

Position statement: management of proximal humerus fractures

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We sought to compare outcomes and reoperation rates for the surgical treatment of proximal humerus fractures (excluding head-splitting fractures, fracture-dislocations, and isolated greater-tuberosity fractures) in men and women older than 60 years. We searched MEDLINE, Embase, and Cochrane through to Feb. 1, 2022, and included all English-language randomized trials comparing operative versus nonoperative treatment; open reduction and internal fixation (ORIF) with locking plate versus intramedullary nail; arthroplasty versus ORIF; and reverse shoulder arthroplasty versus hemiarthroplasty. Outcomes of interest were functional outcomes (e.g., Constant score), pain outcomes (visual analogue scale scores), and reoperation rates for the interventions of interest when available. We rated the quality of the evidence and strength of recommendations using the Grading of Recommendations, Assessment, Development and Evaluation (GRADE) approach. This guideline will benefit patients considering surgical intervention for fractures of the proximal humerus by improving counselling on surgical treatment options and possible outcomes. It will also benefit surgical providers by improving their knowledge of various surgical approaches. Data presented could be used to develop frameworks and tools for shared decision-making.

Nous avons cherché à comparer les résultats et les taux de réintervention à la suite d'un traitement chirurgical pour une fracture de l'humérus proximal (excluant les fractures de la tête humérale, les fractures-luxations et les fractures isolées de la grande tubérosité) chez les hommes et les femmes âgés de plus de 60 ans. Nous avons effectué des recherches dans les bases de données MEDLINE, Embase, et Cochrane jusqu'au 1^{er} février 2022 et avons inclus tous les essais randomisés publiés en anglais comparant différents duos d'interventions : traitements chirurgicaux ou non chirurgicaux; réductions ouvertes avec fixation interne (ROFI) réalisées à l'aide d'une plaque verrouillée ou enclouages centromédullaires; arthroplasties ou ROFI; et arthroplasties inversées de l'épaule ou hémiarthroplasties. Les paramètres d'intérêt étaient la capacité fonctionnelle (p. ex., score de Constant), la douleur (p. ex., échelle analogique visuelle) et le taux de réintervention pour les interventions d'intérêt, selon les données disponibles. Nous avons évalué la qualité des données probantes et la solidité des recommandations à l'aide de l'approche GRADE (Grading of Recommendations, Assessment, Development and Evaluation). Cette ligne directrice profitera aux patients qui envisagent une intervention chirurgicale après une fracture de l'humérus proximal en améliorant les consultations sur les options de traitement chirurgical et les résultats escomptés. Elle aidera aussi les chirurgiens en améliorant leurs connaissances sur différentes approches chirurgicales. Les données présentées pourraient servir à mettre au point des cadres et des outils pour une prise de décision partagée.

Proximal humerus fractures (PHFs) are extremely common,¹ and the incidence is expected to rise significantly as the population ages.² Most commonly, PHFs consist of osteoporotic fragility fractures; they are more common in women and follow a unimodal distribution pattern, with incidence increasing with age.¹

There is controversy regarding the optimal surgical treatment of PHFs. Whether surgery offers any benefit over nonoperative treatment continues to be a matter of debate.³⁻⁷ More than 80% of fractures are thought to be suitable for nonoperative treatment with a period of immobilization followed by physiotherapy.⁸ However, although it appears that most patients with PHFs may be treated successfully with nonoperative means, about 15% have persistent functional deficits that affect their quality of life.⁹

Key points

- In general, for patients older than 60 years with proximal humerus fractures (PHFs), excluding reverse shoulder arthroplasty (RSA), surgical treatment does not provide superior functional or pain outcomes; it is more likely that patients who undergo open reduction and internal fixation (ORIF) for 3- and 4-part fractures will require reoperation than it is for non-operative treatment to fail and require those patients to undergo surgery.
- Objective and subjective outcomes of various procedures may differ, and further data are needed to determine whether certain patient subgroups may benefit from surgical intervention.
- An exploration of patient expectations is essential before any surgical intervention to treat PHFs.
- Patients should be counselled that there are limited data regarding the outcomes of function, pain, and reoperation rates following surgical treatment, but existing data indicate that in patients who are candidates for surgical intervention:
 - RSA and hemiarthroplasty (HA) result in superior functional outcomes than ORIF
 - RSA results in superior function and pain outcomes than HA
- Data on the long-term durability of all surgical options are lacking.
- Surgery for PHFs is technically demanding and should be considered by surgeons with the appropriate degree of training and experience.

