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Comparison of arthroscopy-assisted vs. open reduction and fixation of coronoid fractures of the ulna

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Purpose: The purpose of this study was to compare clinical and radiographic outcomes and complications for arthroscopy-assisted vs. open reduction and fixation of coronoid fractures in patients with complex elbow fracture-dislocations.

Methods: This retrospective study analyzed patients with complex elbow fracture-dislocations who underwent surgical fixation for coronoid fractures of the ulna from March 2009 to January 2016. Subjects included those who received either arthroscopy-assisted (group A) or open surgery (group O) for coronoid fractures and concurrent reconstruction of the lateral column (radial head and/or lateral ulnar collateral ligament) with follow-up for at least 2 years. Clinical outcomes were assessed using the visual analog scale for pain, range of motion, Mayo Elbow Performance Score, and Disabilities of the Arm, Shoulder, and Hand score at 2 years after surgery. For radiographic assessment, union of the coronoid, development of heterotopic ossification, and arthritic changes were evaluated. We also reviewed surgery-related complications.

Results: Twenty-five patients (mean age, 40.0 ± 12.4 years) were enrolled in this study (group A, 15 patients; group O, 10 patients), and there were no statistical differences in baseline data between the 2 groups. Clinical outcomes did not differ between the 2 groups. All fractures were united and that the prevalence of heterotopic ossification and arthritic changes were similar between the 2 groups. However, operation-related complications were more common in group O than in group A (group A, 13.3%; group O, 40.0%), including 1 patient who underwent ulnar nerve neurolysis and anterior transposition at 3 months after the initial operation.

Conclusions: Eliciting fewer complications, arthroscopy-assisted reduction and fixation of coronoid fractures shows union rates and clinical results comparable to open fixation in patients with complex elbow fracture-dislocation.

Level of Evidence: Level III; Retrospective Cohort Comparison; Treatment Study

Keywords: Ulnar coronoid process; fracture fixation; arthroscopic surgery

Complex elbow fracture-dislocations encompass various injuries, including terrible triad fracture-dislocation, posteromedial rotatory injury, transolecranon fracture-dislocation, posterior Monteggia fracture-dislocation, radial head fracture with lateral collateral ligament rupture, and solitary coronoid fracture of the ulna.[1,2,7,11,14,23,29] Among these injuries, terrible triad fracture-dislocation and posteromedial

The Yonsei University Health System, Severance Hospital, Institutional Review Board approved the study and waived the requirement for informed consent because of the retrospective nature of the study (study no. 4-2019-1132).

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rotatory injury concurrently involve fracture of the coronoid process and the lateral column of the elbow (radial head and/or lateral collateral ligament). If the ulnohumeral joint is incongruent or eccentric, these structures must be stabilized to prevent chronic instability and arthrosis of the elbow and to facilitate early rehabilitation in an effort to alleviate elbow stiffness.[10,11,22,23,29]

The coronoid process simultaneously provides anterior and varus buttress stability with valgus constraint.[11,28,29,31] Although it is generally recognized that surgical fixation is indicated when a fracture involves more than 50% of the coronoid process in the sagittal plane (Regan-Morrey type III),[28] there are no clear surgical indications for coronoid fractures. Although Regan-Morrey's study was established prior to our understanding of the importance of ligamentous constraints, O'Driscoll and colleagues took an important step in recognizing the need of surgical fixation for coronoid fractures and instability patterns associated with complex posterolateral rotatory injury and posteromedial rotatory injury. According to O'Driscoll's classification, even for coronoid fractures involving less than 50% of the process in the coronal plane, which corresponds to Regan-Morrey type I or II, surgery should be considered if there is evidence of a combined subluxation or instability of the elbow.[4,7,10,23] This is because O'Driscoll type I (the tip) fractures are frequently associated with terrible triad injuries, whereas type II (the anteromedial facet) fractures are associated with posteromedial rotatory injuries.[7,23,29] Meanwhile, for small avulsion coronoid fragments, described as Regan-Morrey type I or O'Driscoll type I1, the benefits of suture fixation are uncertain.[3] Thus, fixation for coronoid fracture in elbow fracture-dislocations is generally recommended for Regan-Morrey type II with elbow instability (or subluxation) and type III coronoid fractures.

For reconstruction of coronoid fractures in terrible triad or posteromedial rotatory injuries, either arthroscopic or open reduction and fixation can be performed. For comminuted radial head fractures requiring reconstruction or replacement, surgeons can use the same lateral approach to fix coronoid fractures through the defect space of the radial head.[23,34] Otherwise, in an open technique, surgeons must choose between a longitudinal posterior incision or an additional medial incision to approach the medial and lateral aspects of the elbow.[9] Both of these supplementary incisions can increase the risk of complications, such as neurovascular injury, seromas and hematomas, or flap necrosis.[9,11,23] As an alternative option, arthroscopy-assisted reduction and fixation for coronoid fractures can obviate the need for unnecessary dissection of soft tissue and complications associated therewith.

