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Clinical outcomes of a combined arthroscopic and mini-open Outerbridge-Kashiwagi procedure for elbow osteoarthritis

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Background: To evaluate the short-term clinical outcomes of a modified Outerbridge-Kashiwagi (O-K) procedure in the treatment of elbow osteoarthritis.

Methods: Between January 2012 and December 2016, 27 patients with elbow osteoarthritis were treated with a modified O-K procedure combining mini-open and arthroscopic technique in our institution. All patients with primary osteoarthritis and post-traumatic degenerative osteoarthritis of the elbow were included in the study if they had undergone the modified O-K procedure. Clinical outcomes were assessed using the visual analog scale (VAS), degree of flexion, extension loss, arc of motion, Mayo Elbow Performance Score (MEPS), and radiographs.

Results: Twenty-five patients with a mean age of 47.2 years (range, 21-69 years) at surgery were followed up for a mean of 54.5 months (range, 27-86 months). The VAS improved from 8.0 ± 1.4 (range, 6-10) preoperatively to 1.3 ± 1.1 (range, 0-3) at the final follow-up ($P < .001$), degree of flexion from 115.2° ± 12.0° (range, 90°-135°) to 130.6° ± 6.3° (range, 120°-140°) ($P < .001$), extension loss from 31.2° ± 15.0° (range, 10°-60°) to 10.2° ± 7.7° (range, 0°-30°) ($P < .001$), arc of motion from 84.0° ± 18.8° (range, 55°-120°) to 120.4° ± 9.3° (range, 105°-135°) ($P < .001$), and MEPS from 55.8 ± 8.1 (range, 40-70) to 88.4 ± 7.2 (range, 70-100) ($P < .001$). Radiographs at the final follow-up showed that 9 patients (36%) had significant recurrence of bone formation within the fenestration of the olecranon fossa. One patient developed delayed-onset ulnar neuropathy, with only slight numbness in the ulnar nerve distribution 6 months after surgery.

Conclusions: The modified O-K procedure is safe and effective in pain relief and function restoration in patients with elbow osteoarthritis.

Level of evidence: Level IV; Case Series; Treatment Study

Keywords: Outerbridge-Kashiwagi; elbow osteoarthritis; mini-open; arthroscopy

Elbow osteoarthritis is an uncommon but troublesome disorder that usually affects middle-aged men with an occupation or activity involving the heavy use of their dominant arm.[24] It causes severe disabling symptoms such as pain, locking, and stiffness. Ulnar neuropathy is also a common symptom typically characterized by persistent paraesthesia, objective motor weakness, or muscular atrophy. Mild to moderate ulnar neuropathy can be successfully treated with nonsurgical management, whereas patients who fail nonsurgical measures might require surgical treatment.[4] Post-traumatic osteoarthritis is more common than a primary disorder and often involves younger active

This study was approved by the Ethical Review Committee of Chinese PLA General Hospital.

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patients. It usually encompasses both intrinsic components (intra-articular pathology including articular incongruity, adhesions, impingement, articular cartilage degeneration, or a multifaceted cause) and extrinsic components (extra-articular pathology including heterotopic ossification or extra-articular soft tissue contracture).[3] Conservative treatment consists of anti-inflammatory medications, physical therapy, and bracing, which always provides unsatisfactory results in severe cases.[17] More aggressive treatment ranges from open or arthroscopic débridement, interposition arthroplasty using fascia or an artificial membrane to total elbow replacement, which can yield more predictable outcomes.[12,19,30,33]

