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PHILOS plating of periprosthetic humeral shaft fracture after onlay-type reverse total shoulder arthroplasty: a case report

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As a result of the expansion of the indications for reverse shoulder arthroplasty (RSA), the number of RSA cases is increasing.[5,8] Because of the increase in RSA cases and the aging society, the incidence of periprosthetic humeral fracture is also increasing.[3] The treatment of periprosthetic humeral fracture is challenging, and the treatment options range from conservative treatment to open reduction and internal fixation (ORIF) and revision arthroplasty.[3] Fracture displacement may be an indication for surgical treatment. Revision surgery should be considered when loosening of the humeral component is detected. However, ORIF is a treatment option in cases with no evidence of component loosening.[1,6] One of the biggest concerns when performing ORIF is the plate selection, as the humeral component occupies the proximal diaphysis, which makes it difficult to insert the screws. As an alternative to screws, cerclage cable is used to fix the proximal bone fragment to the plate. However, simple cerclage cable is inferior to monocortical and bicortical locking screws with respect to torsion load and axial compression load.[7] In addition, as some fracture types (including transverse fracture) require compression of the fracture site with a plate, it is necessary to securely fix the proximal fragment. Thus, it is preferable to insert screws into the proximal bone if possible.

Recently, the design of the humeral stem used in RSA has changed, with an increase in the use of a short stem that preserves the bone stock of the greater tuberosity (onlay-type RSA).[4] Onlay-type RSA results in more space to insert the screws into the greater tuberosity compared with conventional inlay-type RSA. However, to our knowledge, there are few reports on the treatment of periprosthetic humeral shaft fracture after onlay-type RSA with locking screws inserted into the proximal bone fragment. Herein, we describe one treatment option for periprosthetic humeral shaft fracture after onlay-type RSA.

Case presentation

A 78-year-old woman injured her left humerus due to a fall. Initial radiographs revealed a periprosthetic humeral shaft fracture (Fig. 1). Onlay-type RSA (Aequalis Ascend Flex™, Wright) had been performed for irreparable massive rotator cuff tear 4 months before the fracture. During the RSA, cement had been used to fix the humeral component due to the occurrence of hairline fracture at the proximal end of the humerus during the press fitting of the humeral component. Before the periprosthetic fracture at 4 months after the RSA, the patient had not reported any pain and her active range of shoulder motion was as follows: anterior elevation, 90°; external rotation with the arm at the side, 30°; internal rotation, 3rd lumbar vertebra. As the fracture was displaced and there was no evidence of humeral component loosening, ORIF was performed at 1 week after the fracture in accordance with the treatment strategy proposed by Kirchhoff et al.[6]

The patient was placed in the beach chair position with arm positioners. The prior deltopectoral skin incision was used, with an additional distal skin incision to insert distal screws. A 2-cm incision was also made in the proximal side of the pectoralis major muscle attached to the humeral bone to enable clear visualization of the fracture site. Reduction was performed easily. The nine-hole proximal humeral plate (PHILOS™ long plating

This case report was approved by our ethics review board (protocol A19-254).
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Figure 1 Initial radiograph showing a left displaced periprosthetic humeral shaft fracture.