Although previous studies on arthroscopic coronoid fixation have reported excellent outcomes,[1,20] research comparing open and arthroscopic outcomes for the same surgical indication is lacking. Accordingly, we sought to compare clinical and radiographic outcomes, as well as complications, between arthroscopy-assisted and open reduction and fixation for coronoid fractures in patients with terrible triad or posteromedial injuries. We hypothesized that arthroscopy-assisted surgery would result in improved clinical outcomes and fewer complications after surgery.

Materials and methods

This is a retrospective case-control study, and we reviewed the medical records of patients diagnosed with complex elbow fracture-dislocations at our institution from March 2009 to January 2016. The inclusion criteria of this study were (1) patients who underwent either arthroscopy-assisted or open surgery for coronoid fracture and concurrent reconstruction of the lateral column (radial head and/or lateral ulnar collateral ligament) and (2) patients who were followed up for at least 2 years. Patients meeting the following criteria were excluded: (1) delayed operation >2 weeks; (2) combined olecranon fracture (O'Driscoll type III2); (3) anteromedial facet of the coronoid fracture involving the sublime tubercle (O'Driscoll type II3) deemed unapproachable by arthroscopic methods and requiring anatomic reconstruction by open surgery[1,30]; (4) replacement for radial head fracture (Mason type III), allowing coronoid fixation by a simultaneous lateral approach[23]; and (5) involvement of more than 3 columns of the elbow (described by Jupiter[29]) necessitating additional medial collateral ligament repair or external fixation (Fig. 1).

Surgical techniques

All patients received general anesthesia, and the degree of elbow instability was determined manually and under fluoroscopy before the operation. An essential part of arthroscopy-assisted reconstruction of a coronoid fracture is to rule out cases that are unfit for arthroscopic methods. If the elbow is repeatedly dislocated and shows multidirectional instability without any stable position, surgeons ought to suspect an injury involving more than 3 columns of the elbow and the potential for disruption of the flexor and extensor muscle groups.[29] These unstable injuries are indicated for open surgery, and reconstruction of the medial column and external fixation should be prepared preoperatively.[11,23]

For arthroscopy-assisted surgery (group A, Figs. 2 and 3), patients were placed in the prone position, with the arm supported on an arm positioner. A posterior transarticular portal, as described by Kim et al,[19] was initially established as an entry portal, because attenuated injury on the anterior and lateral columns of the elbow can interrupt the placement of anterior portals. Next, a blunt trocar and sheath were inserted, and intra-articular fluid containing hematoma was washed out several times to obtain a better arthroscopic view. A 4.0-mm arthroscope was then introduced through a proximal anterolateral portal, and a probe was inserted through a proximal anteromedial portal, which was used to reduce the displaced coronoid fragment under direct arthroscopic view. Another probe was then inserted through a posterior transarticular portal to stabilize the reduced coronoid fragment together with the probe from the proximal anteromedial portal (Fig. 2, *C* and *D*). After the reduction, 1 or 2 temporary Kirschner (K) wires were inserted from the posterior proximal ulna to fix the fracture fragment percutaneously under fluoroscopic guidance (Fig. 2, *E* and *F*). When coronoid fragments were large enough, 1 or 2 headless compression screws (2.2- or 3.0-mm) were used to fix the fracture fragment over the temporary K-wires (Fig. 2, *G*). For multifragmented or small

