Surgical approach for fracture of distal humerus: Posterior *vs* lateral

Michela Saracco, Alessandro Smimmo, Davide De Marco, Osvaldo Palmacci, Giuseppe Malerba, Raffaele Vitiello, Giulio Maccauro, Felice Minutillo, Giuseppe Rovere

Department of Orthopaedics and Traumatology, Fondazione Policlinico Universitario A. Gemelli IRCCS, Rome; Università Cattolica del Sacro Cuore, Rome, Italy

Abstract

Humeral fractures have an incidence of 3-5% and a bimodal age distribution. They may occur in young patients after high-energy traumas or in elderly osteoporotic patients after low-energy injuries. In non-displaced fractures or in elderly patients, humeral fractures are treated by conservative methods. Open reduction and internal fixation (ORIF) should be the treatment of choice in case of multi-fragmentary fractures associated with radial nerve palsy or not. ORIF is usually regarded as the gold standard treatment, but, depending on the different types of fracture, the surgical approach can change. In this review, we compare results and complication rates between lateral and posterior surgical approaches in the management of extraarticular distal humeral shaft fractures. An internet-based literature research was performed on Pubmed, Google Scholars and Cochrane Library. 265 patients were enrolled: 148 were treated by lateral or antero-lateral approach, while 117 by posterior or postero-lateral approach. The literature shows that no differences between the posterior and lateral approach exist. Certainly, the posterior approach offers undoubted advantages in terms of exposure of the fracture and visualization of the radial nerve. In our opinion, the posterior approach may also allow better management of complex and multi-fragmentary fractures.

Introduction

Humeral fractures have an incidence of 3-5% and a bimodal age distribution. They may occur in young patients after high-energy traumas or in elderly osteoporotic patients after low-energy injuries.[1,2] Distal-third diaphyseal fractures can be due to direct or indirect traumas. Direct traumas determine a two-fragment fracture, often involving the radial nerve through a direct contusive trauma. Indirect traumas, by twisting, determine a spiroid fracture, often with three or more fragments. In this case, the radial nerve traumatic injury is linked to traction or to a breakdown of a fragment which dislocates and therefore stretches the nerve.[3] Humerus is a long bone of the upper limb and can be divided into three parts: proximal, medial and distal. The proximal epiphysis articulates with the scapula, forming the scapulohumeral joint, the distal epiphysis articulates with the two bones of the forearm. The trochlea articulates with the olecranon allowing flexion and extension of the forearm on the sagittal plane while the capitellum articulates with the proximal radius allowing for forearm rotation. The muscles that insert on the humerus are pectoralis major and deltoid; while those that originate from the humerus are brachialis, triceps and brachioradialis. The common flexors muscles originate from the medial epicondyle and are composed by: pronator teres, flexor carpi radialis, palmaris longus, Flexor Digitorum Superficialis (FDS), Flexor Carpi Ulnaris (FCU). The common extensors originate from the lateral epicondyle and are composed by: anconeus, Extensor Carpi Radialis Longus (ECRL), Extensor Carpi Radialis Brevis (ECRB), extensor digiti minimi (EDM), extensor carpi ulnaris (ECU). As regards the nerves of this segment, the ulnar nerve resides in the cubital tunnel in a subcutaneous position below the medial condyle. The radial nerve resides in the spiral groove 15cm proximal to the humeral articular surface and runs between the brachioradialis and the brachialis muscles. Proximal to the elbow, at the level of the radial head, it divides into posterior interosseous nerve (PIN) and superficial radial nerve.[4]

Humeral fractures are classified based on the AO classification, according to the type of fracture, its location, and according to the underlying bone condition (Figure 1).

In non-displaced fractures or in elderly patients for which surgical treatment could be dangerous, humeral fractures are often treated by conservative methods.

Humeral fractures with concomitant radial nerve palsy or in young patients for which the lack of a fast and perfect reduction and osteosynthesis can cause significant aesthetic and functional sequelae, Open reduction and internal fixation (ORIF) should be the treatment of choice.[5]

Conservative treatment must always be considered when possible. In the other cases, surgical treatment and internal osteosynthesis remain the most appropriate approach.[6] Osteosynthesis techniques for humeral fractures, such as intramedullary nailing, external and internal fixation, have significantly improved over time. Reduction and anatomical bony union become more difficult as the number of fragments increases, due to their displacement and comminution.

