WJPMR, 2026, 12(6), 358-365

Research Article

WORLD JOURNAL OF PHARMACEUTICAL AND MEDICAL RESEARCH

www.wjpmr.com

Impact Factor: 7.555

ISSN (O): 2455-3301

ISSN (P): 3051-2557

Coden USA: WJPMBB

POST TRAUMATIC BILATERAL SHOULDER ARTHROPLASTY

Teghida Aadel*[1], M. Alhusan[2], I. Antri[3], A. Bennis[4], M. Benchakroun[5], S. Bouabid[6], D. Benchebba[7]

Department of Orthopedics and Traumatology 1, Military Training Hospital Mohamed V Rabat. Hospital center Emile Roux Le Puy-en-Velay.

***Corresponding Author: Teghida Aadel**

Department of Orthopedics and Traumatology 1, Military Training Hospital Mohamed V Rabat. Hospital center Emile Roux Le Puy-en-Velay.

DOI: https://doi.org/10.5281/zenodo.20525365

How to cite this Article: Teghida Aadel*1, M. Alhusan2, I. Antri3, A. Bennis4, M. Benchakroun5, S. Bouabid6, D. Benchebba7. (2026). Post Traumatic Bilateral Shoulder Arthroplasty. World Journal of Pharmaceutical and Medical Research, 12(6), 358–365.

Article Received on 05/05/2026 **Article Revised on 25/05/2026** **Article Published on 01/06/2026**

ABSTRACT

Bilateral proximal humerus fracture is an uncommon incident, we describe one case of right and left humerus posttraumatic fracture, patient received two reverse total shoulder prosthesis in the same procedure.

KEYWORDS: Shoulder, fracture, bilateral, arthroplasty.

INTRODUCTION

Proximal humerus fractures (PHF) account for 5-6% of all adult fractures. There is increasing recognition given in regard to managing these fractures in the setting of elderly, low-energy falls as these events are contributing to the global impact of direct and indirect costs of osteoporosis and fragility fractures.[1,2] Moreover, as the general population continues to age and an increasing percentage of these patients are being considered bone density compromised, the overall nonoperative and operative management of PHFs continue to receive considerable attention in the literature.

MATERIALS AND METHODS

Study of the case of a patient admitted to the emergency department for bilateral posttraumatic proximal humeral fracture.

PATIENT AND OBSERVATION

A 78-year-old patient, with a history of hypertension and coronary artery disease, admitted to the emergency department for a double shoulder injury following a fall from standing height. Clinical examination revealed a conscious patient in good general condition, but with pain and complete weakness in both shoulders and skin abrasions. Neurovascular examination was unremarkable. An AP radiological assessment of both shoulders allows the diagnosis of bilateral proximal humeral fracture.

Figure 1: Anteroposterior chest x-ray showing bilateral proximal humeral fracture PHF.

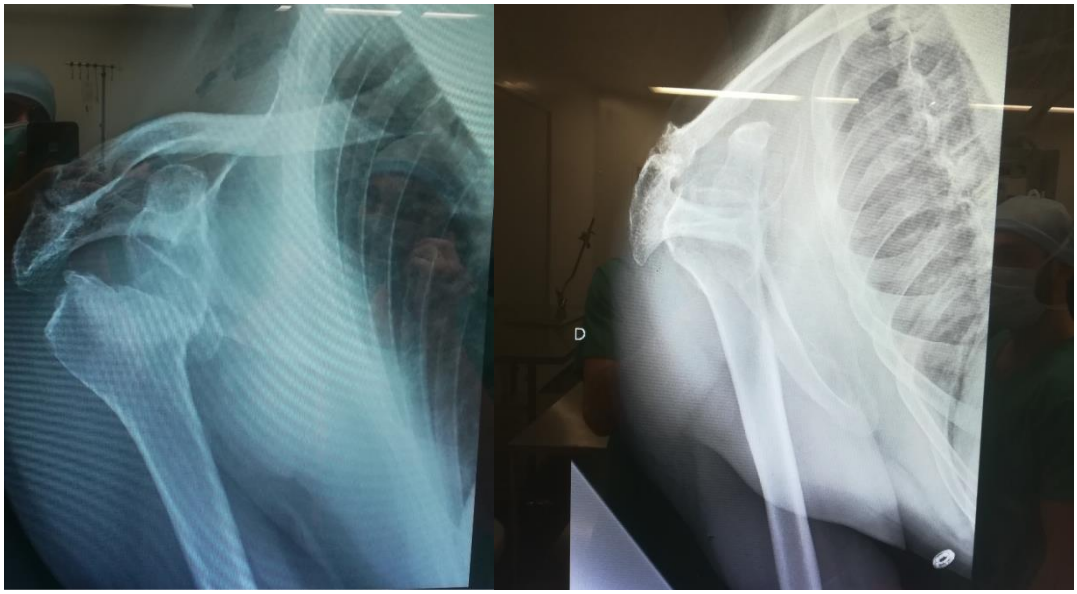

Figure 2: Anteroposterior right shoulder x-ray showing PHF.