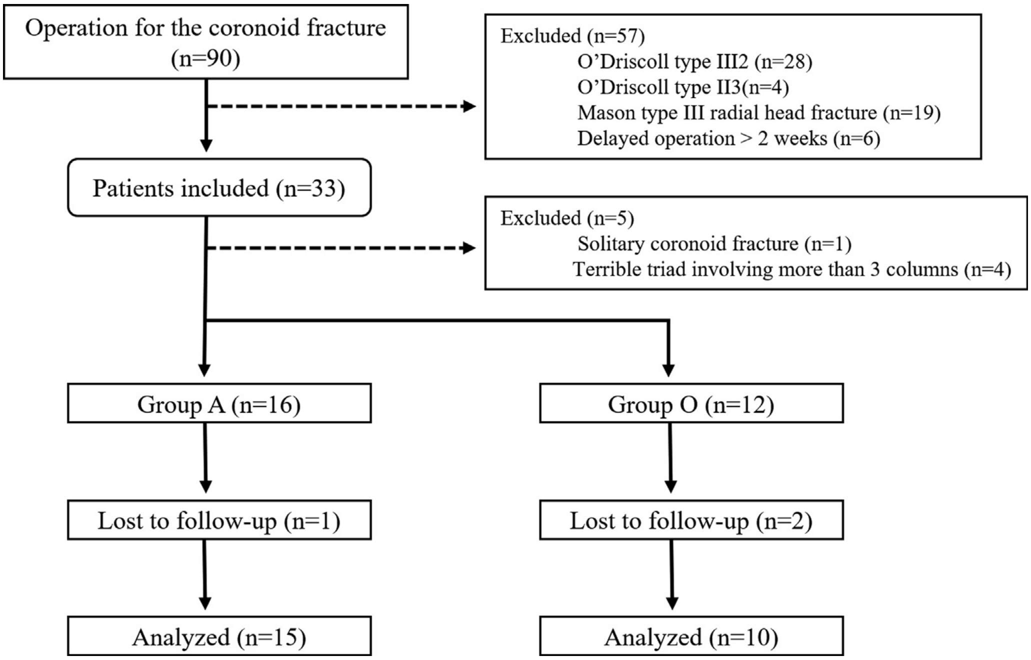

Figure 1 Flowchart of patient enrollment. This study included patients who underwent arthroscopic or medial-open coronoid fixation combined with lateral column reconstruction. Fifty-seven patients were removed according to exclusion criteria after examining preoperative medical records, plain radiographs, and computed tomographic scans. An additional 5 patients were excluded after fluoroscopy-guided physical evaluation under general anesthesia.

coronoid fractures, temporary K-wires were left as the final fixation. Displaced radial head fractures associated with a coronoid fracture were reduced and fixed with headless compression screws or a plate and screws using another lateral elbow approach splitting the extensor digitorum communis. The lateral ulnar collateral ligament was repaired using either a metal or a bioabsorbable suture anchor.

For open surgery (group O; Fig. 4), patients were placed in the supine position, with the arm prepped and draped on a hand table. The fractured coronoid was exposed using the flexor carpi ulnaris–splitting approach.[18,24] The coronoid fracture was reduced and fixed with headless compression screws, K-wires, or buttress plates. Associated radial head fractures and ruptured lateral collateral ligaments were fixed as described above for group A.

After surgery, the elbow was immobilized in a long arm splint at 90° of flexion and neutral rotation for 2 weeks. After 2 weeks, a hinged elbow brace was applied to allow active and passive flexion-extension motion with a 45° extension block. Patients were gradually increased to an active range of movement over a 4-week period. Active pronation and supination movements were allowed with the elbow placed in 90° of flexion. Six weeks after surgery, the elbow brace was discarded, and active maximum range of motion exercises were initiated through physical postures. Strengthening was initiated when sufficient bony and ligamentous healing had occurred.

The senior elbow surgeon (Y.C.) performed all surgeries and alternatively chose surgical techniques for each patient.

Clinical and radiologic assessments

Preoperative evaluations consisted of plain radiographs of the elbow, including anteroposterior, lateral, and 45° internal and external oblique views. All patients initially underwent computed tomography (CT) scans to evaluate the height of the coronoid fracture and ulnohumeral joint concentricity or subluxation. One senior resident and 1 orthopedic surgeon retrospectively reviewed initial plain radiographs and CT scans to determine Regan-Morrey and O'Driscoll types according to their classification criteria.[28,30] The entire coronoid height was measured by adding the height of the fractured coronoid process and the remaining portion, setting the reference baseline as a connection between points at the base of the trochlear notch and the anterior ulnar cortical margin. The coronoid height was calculated by dividing the fractured coronoid by the entire coronoid height (Fig. 2, *B*).[8] Postoperatively, all patients underwent regular follow-up visits in an outpatient clinic at 2 weeks, 6 weeks, 3 months, 6 months, 1 year, and 2 years after surgery, with continued follow-up thereafter every 2 years. The same 4 radiographic views of the elbow used in the preoperative evaluation were obtained at each follow-up visit.

For investigation of clinical outcomes, one observer (H.C.), a physician's assistant, who was uninvolved in patient treatment performed all of the clinical assessments, including visual analog scale (VAS) pain score (0-10), active flexion-extension arc and pronation-supination arc of the affected elbow, Mayo Elbow Performance Score (MEPS) (a commonly used rating system[32,33]), and Disabilities of the Arm, Shoulder, and Hand (DASH) score,[17] at each follow-up visit starting at 3 months after surgery. Active range of motion was measured using a handheld goniometer.

To assess radiologic outcomes, union of the coronoid process, the presence of heterotopic ossification (HO), and arthritic changes were evaluated by 1 senior resident and 1 orthopedic surgeon uninvolved in the surgery. HO was graded according to the Hasting and Graham classification,[15] and arthritic changes in the elbow were assessed using the Broberg and Morrey Scale.[21] We also reviewed procedure-related complications, including

