A commentary by Christopher O. Bayne, MD, is linked to the online version of this article.

Surgery for Olecranon Fractures in the Elderly (SOFIE)

Results of the SOFIE Randomized Controlled Trial

Mithun A. Joshi, MBBS(Hons), FRACS(Orth), FAOrthA, Michael Le, BMedSci, MD, MS, Ryan Campbell, BMedSci(Hons), MD, MTrau(Orth), Brahman Sivakumar, MBBS, BSc(Med), MS, MSc, FRACS(Orth), FAOrthA, PFET, John Limbers, MBBS(Hons), BSc(Med), FRACS(Orth), FAOrthA, Ian A. Harris, MBBS, MMed(ClinEpi), MSc(HDS), PhD, FRACS(Orth), FAOrthA, FAHMS, and Michael Symes, MBBS(Hons), BAppSc Physio(Hons), MPH, FRACS(Orth), FAOrthA

Background: The financial and resource burden of management of olecranon fractures in the elderly is likely to increase with an aging population. There is limited evidence guiding treatment choice in this cohort. This study aimed to determine whether operative treatment of displaced olecranon fractures in elderly patients provides superior 12-month functional outcomes compared to nonoperative treatment.

Methods: A multicenter pragmatic randomized controlled trial was conducted across 24 hospitals in Australia and New Zealand. Patients aged ≥75 years presenting with an acute (within 14 days), displaced, closed, isolated olecranon fracture were included. Operative treatment involved reduction and stabilization using tension band wiring or plate fixation. Nonoperative treatment consisted of a sling for comfort and early movement as tolerated. The primary outcome was the Disabilities of the Arm, Shoulder and Hand (DASH) score at 12 months. Secondary outcomes were the DASH score at 3 months and pain, quality of life, Mayo Elbow Performance Score (MEPS), active elbow range of motion, and complication rate at 3 and 12 months. Data were analyzed based on an intention-to-treat principle, with sensitivity analyses using as-treated groups.

Results: Sixty participants were randomized, 27 to the operative group (mean age and standard deviation [SD], 83 ± 5.8 years; 22 [81%] females) and 33 to the nonoperative group (mean age, 82 ± 4.5 years; 23 [70%] females), with no significant difference in baseline characteristics. There was no significant difference (mean difference, −6.6; 95% confidence interval [CI] = −14.9 to 1.8; p = 0.12) in the mean DASH scores at 12 months (the primary outcome) between the operative (12.3 ± 14) and nonoperative (18.9 ± 18) groups. Although active elbow extension was significantly superior in the operative group at 12 months, no other secondary outcome differed significantly between groups at 12 months.

Conclusions: The study found no significant difference in DASH scores at 12 months between the operative and nonoperative groups. This supports nonoperative treatment as a reasonable option for displaced stable olecranon fractures in elderly patients.

Level of Evidence: Therapeutic Level I. See Instructions for Authors for a complete description of levels of evidence.

Isolated stable olecranon fracture (Type II according to the Mayo classification) is one of the most common injuries around the elbow[1]. There is an increasing incidence of these fractures in the elderly, especially after the seventh decade of life, due to osteoporosis and a greater risk of falls[2,3]. This creates a substantial burden on both individuals and the health-care systems[4].

Displaced olecranon fractures have traditionally undergone surgical intervention via tension band wiring or plate

Disclosure: This study received funding from the Australian Orthopaedic Association Research Foundation and from AO Trauma Asia Pacific. The **Disclosure of Potential Conflicts of Interest** forms are provided with the online version of the article (http://links.lww.com/JBJS/I327).

A **data-sharing statement** is provided with the online version of the article (http://links.lww.com/JBJS/I329).

fixation, with proponents espousing the possible benefits of restoration of articular congruity and recreation of the extensor mechanism[5-7]. Poor bone quality and a fragile soft-tissue envelope, however, render fracture fixation in the elderly challenging[8]. Complication rates ranging from 15% to 80% have been reported following olecranon fracture stabilization in this population, with wound breakdown, fixation failure, and symptomatic hardware requiring removal reported as the most common adverse sequelae[3,9,10].