The most common approach to the surgical treatment of PHFs involves the use of proximal humeral locking plates.^{10,11} Although the healing rate associated with locking plates has been shown to be high, their use has also been associated with a high reoperation rate and a complication rate that approaches 50%.¹²

Intramedullary nails (IMNs) are also commonly used for the treatment of PHFs. They appear to be best suited for fractures with limited displacement of the greater tuberosity, as reoperation rates appear to be higher with 4-part fractures.^{5,13}

Shoulder hemiarthroplasty (HA) was described in 1955 for the treatment of displaced PHFs¹⁴ and evolved into the treatment of choice for 3- and 4-part fractures and in the setting of osteoporotic bone.⁵ Cementation of the stem is usually recommended, and functional outcomes and patient satisfaction are closely linked to anatomic healing of the tuberosities.¹⁵ Complications of HA include component malpositioning, iatrogenic fracture, axillary nerve injury, tuberosity-related complications (i.e., displacement, malunion, resorption, and nonunion), shoulder stiffness, instability, infection, rotator cuff dysfunction, glenoid erosion, component loosening, and heterotopic ossification.^{15–20}

More recently, reverse shoulder arthroplasty (RSA) has gained popularity in older patients with complex fracture patterns, particularly in the setting of comminuted and osteoporotic fractures in which tuberosity healing is unlikely. The most common complication associated with RSA continues to be scapular notching,²¹ which has an incidence as high as 44% in the first 14 postoperative months.²² However, the incidence of notching appears to be lower with new lateralized designs and lower neck-shaft angles.²³ Acromial insufficiency fractures may occur postoperatively and appear to affect postoperative functional results.²⁴ Arm lengthening occurs in RSA, and brachial plexus strain has also been observed in as many as 20% of patients.²⁵

This position statement, based on a systematic review and meta-analysis,²⁶ provides recommendations for selection of operative treatments based on objective outcomes for PHFs, excluding head-splitting fractures, fracture-dislocations, and isolated greater-tuberosity fractures.

METHODOLOGY

We conducted a systematic review.²⁶ We searched MEDLINE, Embase, and Cochrane through to Feb. 1, 2022, and included all English-language randomized trials comparing operative versus nonoperative treatment; open reduction and internal fixation (ORIF) with locking plate versus IMN; arthroplasty versus ORIF; and RSA versus HA. Following a rigorous methodology, experts in shoulder surgery reviewed the available literature. Outcomes of interest were functional outcomes (e.g., Constant score), pain outcomes (visual analogue scale scores), and reoperation rates for the interventions of interest when available. We rated the quality of the evidence and strength of recommendations using the Grading of Recommendations, Assessment, Development and Evaluation (GRADE) approach (Appendix 1, available at www.canjsurg.ca/lookup/doi/10.1503/cjs.007822/tab-related-content).

RECOMMENDATIONS

1. Patients with displaced PHFs who are considering surgical intervention should be counselled that function and pain are similar with operative and nonoperative treatment (*Strong, moderate*).
2. Patients with displaced PHFs who are considering surgical intervention should be counselled that operative treatment with locking plates in 3- and 4-part fractures is more likely to require reoperation than it is for non-operative treatment to fail and require eventual surgical intervention (*Strong, moderate*).
3. Patients should be counselled that RSA provides similar functional outcomes but superior pain relief than non-operative treatment (*Strong, moderate*).
4. In the absence of reliable data, current best practice is to recommend surgical intervention for surgical neck fractures with greater than 100% displacement of the shaft with respect to the head, and for greater-tuberosity fractures displaced more than 10 mm (*Conditional, very low*).
5. When internal fixation is chosen, appropriately trained surgeons may consider the use of either ORIF with locking plates or with IMNs in the treatment of displaced PHFs, as overall patient-reported outcome measures are similar in the medium term (*Conditional, moderate*).
6. Patients with displaced PHFs who are considering surgical intervention should be counselled that arthroplasty (RSA and HA) provides superior functional outcomes but similar pain outcomes to ORIF (*Strong, low*).