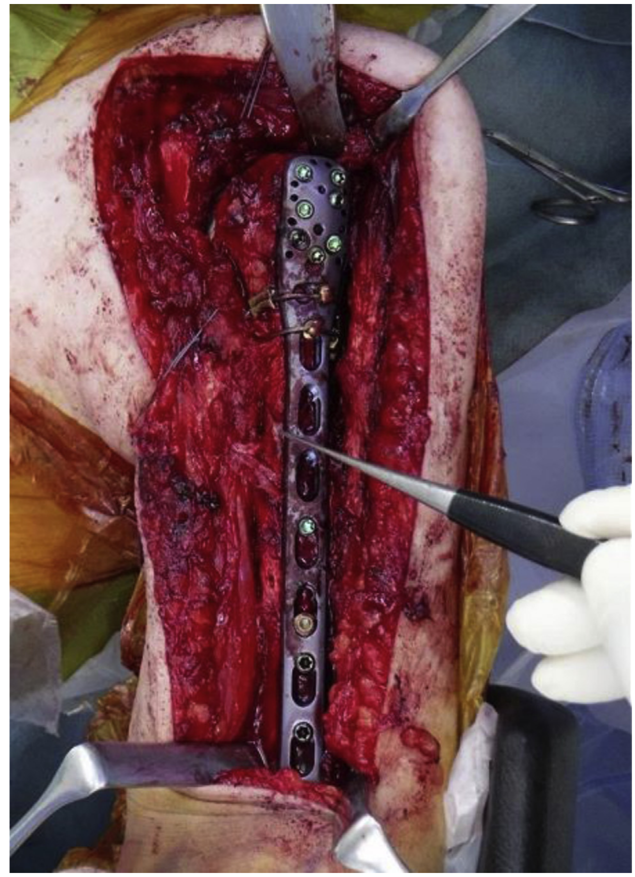

Figure 3 Operative findings.

system, Depuy Synthes) was chosen as a dynamic compression plate, as it enables the insertion of multiple locking screws in the residual greater tuberosity (Fig. 2, A and B). The middle portion of the plate was bent anteriorly to minimize the damage to the deltoid insertion on the humeral bone. Kirschner wire was used to achieve temporary fixation at the appropriate height to enable the insertion of the most proximal screw. Seven locking screws were inserted into the greater tuberosity, and two temporary cerclage cables were inserted loosely at the proximal and middle regions of the insertion of the latissimus dorsi on the humeral bone. We confirmed that the top two screws were inserted in the bone under direct vision. As the fracture type was transverse, compression of the fracture site was absolutely necessary. Therefore, immediately after the fixation of the proximal fragment to the plate, a cortical screw was inserted into the distal fragment through the dynamic hole to compress the fracture site. Locking screws were then inserted into the distal bone fragment.

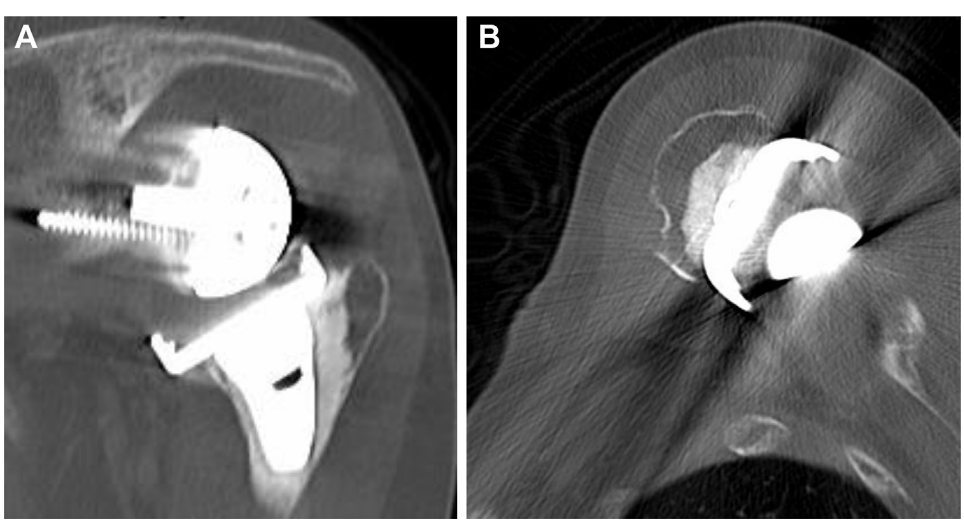

Figure 2 (**A**) Initial CT coronal view showing abundant bone stock at the greater tuberosity. (**B**) Initial CT axial view showing abundant bone stock at the greater tuberosity.

The cerclage cables in the proximal fragment were tightened and fixed to the plate to reinforce the locking screws in the osteoporotic bone. The proximal side of the pectoralis major muscle was repaired with fiber wire (Figs. 3, 4, A and B).