ORIF allows an almost anatomical osteosynthesis of the fragments, prevents from hypertrophic ossification and allows radial nerve exploration.[7,8] This surgical technique, however, should not only be used for fracture osteosynthesis, but above all, it should allow compression of bony fragments. However, plating osteosynthesis is stiff, and does not allow biomechanical elasticity as the intramedullary nailing do.

The orthopedic surgeon has to therefore face three different problems: restore anatomy with stable fixation of the fracture fragments; limit soft tissues dissection; and choose the more suitable surgical approach according to the type of fracture.

Depending on the different types of fracture, surgical approaches to the humerus can change. The lateral approach is reserved

Correspondence: Felice Minutillo, Department of Orthopedics and Traumatology Policlinico Agostino Gemelli, Largo Agostino Gemelli 8, 06168 Roma, Italy.
Tel.: +39 3356936626.
E-mail: feliceminutillo@libero.it

Key words: Distal humeral fracture, humeral complex fracture, humeral surgical approach, posterior humeral approach, lateral humeral approach.

Contributions: The authors contributed equally.

Conflict of interest: The authors declare no potential conflict of interest.

Funding: none.

Availability of data and materials: On request.

Ethics approval and consent to participate: Not applicable.

Informed consent: Not applicable.

Received for publication: 11 April 2020.
Accepted for publication: 17 June 2020.

Orthopedic Reviews 2020; 12(s1):8664
doi:10.4081/or.2020.8664

for sagittal and coronal fractures and for simple transverse fractures. The benefit of this surgical approach is that it allows direct exposure of the radial nerve and supine patient position; however, the posterior antebrachial cutaneous nerve could be at iatrogenic injury risk.[9]

Posterior approach with triceps splitting allows direct exposure of the radial nerve and the application of a broad plate to the distal humerus for distal third fractures. Drawbacks to the posterior approach are: lateral or prone patient positioning which may be problematic for polytraumatized patient or in case of thoracic trauma; radial nerve mobilization for plate application, theoretically increasing the risk of iatrogenic palsy. The posterior approach with triceps sparing (Figure 2) does not split the triceps muscle, which is elevated and mobilized laterally, exposing 90% of the posterior side of the humerus. This approach also allows easy identification of the lower lateral brachial cutaneous nerve, whose origin traced to the radial nerve.[10]

The purpose of this study is to compare treatment results and complication rates between lateral and posterior surgical distal humeral approaches in the management of extraarticular distal humeral shaft fractures.

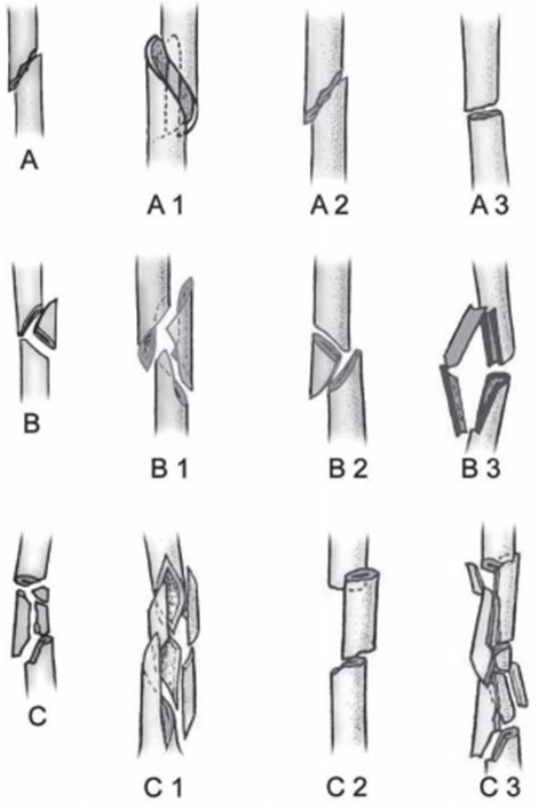

Figure 1. AO classification: distal-third diaphyseal fractures of the humerus.