Studies have demonstrated that nonoperative management can lead to satisfactory functional outcomes, challenging the traditional preference for surgical treatment in this cohort[5-7,9,11-18]. Most, however, are observational cohort studies and case series with small patient volumes[5-7,11-18]. We know of only 1 prior prospective randomized controlled trial comparing nonoperative and operative treatment of displaced olecranon fractures in elderly patients, but that study was terminated prematurely due to an unacceptably high complication rate in the operative group[9]. The authors concluded that the study was underpowered to prove noninferiority of nonoperative treatment.

The aim of the present study was to compare the effectiveness of nonoperative and operative measures in restoring upper limb function 12 months after displaced olecranon fractures in elderly patients. Secondary aims included comparison of pain, subjective general health, range of motion, and complication rates between groups at 3 and 12 months. We hypothesized that operative treatment of displaced olecranon fractures in elderly patients provides superior patient-reported pain and functional outcomes at 12 months compared with nonoperative treatment.

Materials and Methods

Design

This multicenter pragmatic randomized controlled trial was conducted at 24 sites including tertiary trauma centers and district general hospitals across regional and rural Australia and New Zealand. The study was approved by the Hunter New England Human Research Ethics Committee (Trial ID 2019/PID01062) and was prospectively registered with the Australian New Zealand Clinical Trials Registry (ACTRN12614000588695). The study protocol was published in 2015[19] (see Appendix 1).

Eligibility Criteria

Patients were considered eligible for the study (Fig. 1) if they (1) were 75 years of age or older, (2) presented with a displaced (>2 mm)[9] simple or comminuted olecranon fracture (Fig. 2), (3) were treated within 14 days of the injury, and (4) were deemed medically fit for surgery.

Patients were excluded if they (1) were unable to provide consent due to cognitive impairment, (2) had other fractures around the elbow (coronoid, radial head, proximal ulna, or distal humerus), (3) had an associated ligamentous injury, (4) had a subluxated or dislocated ulnohumeral joint (Mayo Type III), (5) had 180° of rotation of the proximal fragment whereby the trabecular surface directly contacted and threatened the overlying skin, (6) had an open injury, and (7) had concomitant ipsilateral fractures. Patients with preexisting ipsilateral upper limb problems such as rotator cuff disease were not excluded.

Participants

Between June 2014 and October 2022, 94 patients with displaced olecranon fractures were screened and 76 of them were deemed eligible for inclusion. Sixty-four of these patients agreed to participate and provided written informed consent. Twenty-nine patients were randomized to the operative group and 35 were allocated to the nonoperative group. Two patients from each group were lost to follow-up and excluded from the primary analysis. The study followed the Consolidated Standards of Reporting Trials (CONSORT) guidelines[20]. The CONSORT flowchart for recruitment and the flow of participants through the trial is outlined in Figure 1.

Randomization

Randomization was performed using a central web-based system (Sealed Envelope) using the technique of minimization to ensure balance of groups by sex, age (75 to 80 years versus ≥81 years) and preexisting upper limb pathology. While participants and surgeons were not blinded to treatment allocation, outcome assessors and the statistician were. Masking of treatment allocation using dummy intervention group names was maintained until all authors agreed on the results and interpretation of the statistical analysis.

Interventions

Participants in the nonoperative group wore a sling for comfort and were allowed early range of motion as tolerated. Patients in the operative group underwent surgery using the treating surgeon's preferred technique (tension band wiring or plate fixation). Postoperatively, an above-the-elbow elbow backslab splint was applied and remained in place for 2 weeks, after which progressive range of motion was allowed as tolerated. All participants were assessed at 2 weeks, 3 months, and 12 months. Referral for formal physiotherapy was not routinely provided for patients in either group.

Outcome Measures

The primary outcome assessed was the Disabilities of the Arm, Shoulder and Hand (DASH) score at 12 months after intervention. This score ranges from 0 to 100, with higher scores indicating greater levels of disability[21,22]. Secondary outcome measures included the DASH score at 3 months, and the following at 3 months and 12 months: the pain score on a visual analog scale (Pain-VAS; scored from 0 to 10, with higher scores indicating greater pain), EuroQol Visual Analog Scale[23] (EQ-VAS; scored from 0 to 100, with higher scores indicating higher health-related quality of life), Mayo Elbow Performance Score[24] (MEPS; ranging from 5 to 100, with higher scores indicating superior elbow function), adverse events, elbow active range of motion, and elbow extension strength.