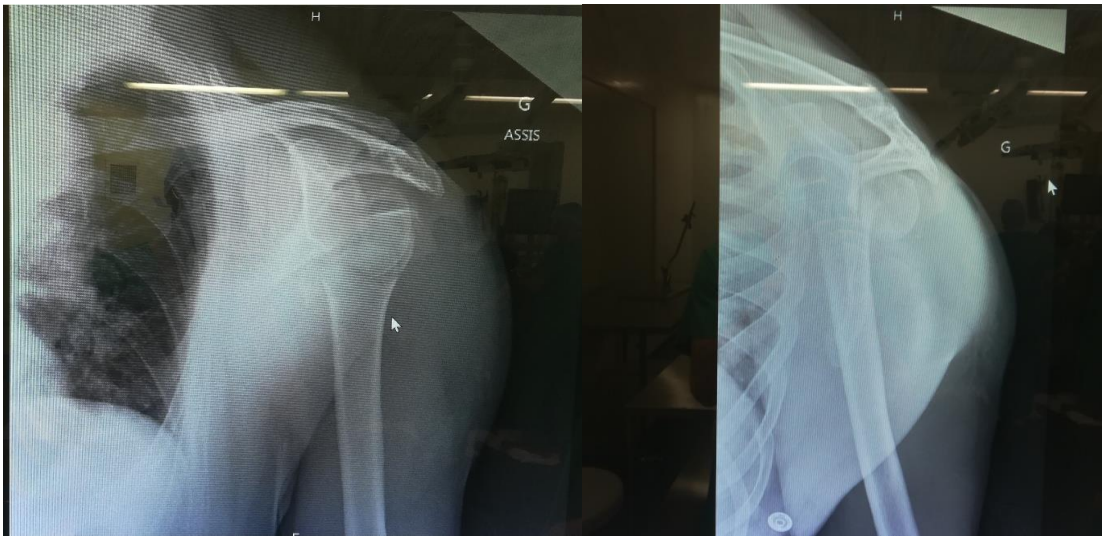

Figure 3: Anteroposterior left soulder x-ray showing proximal humeral fracture and dislocation.

The patient hospitalized in the surgical department and underwent pre-operative assessments and evaluations.

SURGICAL TECHNIQUE

- General anaesthesia combined with a regional block.
- Beach chair position.
- Disinfection with betadine

First stage of the operation: left side

- Delto-pectoral approach, haemostasis, exposure of the fracture site, removal of the humeral head, which was posteriorly dislocated, exposure of the glenoid cavity, then removal of the peripheral rim.
- Preparation of the glenoid using motorised reamers down to the subchondral bone.
- Placement of a standard Metaglene locked in place with 4 screws.
- Placement of a glenosphere. Then checking stability.
- Humeral shaft preparation using manual burrs.
- Stem insertion and stability check, followed by locking with two screws.
- Insertion of an intermediate component and reduction of the prosthesis.
- Stability check: OK.
- Repairing a trochin and trochiter's fracture using sutures.
- Redon drain insertion.
- Layered closure performed followed by sterile dressing.

For the second surgical stage on the right side, we performed the same surgical approach and technique, with new equipment and instrumentation.

- Both upper limbs were immobilised using two elbow-to-body splints.

Figure 4: beach chair (BC) position.