Osteoarthritic changes of the elbow start with formation of osteophytes on the coronoid and olecranon. The size of these osteophytes seemed closely related to the degree of flexion and extension loss.[32] Based on this observation, Kashiwagi originally developed the Outerbridge-Kashiwagi (O-K) procedure in 1978 according to the idea and suggestion of Outerbridge.[10,11] It has been used as a treatment for elbow osteoarthritis involving the anterior and posterior compartment through a single 8-cm posterior triceps-splitting incision with removal of osteophytes and fenestration of the olecranon fossa to improve motion and allow access to the anterior compartment. This open approach was preferred by many surgeons because of its simplicity, effectiveness, and ease of visualization and access, correspondingly producing favorable results in treating elbow osteoarthritis.[2,25,28] However, a previous report has expressed concern regarding the suitability of the O-K procedure in patients with loose bodies in both anterior and posterior compartments.[23] The adequacy of débridement of the anterior compartment without an anterior portal was also called into question. Furthermore, the O-K procedure is unable to access the medial and lateral wings, and it does not allow management of the posterolateral compartments nor osteophytes or loose bodies behind the capitellum, which are common in more advanced cases.[7]

Elbow arthroscopy has been proved to be a safe and effective procedure,[12,31] although it is contraindicated in the presence of ankylosis preventing adequate entry into and distension of the joint, or local infection at the site of an intended portal.[8] With the development of elbow arthroscopy, the O-K procedure can now also be performed arthroscopically.[18,27,29] Redden and Stanley have undertaken a similar procedure with arthroscopic débridement and fenestration of the olecranon fossa using a 3.2-mm drill bit through a small posterior midline stab incision.[27] This less-invasive procedure should produce less trauma and scarring to the elbow joint and thus may produce greater pain relief, at least in the short term. Recently, Carlier et al[6] have reported that arthroscopic débridement without fenestration of the olecranon fossa can also provide significant improvements in pain, strength, elbow motion, and functional scores. Although arthroscopic débridement allows access to the entire elbow joint, it is more time-consuming and creates a significant amount of bone debris, which is difficult to be thoroughly washed out through the minimally invasive portals, and the residual debris may increase the risk of heterotopic ossification. Additionally, arthroscopic débridement requires a greater learning curve and is more challenging than open technique.[14,26]

Encouraged by the promising results of open fenestration in the ulnohumeral arthroplasty, we developed a modified O-K procedure combining mini-open and arthroscopic technique as an intermediate step in the treatment of elbow osteoarthritis. This systemic approach combines the efficacy of open débridement, osteophyte removal, and olecranon fossa fenestration with the known advantages of arthroscopy to ensure adequate débridement of the anterior compartment. The hypothesis was that the modified O-K procedure can achieve short-term clinical success in pain relief and function restoration in patients with elbow osteoarthritis.

Methods

Patient selection

We performed a nonrandomized retrospective cohort study after obtaining approval from our ethical review committee and consent from the patients. Between January 2012 and December 2016, 27 consecutive patients were treated with the modified O-K procedure by the senior surgeon based on surgical indication for elbow osteoarthritis with persistent pain and functional limitation not responding to conservative treatment and radiographic evidence of osteophytes or loose bodies in the joint (Fig. 1). The procedure was not performed in patients with neuropathic joints, muscle imbalance around the elbow, and a previous history of local infection or ulnar nerve transposition. All patients with primary osteoarthritis and post-traumatic degenerative osteoarthritis of the elbow were included in the study if they had undergone the modified O-K procedure. Two patients (7.4%) were lost to follow-up before 2 years after surgery, and 25 (92.6%) were available for final analysis. Of the 25 patients, 11 had primary osteoarthritis and 14 had post-traumatic degenerative osteoarthritis.

Clinical assessments

Postoperative assessments were performed regularly on an outpatient basis at 6, 12, and 24 weeks postoperatively, and every 6 months thereafter. The level of pain was recorded using the visual analog scale (VAS), where zero is no pain and 10 is maximum pain. Preoperative and postoperative ranges of motion (ROMs) including degree of flexion, extension loss, and arc of motion were measured to the point of pain with a goniometer. Functional outcome was evaluated using Mayo Elbow Performance Score (MEPS) according to pain (45 points), motion (20 points), stability (10 points), and function (25 points) and was classified as excellent ($\geq$90 points), good (75-89 points), fair (60-74 points), or poor ($<$60 points).[9] The patients' satisfaction was assessed by asking them how they felt at the time of follow-up