Sample Size and Statistical Analysis

A power calculation determined that a sample size of 26 participants in each group would provide 95% power to detect the minimum clinically important difference (15 points) in the

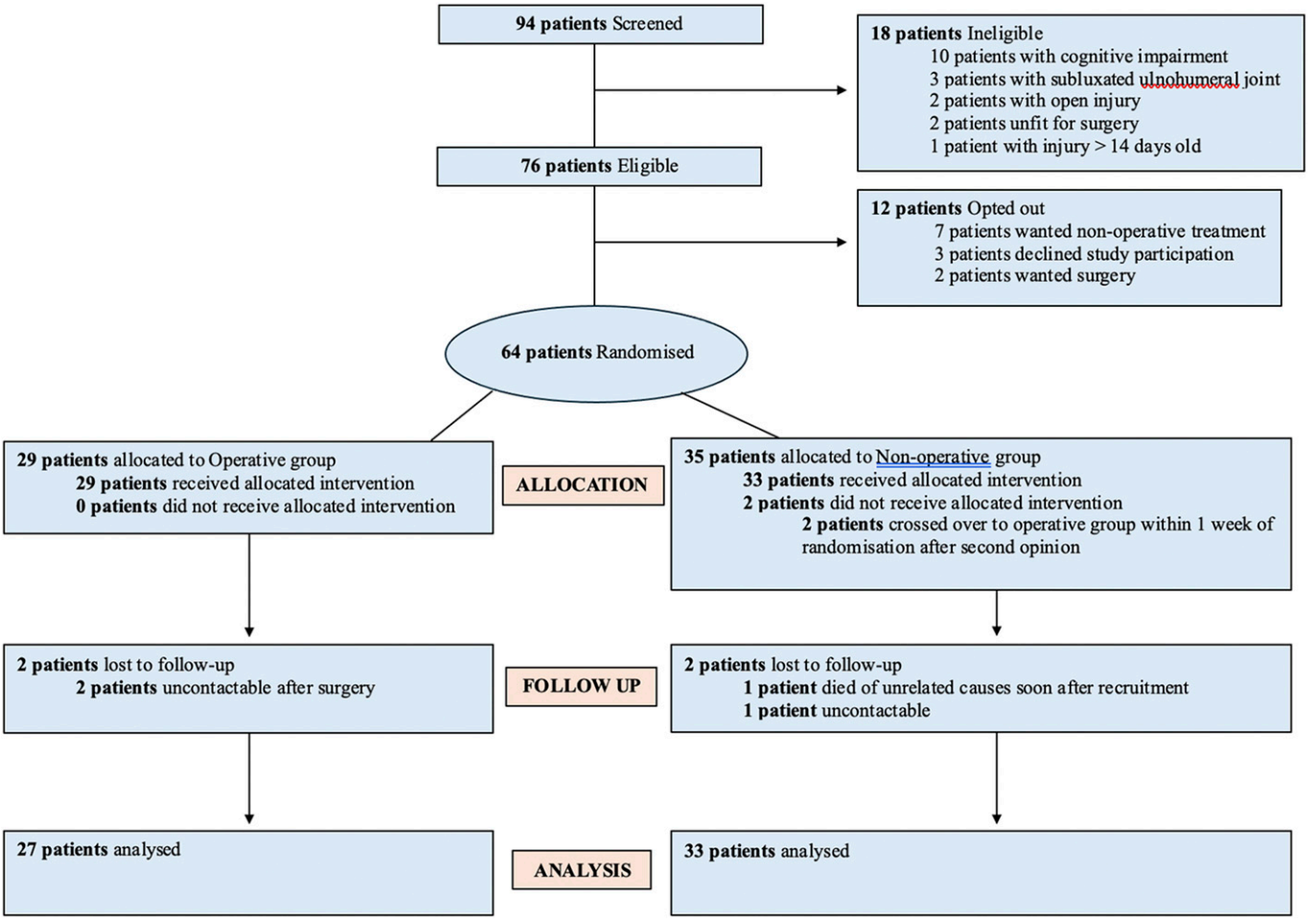

Fig. 1

CONSORT flow diagram showing recruitment and flow of patients through the trial.