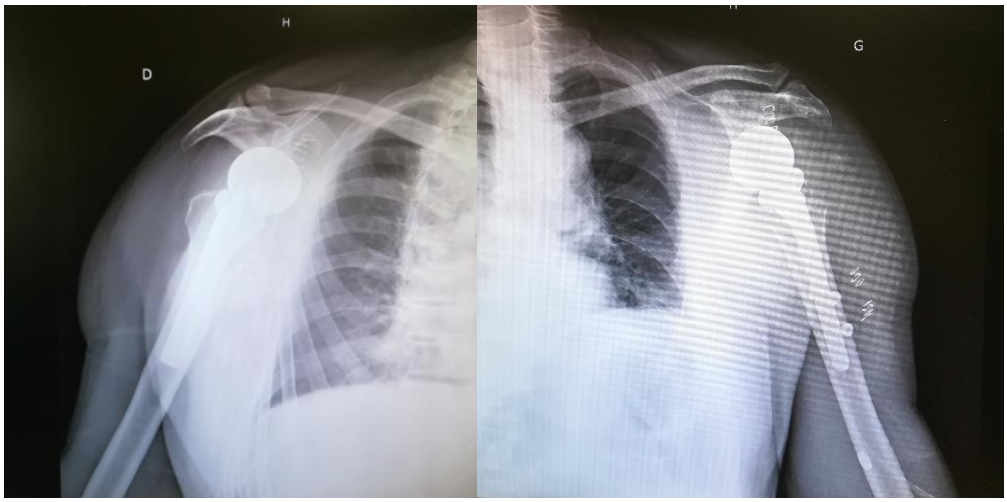

Figure 5: Right and left Anteroposterior post operatvive x ray of reverse shoulder arthroplasty (RSA).

Figure 6: Post-operative immobilization.

DISCUSSION

The incidence of proximal humerus fractures (PHF) is increasing worldwide. PHF typically presents in a bimodal distribution with younger patients associated with higher energy trauma and the elderly (over 65 years), associated with lower-energy mechanisms or fragility fractures.[1,2] There is also a gender discrepancy, with older female patients sustaining PHF two to three

times more often than males.[3] The association with Osteoporosis has led to an increase in its occurrence as well as complexity of the fracture configuration with increasing age.

The long-term sequelae from PHF can be significant; these can include mal union and non-union, avascular necrosis and traumatic arthritis,. They can precipitate lengthy and costly rehabilitation whether managed surgically or non-operatively, as well as lead to a long term decline in functional ability and persisting residual dysfunction.[1,2,3]

The treatment of PHF continues to be debated and indeed, there exists a significant geographical variation in the local management of PHF which is indicative of the relative paucity of evidence as to the optimal management for these injuries.[1,3,4] The vast majority of PHFs can be managed non-operatively however for those PHF that do mandate surgical intervention, there remains no consensus as to the optimum treatment strategies. The introduction of locking plates has broadened the possible indications for open reduction with internal fixation, whilst reverse shoulder arthroplasty (RSA) use is on the rise for elderly patients with displaced PHF.

We present an overview of present clinical practice in the management of PHF reinforced on the current literature.

1. Clinical evaluation

The full holistic assessment of a patient with PHF helps guide decision making and therefore an imperative step in formulating a structured management plan. Many elderly patients may suffer from multiple systemic comorbidities and the anaesthetic and surgical risks may outweigh the benefits of surgery. In addition, many elderly patients may opt for non-operative treatment. In this cohort, a focussed history including hand dominance, hobbies/pastimes and functional demands should be obtained. In the relatively younger population occupation, smoking, alcohol history and history of intravenous drug abuse may have a bearing on choice of management.

Open PHFs are uncommon and would require management as per standardised open fracture guidelines.[5] A neurovascular examination of the distal aspect of the affected limb is the next priority.

Vascular injuries are not common but can be more expected in the setting of a fracture-dislocation of the shoulder. A large expanding haematoma, hypotension with no clear cause, blood tests demonstrating low haemoglobin, pulsatile active bleeding and concomitant nerve trunk or brachial plexus injury ought to raise the awareness of a potential vascular injury. Over 90% of cases reported occur in patients over the age of 50, likely due to the increased stiffness within the lining of vessel walls due to the build-up of atherosclerosis.[6] If there is any doubt a CT angiogram may aid the diagnosis and a review by the vascular surgeons should follow.

A brachial plexus and axillary nerve examination, in particular, is essential but can prove a challenge following acute trauma, nevertheless assessment of the fingers, wrist, and elbow can still often be attempted. Nerve injuries are, again, more probable in the setting of a shoulder fracture-dislocation.[7]

2. Radiological evaluation

Initial plain radiographs of the glenohumeral joint include a true anteroposterior (AP), lateral, and a mandatory orthogonal view, as a proper axillary view may not always be possible. This should help with the initial determination of glenohumeral joint congruency and PHF pattern.

