majority of enchondromas do not need surgery and may be monitored while the associated condition is treated.[2] On the other hand, symptomatic enchondromas may require intralesional excision to reduce pain, prevent fractures, and avoid conversion into a chondrosarcoma.[10,13] Patients with proximal humerus enchondromas who were treated by intralesional resection followed by bone cement filling have been shown to have excellent clinical outcomes.[13] If a proximal humerus tumor excision results in functional impairment, oftentimes due to resection of the rotator cuff, a reverse total shoulder arthroplasty can help restore movement abilities in patients.[15]

In the event that a patient requires a total joint arthroplasty, proximal humerus bone tumors play a role in the surgical procedure. Shin et al[14] found that shoulder arthroplasty reconstruction following humeral tumor excision resulted in good clinical outcomes among 11 patients with aggressive or malignant bone tumors. However, most benign bone tumors do not require prior resection, and there is a lack of literature on total shoulder arthroplasties in the presence of asymptomatic bone tumors. One case study found that an enchondroma present in the proximal humerus caused complications during a reverse total shoulder arthroplasty procedure, as the reamer was unable to pass through the benign bone tumor and the enchondroma subsequently had to be resected.[11]

This shows that in the case of patients with osteoarthritis, an enchondroma may cause complications when planning for a shoulder arthroplasty. To our knowledge, the case study described above is the only literature detailing a

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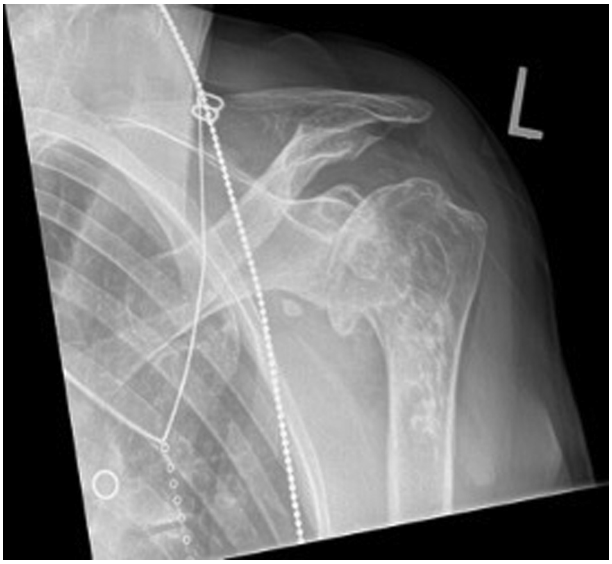

Figure 1 Radiographs taken preoperatively showing severe glenohumeral joint osteoarthritis.

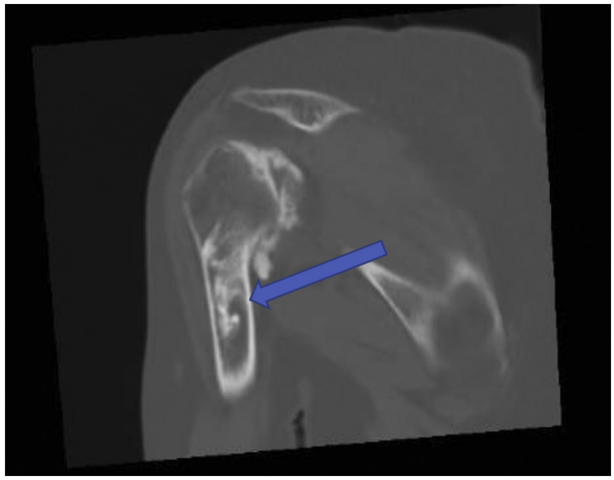

Figure 2 Computed tomography arthrogram revealing proximal humerus enchondroma (*blue arrow*).

shoulder arthroplasty procedure for a patient with a humeral enchondroma. Because the number of total shoulder arthroplasty procedures in the United States is increasing and orthopedic surgeons are therefore performing this procedure at a growing rate, it is likely that the number of patients with benign humeral bone tumors in need of a shoulder arthroplasty will also increase.[3,8] It is imperative that surgeons be aware of the complications that may arise and strategies for treatment in these cases. The purpose of this case study is to describe a primary total shoulder arthroplasty procedure for a patient with a proximal humerus enchondroma. This case highlights the difficulties that arise in this situation and suggests surgical techniques for overcoming these complications. Given that enchondromas are one of the most common bone tumors and can be found in long bones, it is important to better understand how they can be treated when arthroplasty is warranted.