Materials and Methods

An internet-based literature research was performed on Pubmed, Google Scholars and Cochrane Library. To find relevant studies, the following search-terms were used: *"distal" AND "humeral" OR "humerus" AND "fractures" AND "shaft" OR "diaphyseal" OR "midshaft" AND "posterior [Title/Abstract]" OR "lateral [Title/Abstract]"* and their mesh combinations.

Researches were updated to March 2020.

Case reports, reviews, editorials, letters to the editor, cadaveric studies as well as publications in other than the English language were excluded.

The reference lists of all manuscripts were screened for identify further suitable articles.

The following criteria of eligibility were used:

1. The treatment for the sustained injuries should include surgical approach.
2. The outcome variables examined should concern post-operative data.
3. The surgical procedure performed should be clearly described.
4. The site of fracture should be described as extra-articular (AO 12 type A or B)

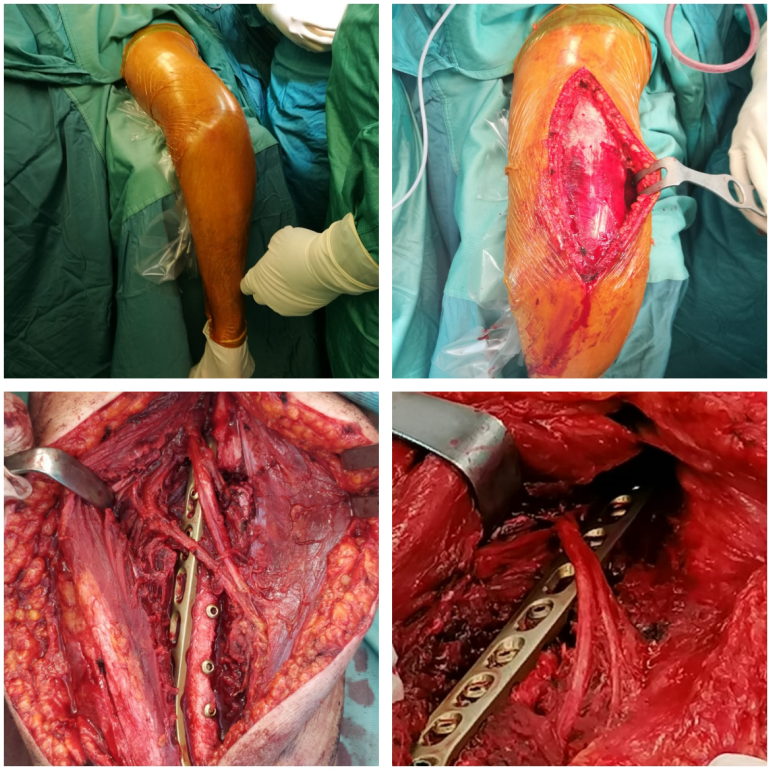

Figure 2. Surgical view of the posterior approach with triceps-sparing: this approach damages the triceps muscle less during surgery because it is entirely pulled out medially. In addition, this access allows to have a direct view of the fracture, which facilitates reduction and osteosynthesis.

Our search resulted in a total of 35 abstracts and full-text papers. After exclusion and inclusion criteria were met, there were 10 studies left for the review.

All data were elaborated by two of the authors. Age, sex, AO fracture classification, trauma modalities, surgical approach, type of plate and screws used during the surgical procedure, post-operative outcomes (elbow Range of Motion (ROM), Disabilities of the Arm, Shoulder and Hand (DASH) Score, Mayo Elbow Performance Index (MEPI) Score), pre and post-operative complications, follow up period were reviewed for this paper.

There are two traditional types of surgical accesses in the treatment of distal-third fractures of the humerus: a lateral approach with supine position of the patient or a posterior approach with prone or lateral position. Each surgical approach has advantages and disadvantages. In the lateral approach, patient positioning is simple and, in case of neurological deficits, the radial nerve is easy to be explored. On the other hand, the radial nerve crosses the surgical area and can make reduction difficult to manage, with the risk of iatrogenic nerve injury. In addition, in cases of fractures with more fragments, reduction can be more complex through this access, since the medial fragment cannot be properly seen. In the posterior approach, the patient is in prone or lateral position. In elder patients or in case of thoracic traumas, prone position could not be advisable. Trans-triceps or triceps-sparing posterior approach are easier to perform since it allows to have a direct view of the fracture, which facilitates reduction and osteosynthesis. The triceps-sparing access certainly damages this muscle less during surgery because it is entirely pulled out medially. Moreover, sometimes, it is necessary to isolate the ulnar nerve, which is not essential in trans-triceps approach since the nerve is protected by muscular fibres.