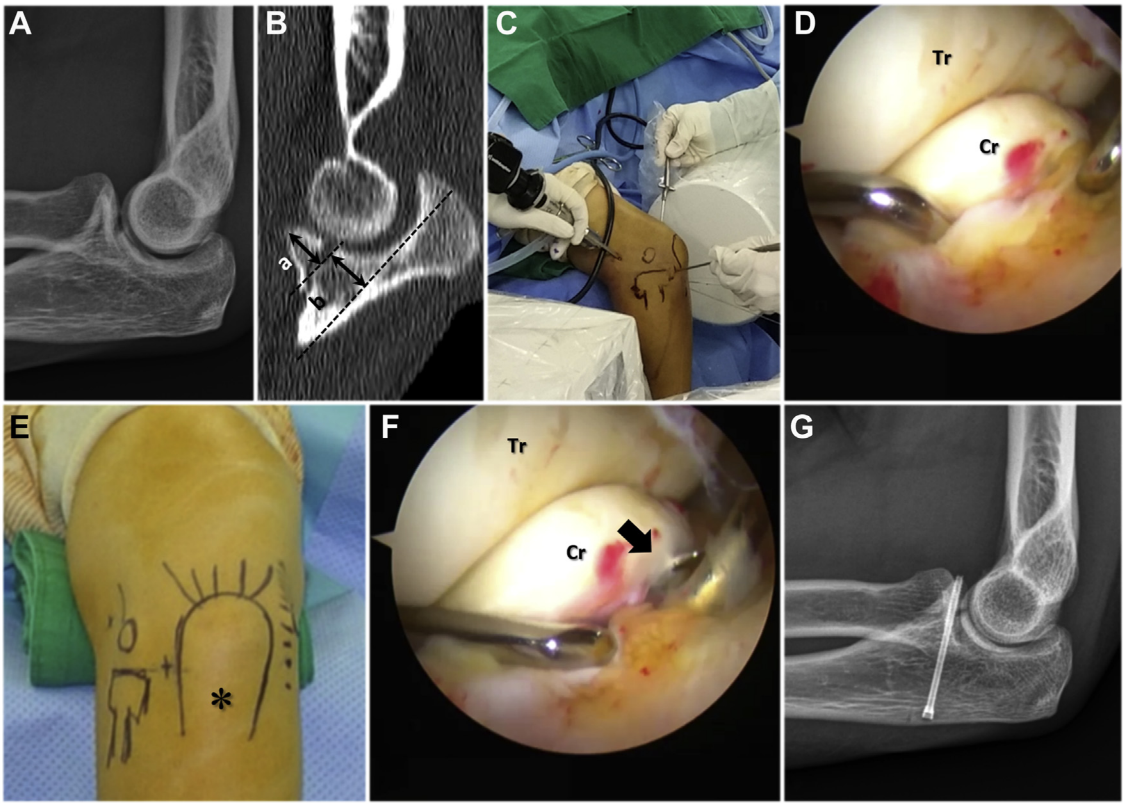

Figure 2 Arthroscopy-assisted reduction and fixation surgical technique for coronoid fracture. (**A**) Lateral view of the elbow radiograph shows a fracture of the coronoid process of the ulna. (**B**) On the sagittal view of the computed tomography, the percentage coronoid height (a / ($a + b$) × 100) was measured to classify according to Regan-Morrey classification. The joint subluxation (eccentric position of the trochlea) is shown, suggesting residual instability of the elbow. (**C, D**) With the patient in a prone position, the proximal anterolateral portal is used as a viewing portal, whereas the proximal anteromedial and posterior transarticular portals are used as working portals. An arthroscopy-assisted reduction is performed using 2 probes while an assistant maintains the operative view by holding an arthroscope. (**E, F**) After the reduction, a Kirschner wire is inserted to fix the fracture fragment. The entry point is the midpoint along the posterior aspect of the olecranon on the same level of the radial head (*), inserted slightly proximal to the targeting tip of the coronoid process (➡). (**G**) Lateral view of a postoperative radiograph shows that a headless compression screw, changed along the Kirschner wire as a guide pin, is appropriately holding the fracture fragment. *Tr*, trochlea; *Cr*, Coronoid process.

neurologic symptoms, postoperative infection, hardware irritation, hematoma, reoperation, residual elbow instability, and elbow stiffness. Complication rates for each group were calculated as a percentage of the number of complications divided by the number of patients. No patient was recalled to our institution specifically for this study. All data were obtained from medical records without missing information.

Statistical analysis

Data are presented as a mean ± standard deviation unless otherwise indicated. All statistical computations were conducted using standard software (R freeware v3.5.2, www.r-project.org; R Foundation for Statistical Computing, Vienna, Austria). A 2-sample t test or Wilcoxon rank-sum test was applied for between-group comparisons of continuous data (eg, VAS pain score, range of motion, MEPS, and DASH score). The chi-square test and Fisher exact test were used to compare categorical data (eg, demographic characteristics, presence/absence of arthritis and HO, and complications) between groups. A P value less than .05 was considered statistically significant. Power analysis was performed with variables with a higher effect size (sample size: 10; significance level: .05; type: 2-sided).