7. Patients with displaced PHFs who are considering surgery should be counselled that RSA provides superior functional and pain outcomes to HA (*Strong, moderate*).
8. Patients older than 60 years should be counselled that data on function, pain, and reoperation rates are lacking and that it is unknown whether certain patient subgroups may benefit from surgery (*Strong, very low*).

All recommendations and summary statements refer to surgical treatment of PHFs in patients older than 60 years in the short and medium term (up to 2 yr), except when otherwise specified. The strength of the recommendation and the GRADE assessment of the quality of the evidence is indicated in parentheses (Appendix 2, available at www.canjsurg.ca/lookup/doi/10.1503/cjs.007822/tab-related-content).

Operative versus nonoperative treatment

Our meta-analysis compared proximal humeral locking plates, HA, and RSA.^{17,18,27-29} Functional outcomes of operative treatment were very similar to those of nonoperative treatment. Similarly, postintervention pain, as determined with a visual analogue scale (VAS), was not found to be different between operative and nonoperative interventions. There were significantly more patients who received operative treatment with locking plates in 3- and 4-part fractures who required reoperation than patients who received nonoperative treatment that failed and had to undergo surgical intervention (mean difference [MD] 7.98, 95% confidence interval [CI] 1.72 to 37.07, $p = 0.008$).

There was a lack of data on patient subgroups that might benefit from operative treatment, including those with fracture displacement greater than 100%, greater ($> 20^\circ$) humeral head angulation, more (> 10 mm) tuberosity displacement, and younger patients.

We identified only 1 trial comparing RSA with nonoperative treatment.³⁰ There was a trend toward superior Constant scores in favour of RSA compared with nonoperative treatment (MD 6.0, 95% CI -0.1 to 12.1, $p = 0.071$). Pain scores were statistically superior in favour of RSA compared with nonoperative treatment (MD difference -0.7 , $p = 0.011$) (Box 1).

Box 1: Summary statements 1-4, recommendations 1-4 and 8

1. In general, operative treatment was similar to nonoperative treatment of PHFs for the outcomes of:

- Overall PROMs for function (*moderate level of evidence*)
- Overall patient-rated pain measures (*moderate level of evidence*)

2. In general, operative treatment with locking plates for 3- and 4-part fractures was inferior to nonoperative treatment in the outcome of:

- Reoperation rates (*moderate level of evidence*)

3. Compared with nonoperative treatment, RSA was similar with a trend toward superiority for the outcome of:

- Overall PROMs for function (*moderate level of evidence*)

4. Compared with nonoperative treatment, RSA was superior for the outcome of:

- Overall patient-rated pain measures (*moderate level of evidence*)

PHF = proximal humerus fracture; PROM = patient-reported outcome measure; RSA = reverse shoulder arthroplasty.

ORIF with locking plate versus ORIF with IMNs

Locking plate fixation was compared with IMN fixation in 2-part fractures in 2 trials.^{31,32} Analysis of the Constant score and VAS pain scores as well as reoperation rates did not reveal any significant differences between interventions. Locking plate fixation was compared with IMN fixation in 3- and 4-part fractures in a single trial.³³ The Constant score was higher in the IMN group (MD 6, $p = 0.043$). The VAS pain scores were higher in favour of IMNs (MD 1.00, 95% CI 0.44 to 1.56, $p = 0.001$). Reoperation rates were higher with locking plates than with IMNs (odds ratio [OR] 3.49, 95% CI 1.4 to 8.71, $p = 0.007$) (Box 2).