The Lateral Approach

The lateral approach is performed in the supine position with the injured arm on an arm board. The landmarks for the anterolateral approach are the coracoid process of the scapula and the lateral boarder of the biceps muscle. The skin incision is made at the lateral border of the biceps muscle. The muscular interval between the biceps brachii and brachialis muscles is identified upon making the deep fascia incision. The biceps muscle is retracted medially and the anterior part of the brachialis muscle is exposed. Dissection of this muscle is performed to expose the fracture. The radial nerve is then visualized through the fracture gap to exclude nerve damage and isolated. An elastic lace can be used to move it, although it is recommended to touch it as little as possible. During reduction, the surgeon must constantly keep an eye on the nerve, to avoid damaging it. This access is used in fractures with two or more fragments in which there is enough space to insert at least two bi-cortical screws in distal position and in which the reduction is likely not to be particularly difficult. After reduction, it can be possible to use an interfragmentary screw or the plate directly. When the fracture is very distal or in patients with poor bone quality, it is possible to use a second plate with 3.5-mm screws, positioning it in the front to obtain greater stability. At the end of the surgical procedure, the radial nerve must always be checked.[9]

The Triceps-Sparing Posterior Approach

The patient is in prone position with the arm, draped freely, on a cylindric arm board which allows the elbow to be bended over 90 degrees. A midline skin incision followed a line from the olecranon to the proximal third of the posterior arm is performed. The fascia was divided along the same line. The lateral and long heads of the triceps were identified. On the lateral side, using blunt dissection, the lower lateral cutaneous nerve of the arm is identified and its origin traced to the radial nerve. The radial nerve was identified through the lateral intermuscular septum, carefully dissected and followed proximally to where it crosses the humerus in its intermediate third. Distally, the common triceps tendon was split to expose the distal third of the posterior humeral shaft. The triceps is elevated from the lateral inter-muscular septum and the lateral supracondylar ridge.[10] After adequate fracture visualization, reduction clamps are used to reduce the fracture fragments. An extra-articular distal humeral plate is applied, centrally, over the posterior surface of humeral shaft and fixed with locking screws distally and a combination of cortical and locking screws proximally. This access is especially useful in very distal fractures with more fragments. At the end of osteosynthesis, the radial nerve must always be checked.

Results

Descriptive data are given in Figure 3. The total number of patients enrolled was: 265 (162 males; 103 female) with a mean age of 41.7 years (range:14-97, SD: 9.2). The majority of patients was aged less than 50 years. The mean Follow up was 18.8 months (range: 6-34.6, SD: 10.64). The male/female ratio was 1.57.

The causes of injury consisted in car accidents (71 cases),[11,14-17] followed by falls (40 cases), [11,14-17] occupational accidents (5 cases),[17] others (54 cases).[11,14,17]

Fractures most frequently found was the 12 A1 of the AO classification, on the contrary, the rarest ones were the 12 C1.

To stabilize distal humeral fractures, all authors describe the use of the LCP plate introduced through various surgical approaches. Overall, 148 Patients have been treated with lateral or anterolateral approach,[11,12,15,16,17] while 117 have been treated with posterior approach.[12,13,14,15] A Subgroup of 20 patients underwent postero-lateral combined approach.[16]

Bony union details are reported in 6 papers. It was achieved in all patients except for 2 cases, with a mean healing time of 14.05 weeks (range: 11.2-16.2; SD: 2.46) for the lateral approach and of 16.22 (range: 12-24; SD: 5.46) for the posterior approach.