DASH score at a significance level of 0.05[19,21,25,26]. To account for a 20% loss to follow-up, we started with a target sample size of 65 patients. Randomization, however, was stopped at 64 instead of 65 patients because an adequate sample size per the power analysis was reached with minimal loss to follow-up (4 of 64 randomized patients or 6% loss to follow-up).

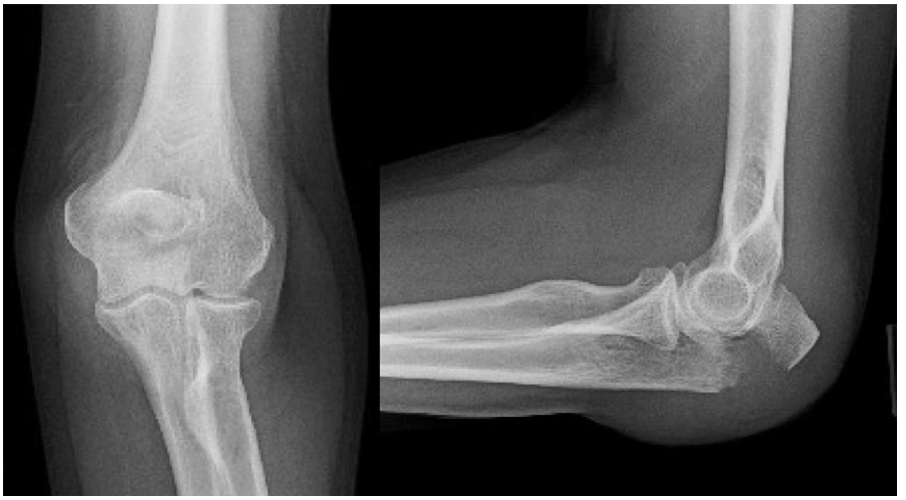

Fig. 2

Anteroposterior and lateral radiographs of a recruited patient's olecranon fracture.

TABLE I Baseline Characteristics for 60 Patients Randomized to Operative and Nonoperative Groups

Characteristic*	Operative (N = 27)	Nonoperative (N = 33)	P Value
Age: mean (SD) [range] *(yr)*	83 (5.8) [75-95]	82 (4.5) [75-91]	0.19
Female sex	22 (81)	23 (70)	0.45
Right hand dominant	15 (56)	20 (61)	0.90
Comorbidities			
Diabetes mellitus	1 (4)	6 (18)	0.09
Smoking	0 (0)	0 (0)	—
Residential status			0.34
Home	24 (89)	24 (73)	
Retirement village	2 (7)	2 (6)	
Nursing home	1(4)	7 (21)	
Preexisting upper limb problems	4 (15)	10 (30)	0.26
Mayo fracture classification[28]			0.51
IIA	14 (52)	21 (64)	
IIB	13 (48)	12 (36)	

*Categorical characteristics are presented as number (%). SD = standard deviation.

Data were analyzed based on an intention-to-treat principle, with sensitivity analyses using as-treated groups. The Welch t test was used for analysis of continuous variables, and the Fisher exact test was used to assess categorical variables. All statistical analysis was performed using R statistical computing software (version 4.1.1, R Foundation for Statistical Computing)[27].

Results

Demographics

There was no significant difference in baseline characteristics between the 27 patients allocated to operative treatment (mean age and standard deviation [SD], 83 ± 5.8 years; 22 [81%] females) and the 33 patients allocated to nonoperative treatment (mean age, 82 ± 4.5 years; 23 [70%] females) (Table I). Race and ethnicity data were not collected.

Primary Outcome

No significant difference (p = 0.12) was observed in the DASH scores at 12 months (the primary outcome). The mean DASH score was 12.3 ± 14 for the operative group and 18.9 ± 18 for the nonoperative group. The mean difference was −6.6 (95% confidence interval [CI], −14.9 to 1.8) in favor of the operative group.