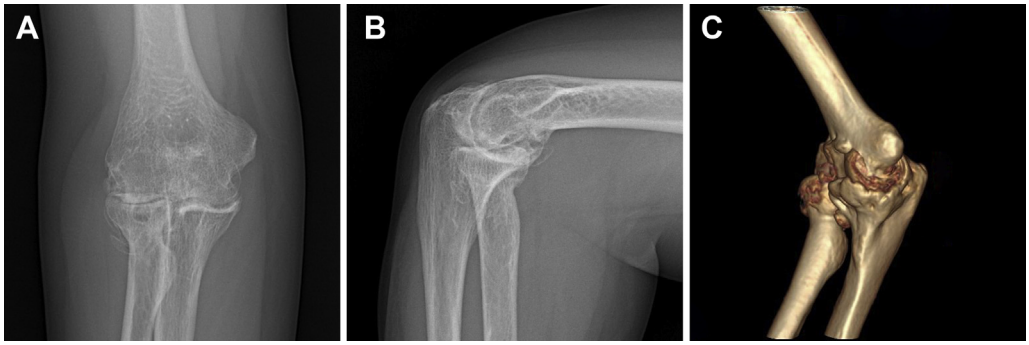

Figure 1 Preoperative imaging examinations were used to evaluate the elbow osteoarthritis. (**A**) Anteroposterior radiograph, (**B**) lateral radiograph, (**C**) 3-dimensional computed tomographic scan.

compared with how they felt before the operation and was graded as much better, better, same, or worse.[8] Standard anteroposterior and lateral radiographs were taken immediately after surgery and at every follow-up to evaluate the adequacy of débridement and recurrence of degenerative changes. The recurrence of bone formation within the fenestration of the olecranon fossa was assessed using the method of Phillips et al.[25] Radiographs that had more than 75% of fenestration still visible were graded as ''open,'' between 25% and 75% as ''partial closed'' and less than 25% as ''closed.'' Chart review was performed to determine whether complications had occurred. Clinical assessments were conducted by an orthopedic surgeon independent from the treating team.

Surgical technique

After brachial plexus or general anesthesia, the patient was placed in the supine position with the shoulder and elbow both flexed at 90°, and the forearm and hand were held by the surgical assistant to stabilize the elbow (Fig. 2, *A*). Fifteen to 20 mL of normal saline was injected into the elbow joint via the posterior compartment to distend the capsule. A 30° arthroscope was then introduced via an anterolateral portal to inspect the anterior compartment and identify the pathologic structures. An anteromedial portal was established for instrumentation to débride osteophytes and loose bodies in the anterior compartment under direct visualization.

The modified O-K procedure was performed through a 5-cm posterior triceps-splitting incision. Those who had signs of cubital tunnel syndrome also underwent ulnar nerve decompression through the same incision. Of the 25 patients, 1 patient had ulnar nerve decompression and the other 24 patients had no ulnar nerve surgery. The posterior compartment of the elbow was débrided using a rongeur or osteotome to remove osteophytes from the olecranon process and olecranon fossa; all loose bodies were also removed. A Wissinger rod was passed through the anterolateral and anteromedial portals, followed by fenestration of the olecranon fossa with a trephine, giving access to the anterior compartment of the elbow. This could provide the tactile feedback required to avoid plunging the trephine too far into the anterior compartment once the fenestration is completed. The fenestration was performed by centering the trephine on the olecranon fossa, aligning it perpendicular to the plane of the distal humerus and directing it toward the anterior compartment of the elbow to create a foramen with a diameter of 1.5 cm (Fig. 2, *B*).[15,22] In smaller humeri, extra care was taken to avoid over-resection of bone from the medial column, which is usually thinner than the lateral column and may be prone to fracture. With the elbow maximally flexed, the coronoid process could be visualized and débrided of residual osteophytes through the foramen. The foramen was then trimmed using a rongeur or burr to be more congruent with the olecranon and coronoid. Any residual debris and loose bodies in the anterior compartment were washed out during flexion and extension of the elbow. After a thorough débridement confirmed arthroscopically, the improvement of ROM was verified, and the incision was then closed. Thorough hemostasis was achieved and drains were placed before wound closure to minimize the risk of postoperative effusion. Ropivacaine and tranexamic acid were introduced to the surgical site to relieve postoperative pain and prevent hematoma. Radiographs were performed immediately after surgery to evaluate the fenestration. Anti-inflammatory medications were used as prophylactic against heterotopic ossification. All patients had surgery as inpatients.