Non-Union occurred in 2 cases, 1 treated with lateral approach and the other with the posterior one.[12]

The DASH Score, used in the half of the studies analyzed but the value is available only in two papers, is higher in patients treated with posterior approach than the ones treated with lateral approach: that means better functional results in patients treated with the posterior one.[13,15]

After surgery, the ROM of the elbow in patients treated with lateral approach was: 134.2° (range: 131.5-139.2; SD: 4.31) of flexion and 2.4° (range: 0-4.2; SD: 2.16) of extension. While, the average ROM of the elbow in patients treated with posterior approach was: 135.9° (range: 125-145; SD:10.13) of flexion and 4.03° (range: 0-7.1; SD: 3.62) of extension. Data about elbow flexion were recorded in 6 papers, while elbow extension was reported only in 4 papers. After the surgery, elbow stiffness remained in 14 patients.[13]

32 patients (more than 10%) had preoperative radial nerve palsy.[12]Through intraoperative exploration, the radial nerve was pull and compressed by the fracture in 6 of these cases. In a small number of cases, there were other complications: 1 injury of the median nerve, 1 elbow dislocation, 1brachial artery injury.[14]

2 patients treated with lateral approach suffered postoperative radial nerve injury, while this iatrogenic complication occurred in 6 patients who underwent posterior approach.

No permanent radial palsy related to surgery was reported in the analyzed cases. All authors describe at least partial recovery

at one year follow up after surgery except in one case where radial nerve injury was associated to brachial artery injury, as described by Capo JT *et al*.[14]

We recorded only 1 case of deep infection in a patient treated with lateral approach. Surgical revision was necessary, screws and plate were removed and long-term antibiotic therapy was administered.[14]

In our experience, we retrospectively enrolled 8 patients with distal-third diaphyseal humerus fractures, treated at Policlinico Gemelli (Rome) between March 2019 and January 2020. All of these patients underwent LCP plating conventional ORIF and posterior surgical approach (Figure 2). Fractures were defined according to the AO classification, with all the cases being of types A and B. They were 6 males and 2 females, aged from 20 to 73 years (mean: 51.38; SD: 16.64). The minimum duration of follow-up was 2 months (mean: 5.62; range: 2-12; SD: 3.25). 2 patients had preoperative radial nerve palsy. All patients were hospitalized to receive surgical treatment. Preoperatively, the fractured limb was immobilized with plaster and checked periodically. The injured upper limb was lifted on a pillow, with ice compression applied to reduce swelling. The operation was carried out under general anesthesia. The patient was placed in a prone position and the fractured arm is kept in abduction and the elbow flexed at 60°-90°. Intravenous antibiotics were used 60 minutes (cefazolin 2g) before surgery to prevent infection. The injured upper arms were immobilized in a sling for 4 weeks postoperatively and the incision stitches were taken out 10-12 days after surgery. The elbow was trained to flex and extend passively three times every day from the five day after operation to prevent stiffness. All patients were re-examined clinically and radiographically (anterior-posterior and lateral radiographs) to evaluate bony union and functional recovery at postoperative 4 weeks, 8 weeks, 3 months, 6 months and 12 months. No major complications or pseudoarthrosis were recorded. Good elbow ROM was achieved in 3 months. Using reduction of fracture and neurolysis, the nerve function was recovered at least 6 months after the surgical procedure in patients with traumatic radial nerve palsy.

Discussion

Distal-third diaphyseal fractures of the humerus type A and B (according to the AO classification) are notoriously difficult for orthopedic surgeons to manage. Traumatic injury of the radial nerve is often associated and the surgical approach itself exposes to nerve iatrogenic damage. For proper fracture reduction and osteosynthesis, it is necessary to use a safe surgical approach that allows good exposure. In the literature and historically, different surgical approaches are proposed. In particular, we have focused our attention on the posterior and lateral surgical approaches by analyzing their advantages and disadvantages. Maresca *et al* compared the clinical and radiographic outcomes of 37 patients, 22 of whom underwent to posterior midline with triceps-splitting approach, 3 to posterior approach with olecranon osteotomy and 12 to lateral approach. 30 patients were followed throughout the follow-up. The results were overlapping and bony union was achieved in all of them at an average time of 16 weeks, with a complete elbow range of motion restoration in 25 cases. There were 2 radial nerve injuries, then recovered, one in the trans-triceps approach and another in the lateral approach. The 2 cases of pseudoarthrosis that required revision of the osteosynthesis occurred in a lateral access and a trans-tricipital one. But in both cases, it was not attributable to the approach used, as they were comminuted fractures with bone loss. Unfortunately, no clinical scores were used in this study.[12] A larger case-series is the one proposed by Yin *et al*., 68 patients, 30 of whom underwent to lateral approach and 26 to posterior approach. In all patients there was a good restoration of the elbow ROM, with average values of about 140° of flexion and 5° of extension. The clinical scale used was MEPI, which gave excellent and overlapping values in the two groups (about 85 points). Similarly, there were no significant differences in terms of bony union, operative