Postoperatively, a sugar tongue splint from shoulder to forearm was applied for 2 weeks. After that, a functional brace was applied for 6 weeks, and shoulder and elbow motion was permitted. Daily teriparatide and low-intensity pulsed ultrasound therapy were started at 2 days after ORIF. Radiographic examination was performed once a month after surgery and showed bony union at 5 months after ORIF (Fig. 5, A and B). At final follow-up performed 6 months after ORIF, the active shoulder ranges of motion were an anterior elevation of 90°, external rotation at the side of 30°, and internal rotation to the 4th lumbar vertebra. The numerical rating scale for pain was zero. The American Shoulder and Elbow Surgeons shoulder score was 70. The patient's physical findings were the same as before the periprosthetic fracture, and she was able to perform all daily activities without assistance.

Discussion

The present case describes one treatment option for periprosthetic humeral shaft fracture after onlay-type RSA. The PHILOS™ long plate is suitable in such cases, as it enables the insertion of multiple locking screws into the residual greater tuberosity to achieve compression of the fracture site. Anterior plate bending may minimize the damage to the deltoid insertion on the humeral bone.

Figure 4 (**A**) Anteroposterior radiograph taken immediately after surgery. (**B**) Lateral radiograph taken immediately after surgery.

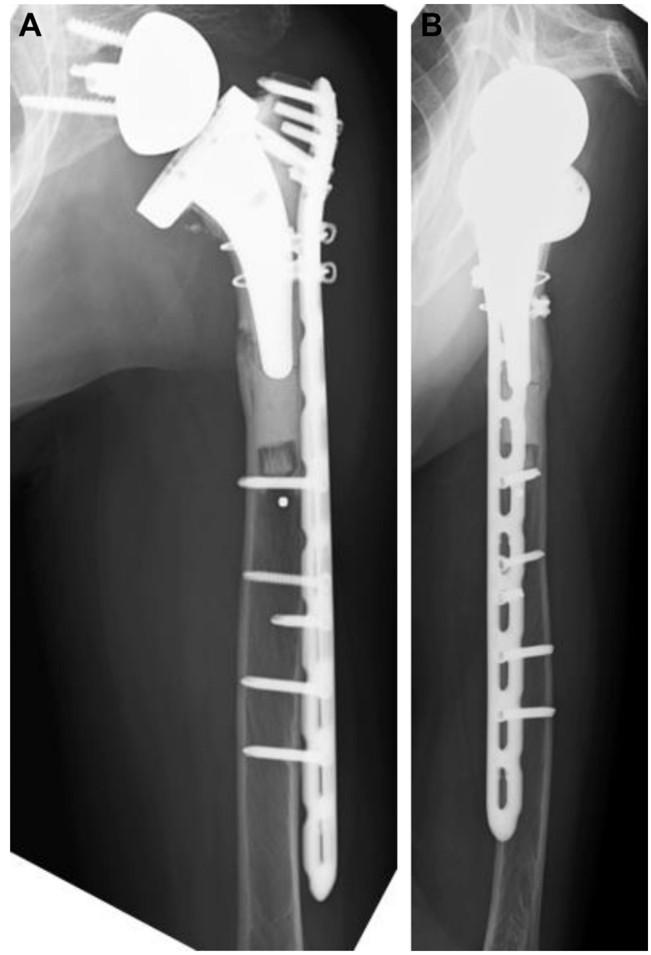

Figure 5 (**A**) Anteroposterior radiograph taken at final follow-up 6 months postoperatively. (**B**) Lateral radiograph taken at final follow-up 6 months postoperatively.