Computed tomography (CT) scans, with the increasing use of three-dimensional reconstructed (3D-CT) models, enable better visualisation and appreciation of the fracture configuration and facilitate the treatment plan. CT is recommended for complex fractures (with 3D reconstruction), particularly when fracture lines may not be clearly visualised on plain radiographs. Although not commonly used magnetic resonance imaging (MRI) may be valuable for evaluating the integrity of the rotator cuff in the setting of PHF. A prospective study which involved 30 patients demonstrated approximately 40% of the PHFs were in combination with rotator cuff tears.[8] Fjalestad et al. performed MRI scan on 76 patients whom had PHF, they demonstrated 22 had established rotator cuff tears at the time of sustaining the injury, and 10 went on to develop tears later, at one year. Impaired functional outcome was associated with cuff tears occurring during acute injuries.[9]

Hertel et al.,[10] in their seminal paper, suggested that fractures demonstrating a shortened medial calcar (<8 mm), a clear break of the medial hinge, and where there is anatomical neck involvement are most at risk of developing ischaemia. Therefore, patients with any of these signs should be observed closely if being managed non-operatively or indeed should be for higher consideration of surgical fixation. Bone density is another predictor for the quality of surgical fixation possible and the likelihood of potential metal work complications.[11]

3. Classification

An early classification of proximal humerus fractures was created in 1934 by Ernest Codman, Charles Neer expanded upon Codman's use of the four main anatomic segments in 1970 and it still continues to be commonly used.[12,13] The fractures are classified as two part, three part or four part corresponding to the number of displaced parts. The Hertel's binary fracture description approach[10] was based on the analysis of the planes of the fracture and not merely on the number of fragments. It encompasses a total of 12 different basic fracture

patterns. Another classification is provided by AO[14] Studies which have assessed the utility of PHF classification systems show low intraobserver and interobserver reliability.[15] The use of a classification for PHFs in guiding our decision making and aiding within research remains challenging.

4. Non-operative management

Approximately 85% of PHFs can be managed non-operatively.[12] Over the last decade, especially in more elderly patients, PHFs have been increasingly treated non-operatively.[14,16] The PROFHER study[17] (a multicentre RCT in the UK, compared non-operative and operative treatment) reported no significant difference in the patient reported outcome measures (PROMs) between surgical and conservative treatment. It is noteworthy, that this pragmatic RCT showed no difference in the outcomes for those fractures where the treating surgeons were genuinely unsure of whether to treat the fracture operatively or non-operatively. However in other fracture configurations where the surgeon felt surgery would be advantageous, they were still treated operatively. Further systematic reviews.[18] have also concluded that, in elderly patients, there was no difference in the PROMs for displaced PHF, whether managed operatively or non-operatively.

The limitations of the PROFHER study are that most fractures (>80%) were two part with or without greater tuberosity fractures and RSA procedures were not included in the operated group. Additionally only 4.4% of the operated group were Neer four part fractures in the PROFHER study compared to 21% reported in a meta-analysis, demonstrating a discrepancy of their incidence.[18] Another limitation of the PROFHER trial was that different fixation options were all grouped together under the surgical arm and therefore making the generalisability of the results. Discrepancy was further demonstrated with a higher risk of non-union reported in the non-operative group than expected. In non-operative management a medially displaced greater tuberosity fragment significantly overlapping with the humeral articular surface could lead to adverse outcomes**.**[19]

Patients managed non-operatively usually have a short period of immobilisation and progressive supervised physiotherapy. Current evidence supports the early mobilisation, within two weeks, of PHFs**,** although there is no evidence to suggest its superiority or any demonstrable difference in outcomes.**[19]** There remains a paucity of high-quality evidence to aid the understanding of optimal rehabilitation timing following PHFs and this would certainly help avoid the detrimental consequences of immobilising patients longer than required.[20]

5. Operative management

Although most PHFs are managed non-operatively, there are some clear indications for operative management. These include fracture dislocations of the shoulder, open fractures, head splitting fractures, severe varus or valgus displacement of the humeral head and completely off-ended fractures especially if there is significant displacement between the humeral head and shaft. Other indications for surgical treatment can be debated. Before embarking on surgical fixation, one should consider the patients age, their functional level, the fracture personality, the patients' ability to comply with the post-operative rehabilitation, any associated injuries, the patients' bone quality, the likely disruption to the humeral head vascularity and the experience of the treating surgeon.