Secondary Outcomes

There was a significant difference, favoring the operative group, in the DASH score and MEPS at 3 months. The MEPS at 12 months, however, did not differ significantly between groups. Pain-VAS and EQ-VAS did not differ significantly between groups at either 3 or 12 months. Active elbow extension was significantly better in the operative group than in the nonoperative group at 3 months (p = 0.004) and

TABLE II Secondary Outcomes at 3 Months for 60 Patients Randomized to Operative and Nonoperative Groups*

Secondary Outcome	Mean (SD)		MD (95% CI)	P Value
	Operative (N = 27)	Nonoperative (N = 33)		
DASH	18.2 (15)	29.9 (23)	−11.7 (−21.6 to −1.6)	0.02†
Pain-VAS	1.3 (1.5)	2.1 (2.2)	−0.8 (−1.7 to 0.2)	0.14
EQ-VAS	72.4 (16)	73.6 (16)	−1.2 (−9.6 to 7.1)	0.76
Active elbow ROM *(°)*				
Flexion	133.4 (12)	124.1 (16)	9 (2.1 to 16.5)	0.01†
Extension	11.0 (11)	19.4 (11)	−8.4 (−13 to −2.8)	0.004†
MEPS	89.6 (11)	81.4 (18)	8.2 (0.3 to 16.1)	0.04†

*SD = standard deviation, MD = mean difference, CI = confidence interval, DASH = Disabilities of the Arm, Shoulder and Hand score, Pain-VAS = pain visual analog scale, EQ-VAS = EuroQol visual analog scale, ROM = range of motion, MEPS = Mayo Elbow Performance Score. †Significant.

TABLE III Primary (DASH) and Secondary Outcomes at 12 Months for 60 Patients Randomized to Operative and Nonoperative Groups*

Outcome†	Mean (SD)		MD (95% CI)	P Value
	Operative (N = 27)	Nonoperative (N = 33)		
DASH	12.3 (14)	18.9 (18)	−6.6 (−14.9 to 1.8)	0.12
Pain-VAS	0.9 (1.5)	1.2 (1.9)	−0.3 (−1.2 to 0.5)	0.45
EQ-VAS	67.9 (22)	76.3 (20)	−8.4 (−19.3 to 2.4)	0.12
Active elbow ROM *(°)*				
Flexion	133.6 (11)	132.5 (9.2)	1.1 (−4.1 to 6.3)	0.67
Extension	9.4 (8.4)	15.5 (11)	−6.1 (−11.2 to −1.1)	0.02†
MEPS	95.0 (8.3)	90.8 (15)	4.2 (−1.9 to 10.4)	0.17

*DASH = Disabilities of Arm, Shoulder and Hand score, SD = standard deviation, MD = mean difference, CI = confidence interval, Pain-VAS = pain visual analog scale, EQ-VAS = EuroQol visual analog scale, ROM = range of motion, MEPS = Mayo Elbow Performance Score.
†Significant.

12 months (p = 0.02). Although active elbow flexion was significantly better in the operative group at 3 months, it did not differ significantly between the groups at 12 months. Although our hope was to compare the groups with respect to extension strength measured with a dynamometer, this outcome measure was abandoned as not all hospitals had access to a dynamometer and reliable strength assessment proved difficult in frail elderly patients. Similar to Duckworth et al.[9], we assumed that any loss of strength affecting function would be reflected in patient-reported outcome measures. All outcomes are summarized in Tables II and III.

Complications

Adverse events were defined as death, infection, implant failure, and any additional surgery. There were 4 complications (15%) in the operative group. Four patients (12%) randomized to the nonoperative group crossed over to the operative group. Two of these patients sought a second opinion from another surgeon in the private sector within 1 week after randomization. The reasons for a second opinion and for the decision to manage surgically were unknown. The other 2 patients crossed over due to progression to an open fracture (1) or a painful nonunion (1). No significant difference in complication rate was observed between the operative and nonoperative groups at 12 months (odds ratio [OR] = 1.03, 95% CI = 0.20 to 5.81, p = 1.00). Complications and crossover time points are summarized in Table IV.

Sensitivity Analysis

Four patients crossed over between treatment groups, all from the nonoperative to the operative group. A sensitivity analysis based on the treatment received produced results similar to those of the intention-to-treat analysis (see Appendix 2).