Case presentation

A 65-year-old right hand–dominant woman presented to our office with left shoulder pain, which she reported began gradually 4 years prior. She reported a history of a left shoulder subacromial decompression 20 years prior and had trialed physical therapy. Radiographs taken revealed severe joint-space narrowing at the glenohumeral joint, osteophytes, and sclerosis (Fig. 1). A left shoulder magnetic resonance imaging without contrast showed severe osteoarthritic changes affecting the glenohumeral joint and osseous glenoid with intact rotator cuff tendons. There was also evidence of a 5.8-cm enchondroma within the humeral neck.

At that point, we wanted to gain more information for surgical planning and obtained a computed tomographic arthrogram. The imaging revealed sclerotic lesions involving the proximal humerus, severe glenohumeral osteoarthrosis, and no evidence of rotator cuff tear or fracture (Fig. 2). Nonoperative vs. operative treatment options, outcomes, and complications were discussed and the patient elected to go forward with a total vs. reverse shoulder arthroplasty.

Surgical procedure

Examination under anesthesia

Once the patient was positioned, examination under anesthesia showed that passive forward elevation was 70°, external rotation was 30°, abduction was 30°, and internal rotation was to the anterior hip.

Exposure

A deltopectoral interval was used, and the rotator cuff was found to be in excellent condition. A lesser tuberosity osteotomy was made taking a small wafer of bone. The proximal humerus was gently extended and externally rotated, and the proximal humerus was subluxated anteriorly. We released the inferior capsule exposing a small loose body that was 10×10 mm, which was removed from the joint. We then removed all osteophytes around the proximal humerus demonstrating the anatomic humeral head. We made a freehand cut in the patient's anatomic version and subluxated the proximal humerus posteriorly.

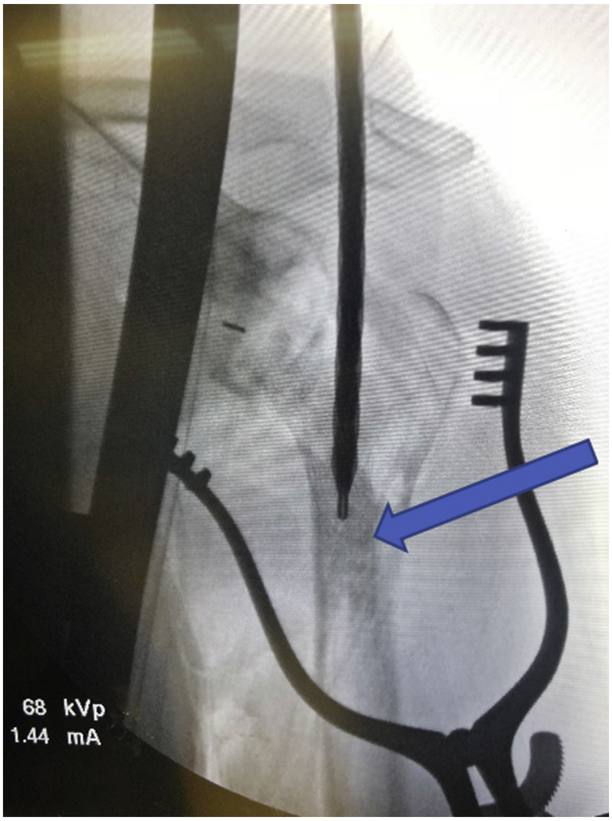

Figure 3 Intraoperative fluoroscopy showing tip of the reamer unable to pass through the enchondroma (*blue arrow*).