Percutaneous fixation

Although the indications for this technique are limited they can be used in a range of fracture patterns and even in the setting of a fracture dislocation.[21] Percutaneous screw fixation is best used for valgus impacted, three- or four-part fractures and fractures where some improvement in fracture position could lead to a satisfactory position with minimal fixation. The main advantage of this percutaneous technique is minimal soft tissue envelope disturbance, reduced interference of the vascularity to the humeral head and, if required, provides an easier means for future metal work removal.[22]

Roberts et al.[23] described a technique which relies on an established configuration of screw placement with good outcomes and low complication rates. They highlighted that preservation of the periosteal bridges and soft-tissue attachments of the fractures were important for successful outcomes. Resch et al. further showed low osteonecrosis rates and reduced soft tissue adhesions with this technique.[24] Johnson et al. reported low metal work complications and no screw penetrations with the percutaneous technique, unlike with the use of locking plates.[21]

Locking plate fixation

Locking plate fixation remains the most commonly used fixation modality for displaced PHFs. Locking screws offer stronger angular stability and higher resistance to failure over use of non-locking screws.[22] It is vital that the humeral head is not fixed in a varus position and the medial calcar hinge is reduced. In order to achieve this one can use a inferomedial calcar screw, fibular allograft augmentation or bone cement augmentation.[25] Augmentation with a fibular strut allograft consistently improves the stiffness of the construct, as well as improving the load to failure and preventing fracture displacement. Given that locking plate use necessitates a degree of soft tissue dissection it can have significant complication rates (especially that of screw penetration). Locking plate fixation requires detailed surgical planning, meticulous surgical technique, soft tissue handling and imperative use of intraoperative imaging. Locking plates are mostly used in two- or three-part PHF in the younger cohort of patients. Although debatable, some studies suggest locking plate use in displaced four-part fractures, even with poor bone quality, demonstrating improved outcomes with low

complication rates.[26] A Recent systematic review Kavuri et al.[27] including more than 3400 proximal humeral fractures treated with locking plates noted the complications of locking plates as follows: Intra-articular crew penetration (9.5%). Primary penetration is due to intra-operative placement. Secondary placement is usually due to the Varus collapse, AVN or failure of fixation. Other complications of locking plates include varus collapse (6.8%), subacromial impingement (5.0%), Avascular Necrosis (4.4%) and the re-operation rate was reported to be 13.8%.

Intramedullary nailing

Intramedullary (IM) nails are a biologically and biomechanically appealing option. Ideal indications for an IM nail are two-part PHF and selective three-part fractures. The technique allows for the preservation of the periosteal blood supply and adjacent soft tissue anatomy. However, some of the risks include: Avascular necrosis (AVN) (4%), proximal screw migration, sub-acromial impingement and rotator cuff dysfunction.[28] There have been particular concerns about rotator cuff dysfunction with IM Nails as older curvilinear shaped IM nails had higher complications and re-operation rates.[29] Newer generations of IM nails are straighter and offer multiple locking options. The entry point is typically at the apex of the humeral head articular surface, using a supraspinatus muscle split rather than tendon split approach, about 1.5 cm medial to the footprint of rotator cuff attachment and posterior to the biceps tendon thus avoiding the crucial watershed area of vascularity within the rotator cuff, also any potential iatrogenic tuberosity fracture.[30] Muccioli et al. found the incidence of supraspinatus tendon lesions following IM nail to be no higher than its incidence in general population.[31] Evolving implant designs and surgical techniques have allowed humeral IM nails to become one of the main fixation techniques in managing PHFs.

Arthroplasty

Arthroplasty in the context of PHFs is either by way of shoulder hemiarthroplasty (HA) or reverse shoulder arthroplasty (RSA). Patient specific indications for arthroplasty are those patients who are elderly or those with poor bone quality. Fracture specific factors when arthroplasty should be considered are comminuted fractures, or in the setting of a fracture dislocation, head splitting fractures and fracture configurations, which are not deemed amenable to an optimal fixation technique.

Hemiarthroplasty

The role of shoulder HA, whilst diminishing somewhat in its use, still serves as a viable management option in complex un-reconstructable PHF with no evidence of glenohumeral arthritis. It is indicated in the relatively younger patient cohort with three or four part PHFs not amenable to surgical fixation but does mandate a functioning rotator cuff in order to achieve biomechanical success.[9] The key to the success of HA use is the fixation of the tuberosities and their healing, if the tuberosities fail to heal the outcomes are known to be very poor.[32] HA can provide excellent pain relief for patients, however predicting functional outcome is more difficult. The other fundamental factors that should be considered for the successful return of function are restoration of correct height, offset and humeral version.[33] When faced with a fracture pattern demonstrating a high degree of comminution of the tuberosity (not amenable to reconstruction) or a high suspicion of a very degenerate rotator cuff, RSA can provide a suitable alterative arthroplasty option.