Discussion

The study found no significant difference in overall upper limb disability, as assessed by DASH scores, between the operative and nonoperative groups at 12 months after intervention. However, the 95% CI for the primary outcome does not exclude a clinically important difference in the DASH score favoring

TABLE IV Complications at 12 Months for 60 Patients Randomized to Operative and Nonoperative Groups

Group	Complication	Additional Information
Operative	Deep infection and secondary fixation failure	Reoperation for hardware removal and debridement
Operative	Hardware irritation	Reoperation for hardware removal
Operative	Hardware migration and fracture displacement	Managed nonoperatively
Operative	Death	Embolic cerebrovascular accident unrelated to surgery
Nonoperative	Crossover to surgery, reason unknown	Sought second opinion within 1 week post-randomization
Nonoperative	Crossover to surgery, reason unknown	Sought second opinion within 1 week post-randomization
Nonoperative	Skin tenting by displaced fragment and progression to open fracture	Managed surgically at 7 weeks post-randomization
Nonoperative	Painful nonunion	Managed surgically at 9 months post-randomization
Nonoperative	Death	Aspiration pneumonia unrelated to admission for elbow fracture

operative treatment. Better upper limb function (DASH and MEPS outcomes) and elbow flexion at 3 months, and elbow extension at 3 and 12 months, were noted in the operative group. No other secondary outcome, including pain, subjective general health, or complication rate, differed between the 2 groups.

The findings in this study are consistent with the only previous randomized controlled trial on this topic[9]. The previous trial, however, reported a much higher complication rate in the operative group (81.8% versus 15% in the current study), resulting in its premature termination[9]. Complications including infection and failure of fixation may occur more commonly in this age group due to poor bone and soft-tissue quality, reduced compliance with postoperative movement restriction, and increased comorbidities. Our findings are also in agreement with observational cohort studies and case series demonstrating satisfactory outcomes and safety with nonoperative treatment of displaced olecranon fractures[5-7,11-18]. Earlier functional recovery was experienced in the operative group, with better DASH and MEPS outcomes at 3 months. Thus, surgery may have a role in elderly patients who require an early return to function, such as those who are currently employed or living independently.

We believe that this is the first adequately powered study to provide experimental evidence supporting the use of nonoperative treatment for displaced stable olecranon fractures in the elderly. The low rate of crossover, blinding of the statistician and outcome assessors, success of randomization in achieving similar group characteristics, and the high follow-up rate support the internal validity, and the inclusion of multiple centers and surgeons supports generalizability.

This study should be interpreted with consideration of certain limitations. The unavailability of race and ethnicity data may affect the study's generalizability. The non-blinded nature of the interventions may have introduced performance bias, potentially influencing outcome measures such as pain and functional assessments. It is also possible that the effect of surgery may be affected or modified by the degree of displacement, a question that we were unable to answer in our study due to its design. Radiographic outcomes were not recorded and may have differed between groups. However, any such differences were not reflected in the clinical outcomes. While the sample size was adequate to detect important differences in DASH scores, the study may not have been adequately powered for all clinical outcomes. Additionally, the findings at 12 months may not represent longer-term outcomes. Finally, the recruitment phase was slow, due to strict adherence to rigorous inclusion and exclusion criteria, leading to an 8-year study period.

Conclusions

Contrary to our hypothesis, the findings of the SOFIE trial suggest that nonoperative treatment is a reasonable option in elderly patients with displaced stable olecranon fractures as it provides functional outcomes similar to those of operative treatment.

Appendix

eA Supporting material provided by the authors is posted with the online version of this article as a data supplement at jbjs.org (http://links.lww.com/JBJS/I328). ■

Mithun A. Joshi, MBBS(Hons), FRACS(Orth), FAOrthA[1]
Michael Le, BMedSci, MD, MS[2,3]
Ryan Campbell, BMedSci(Hons), MD, MTrau(Orth)[4]
Brahman Sivakumar, MBBS, BSc(Med), MS, MSc, FRACS(Orth), FAOrthA, PFET[4,5,6,7]
John Limbers, MBBS(Hons), BSc(Med), FRACS(Orth), FAOrthA[1]
Ian A. Harris, MBBS, MMed(ClinEpi), MSc(HDS), PhD, FRACS(Orth), FAOrthA, FAHMS[8,9]
Michael Symes, MBBS(Hons), BAppSc Physio(Hons), MPH, FRACS(Orth), FAOrthA[4,10]