The PHILOS™ long plate enables the insertion of locking screws into the residual greater tuberosity after onlay-type RSA. Although a large locking plate and proximal cerclage cable is often used to treat periprosthetic humeral fracture, it is difficult to insert the large locking screw into the residual greater tuberosity. Furthermore, simple cerclage cable is inferior to monocortical and bicortical locking screws with respect to torsion load and axial compression load.[7] In addition, as the present case involved a transverse fracture, compression of the fracture site was absolutely necessary and the use of a dynamic compression plate was required. Hence, it was important to securely fix the proximal fragment to the plate before inserting the dynamic compression screws into the distal fragment, and so locking screws were inserted into the proximal fragment. Fortunately, onlay-type RSA preserves the greater tuberosity bone stock. The humeral stem has a low-profile lateral border to protect the rotator cuff insertion.[4] Furthermore, the PHILOS™ plate achieves a good fit to the greater tubercle in the fixation of a proximal humeral fracture. Even if the plate fit is not good enough to enable the insertion of all of the locking screws into the residual greater tuberosity, a certain amount of proximal plate installation is permissible because of the increased acromiohumeral distance after RSA,[9] as long as impingement is avoided. Therefore, it is reasonable to use the PHILOS™ long plate for periprosthetic humeral shaft fracture after onlay-type RSA.

In RSA, the humerus is lowered relative to the acromion, which restores and even increases the deltoid tension.[2] The deltoid muscle is the key to achieving good clinical results after RSA.

Therefore, minimization of the damage to the deltoid insertion is important in achieving a good clinical outcome. Bending the plate anteriorly may be a good way to avoid or minimize the damage to the deltoid insertion.

Conclusion

Periprosthetic humeral shaft fracture after onlay-type RSA may be treated with an anteriorly bent PHILOS™ long plate because this enables the insertion of multiple locking screws into the residual greater tuberosity bone stock to achieve compression of the fracture site and minimizes injury to the deltoid insertion.

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Conflict of interest

The 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.

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Patient consent

Obtained.

References

1. Anderson JR, Williams CD, Cain BR, Mighell M, Frankle M. Surgically treated humeral shaft fractures following shoulder arthroplasty. J Bone and Joint Surg 2013;95:9-18. https://doi.org/10.2106/JBJS.K.00863.
2. Boileau P, Watkinson DJ, Hatzidakis AM, Balg F. Grammont reverse prosthesis: Design, rationale, and biomechanics. J Shoulder Elbow Surg 2005;14:147-61. https://doi.org/10.1016/j.jse.2004.10.006.
3. Canton G, Fazzari F, Fattori R, Ratti C, Murena L. Post-operative periprosthetic humeral fractures after reverse shoulder arthroplasty: a review of the literature. Acta Biomed 2019;90(supplement):8-13. https://doi.org/10.23750/abm.v90i12-S.8974.
4. Casagrande DJ, Parks DL, Torngren T, Schrumpf MA, Harmsen SM, Norris TR, Kelly JD II. Radiographic evaluation of short-stem press-fit total shoulder arthroplasty: short-term follow-up. J Shoulder Elbow Surg 2016;25:1163-9. https://doi.org/10.1016/j.jse.2015.11.067.
5. Kim SH, Wise BL, Zhang Y, Szabo RM. Increasing incidence of shoulder arthroplasty in the United States. J Bone Joint Surg Am 2011;93:2249-54. https://doi.org/10.2106/JBJS.J.01994.
6. Kirchhoff C, Beirer M, Brunner U, Buchholz A, Biberthaler P, Cronlein M. Validation of a new classification for periprosthetic shoulder fractures. Int Orthop 2018;42:1371-7. https://doi.org/10.1007/s00264-018-3774-5.
7. Lenz M, Perren SM, Georguiev B, Hontzsch D, Windolf M. Mechanical behavior of fixation components for periprosthetic fracture surgery. Clin Biomech 2013;28:988-93. https://doi.org/10.1016/j.clinbiomech.2013.09.005.
8. Smith CD, Guyver P, Bunker TD. Indications for reverse shoulder replacement: A systematic review. J Bone Joint Surg Br 2012;94:577-83. https://doi.org/10.1302/0301-620X.94B5.27596.
9. Werner BS, Jacquot A, Molé D, Walch G. Is radiographic measurement of acromiohumeral distance on anteroposterior view after reverse shoulder arthroplasty reliable? J Shoulder Elbow Surg 2016;15:e276-80. https://doi.org/10.1016/j.jse.2016.02.017.