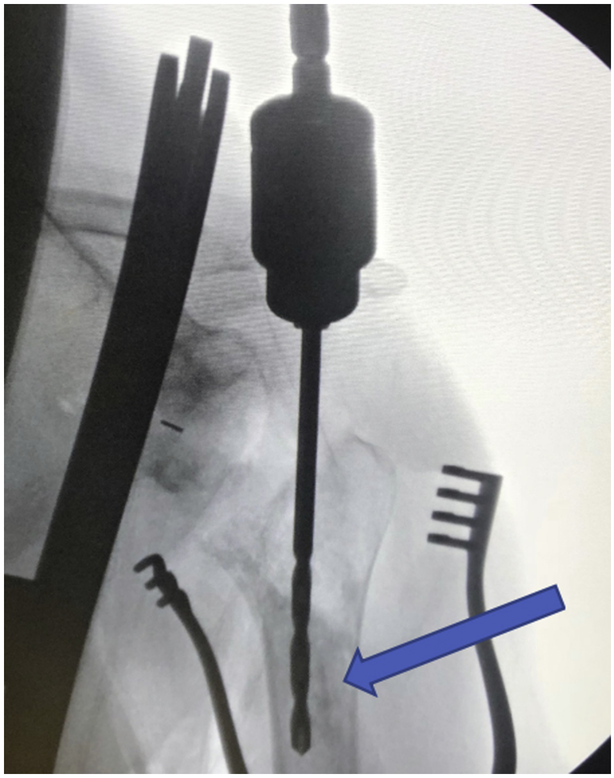

Figure 4 Intraoperative fluoroscopy showing hand drill used to pass through the enchondroma (*blue arrow*).

Glenoid preparation and implantation

The glenoid was exposed, prepared, and implanted in the standard fashion. A trial glenoid was used to size the 44-mm glenoid and determine the location of the center guide pin, which was inserted in line with the patient's native glenoid version. A 44-mm reamer was then used to gently ream the glenoid. We made our center peg tunnel and then our peripheral lug holes and trialed a 44-mm glenoid. There was no rocking, and the fixation was excellent. We then used fourth-generation cementing technique to cement our final glenoid component.

Humeral preparation through the enchondroma and implantation

We subluxated the proximal humerus anteriorly. Using an opening 6-mm reamer, we immediately ran into the enchondroma in the diaphysis. The enchondroma was extremely hard, and we were unable to safely ream through the mass by hand using our standard 6-mm opening reamer (Fig. 3). As a result, we used C-arm fluoroscopy to drill a 2-mm drill through the center of this enchondroma. We used C-arm fluoroscopy to confirm intramedullary reaming and to avoid breaching the proximal humerus metaphysis and diaphysis.

Once we were able to pass the 2-mm drill under C-arm fluroscopy guidance, checking both anteroposterior and axillary lateral views, we then sequentially increased drill bits drilling by hand, again to avoid breaching the cortical bone of the proximal humeral metaphysis and diaphysis. Once we were able to get a 6-mm drill bit through the enchondroma, we then finally used our standard 6-mm opening reamer that could now easily and safely pass the enchondroma (Fig. 4). We felt that using a >6-mm reamer could risk periprosthetic fracture. As a result, we accepted that we would have a smaller diaphyseal component; however, the enchondroma was so sclerotic the implant would be extremely stable as a press-fit construct. In addition, given the implant is designed to fit in the metaphysis, we felt that the 6-mm diaphyseal component would be adequate. We checked anteroposterior and axillary C-arm radiographs to confirm intramedullary placement of the reamer.

We used a broach and carefully impacted the 6-mm brosteotome to open the metaphyseal component, being very careful not to create a periprosthetic fracture. Once we were able to get the 6-mm broach down, which required several passes and using a rongeur to remove pieces of the enchondroma, we then trialed. We sent a biopsy of the enchondroma to pathology to confirm the diagnosis.

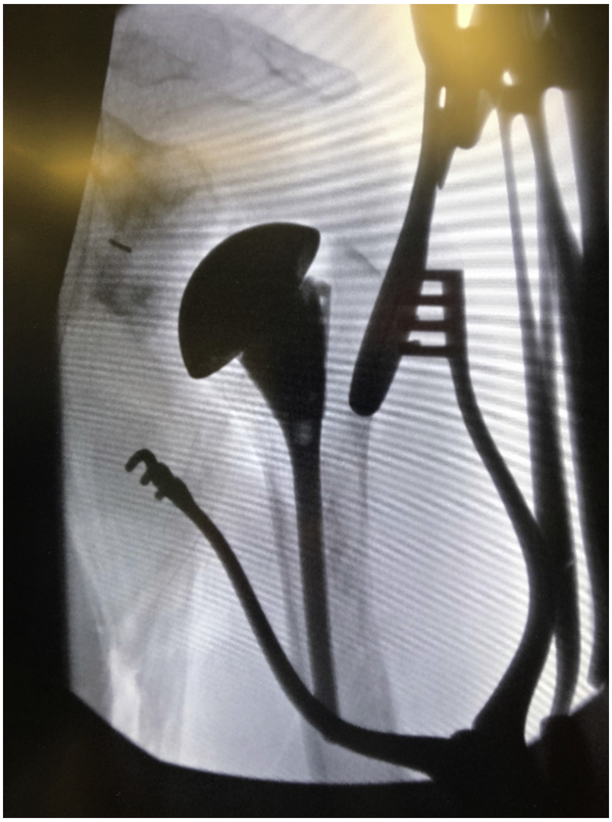

Figure 5 Intraoperative fluoroscopy showing acceptable alignment, no dislocation, and no fracture.