Box 2: Summary statements 5a and 5b, recommendation 5

5a. Locking plates compared with IMNs were similar for 2-part fractures in the outcomes of:

- Overall PROMs for function (*moderate level of evidence*)
- Overall patient-rated pain measures (*moderate level of evidence*)
- Reoperation rates (*moderate level of evidence*)

5b. IMNs were superior to locking plates for 3- and 4-part fractures in the outcomes of

- Overall PROMs for function (*moderate level of evidence*)
- Overall patient-rated pain measures (*moderate level of evidence*)
- Reoperation rates (*moderate level of evidence*)

IMN = intramedullary nail; PROM = patient-reported outcome measure.

Arthroplasty versus ORIF

Few studies compared arthroplasty with ORIF. A single study³⁴ compared ORIF with HA at 2-year follow-up. Hemiarthroplasty had a superior Constant score (MD 12.20, 95% CI 2.75 to 21.65, $p = 0.05$). However, there was no difference in the mean VAS scores at final follow-up between groups. Compared with ORIF, RSA had statistically higher Constant scores (MD 13.4 points, 95% CI 6.2 to 20.6 points, $p < 0.001$).³⁵ No difference was seen between groups in the pain scores at 24-month follow-up. Both studies exceeded the minimum clinically important difference (MCID) for the Constant score of 5.6.³⁶ No definitive conclusions may be drawn regarding reoperation rates given the low event rate in either study (Box 3).

Box 3: Summary statements 6 and 7, recommendation 6

6. Arthroplasty (RSA and HA) compared with ORIF was superior for the outcomes of:

- Overall PROMs for function (HA: *low-certainty evidence*; RSA: *moderate level of evidence*)

7. Arthroplasty (RSA and HA) compared with ORIF was similar for the outcomes of:

- Overall patient-rated pain measures (HA: *low level of evidence*; RSA: *moderate level of evidence*)

HA = hemiarthroplasty; ORIF = open reduction and internal fixation; PROM = patient-reported outcome measure; RSA = reverse shoulder arthroplasty.

RSA versus HA

Data from 3 trials were pooled for this comparison.^{37–39} Reverse shoulder arthroplasty had higher functional scores (MD 16.1, 95% CI 11.5 to 20.7, $p < 0.001$) and higher VAS pain scores than HA (MD -1.69 , 95% CI -2.05 to -1.32 , $p < 0.001$). The incidence of reoperation was higher with HA than RSA, and this trended toward statistical significance (OR 0.22, 95% CI 0.04 to 1.12, $p = 0.07$) (Box 4).

Box 4: Summary statements 8 and 9, recommendation 7

8. RSA compared with HA was superior in the outcomes of:
 - Overall PROMs for function (*moderate level of evidence*)
 - Overall patient-rated pain measures (*moderate level of evidence*)
9. RSA compared with HA was similar in reoperation rates (*moderate level of evidence*)

HA = hemiarthroplasty; ORIF = open reduction and internal fixation; PROM = patient-reported outcome measure; RSA = reverse shoulder arthroplasty.

DISCUSSION

A recent review by Orman and colleagues⁴⁰ that included prospective randomized trials of 3- and 4-part fractures comparing treatment of PHFs found that nonsurgical treatment was associated with a lower rate of additional surgery than ORIF. In the current review, the pooled data showed that fewer patients received nonoperative treatment and had to undergo a subsequent surgical intervention than patients who underwent ORIF in 3- and 4-part displaced PHFs and required reoperation. Orman and colleagues⁴⁰ reported that RSA had better clinical outcomes than HA, a finding similar to what we found in this review.

A review by Sun and colleagues⁴¹ included prospective randomized trials, prospective observational, and retrospective studies comparing locking plates with IMNs. The study found higher screw penetration rates with locking plates, but similar functional outcomes, pain scores, and complication rates overall between the 2 treatment approaches. These findings were similar to those of the current review.