AUTHORS	N. OF PATIENTS	SEX		AGE	TRAUMATIC MECHANISM				FRACTURE SITE	AO CLASSIFICATION		
		M	F		FALLING	TRAFFIC ACCIDENT	OCCUPATIONAL ACCIDENT	OTHER		12 A	12 B	12C
Chang H et al. [11]	38	33	5	(30.3) 17-49	5	1	/	32	third distal homerus diaphysis	24 (16 A1, 7 A2, 1 A3)	14 (7 B1, 4 B2, 3 B3)	/
Maresca A et al [12]	37	18	19	(43.6) 14-95	/	/	/	/	Third distal homerus diaphysis	16 (9 A1, 3 A2, 4 A3)	20 (14 B1, 2 B2, 4 B3)	/
Lotzien S et al. [13]	58	30	28	(59.9) 19-97	/	/	/	/	Third distal homerus diaphysis	38 (23 A1, 2 A2, 13 A3)	14 (8 B1, 4 B2, 2 B3)	6 (6 C1, 2 C2)
Capo JT et al. [14]	21	12	9	(39) 19-91	4	8	/	9	Metaphyseal extra-articular distal homerus	21	/	/
Yin P et al. [15]	56	30	26	(37.9) 20-73	17	39	/	/	Third distal homerus diaphysis	11	28	17
Kharbanda Y et al. [16]	20	13	7	(44) 31-56	9	11	/	/	Extra-articular distal homerus shaft	5 (3 A1, 2 A2)	11 (9 B1, 2 B2)	4 (4 C1)
Lee TJ et al. [17]	35	26	9	(37.7) 14-70	5	12	5	13	Third distal homerus diaphysis extra-articular	/	/	/

AUTHORS	SURGICAL APPROACH	ORTHOPEDIC TREATMENT	EVALUATION SCALES	OUTCOMES			
				UNION TIME (Weeks)	ELBOW ROM		DASH SCORE
					FLEX.	EXT.	
Chang H et al. [11]	Antero-lateral	LCP 4,5	ROM;UNION TIME;UCLA;MEPI.	16.2	131.5°	3°	/
Maresca A et al [12]	Lateral (12); Posterior (25)	LCP 3,5/LCP 4,5	ROM; UNION TIME	16	145°	0°	/
Lotzien S et al. [13]	Anterior (33); Posterior (25)	LCDCP	/	/	/	/	/
Capo JT et al. [14]	Posterior	EADHP J PLATE	ROM; UNION TIME; DASH SCORE; VAS	24	127°	7°	25.8
Yin P et al. [15]	Lateral (30); Posterior (26)	LCP	ROM; UNION TIME; MEPI	12.8 (lat); 12.9 (post)	139.2° (lat); 137.8 (post)	4.2° (lat); 5.1° (post)	/
Kharbanda Y et al. [16]	Posterior- lateral	LCP(LCDCP 3.5)	ROM; UNION TIME; DASH SCORE; VAS	12	125°	/	17.6
Lee TJ et al. [17]	Combined Anterolateral-lateral	LCP	ROM; UNION TIME; MEPI	11.2	132°	/	/

AUTHORS	COMPLICATIONS		FOLLOW-UP (MONTHS)
	PRE-OPERATIVE	POST-OPERATIVE	
Chang H et al. [11]	Radial nerve palsy (6)	/	11.4 (3-36)
Maresca A et al [12]	Radial nerve palsy (3); Radial nerve incarceration (6); Radial nerve perforation (1)	Radial nerve iatrogenic paralysis (1 lat, 1 post); Pseudoarthrosis (1 lat, 1 post)	6(5-12)
Lotzien S et al. [13]	Radial nerve palsy (12; 5 trattati anteriormente, 7 trattati posteriormente)	Radial nerv iatrogenic paralysis (4; 1 ant, 3 post)	34.6 (6-103)
Capo JT et al. [14]	Radial nerve injuries (9); Median nerve injury (1); Brachial artery injury (1); Elbow dislocation (1)	Infection (1); Transient ulnar nerve injury (1); Elbow stiffness (1)	10.4 (3-36)
Yin P et al. [15]	/	Radial nerve iatrogenic paralysis (3 post); Infection (1 lat); Removing plate (2 post); Triceps rupture (1)	15.8
Kharbanda Y et al. [16]	Radial nerve palsy (2)		25.6 (12-42)
Lee TJ et al. [17]	/	Mild elbw pain (14)	28.1(24-50)

