



## Single-stage bilateral uncemented reverse shoulder arthroplasty for traumatic proximal humerus fractures: a case report



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### ARTICLE INFO

#### Keywords:

Arthroplasty  
Simultaneous  
Bilateral  
Proximal humerus fracture  
Reverse total shoulder arthroplasty  
Uncemented  
Trauma

Proximal humerus fractures (PHFs) are the seventh most frequent fracture in adults and have an unadjusted incidence of 82 per 100,000 person-years.<sup>28,35</sup> Although they are commonly associated with high-energy mechanisms of injury in younger patients, they also occur with increasing incidence in older patients through low-energy trauma.<sup>35</sup> The bimodal distribution of these injuries indicates that PHFs are the third most common osteoporotic fracture behind the distal radius and vertebrae.<sup>11</sup> Furthermore, stratifying the demographics of PHFs in the older population found that women were more likely to suffer from a PHF than men by a ratio of 7:3.<sup>14</sup> The incidence of bilateral PHFs has not been studied to the extent of unilateral cases, although there have been case reports published describing these events.<sup>3,12,19,29,50</sup>

In addition to the paucity of literature available for bilateral PHFs in older patients, treatment options for these fracture patterns are also a controversial topic. This includes a nonoperative approach, closed reduction and percutaneous fixation, suture fixation, operative fixation with plate and screw construct (open-reduction internal-fixation (ORIF)), intramedullary fixation, hemiarthroplasty (HA), and reverse shoulder arthroplasty (RSA).<sup>31</sup> Treatment choice predominantly depends on the patient's age, comorbidities, pre-existing arthritis or rotator cuff pathology in the fractured shoulder and fracture characteristics such as Neer classification, bone quality, and the amount of calcar that remains which corresponds to risk of avascular necrosis.<sup>27</sup> In elderly patients with Neer 3 and 4-

part fractures, reverse total arthroplasty has been shown to have better functional outcomes and lower complication rates than ORIF or HA making RSA the predominant surgical treatment for these patients.<sup>3,8,13,26,34,44,46</sup>

Although there is a general trend to treat Neer 3 and 4-part fractures in elderly patients with reverse total shoulder arthroplasty, there are still differences in technique and in decision-making when a patient presents with bilateral PHFs. Various case studies have been reported for the treatment of bilateral PHFs including the use of nonoperative treatment,<sup>47</sup> bilateral ORIF,<sup>50</sup> ORIF and HA,<sup>19</sup> RSA and intramedullary nailing,<sup>50</sup> and bilateral RSA.<sup>12,29</sup> The differences in technique were primarily identified in case reports of bilateral RSA being utilized where the majority of surgeons opted for cementing their stems.<sup>12,29,55</sup> Differences were also observed in treatment planning as either acute or delayed treatment of PHFs with RSA. However, Lu et al recently determined that acute treatment of PHFs with RSA provided better clinical outcomes compared to delayed treatment.<sup>38</sup> Earlier fixation of these fractures with early arm use for activities of daily living (ADLs) may also allow these elderly patients to return to activities and independent living faster which is important in this patient population. In this report, we present the case of a 74-year-old woman with bilateral 3-part PHFs following a fall from standing height who underwent simultaneous uncemented bilateral RSA with early range of motion (ROM) for ADLs postoperatively. Consent was obtained from the patient for this case report.

### Case

A 74-year-old right-hand-dominant woman (body mass index, 47.64 kg/m<sup>2</sup>) with a history of diabetes mellitus and deep vein

Institutional review board approval was not required for this case report.

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<https://doi.org/10.1016/j.xrrt.2024.04.009>

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thrombosis, on treatment with warfarin (International normalized ratio on presentation 1.4), presented to an outside emergency department following a traumatic fall from standing height off a curb. The patient attempted to catch herself before landing on bilateral outstretched hands. The patient did hit her head but denied any loss of consciousness. Initial radiographic imaging (Fig. 1) at the outside hospital revealed bilateral PHFs. Due to the complexity of the fractures, the outside hospital elected to transfer the patient to our level 1 trauma center for further surgical evaluation.