Reverse shoulder arthroplasty (RSA)

RSA was primarily used as a salvage procedure in the management of failed HA, but in an increasingly aging population in whom rotator cuff dysfunction is common, and tuberosity fixation doubtful, the indications for RSA have broadened. The existence of a premorbid rotator cuff tear, glenohumeral joint osteoarthritis and fractures in patients judged to have high risk of surgical fixation failure, form the bulk of the patients for whom RSA has progressively increased in its use. RSA continues to play a role in revision surgery demonstrating excellent outcomes in 79% of patients following failed surgical fixation.[34]

Although important, it is not crucial to obtain accurate tuberosity reconstruction for the success of RSA compared with HA, however if well fixed, this has been reported to have improved external rotation.[35] However, few authors have reported very good tuberosity healing rates (>80%) nor with improved range of movement, especially that of external rotation.[36]

A recent meta-analysis.[37] recommended RSA in older aged patients, with three- or four-part fractures as this procedure returned the best patient reported outcome measure (PROMs) ranking with respect to Constant score and re-operation rate. In addition, a few studies[38] have reported predictable improvement in pain and improved functional outcome with RSA when used in elderly patients suffering PHFs. This is likely the reasoning for the increasing use of RSA as the operative treatment of choice for many departments in those more elderly patients whom have displaced three- or four-part PHFs.

CONCLUSION

RSA has become the mainstay in the management of unreconstructable PHF, especially in the elderly, as well as for salvage situations with reliable outcomes. RSA in fractures is technically demanding and a surgeon's experience is crucial in reducing complications and improving outcomes. The treatment of PHFs should be individualised to the patients and fracture characteristics.