Figure 3. Summary of studies included in the review.

time, hospitalization and intra-operative bleeding. At the same time, the authors report an increased incidence of complications with the posterior approach, such as tricipital tendon rupture requiring repair, transient iatrogenic radial nerve palsy and superficial surgical site complication ($p<0.041$). We think, being the only study that demonstrates this, that these data are influenced by the surgeon's familiarity with one or the other surgical access, and that the incidence of complications related to the approach are mainly due to the surgeon's training.[15] The reliability of the posterior with triceps-sparing access is also confirmed by Kharbanda *et al*. This author showed us a case-series of 20 patients, who reached bony union in about 14 weeks, without complications related to the surgical approach. Good elbow ROM and excellent DASH values were obtained. At the same time, variations of the traditional surgical approaches analyzed in our work exist.[16] Lotzien *et al*. proposed a comparison between the posterior and anterior approach, finding no significant differences in terms of complications. The anterior approach offers the advantage of the supine position. The same advantage can be obtained in the combined anterolateral and lateral approach, also in this case without particular differences in terms of complications and functional outcomes.[13] Nowadays, the aesthetic impact and also the respect of soft tissues have not inconsiderable part in the good success of the performed surgical procedure. This is why MIPO procedures are becoming more and more popular. This technique also offers undoubted soft tissue savings. In particular, Gallucci *et al*. proposed a case-series of 11 patients undergoing to posterior approach with the MIPO technique. In one case there was a radial nerve injury totally recovered in about 6 months. The small number of patients does not allow for exhaustive conclusions about the safety of the technique and the real risk of iatrogenic radial nerve injury.[18] Surely, the aesthetic impact is significantly better, although there are no particular advantages in terms of function and quality of life. In fact, we believe that even traditional posterior access, as it is posterior, does not cause particular discomfort to the patient as it is not easily visible to him/her. Several papers are present in the literature regarding the MIPO technique applied to the lateral and antero-lateral approaches to the distal humerus. In particular, Zhao *et al*. and Zamboni *et al*. have published two case-series of 28 and 11 patients, respectively, treated with the anterolateral MIPO approach.[19,20] Zhao *et al*. emphasized that the small incision for the exploration of the radial nerve is essential to avoid nerve iatrogenic injuries or to decompress the nerve if it involved in the trauma (as in 5 of 28 patients, who recovered completely).[19] Zamboni *et al*. analysed the difficulty of avoiding rotation errors with the MIPO technique, concluding that, even if this often happens, an increase in humeral head retroversion is well tolerated and does not lead to functional insufficiency of the shoulder.[20] Similarly, Chang *et al*. published a case-series of 38 patients treated with the MIPO lateral approach and small incision for radial nerve exploration and fracture reduction. Again, the results overlapped the previous ones, not reporting significant advantages over traditional approaches.[11] We agree that an incision, even if small in size, which allows a good fracture's visualization is always fundamental in order to ensure acceptable reduction and to allow the exploration of the radial nerve, not rarely involved in the trauma, as well as to protect it from possible iatrogenic damage.

Conclusions

Fractures of the distal-third diaphyseal humerus are often a challenge for the orthopaedic surgeon and the choice of the best surgical approach for proper reduction and osteosynthesis is crucial. Several surgical approaches are suggested and it is certainly familiarity with one or the other that should lead the surgeon to prefer one. The literature shows that no significant differences between the posterior and lateral approach exist, neither in terms of clinical and radiographic outcomes, nor in terms of radial nerve injuries. Certainly, the posterior approach offers undoubted advantages in terms of exposure of the fracture and visualization of the radial nerve, but also disadvantages, such as the prone position that often creates anaesthesiologic contraindications. At the same time, we believe that the posterior scar on the arm does not create any particular aesthetic problem. In addition, these scars are rarely retracted due to the abundance of subcutaneous tissue. In our opinion, the posterior approach also allows for optimal management of complex and multi-fragmentary fractures. In fact, this surgical access allows to view the humerus at 360 degrees, moreover the prone position with the arm on a suitable support allows to facilitate the reduction by force of gravity.