Upon arrival at our hospital, a level 1 trauma center, the patient was evaluated by our orthopedic team and reported bilateral shoulder pain with no other acute complaints. Before this injury, the patient reported having chronic right shoulder pain for which she had been receiving physical therapy, although she was unclear of her exact diagnosis. She lived and functioned independently and worked as a hotel manager. On physical exam, she was in bilateral slings with no visible deformity. No focal neurological or vascular deficits were noted, compartments were soft and compressible, and there was significant tenderness to palpation of shoulders bilaterally. Computed tomography (Fig. 2) was performed and determined the patient had bilateral 3-part PHFs.

The patient remained in bilateral slings and was admitted to the hospital. Considering the patient's age, fracture pattern, and activity level, we deemed surgical intervention would be the best option for her to attempt to allow early use of her arms and return to independence. The surgeon felt that RSA using an uncemented fracture stem with a robust tuberosity repair to allow early ROM was indicated. Given that the patient did not have significant cardiac or pulmonary comorbidities, it was felt that both PHFs could safely be repaired in a single-anesthesia event. The patient was brought to the operating room 4 days after presentation to allow for adequate time for preoperative medical optimization.

### Surgery

General anesthesia was induced, and the patient was positioned in a beach chair position with both arms prepped and draped. An interscalene block was not utilized on either side to reduce the risk of bilateral phrenic nerve paralysis.<sup>57</sup> Hydraulic arm positioners were utilized. The patient was given weight-based doses of antibiotics before surgical incision. A standard deltopectoral incision and approach was utilized. The biceps tendon was then tagged with nonabsorbable sutures and the bicipital groove opened. The subscapularis and lesser tuberosity were tagged with sutures and osteotomized. The posterior superior rotator cuff was then tagged and the greater tuberosity mobilized. The fractured humeral head was identified and removed. Once removed, the axillary nerve was identified and grossly intact.

Next, the glenoid was exposed. Electrocautery was used to remove the labrum and a Cobb was used to clean the glenoid. A guide was used to place the center guide wire into the glenoid in neutral version and inclination. The glenoid was then reamed on power with a size 24 reamer, up to a size 33-mm reamer. A 24-mm Arthrex Univers baseplate (Arthrex, Naples, FL, USA) was then placed and a size 33 glenosphere was impacted into place. No lateralization was added to the baseplate or the glenosphere so as not to overtension the tuberosity repair.

The humerus was prepared by gentle reaming of the canal and broaching at 20° of version. The humerus was sequentially broached until a press-fit with axial and rotational stability was achieved. Care was taken to not fracture the calcar during broaching. A standard cup and polyethylene were trialed and found to be stable. Height was chosen so that the tuberosities reduced anatomically to the shaft without tension once the humerus was reduced. If the calcar remains attached to the shaft, as is often the