Pizzo and colleagues included prospective randomized studies and retrospective data in a comparison of ORIF, HA, and RSA in the treatment of PHFs.⁴² They found higher outcome scores with ORIF than with HA and RSA, although the groups may not have been comparable in terms of age and fracture complexity. The current review included only randomized trials, but found higher Constant scores in a single trial comparing HA with ORIF,³⁴ and higher Constant scores in a single trial comparing RSA with ORIF.³⁵ Pizzo and colleagues⁴² reported higher Constant scores with RSA than with HA, along with a lower risk of complications; those findings were similar to ours.

Limitations

A limitation inherent in any comparison of ORIF with arthroplasty is the risk of comparing dissimilar groups. Open reduction and internal fixation tends to be selected for less complex fractures in younger patients, whereas arthroplasty is often reserved for older patients with poorer bone. Despite this, we found higher functional scores with both HA and RSA than with ORIF. Another potential limitation of the current review is related to its methodology and the use of prospective randomized trials. The use of aggregate data does not allow for the analysis of patient subgroups with certain fracture patterns that may benefit from surgical treatment. In light of this, and in the absence of further high-level evidence, we made a best practice recommendation based on expert opinion only: that surgical treatment may be considered over nonoperative management in the presence of gross (100%) fracture displacement between the head and shaft, and displacement greater than 10 mm of the greater tuberosity.⁴³ Finally, patients included in the current analysis had isolated fractures, and data on multi-trauma fracture patients with both upper- and lower-extremity fractures were limited.

As most studies were limited to 2-year follow-up, there was a lack of data on the long-term durability of all treatment options. No randomized studies included in the meta-analysis had follow-up beyond 2 years. A recent prospective cohort study reported the 7-year results in 32 patients who underwent RSA for PHFs.⁴⁴ The Constant score increased from 64 at 12 months to 70 at 7 years postoperative. There were 2 reoperations: 1 for dislocation and 1 for a periprosthetic fracture. There were no revisions due to loosening.

The cost-effectiveness of RSA versus ORIF was recently reported by Austin and colleagues.⁴⁵ They found RSA to be more cost-effective than ORIF in patients older than 65 years with any Charlson Comorbidity Index score. Similarly, in a series of pairwise comparisons including nonoperative treatment, ORIF, HA, and RSA, RSA was found to be the most cost-effective option in patients older than 65 years.⁴⁶

The grading of outcomes was generally low or moderate owing to the possibility of bias. In a few instances where grading was low, evidence was derived from a single randomized trial with a small number of participants.

Surgical intervention for PHFs is often technically demanding, and the incidence of failure may be related to the quality of the reconstruction.⁴⁷ Recommendations in favour of certain treatment options assume that the surgeon has the appropriate level of training, skill, and experience to perform the intervention. The inclusion of surgeon expertise may be an important factor in future studies to determine the true effect of surgical interventions.

CONCLUSION

Surgeons counselling patients older than 60 years of age on treatment options for the management of PHFs should be aware that there are similar subjective outcomes in the medium term for operative and nonoperative treatment; however, it is more likely that patients who undergo ORIF for 3- and 4-part fractures will require reoperation than it is for nonoperative treatment of PHFs to fail and require surgical intervention. Data comparing operative and nonoperative treatment in younger patients are lacking, and further studies are needed to clarify this question. Preliminary evidence shows that RSA results in similar functional and pain outcomes as nonoperative treatment, although there was a trend toward superior function with RSA. In patients in whom fixation is selected, use of locking plates results in similar patient-reported outcome measures as use of IMNs. Preliminary evidence shows that arthroplasty (either HA or RSA) appears to be associated with superior functional outcomes than ORIF if patients are candidates for both treatment options. Further studies are required to better define what patient age subgroups benefit most from arthroplasty. Reverse shoulder arthroplasty results in superior functional and pain outcomes than HA. Further well-designed studies comparing surgical procedures with nonoperative management in certain patient subgroups would be of benefit. These include those at potentially higher risk of nonunion (owing to high degrees of fracture displacement) or tuberosity-related complications (owing to significant displacement of the greater tuberosity).

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