Results

During the study period, there were 90 patients who had undergone arthroscopic or open surgery for coronoid fractures of the ulna (Fig. 1). Fifty-seven patients were excluded from analysis after examining preoperative medical records, plain radiographs, and CT scans (combined olecranon fracture, n = 28; anteromedial facet fracture involving the sublime tubercle, n = 4; comminuted radial head fracture, n = 19; delayed operation over 2 weeks, n = 6). We also excluded an additional 5 patients whose preestablished surgical plan changed prior to surgery after fluoroscopy-guided physical evaluation under general anesthesia (solitary coronoid fracture, n = 1; terrible triad involving more than 3 columns, n = 4). After excluding

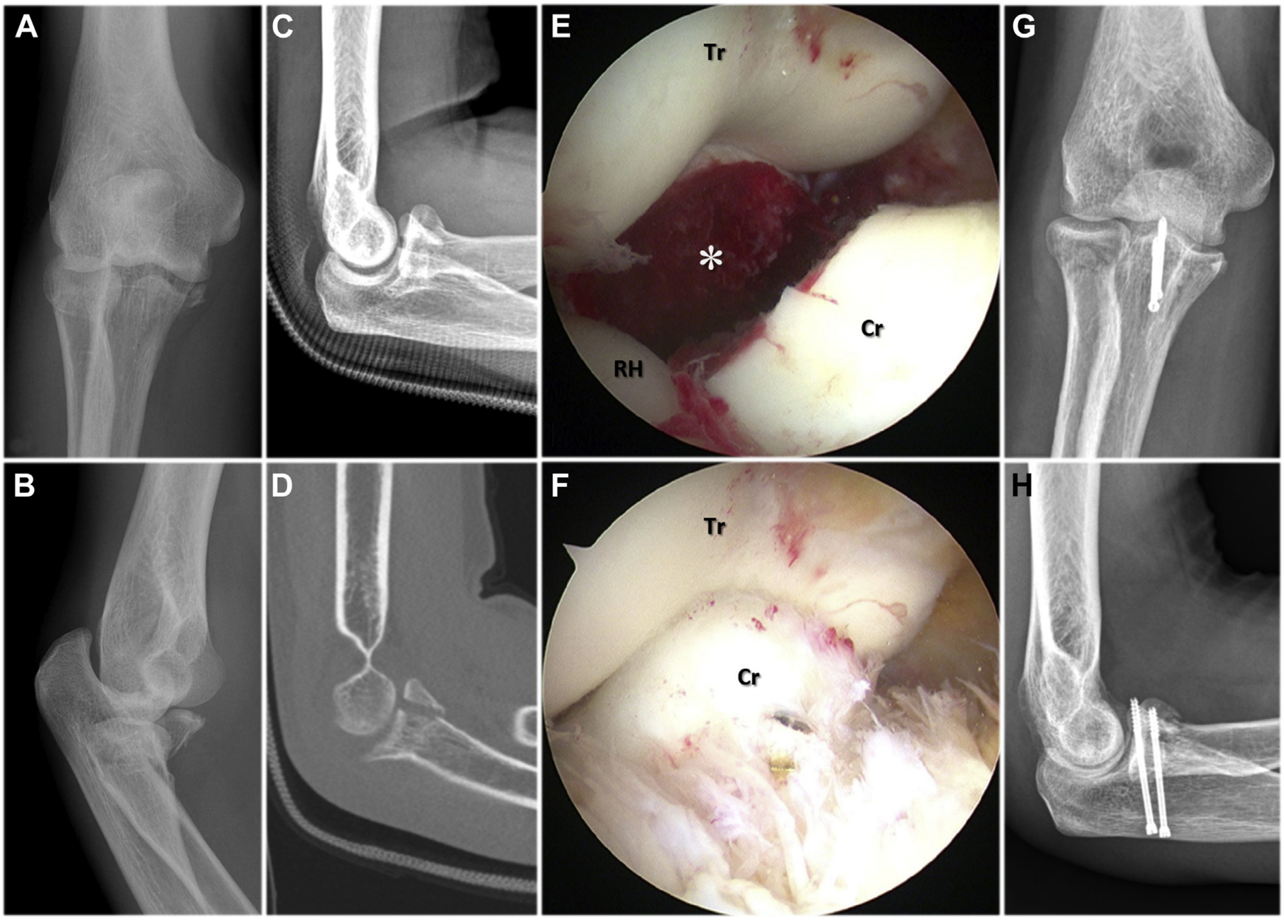

Figure 3 Arthroscopy-assisted reduction and fixation for coronoid fracture in a posterolateral rotatory instability (PLRI) patient. (**A, B**) Anteroposterior and lateral views of the preoperative radiographs of a 47-year-old man showing the coronoid and combined radial neck fractures of the right elbow. (**C, D**) Lateral view of a radiograph and sagittal view of a CT showing less than 50% involvement of the coronoid height. (**E, F**) Proximal anterolateral viewing portal showing the coronoid fracture (*). Anatomic reduction and fixation was performed. (**G, H**) Anteroposterior and lateral views of radiographs after conducting the arthroscopy-assisted reduction and fixation for the coronoid fracture, open reduction for the radial neck fracture, and open repair for the lateral ulnar collateral ligament. *Tr*, trochlea; *RH*, radial head; *Cr*, coronoid process.

another 3 patients who did not meet follow-up qualifications, a total of 25 patients were included in this study: 15 in group A (arthroscopic surgery) and 10 in group O (open surgery). Baseline characteristics showed no statistical differences between these 2 groups (Table I).