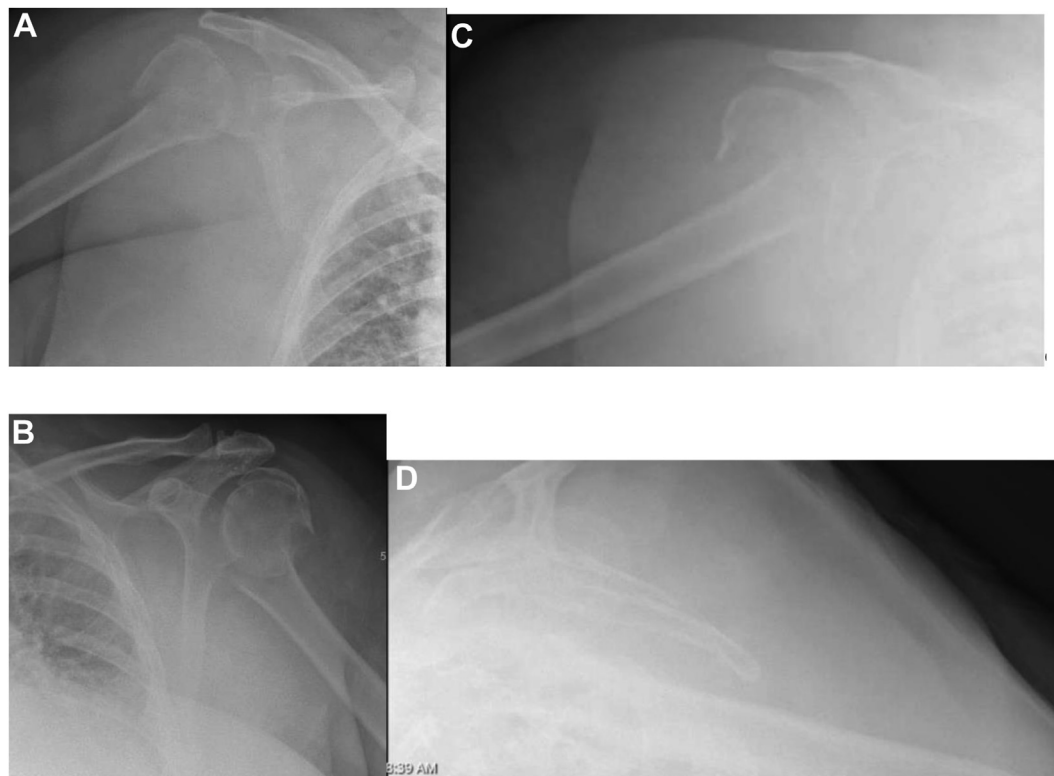
case in our older osteoporotic fractures, it can be used as a guide for where to position the humeral stem to when broaching. The senior author often utilizes this as a reference point and places the stem so the medial calcar of the stem is level or just above the medial calcar on the shaft. The stem that had axial and rotational stability was selected. The Arthrex Univers Revers Fracture Stem (Arthrex, Naples, FL, USA) was used. Two number 2 high-tensile nonabsorbable sutures were placed in the shaft through 2 drill holes and 4 number 2 high-tensile nonabsorbable sutures were placed through the holes in the suture cup for tuberosity repair (2 for the greater tuberosity and 2 for the lesser tuberosity). Before impacting the final stem, 4 0-Vicryls (Ethicon, Raritan, NJ, USA) sutures were passed around the greater tuberosity to use as passing sutures for the nonabsorbable sutures in the stem. The stem was impacted into place in a press-fit fashion at 20° of retroversion. The shoulder was reduced and deemed to be stable. The tuberosities were repaired using the sutures in both the shaft and stem using the technique recommended for the Univers Revers Fracture Stem<sup>22</sup> as tuberosity repair and healing has been shown to lead to better function compared to resection.<sup>2,23,42</sup> First, the 2 sutures on the greater tuberosity side of the stem were passed through the greater tuberosity using the 4 previously passed 0-Vicryls. All 4 limbs from the 2 sutures were passed. The 4 limbs from the 2 sutures on the lesser tuberosity side of the cup were passed around the lesser tuberosity through the subscapularis using a free needle. The sutures from the greater and the lesser tuberosity were tied to each other in a linked construct. The sutures from the shaft were then passed through the subscapularis and the supraspinatus at the edge of the tuberosities in a figure-of-eight fashion and tied. The wound was then closed using standard techniques. As the team began to close the first side, the surgeon began to replace the contralateral shoulder using the same technique.

Estimated blood loss for the case was 400 mL. Total duration in the operating room was 5 hours and 1 minute. Total anesthesia duration was 4 hours and 55 minutes. Radiographic imaging obtained in the operating room showed successful uncemented bilateral RSA (Fig. 3). There were no perioperative complications.

### Postoperative follow-up

The patient was administered cefazolin for 24 hours postoperatively and was given prophylactic lovenox. She was placed in bilateral shoulder slings for comfort only and was non-weight-bearing for transfers but allowed to use her hands and arms immediately for ADLs as tolerated. Occupational therapy saw the patient on postoperative day 1 to help the patient return to independent function. The patient was discharged to a rehabilitation facility on postoperative day 4.