[1]Central Coast Local Health District, Gosford, New South Wales, Australia

[2]Royal Prince Alfred Hospital, Camperdown, New South Wales, Australia

[3]St George and Sutherland Clinical School, University of New South Wales, Sydney, New South Wales, Australia

[4]Royal North Shore Hospital, St Leonards, New South Wales, Australia

[5]Hornsby Ku-ring-gai Hospital, Hornsby, New South Wales, Australia

[6]Nepean Hospital, Kingswood, New South Wales, Australia

[7]Sydney Medical School, Faculty of Medicine and Health, University of Sydney, Camperdown, New South Wales, Australia

[8]Whitlam Orthopaedic Research Centre, Ingham Institute for Applied Medical Research, Sydney, New South Wales, Australia

[9]South West Sydney Clinical Campus, School of Clinical Medicine, UNSW Medicine & Health, University of New South Wales Sydney, Sydney, New South Wales, Australia

[10]St George and Sutherland Hospitals, Kogarah, New South Wales, Australia

Email for corresponding author: rj.campbel16@gmail.com

References

1. Duckworth AD, Carter TH, Chen MJ, Gardner MJ, Watts AC. Olecranon fractures: current treatment concepts. Bone Joint J. 2023 Feb;105-B(2):112-23.

2. Parkes J, Limb R, Quadri ST, Lamb JN, Mohrir G, Yousef A, West RM, Cowling P. Complications and mortality associated with olecranon fractures in the elderly: a retrospective cohort comparison from a large level one trauma centre. Shoulder Elbow. 2022 Apr;14(2):200-10.

3. Rantalaiho I, Laaksonen I, Launonen AP, Luokkala T, Flinkkilä T, Salmela M, Adolfsson L, Olsen B, Isotalo K, Ryösä A, Äärimaa V; SCORE study group. Scandinavian Olecranon Research in the Elderly (SCORE): protocol for a non-inferiority, randomised, controlled, multicentre trial comparing operative and conservative treatment of olecranon fractures in the elderly. BMJ Open. 2022 Jan 31;12(1):e055097.

4. Welch JM, Zhuang T, Shapiro LM, Gardner MJ, Xiao M, Kamal RN. Cost minimization analysis of the treatment of olecranon fracture in elderly patients: a retrospective analysis. Curr Orthop Pract. 2022 Nov-Dec;33(6):559-64.