Clinical outcomes at 2 years postoperation were similar between the 2 groups (Table II). Further flexion of the elbow was greater in group A ($140^\circ \pm 5.0^\circ$; group O = $135^\circ \pm 8^\circ$; $P = .049$), although power analysis with further flexion (effect size: 0.79) indicated a power of 0.39 (sample size: 10, significance level: 0.05). The calculated sample size of our study when setting the power at 0.8 was 25.9. All coronoid process fractures and radial heads were united in both groups. Radiologic outcomes, including the prevalence of HO and arthritic changes, were also similar between the 2 groups at 2 years postoperation (Table III).

Operation-related complications were more common in group O (group A, 13.3%; group O, 40.0%). Two patients in group O presented with ulnar nerve symptoms, with 1 eventually undergoing ulnar nerve neurolysis and anterior transposition as a result of an unrelieved tingling sensation at 3 months after surgery. One patient in group A reported an unspecific tingling sensation postoperatively that spontaneously resolved 1 week after surgery, and 1 patient had a superficial wound infection that was treated by oral antibiotics without admission. One patient in group O developed a hematoma on the medial aspect of the elbow that progressively absorbed over 3 weeks without the need for any intervention (Table III).

Discussion

In this retrospective study, we compared clinical and radiographic outcomes of arthroscopy-assisted vs. open fixation of coronoid fractures within the same surgical

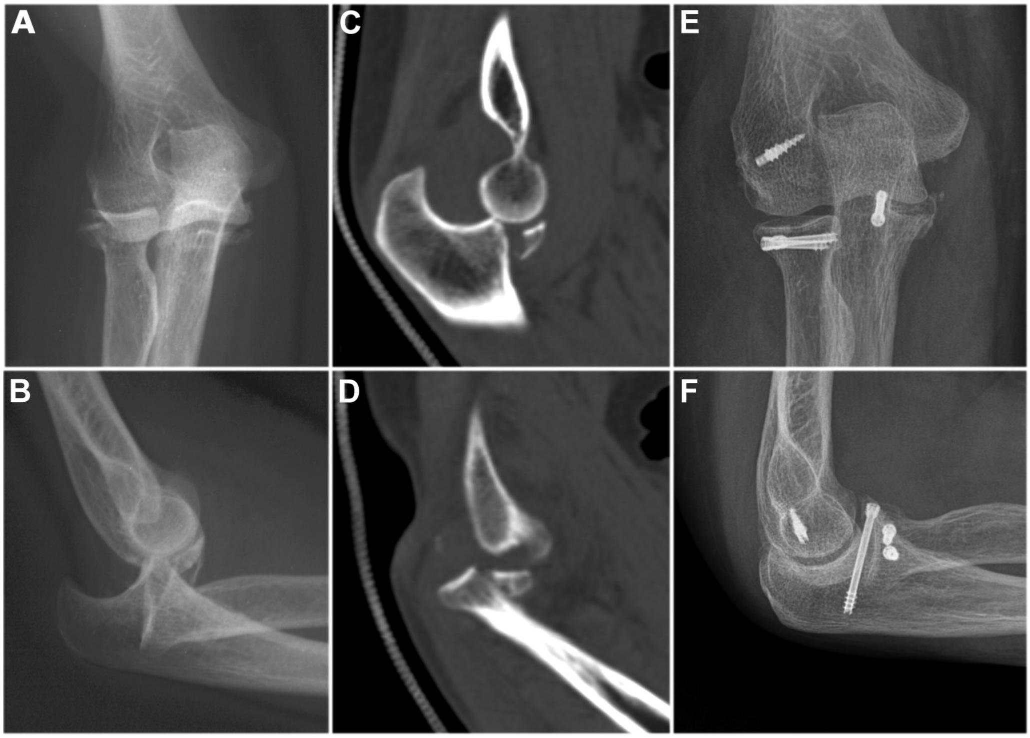

Figure 4 Open reduction and fixation for coronoid fracture in a posterolateral rotatory instability (PLRI) patient. (**A, B**) Anteroposterior and lateral views of preoperative radiographs of a 60-year-old woman showing posterior dislocation of the ulnohumeral joint with coronoid and radial head fractures of the right elbow. (**C, D**) The dislocated ulnohumeral joint was consistently apparent, although a closed reduction was attempted. (**E, F**) Anteroposterior and lateral views of the postoperative radiographs. An open reduction and fixation for coronoid fracture was performed through a medial approach, and open reduction and fixation of the radial head fracture and open repair of the lateral ulnar collateral ligament were achieved through a lateral approach.

indication of complex elbow fracture-dislocations. In our analysis, further flexion of the elbow was higher in the arthroscopy group, with a lower complication rate, although VAS pain score, MES, DASH score, and radiographic outcomes showed no statistical differences between the arthroscopy and open surgery groups.