Physical therapy started immediately with passive ROM until 4 weeks postoperatively. Her self-reported pain score was 2/10 bilaterally at 2 weeks and 0/10 bilaterally at 6 weeks postoperatively. Active ROM (AROM) was assessed by the surgeon at 2 weeks, 6 weeks, 12 weeks, 6 months, and 1-year follow-up. The left arm lagged behind the right arm in AROM throughout the follow-up duration. At 2 weeks, AROM forward flexion was 20° on the right and 0° on the left, and abduction was 30° on the right and 0° on the left. At 6 weeks, AROM forward flexion was 50° on the right and 30° on the left, abduction was 80° on the right and 40° on the left, and external rotation was 10° on the right and 0° on the left. At 6 months, AROM forward flexion was 130° on the right and 80° on the left, abduction was 90° on the right and 80° on the left, and external rotation was 30° on the right and 0° on the left. However, at 1 year, bilateral arms had equal AROM with 120° forward flexion, 90° abduction, and 30° external and internal rotation to the



**Figure 1** X-ray radiograph in anterior-posterior view showing (A) Right and (B) Left bilateral proximal humerus fractures as well as orthogonal views for the right and left in figures (C) and (D), respectively.

buttock. The American Shoulder and Elbow Surgeons score was calculated 1 year postoperatively to assess shoulder function and was found to be 50 bilaterally. Throughout the 1-year follow-up period, the patient remained satisfied with her treatment and progress.

All follow-up radiographic imaging within the 1-year follow-up were taken at our associated clinic and showed stable bilateral RSA without evidence of loosening, dislocation, or failure (Fig. 4). The imaging did not reveal scapular notching and the patient's tuberosity healed well. The patient is scheduled for follow-up again at 2 years postoperatively.

## Discussion

### Defining case characteristics

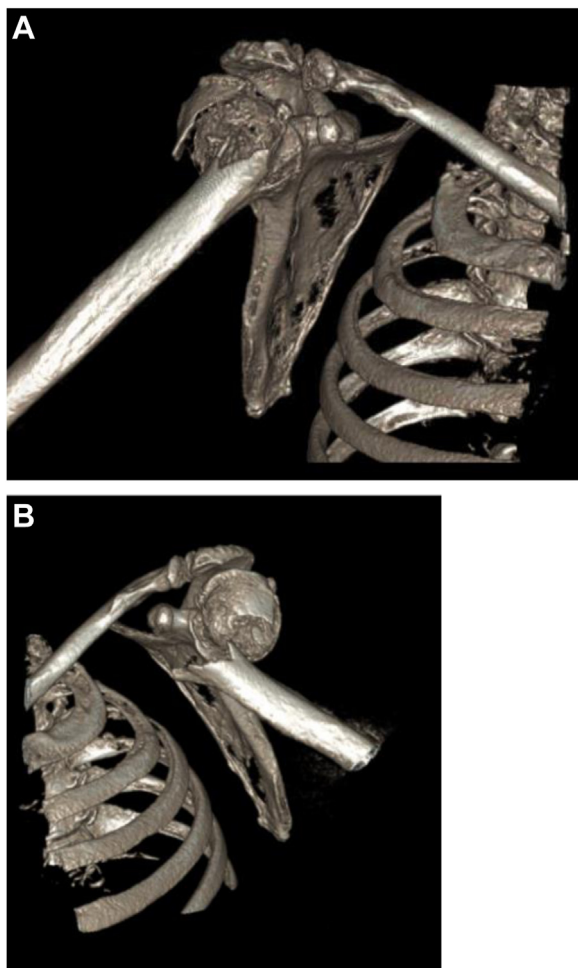
This is one of the first reports published on simultaneous uncemented RSA for bilateral PHF in an older patient where the patient was allowed early use of her arms for ADLs. Of note, the current literature available on simultaneous bilateral RSA has primarily been in patients who sustained bilateral posterior fracture-dislocations following a seizure.<sup>5,18,58</sup> This is an important distinction, as a shoulder dislocation predisposes the patient to increased risks including osteonecrosis, post-traumatic arthritis, and joint stiffness, making the RSA a better treatment choice in a patient with a fracture-dislocation.<sup>15</sup> Although our reported case did not experience a concordant dislocation, we still opted for an RSA due to the patient's age, poor bone quality, and fracture severity.