With a 44 × 15-mm high eccentricity head with a 6-mm humeral trial and a 128° metaphyseal component, we had excellent rotational stability and coverage of the proximal humerus. On reduction of the trial, we had 50% posterior subluxation. The patient was able to reach the opposite shoulder, extend 50°, externally rotate 70°, and forward elevate 170°. We accepted these implants and decided that no cementation was necessary.

Implantation of components and closure

Three drill holes were placed on both medial and lateral aspects of our lesser tuberosity osteotomy, avoiding the remaining enchondroma. We placed no. 5 Ethibond through these. As the proximal humerus was then prepared on the back table, we gently impacted it into the humerus wrapping our sutures around the stem to create a tension band construct. We implanted the proximal humerus without complication. We then reduced the proximal humerus. We had proper posterior subluxation of no more than 50% of the humeral head. The patient was able to reach the opposite shoulder and externally rotate 70° with forward elevation of 170° and extension of 50°. We then had the arm in neutral rotation. With the lesser tuberosity osteotomy anatomically reduced, we passed our 3 sutures medial to our bone block in a Mason-Allen fashion. Holding the

Figure 6 Radiographs taken 1 week postoperatively showing shoulder implant in place.

subscapularis and the lesser tuberosity osteotomy anatomically reduced, we tied these 3 stitches down repairing our subscapularis and lesser tuberosity osteotomy in a transosseous fashion. The rotator interval was closed with 2 figure-of-8 no. 2 FiberWires (Arthrex, Naples, FL, USA). Copious 3 liters of lavage was performed. We closed the deltopectoral junction with the Arthrex FiberTape loosely. We closed the skin in a subcuticular fashion. The patient was placed into a regular sling. Radiographs confirmed no periprosthetic fracture or dislocation (Fig. 5). At the patient's initial postoperative visit 1 week later, radiographs revealed intact hardware and acceptable alignment (Fig. 6).

Discussion

Total shoulder arthroplasty is the third most common joint replacement procedure, yet it has been reported that 75% of surgeons perform 4 or fewer total shoulder arthroplasties per year.[5,6] Surgeons who perform fewer shoulder replacements have higher complication rates, and a review study revealed a complication rate of 14.7% for total shoulder replacements.[1,5] Intraoperative fractures, glenoid compartment loosening, and humeral head subluxation are some of the most common complications.[1,12]

Given the high complication rate for this procedure and the fact that most orthopedic surgeons perform a low number of total shoulder arthroplasties per year, it is important that surgeons be aware of the complications that may arise in patients with bone tumors. The current study describes a case in which a patient with a humeral enchondroma underwent a primary total shoulder arthroplasty. We found that the enchondroma was much denser than bone, which posed difficulties when preparing the humeral component. In patients with benign bone tumors, we therefore feel that using a small power drill (2-mm) under C-arm fluoroscopic guidance can help ensure intramedullary reaming. This also assists with passage through the tumor, as hand reaming is too difficult, unsafe, and sometimes impossible. Once the enchondroma has been drilled, we recommend sequentially increasing the size of the drill bit and drilling/reaming by hand until reaching a diameter that matches the smallest intramedullary reamer that is 1 size larger than the implant. This sequential approach can help the reamer get through the extremely hard tissue of the enchondroma, and over-reaming allows enough room for the implant to fit into the bone, minimizing the risk of periprosthetic fracture. We also recommend using C-arm fluoroscopy guidance to avoid inadvertently puncturing the cortex of the bone.

Although these recommendations can help reduce complications with this procedure, further studies and industrial development can be helpful to develop tools that can more easily pass through enchondromas and other bone tumors that are too dense for hand reaming. We found that with the available rigid reamers, it was very difficult to pass through the dense material of the enchondroma. Because these bone tumors create great difficulties when attempting a total shoulder arthroplasty, stronger and more accurate tools and perhaps flexible reamers could help decrease the complications that arise in this procedure.

Disclaimer

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