Table I Baseline characteristics of the patient groups

Variables	Group A (n = 15)	Group O (n = 10)	*P* value[†]
Age, yr, mean ± SD	40 ± 10	41 ± 16	.838
Sex, male / female	11 / 4	7 / 3	.999
Side, dominant / nondominant	4 / 11	7 / 3	.241
Injury mechanism			.999
Fall from height	2	2	
Fall during sports	4	3	
Bicycle accident	5	3	
Traffic accident	4	2	
Type of ulnar coronoid fracture[*]			.999
II	10	6	
III	5	4	
Combined radial head fracture	4	4	.667
Combined LUCL rupture	14	10	.999

SD, standard deviation; *LUCL*, lateral ulnar collateral ligament.
Unless otherwise noted, values are n. Group A: arthroscopic fixation for ulnar coronoid fracture; group O: open fixation for ulnar coronoid fracture. LUCL, lateral ulnar collateral ligament.
[*] Fracture type according to the Regan-Morrey classification.
[†] *P* values were calculated using the Fisher test for categorical variables and the Wilcoxon rank-sum test for continuous variables.

Table II Clinical outcomes at 2 years after surgery

Variables	Group A, Mean ± SD (n = 15)	Group O, Mean ± SD (n = 10)	*P* value*
VAS pain score	1 ± 2	2 ± 2	.836
MEPS	93 ± 8	91 ± 8	.545
DASH score	7.3 ± 6.6	7.3 ± 6.3	.803
Flexion-extension arc (o)	134 ± 10	127 ± 18	.256
Flexion contracture	6 ± 8	8 ± 11	.741
Further flexion	140 ± 5	135 ± 8	.049
Supination-pronation arc (o)	154 ± 7	157 ± 8	.417
Supination	78 ± 4	78 ± 4	.999
Pronation	76 ± 6	79 ± 5	.283

VAS, visual analog scale; *MEPS*, Mayo Elbow Performance Score; *DASH*, Disabilities of Arm, Shoulder, and Hand; *SD*, standard deviation.
Group A: arthroscopic fixation for ulnar coronoid fracture; group O: open fixation for ulnar coronoid fracture.
* *P* values are calculated using a 2-sample *t* test or a Wilcoxon rank-sum test.

Table III Radiographic outcomes and complications at 2 years after surgery

Variables	Group A (n = 15)	Group O (n = 10)	*P* value*
Union / nonunion	15 / 0	10 / 0	.999
Union time, weeks	7 ± 3	7 ± 3	.999
Heterotopic ossification†			.378
I	3	4	
II	0	0	
III	0	0	
Arthritic changes‡			.653
1	3	3	
2	0	0	
3	0	0	
Operation-related complications			
Rate, %	13.3	40.0	.370
Neurologic symptom	1	2	.544
Infection	1	0	.999
Hematoma	0	1	.400
Reoperation	0	1§	.400

Unless otherwise noted, values are n. Group A: arthroscopic fixation for ulnar coronoid fracture; group O: open fixation for ulnar coronoid fracture. The complication rate is the percentage of the number of complications divided by the number of patients.
* *P* values were calculated using the Fisher test for categorical variables and the Wilcoxon rank-sum test for continuous variables.
† Grade according to Hastings classification system.
‡ Grade according to Broberg and Morrey Scale.
§ Patient who underwent neurolysis and anterior transposition of the ulnar nerve due to unrelieved ulnar nerve symptoms at 3 months postoperation.

Although mean further flexion was higher in the arthroscopic group (140° in arthroscopy; 135° in the open), we were unable to report any statistically significant differences because the power of this study was insufficient. Furthermore, the maximal errors of the goniometric measurement of elbow range of motion were 7.0° for flexion and 10.3° for extension.[5] Before our research, no study had directly compared both procedures. In a retrospective study of 10 patients with arthroscopy-assisted surgery for coronoid fractures, Lee et al[20] reported that mean flexion contracture and further flexion were 1.0° and 144.0° at the mean follow-up of 16.9 months, respectively. Michael et al[16] reported 2.5° of mean flexion contracture and 140.0° of further flexion in an analysis of 4 patients with arthroscopic coronoid fixation at a minimum of 1-year follow-up. Meanwhile, Pugh et al[27] examined 36 patients with elbow fracture-dislocations treated by open surgery and reported mean flexion contracture and maximum flexion of 131.0°

and 19.9°, respectively. Garrigues et al[13] described 40 patients with open coronoid fixation that showed 21.0° of average flexion contracture and 136.0° of further flexion. Forthman et al[12] reported a mean flexion contracture of 17.0° and further flexion of 134.0°. Arthroscopic coronoid fixation appears to facilitate achieving a higher range of elbow motion. We speculate that this is because arthroscopic coronoid fixation can prevent surgical disruption of soft tissue surrounding the elbow, resulting in diminished postoperative fibrosis and improved postoperative rehabilitation.