### Operative choice

In patients who have an isolated PHF, alternative treatment options are available, with one of the most popular choices being

ORIF. ORIF is the more popular option when injuries are less severe such as Neer type 2 fractures and also in younger patients.<sup>6</sup> In more severe injuries such as Neer type 3 and 4 fractures, the standard-of-care treatment options in elderly patients are RSA and HA, with RSA showing better outcomes than HA.<sup>6</sup> It is important to note that, although the Neer classification is the standard classification system used for PHF and helps guide treatment decisions, there is a known interobserver/intraobserver disparity in classifying these fractures.<sup>9,10,24,33,52,53</sup> Despite this known disparity, the Neer classification remains the gold standard classification system for PHF at our institution. In regard to operative choice for Neer 3 and 4-part fractures, RSA has been favored over HA in older patients given the superior functional outcomes and lower risk of complications and reoperations when compared to HA.<sup>3</sup> Additionally, RSA utilizes the function of the deltoid muscle and does not rely on the healing of the tuberosities and is therefore a more reliable treatment option for patients with tuberosity fractures.<sup>16</sup> The authors still believe it is important to attempt to anatomically repair the tuberosities as it has been shown that tuberosity healing after RSA for fracture leads to better functional outcomes.<sup>2,23,42</sup>

While postoperative surgical complications and blood loss do not significantly differ between simultaneous ORIF compared to RSA based on current literature,<sup>30,39,56</sup> it is important to note that the risk of hardware failure is higher following ORIF, particularly in osteoporotic patients with an increased risk of poor screw purchase.<sup>15</sup> Recent data has also demonstrated better functional outcomes following the use of RSA in elderly patients.<sup>21,56</sup> Data from the DelPhi trial found a superior 2-year Constant score in RSA compared with ORIF for patients treated for Arbeitsgemeinschaft für Osteosynthesefragen Type C2 fractures.<sup>21</sup> These findings are supported by Tong et al, who found that complex fractures treated with ORIF have worse functional outcomes compared to RSA after the 6-month postoperative point.<sup>56</sup> While ORIF may offer a shorter

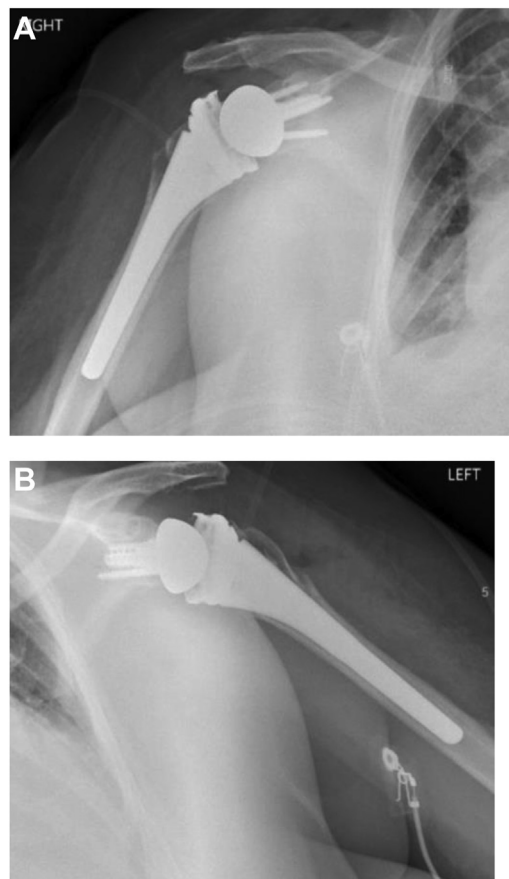


**Figure 2** CT scan with reconstruction of shoulder showing (A) 3-part (Right) and (B) 3-part (Left) bilateral proximal humerus fractures. CT, computed tomography.

postoperative recovery time and quicker transition to weight-bearing.<sup>34,43,45</sup> RSA appears to offer better long-term functional outcomes. The senior author allows all RSA for fracture patients to use their arms immediately postoperatively for ADLs and walker or cane use if necessary. The patients are asked not to use the arm for weight-bearing for transfers until 12 weeks postoperatively to try to prevent dislocation.