REFERENCES

1. Pencle F.J., Varacallo M. Treasure Island. FL; 2022. Proximal humerus fracture.
2. Launonen A.P., Sumrein B.O., Lepola V. Treatment of proximal humerus fractures in the elderly. Duodecim. 2017; 133(4): 353–358.
3. Clement N.D., Duckworth A.D., McQueen M.M., Court-Brown C.M. The outcome of proximal humeral fractures in the elderly: predictors of mortality and function. Bone Joint Lett J. 2014 Jul; 96-B(7): 970–977. doi: 10.1302/0301-620X.96B7.32894.
4. Murray I.R., Amin A.K., White T.O., Robinson C.M. Proximal humeral fractures: current concepts in classification, treatment and outcomes. J Bone Joint Surg Br. 2011 Jan; 93(1): 1–11. doi: 10.1302/0301-620X.93B1.25702.
5. CS.Neer. Displaced proximal humeral fractures. Classification and evaluation. J. Bone joint Surg. (Am) 1970, 52-A; 1077-89
6. Thorsness R., English C., Gross J., Tyler W., Voloshin I., Gorczyca J. Proximal humerus fractures with associated axillary artery injury. J Orthop Trauma. 2014 Nov; 28(11): 659–663. doi: 10.1097/BOT.0000000000000114.
7. Visser C.P., Coene L.N., Brand R., Tavy D.L. Nerve lesions in proximal humeral fractures. J shoulder Elb Surg. 2001; 10(5): 421–427. doi: 10.1067/mse.2001.118002.
8. Gallo R.A., Sciulli R., Daffner R.H., Altman D.T., Altman G.T. Defining the relationship between rotator cuff injury and proximal humerus fractures. Clin Orthop Relat Res. 2007 May; 458: 70–77. doi: 10.1097/BLO.0b013e31803bb400.
9. Fjalestad T., Hole M.Ø., Blücher J., Hovden I.A.H., Stiris M.G., Strømsøe K. Rotator cuff tears in proximal humeral fractures: an MRI cohort study in 76 patients. Arch Orthop Trauma Surg. 2010 May; 130(5): 575–581. doi: 10.1007/s00402-009-0953-2.
10. Hertel R., Hempfing A., Stiehler M., Leunig M. Predictors of humeral head ischemia after intracapsular fracture of the proximal humerus. J shoulder Elb Surg. 2004; 13(4): 427–433. doi: 10.1016/j.jse.2004.01.034.
11. Spross C., Zeledon R., Zdravkovic V., Jost B. How bone quality may influence intraoperative and early postoperative problems after angular stable open reduction-internal fixation of proximal humeral fractures. J shoulder Elb Surg. 2017 Sep; 26(9): 1566–1572. doi: 10.1016/j.jse.2017.02.026.
12. Baker H.P., Gutbrod J., Strelzow J.A., Maassen N.H., Shi L. Management of proximal humerus fractures in adults-A scoping review. J Clin Med. 2022 Oct 18; 11(20): 6140. doi: 10.3390/jcm11206140.
13. Neer C.S., 2nd Displaced proximal humeral fractures. I. Classification and evaluation. J Bone Joint Surg Am. 1970 Sep; 52(6): 1077–1089.
14. Marsh J.L., Slongo T.F., Agel J., et al. Fracture and dislocation classification compendium - 2007: orthopaedic Trauma Association classification, database and outcomes committee. J Orthop Trauma. 2007; 21(10 Suppl): S1–S133. doi: 10.1097/00005131-200711101-00001.
15. Siebenrock K.A., Gerber C. The reproducibility of classification of fractures of the proximal end of the humerus. J Bone Joint Surg Am. 1993 Dec; 75(12): 1751–1755. doi: 10.2106/00004623-199312000-00003.
16. Patel A.H., Wilder J.H., Ofa S.A., et al. Trending a decade of proximal humerus fracture management in older adults. JSES Int. 2022 Jan; 6(1): 137–143. doi: 10.1016/j.jseint.2021.08.006.
17. Handoll H., Brealey S., Rangan A., et al. The ProFHER (PROximal Fracture of the Humerus: evaluation by Randomisation) trial - a pragmatic multicentre randomised controlled trial evaluating the clinical effectiveness and cost-effectiveness of surgical compared with non-surgical treatment for prox. Health Technol Assess. 2015 Mar; 19(24): 1–280. doi: 10.3310/hta19240.
18. Beks R.B., Ochen Y., Frima H., et al. Operative versus nonoperative treatment of proximal humeral fractures: a systematic review, meta-analysis, and comparison of observational studies and randomized controlled trials. J shoulder Elb Surg. 2018 Aug; 27(8): 1526–1534. doi: 10.1016/j.jse.2018.03.009.
19. Foruria A.M., de Gracia M.M., Larson D.R., Munuera L., Sanchez-Sotelo J. The pattern of the fracture and displacement of the fragments predict the outcome in proximal humeral fractures. J Bone Joint Surg Br. 2011 Mar; 93(3): 378–386. doi: 10.1302/0301-620X.93B3.25083. https://online.boneandjoint.org.uk/doi/full/10.1302/0301-620X.93B3.25083
20. Østergaard H.K., Mechlenburg I., Launonen A.P., Vestermark M.T., Mattila V.M., Ponkilainen V.T. The benefits and harms of early mobilization and supervised exercise therapy after non-surgically treated proximal humerus or distal radius fracture: a systematic review and meta-analysis. Curr Rev Musculoskelet Med. 2021 Apr; 14(2): 107–129. doi: 10.1007/s12178-021-09697-5.
21. Johnson N.A., Pandey R. Proximal humerus fracture-dislocation managed by mini-open reduction and percutaneous screw fixation. Shoulder Elbow. 2019 Oct; 11(5): 353–358. doi: 10.1177/1758573218791815.
22. Omid R., Trasolini N.A., Stone M.A., Namdari S. Principles of locking plate fixation of proximal humerus fractures. J Am Acad Orthop Surg. 2021 Jun; 29(11): e523–e535. doi: 10.5435/JAAOS-D-20-00558.
23. Roberts V.I., Komarasamy B., Pandey R. Modification of the Resch procedure: a new technique and its results in managing three- and four-part proximal humeral fractures. J Bone Joint Surg Br. 2012 Oct; 94(10): 1409–1413. doi: 10.1302/0301-620X.94B10.28692.