5. Veras Del Monte L, Sirera Vercher M, Busquets Net R, Castellanos Robles J, Carrera Calderer L, Mir Bullo X. Conservative treatment of displaced fractures of the olecranon in the elderly. Injury. 1999 Mar;30(2):105-10.
6. Gallucci GL, Piuzzi NS, Slullitel PAI, Boretto JG, Alfie VA, Donndorff A, De Carli P. Non-surgical functional treatment for displaced olecranon fractures in the elderly. Bone Joint J. 2014 Apr;96-B(4):530-4.
7. Parker MJ, Richmond PW, Andrew TA, Bewes PC. A review of displaced olecranon fractures treated conservatively. J R Coll Surg Edinb. 1990 Dec;35(6):392-4.
8. Chen MJ, Campbell ST, Finlay AK, Duckworth AD, Bishop JA, Gardner MJ. Surgical and Nonoperative Management of Olecranon Fractures in the Elderly: A Systematic Review and Meta-Analysis. J Orthop Trauma. 2021 Jan 1;35(1):10-6.
9. Duckworth AD, Clement ND, McEachan JE, White TO, Court-Brown CM, McQueen MM. Prospective randomised trial of non-operative versus operative management of olecranon fractures in the elderly. Bone Joint J. 2017 Jul;99-B(7):964-72.
10. Alvara CA, Biedron G, Dunn JC. Nonoperative management of olecranon fractures in elderly patients: a systematic review. Hand (N Y). 2022 Jul;17(4):734-9.
11. Aibinder WR, Sims LA, Athwal GS, King GJW, Faber KJ. Outcomes of nonoperative management of displaced olecranon fractures in medically unwell patients. JSES Int. 2021 Jan 10;5(2):291-5.
12. Duckworth AD, Bugler KE, Clement ND, Court-Brown CM, McQueen MM. Nonoperative management of displaced olecranon fractures in low-demand elderly patients. J Bone Joint Surg Am. 2014 Jan 1;96(1):67-72.
13. Marot V, Bayle-Iniguez X, Cavaignac E, Bonnevialle N, Mansat P, Murgier J. Results of non-operative treatment of olecranon fracture in over 75-year-olds. Orthop Traumatol Surg Res. 2018 Feb;104(1):79-82.
14. Batten TJ, Patel NG, Birdsall P. Olecranon fractures: is nonoperative treatment acceptable in older patients? Curr Orthop Pract. 2016;27(1):103-6.
15. Bruinsma W, Lindenhovius A, McKee M, Athwal GS, Ring D. Non-union of non-operatively treated displaced olecranon fractures. Shoulder Elbow. 2012;4(4):273-6.
16. Nicholson JA, Oliver WM, Gillespie M, Simpson AHRW, White TO, Duckworth AD. Nonoperative management of displaced olecranon fractures in the elderly results in sesamoid-like function: an ultrasound assessment of the relative movement of the fracture fragments. Orthop Proc. 2021;103-B(Supp 7):4-4.
17. Putnam MD, Christophersen CM, Adams JE. Pilot report: non-operative treatment of Mayo Type II olecranon fractures in any-age adult patient. Shoulder Elbow. 2017 Oct;9(4):285-91.
18. Kaiser P, Stock K, Benedikt S, Kastenberger T, Schmidle G, Arora R. Retrospective comparison of conservative treatment and surgery for widely displaced olecranon fractures in low-demanding geriatric patients. Arch Orthop Trauma Surg. 2022 Oct;142(10):2659-67.
19. Symes M, Harris IA, Limbers J, Joshi M. SOFIE: Surgery for Olecranon Fractures in the Elderly: a randomised controlled trial of operative versus non-operative treatment. BMC Musculoskelet Disord. 2015 Oct 27;16:324.
20. Schulz KF, Altman DG, Moher D; CONSORT Group. CONSORT 2010 statement: updated guidelines for reporting parallel group randomised trials. BMJ. 2010 Mar 23;340:c332.
21. Institute for Work & Health. The Disabilities of the Arm, Shoulder and Hand (DASH) Outcome Measure. Accessed 2014 June 29. https://dash.iwh.on.ca/
22. Hudak PL, Amadio PC, Bombardier C; The Upper Extremity Collaborative Group (UECG). Development of an upper extremity outcome measure: the DASH (Disabilities of the Arm, Shoulder and Hand) [corrected]. Am J Ind Med. 1996 Jun;29(6):602-8.
23. EuroQol. Terminology. EQ VAS. Accessed 2014 Jun 29. https://euroqol.org/information-and-support/documentation/terminology/
24. Cusick MC, Bonnaig NS, Azar FM, Mauck BM, Smith RA, Throckmorton TW. Accuracy and reliability of the Mayo Elbow Performance Score. J Hand Surg Am. 2014 Jun;39(6):1146-50.
25. Franchignoni F, Vercelli S, Giordano A, Sartorio F, Bravini E, Ferriero G. Minimal clinically important difference of the Disabilities of the Arm, Shoulder and Hand outcome measure (DASH) and its shortened version (QuickDASH). J Orthop Sports Phys Ther. 2014 Jan;44(1):30-9.
26. Hunsaker FG, Cioffi DA, Amadio PC, Wright JG, Caughlin B. The American Academy of Orthopaedic Surgeons outcomes instruments: normative values from the general population. J Bone Joint Surg Am. 2002 Feb;84(2):208-15.
27. R Core Team. R: A Language and Environment for Statistical Computing. 2018. Accessed 2024 Oct 2. https://www.R-project.org/
28. Cabanela ME, Morrey BF. The elbow and its disorders. 2nd ed. Philadelphia: WB Saunders; 1993.