#### Cementation

While the operative time and associated duration under anesthesia do not differ between the 2 procedures themselves, the surgical duration may be prolonged if the decision is made to utilize a cemented stem. Case reports of RSA for PHFs have differed such as Vitali et al<sup>58</sup> and Azad et al,<sup>5</sup> where a press-fit stem was utilized whereas El Rassi et al,<sup>18</sup> Ijima et al,<sup>29</sup> and Murphy et al,<sup>40</sup> utilized a cemented stem. Using a cemented stem should theoretically extend the case duration; however, cementation status is only one of many factors that affect operative time.<sup>32,36,49</sup> These results are consistent with our literature review on bilateral cemented RSA for PHF where El Rassi et al, documents an operative time of 4 hours<sup>18</sup> and Ijima et al, documents an operative time of 5 hours and 16 minutes.<sup>29</sup> In comparison, we utilized an uncemented stem and had a total operative time of 5 hours and 1 minute, demonstrating no clinical difference. Additionally, the data surrounding differences in



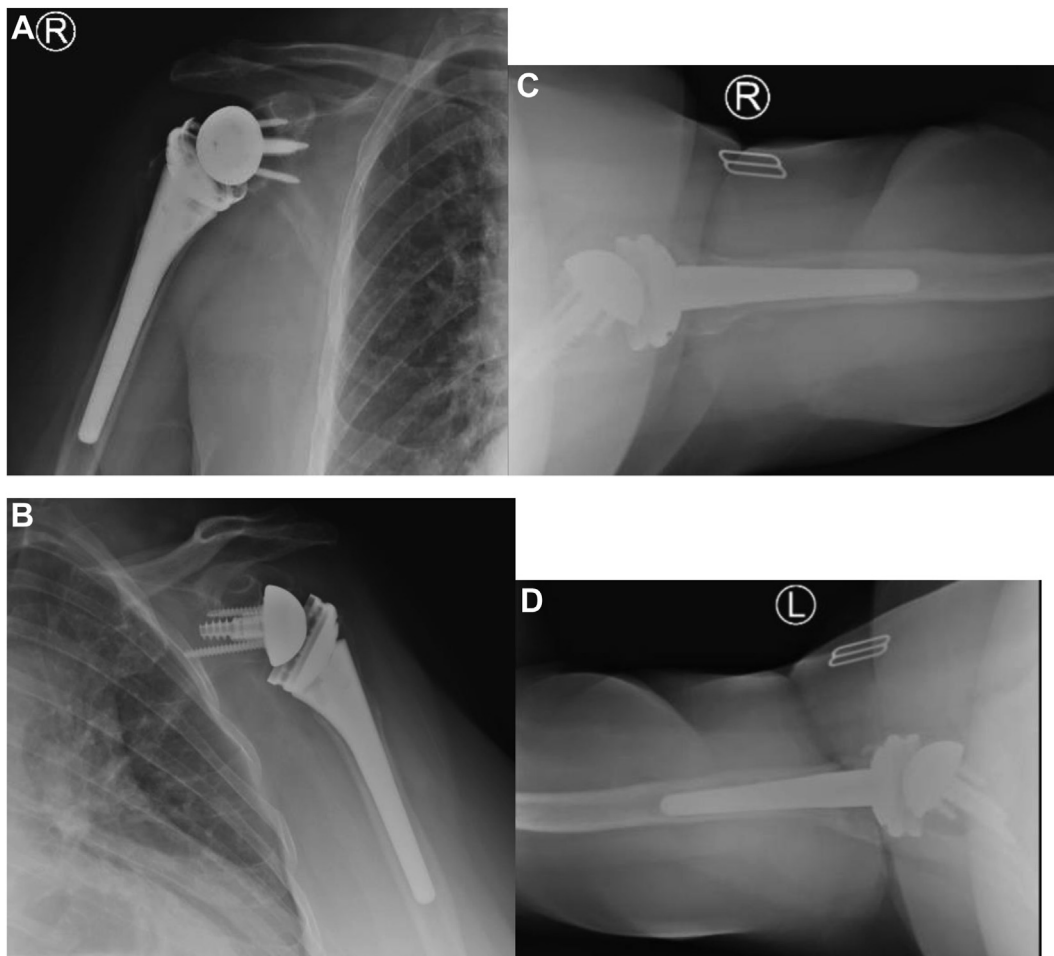
**Figure 3** Initial postoperative X-ray radiograph in the anterior-posterior view showing (A) Right and (B) Left bilateral reverse total shoulder arthroplasty.

functional outcomes have found no significant difference related to cementation status.<sup>48,51</sup> The risk of loosening based on utilizing cemented or press-fit stems is also controversial.<sup>1,37,41</sup> Additional benefits of press-fit stems include improved bone stock preservation in the event a revision is necessary.<sup>41</sup> Using a cementless stem may also improve tuberosity healing by potentially avoiding the risk of thermal necrosis of the tuberosities associated with the cement.<sup>20,54</sup> Most notably, using cement is advantageous in patients with poor bone quality where adequate osteointegration cannot be achieved.<sup>1,41</sup> Based on intraoperative analysis of the patient's bone quality, we felt that a cementless press-fit arthroplasty would provide adequate fixation.