References

1. Galano GJ, Ahmad CS, Levine WN. Current treatment strategies for bicolumnar distal humerusfractures. J Am Acad Orthop Surg 2010;18:20-30.
2. Anglen J. Distal humerus fractures. J Am Acad Orthop Surg 2005;13:291-7.
3. Orthopaedic Trauma Association: Committee for coding and classification. Fracture and dislocation compendium. J Orthop Trauma 1996;10:S1-S154.
4. Paulsen F. Sobotta Anatomy: textbook, Elsevier Oxford, 2018.
5. Müller ME, Allgöwer M, Schneider R, et al. Manual of internal fixation, Springler New York, 1991; p.118-20.
6. Shao YC, Harwood P, Grotz MR, et al. Radial nerve palsy associated with fractures of the shaft of the humerus: a systematic review. J Bone Joint Surg Br 2005;87:1647-52.
7. Dabezies EJ, Banta CJ, Murphy CP et al. Plate fixation of the humeral shaft for acute fractures with and without radial nerve injuries. J Orthop Trauma 1992;6: 10-3.
8. Bell M, Beauchamp C, Kellam JK, et al. The results of plating humeral shaft fractures in patients with multiple injuries. J Bone Joint Surg Br 1985;67: 293-6.
9. Mills WJ, Hanel DP, Smith DG. Lateral approach to the humeral shaft: an alternative approach for fracture treatment. J Orthop Trauma 1996;10:81-6.
10. Gerwin M, Hotchkiss RN, Weiland AJ. Alternative operative exposures of the posterior aspect of the humeral diaphysis. With reference to the radial nerve. J Bone Joint Surg 1996;78:1690-5.
11. Chang H, Yao ZL, Hou YL, et al. Lateral subcutaneous locking compression plate and small incision reduction for distal-third diaphyseal humerus fractures. Orthop Surg 2018;10: 218-26.
12. Maresca S, Fantasia R, Cianforlini M, et al. Distal-third diaphyseal fractures of the humerus: choice of approach and surgical treatment. Musculoskelet Surg 2016;100:97-104.
13. Lotzien S, Hoberg S, Rausch S, et al. Open reduction and internal fixation of humeral midshaft fractures: anterior versus posterior plate fixation. BMC Musculoskelet Disord 2019;20:527.
14. Capo JT, Debkowska MP, Liporace F, et al. Outcomes of distal humerus diaphyseal injuries fixed with a single-column anatomic plate. Int Orthop 2014;38:1037-43.

15. Yin P, Zhang L, Mao Z et al. Comparison of lateral and posterior surgical approach in management of extra-articular distal humeral shaft fractures. Injury 2014;45:1121-5.
16. Kharbanda Y, Tanwar YS, Srivastava V, et al. Retrospective analysis of extra-articular distal humerus shaft fractures treated with the use of pre-contoured lateral column metaphyseal LCP by triceps-sparing posterolateral approach. Strategies Trauma Limb Reconstr 2017;12:1-9.
17. Lee TJ, Kwon DG, Na SI, et al. Modified Combined Approach for Distal Humerus Shaft Fracture: Anterolateral and Lateral Bimodal Approach. Clin Orthop Surg 2013;5:209-15.
18. Gallucci G, Boretto J, Vujovich A, et al. Posterior Minimally Invasive Plate Osteosynthesis for Humeral Shaft Fracture. Tech Hand Up Extrem Surg 2014;18:25-30.
19. Zhao W, Qu W, Fu C, et al. Antero-lateral minimally invasive plate osteosynthesis (MIPO) with the radial nerve exploration for extra-articular distal-third diaphyseal fractures of the humerus. Int Orthop 2017;41:1757-62.
20. Zamboni C, Durigan JR, Pimentel FD, et al. Rotational evaluation of humeral shaft fractures with proximal extension fixed using the MIPO technique. Injury 2018;49:1558-61.