24. Resch H., Hübner C., Schwaiger R. Minimally invasive reduction and osteosynthesis of articular fractures of the humeral head. Injury. 2001 May; 32(Suppl 1): SA25–SA32. doi: 10.1016/s0020-1383(01)00058-4.
25. Sun Q., Wu X., Wang L., Cai M. The plate fixation strategy of complex proximal humeral fractures. Int Orthop. 2020 Sep; 44(9): 1785–1795. doi: 10.1007/s00264-020-04544-7.
26. Biermann N., Prall W.C., Böcker W., Mayr H.O., Haasters F. Augmentation of plate osteosynthesis for proximal humeral fractures: a systematic review of current biomechanical and clinical studies. Arch Orthop Trauma Surg. 2019 Aug; 139(8): 1075–1099. doi: 10.1007/s00402-019-03162-2.
27. Kavuri V., Bowden B., Kumar N., Cerynik D. Complications associated with locking plate of proximal humerus fractures. Indian J Orthop. 2018 Mar-Apr; 52(2): 108–116. doi: 10.4103/ortho.IJOrtho_243_17.
28. Wong J., Newman J.M., Gruson K.I. Outcomes of intramedullary nailing for acute proximal humerus fractures: a systematic review. J Orthop Traumatol Off J Ital Soc Orthop Traumatol. 2016 Jun; 17(2): 113–122. doi: 10.1007/s10195-015-0384-5.
29. Giannoudis P.V., Xypnitos F.N., Dimitriou R., Manidakis N., Hackney R. Internal fixation of proximal humeral fractures using the Polarus intramedullary nail: our institutional experience and review of the literature. J Orthop Surg Res. 2012 Dec; 7: 39. doi: 10.1186/1749-799X-7-39.
30. Nolan B.M., Kippe M.A., Wiater J.M., Nowinski G.P. Surgical treatment of displaced proximal humerus fractures with a short intramedullary nail. J shoulder Elb Surg. 2011 Dec; 20(8): 1241–1247. doi: 10.1016/j.jse.2010.12.010.
31. Muccioli C., Chelli M., Caudal A., et al. Rotator cuff integrity and shoulder function after intra-medullary humerus nailing. Orthop Traumatol Surg Res. 2020 Feb; 106(1): 17–23. doi: 10.1016/j.otsr.2019.11.004.
32. Boileau P., Krishnan S.G., Tinsi L., Walch G., Coste J.S., Molé D. Tuberosity malposition and migration: reasons for poor outcomes after hemiarthroplasty for displaced fractures of the proximal humerus. J Shoulder Elb Surg [Internet. 2002 Sep; 11(5): 401–412. doi: 10.1067/mse.2002.124527. https://linkinghub.elsevier.com/retrieve/pii/S1058274602000563
33. Gigis I., Nenopoulos A., Giannekas D., Heikenfeld R., Beslikas T., Hatzokos I. Reverse shoulder arthroplasty for the treatment of 3 and 4- Part Fractures of the humeral head in the elderly. Open Orthop J. 2017 Feb 28; 11(1): 108–118. doi: 10.2174/1874325001711010108. https://openorthopaedicsjournal.com/VOLUME/11/PAGE/108/
34. Hussey M.M., Hussey S.E., Mighell M.A. Reverse shoulder arthroplasty as a salvage procedure after failed internal fixation of fractures of the proximal humerus. Bone Joint Lett J. 2015 Jul; 97-B(7) doi: 10.1302/0301-620X.97B7.35713. https://online.boneandjoint.org.uk/doi/10.1302/0301-620X.97B7.35713
35. Chun Y.-M., Kim D.-S., Lee D.-H., Shin S.-J. Reverse shoulder arthroplasty for four-part proximal humerus fracture in elderly patients: can a healed tuberosity improve the functional outcomes? J Shoulder Elbow Surg. 2017 Jul; 26(7): 1216–1221. doi: 10.1016/j.jse.2016.11.034. https://linkinghub.elsevier.com/retrieve/pii/S1058274616306073
36. Boileau P., Alta T.D., Decroocq L., et al. Reverse shoulder arthroplasty for acute fractures in the elderly: is it worth reattaching the tuberosities? J Shoulder Elbow Surg. 2019 Mar; 28(3): 437–444. doi: 10.1016/j.jse.2018.08.025. https://linkinghub.elsevier.com/retrieve/pii/S1058274618306244
37. Guo J., Peng C., Hu Z., Li Y. Different treatments for 3- or 4-part proximal humeral fractures in the elderly patients: a Bayesian network meta-analysis of randomized controlled trials. Front Surg. 2022 Sep; 29(9) doi: 10.3389/fsurg.2022.978798. https://www.frontiersin.org/articles/10.3389/fsurg.2022.978798/full
38. Gallinet D., Ohl X., Decroocq L., Dib C., Valenti P., Boileau P. Is reverse total shoulder arthroplasty more effective than hemiarthroplasty for treating displaced proximal humerus fractures in older adults? A systematic review and meta-analysis. Orthop Traumatol Surg Res. 2018 Oct; 104(6): 759–766. doi: 10.1016/j.otsr.2018.04.025. https://linkinghub.elsevier.com/retrieve/pii/S1877056818301750