#### Postoperative care

Postoperative care is essential for restoring patient functionality and satisfaction. In our case, we encouraged early ADLs, limited sling use to comfort only after surgery, and allowed for passive ROM exercises immediately after surgery. While literature specific to RSA for fracture is limited with regard to postoperative rehabilitation, these guidelines are consistent with the findings of Edwards et al who found that early rehabilitation for primary RSA, specifically for rotator cuff tears or glenohumeral osteoarthritis, with ROM starting at 2 weeks increases arm flexion at 1 year and patient-reported function at 3 and 6 months postoperatively.<sup>17</sup> Hagen et al performed a similar study where they included patients who underwent RSA for any surgical indication and found no significant difference in ROM and functional outcomes between early and delayed physical therapy.<sup>25</sup> However, in cases with an elderly





**Figure 4** One-year postoperative X-ray radiograph in the anterior-posterior view showing (A) Right and (B) Left bilateral reverse total shoulder arthroplasty as well as the axillary view for the right and left in figures (C) and (D), respectively.

patient such as ours with bilateral upper extremity injuries, it is reasonable to allow for early physical therapy to allow immediate use for ADLs and possible earlier return to independence. Patients with bilateral PHFs may require time in a rehabilitation facility as they will likely need 24-hour assistance given their limited ability to care for themselves. Our patient was discharged to a rehabilitation facility until she gained enough use of her arms to independently care for herself at home.

#### Cost effectiveness

In today's healthcare climate, the cost-effectiveness of a procedure and its overall value should always be considered in treatment decisions. Bilateral RSA for fracture is a very costly procedure with regard to implants, hospital stay, and likely length of stay in a rehabilitation facility. In an elderly patient with bilateral PHFs, it is very likely that the costs of treatment such as length of stay in the hospital and/or a rehabilitation facility will be similar regardless of treatment choice due to the significant functional impairments the patient faces. The authors believe the only significant differences will be operative time and implant choice. In this report, the patient underwent bilateral RSA in a single-stage procedure, decreasing overall OR time by having 1 single anesthesia induction, set up time, and the ability to start the second side while closing the first side. Cement may also increase cost both for the cost of the cement itself and likely adding to time in the operating room waiting for the

cement to cure. With regard to implant choice, while ORIF may be a less costly implant, studies have shown either no difference in cost-effectiveness between RSA and ORIF<sup>7</sup> or that RSA is more cost-effective.<sup>4</sup> The authors therefore believe that bilateral uncemented reverse total shoulder arthroplasty for this patient's bilateral PHFs was the best option to give her the best functional outcome for her injury.

#### Conclusion

In this report, we showed the clinical and radiographic success of simultaneously treating bilateral 3-part PHFs in an elderly woman by uncemented RSA with early arm use for ADLs. In doing so, we were able to limit our operating time, anesthesia time, cost, and hospital duration. Additionally, due to our choice of surgical repair, our patient was allowed early ROM leading to a successful recovery process. Although there is still controversy regarding the treatment of bilateral PHFs, in this case report we demonstrate that uncemented RSA is both effective at restoring function and alleviating pain.

#### Disclaimers:

Funding: No funding was disclosed by the authors.  
Conflicts of interest: Catherine Fedorka is a paid consultant of Stryker Medical. No Stryker Medical equipment was used in this

study. She is also a board member for Philadelphia Orthopaedic Society, and a committee member for the American Shoulder and Elbow Surgeons society. The other authors, their immediate families, and any research foundations with which they are affiliated have not received any financial payments or other benefits from any commercial entity related to the subject of this article. Patient consent: The patient provided consent for this case report.

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