In our analysis, MEPS and DASH scores were similar between groups, with values of, respectively, 93 and 7.3 in group A and 91 and 7.3 in group O. After arthroscopic fixation, Lee et al[20] reported MEPS of 98.5 in 10 patients, and Adams et al[1] reported an average MEPS of 100 in 4 patients. After open coronoid fixation in 40 patients, Garrigues et al[13] documented an average Broberg-Morrey score of 90. In a retrospective study of terrible triads, Lindenhovius et al[21] found a mean Broberg-Morrey score of 90 and DASH score of 15. Domos et al[5] reported MEPS and QuickDash scores of 79 and 21, respectively, for 22 patients who underwent open fixation. As previously mentioned, patients with severe soft tissue disruption around the elbow, such as injuries involving more than 3 columns or the sublime tubercle, are unable to undergo arthroscopic treatment. Hence, in previous studies, inclusion criteria varied with the surgical method, making any comparison of those outcomes difficult to interpret. Our analysis attempted to compare these results under controlled indications and did not find one surgical method superior to another.

Heterotopic ossification is one of the most intractable complications in elbow fracture-dislocations. Adams et al[1] reported that of 7 patients, 1 (14.3%) had asymptomatic HO with good clinical scores and range of motion after arthroscopic coronoid fixation. No patients experienced HO after arthroscopic surgery in the studies by Lee et al[20] and Michael et al,[16] although their mean follow-up periods were less than 2 years. According to earlier studies, the prevalence of HO after open coronoid fixation in elbow fracture-dislocation ranges from 4.7% to 22.7%.[6,13,27] Most studies, including the review by Mathew et al,[23] have suggested that HO is uncorrelated with patient symptoms and that clinically significant HO is relatively uncommon. In the current study, HO prevalence was higher in the open fixation group than in the arthroscopic group (40% vs. 20%) without statistical significance. Although the incidence rate was relatively high, this is consistent with previous research indicating that the prevalence of HO lacks clinical significance. Arthritic changes have been reported with a prevalence of 18.2%-38.9% in previous studies, with a mild degree of arthritis comprising a large proportion thereof (8 of 14 in Pugh et al[27] and 8 of 11 in Garrigues et al[13]). Our analysis highlighted arthritic changes in 28% of patients at 2 years after surgery, with all of them mild class I arthritic changes. These patients did not exhibit correlations with functional impairment, although long-term follow-up will be necessary, considering that arthritic conditions progressively deteriorate.

Prior studies have reported a variety of complications after elbow fracture-dislocation treatment, such as residual instability, elbow stiffness, and neurologic discomfort.[1,20,23,25,27] Recurrent instability has been reported in 0%-8%, and about a quarter of patients undergo secondary operations.[13,25,27] Our subjects did not experience recurrent instability postoperatively, which is likely because of our study excluding patients with extensive soft tissue injuries (more than 3 columns of the elbow, described by Jupiter[29]) according to our pre-established criteria. We believed that the initial degree of injury surrounding the elbow would affect the prevalence of recurrent instability. Precise repair and fixation to injured structures are important in preventing this complication, although instability can still occur in spite of proper surgical management if the initial damage was significant.

Elbow joint stiffness without HO is a frequent complication after complex elbow injury for operative or conservative treatments. In our investigation, patients did not experience stiffness during follow-up periods. These patients were encouraged to perform exercise earlier after proper fixation and repair, because we thought that prolonged immobilization could lead to postoperative elbow stiffness and secondary surgical arthrolysis. However, it is still controversial as to whether early active movement is beneficial to preventing postoperative elbow stiffness or HO.[26] Nevertheless, proper fixation and repair for cases requiring surgery are necessary to allow patients to follow appropriate rehabilitation protocols.

For 3 patients with postoperative ulnar nerve symptoms, 2 were in the open fixation group and 1 was in the arthroscopic fixation group. There was no significant difference between the 2 groups, although we anticipated a higher prevalence of ulnar nerve complications in the open fixation group. In previous studies, postoperative ulnar nerve symptoms also occurred in arthroscopic and conservative treatment patients, as well as open surgery.[1,12] This is because elbow fracture-dislocation patients can develop ulnar nerve symptoms as a result of scarring and tightness of Osborne ligament originating from combined medial columnar injury at the initial trauma. A larger size comparative study will be needed to clarify if an open medial approach poses a higher susceptibility to ulnar nerve complications.

Limitations

Our study has several limitations. First, we included a small number of patients, which limited our statistical power (0.39), meaning we were unable to manifest any statistical differences between the 2 groups. Second, selection bias at patient enrollment in each surgical group could be raised.

Although the indication for choosing a surgical technique differs for each clinician, most surgeons normally conduct open surgery for more complex cases. A chance of selection bias remains even though we have attempted to control inclusion and exclusion criteria. Third, different fixation tools, such as headless compression screws, K-wires, and buttress plates, were used to fix coronoid processes. Although this could be a confounding factor, 2 headless compression screws were used for most cases. Also, fixation with K-wires in very small or comminuted coronoid fragments is thought to be strong enough to allow patients early exercise. Fourth, the follow-up period seems to be insufficient to evaluate the clinical influence of HO and the development of posttraumatic arthritis, for which long-term follow-up is required.

Conclusions

Eliciting fewer complications, arthroscopy-assisted reduction and fixation of coronoid fractures shows union rates and clinical results comparable to open fixation in patients with complex elbow fracture-dislocation.

Disclaimer

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