Postoperative rehabilitation

Postoperative rehabilitation was similar for all patients. The involved elbow was supported with a sling for 7-10 days postoperatively. At the early stage, patients may choose to refrain from active ROM exercise for reasons unrelated or only peripherally related to their surgery, such as fear of pain and lack of strength, which can be improved at the later stage. As a result, we used passive rather than active ROM exercise at the early stage for it can objectively reflect the improvement of ROM after this modified O-K procedure. Early passive ROM exercise was initiated from the preoperative ROM at the second day after surgery, and gradually progressed to full ROM within 3 weeks. Active ROM exercise was encouraged as tolerated without pain at 3 weeks postoperatively. Physiotherapy was performed to assist in postoperative rehabilitation. As the modified O-K procedure had little influence on the biomechanical strength of the distal humerus, patients were recommended to wear a dynamic splint rather than a static progressive splint to help improve motion if it was available.

Statistical analysis

Statistical analysis was performed with SPSS, version 17.0 (IBM, Armonk, NY, USA). Data were expressed as mean ± SD. The paired *t* test was used to analyze continuous variables, whereas

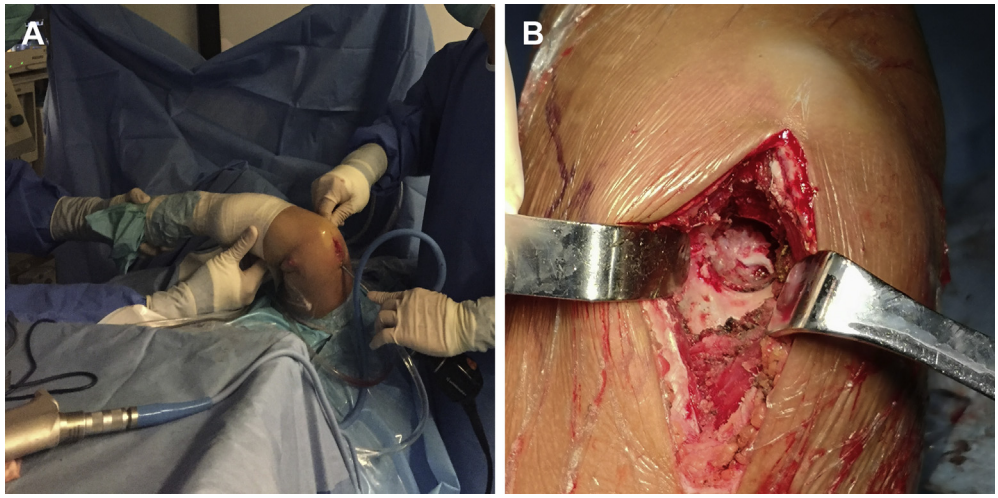

Figure 2 Surgical technique of the modified O-K procedure. (**A**) The patient was placed in the supine position with the shoulder and elbow both flexed at 90°, and the forearm and hand were held by the surgical assistant to stabilize the elbow. (**B**) The fenestration of the olecranon fossa was performed with a trephine to create a foramen with a diameter of 1.5 cm. *O-K*, Outerbridge-Kashiwagi.

categorical variables were analyzed by chi-square test. The statistical significance was set at $P < .05$.

Results

Demographic characteristics

During the study period, 27 patients who underwent the modified O-K procedure were included in this study. Of the 27 patients, 2 (7.4%) were lost to follow-up before 2 years after surgery and 25 (92.6%) were finally analyzed. There were 20 men and 5 women, with a mean age of 47.2 years (range, 21-69 years). The dominant elbow was involved in 18 patients and the non-dominant one in 7. The arthritic changes were caused by primary osteoarthritis in 11 patients and post-traumatic degenerative osteoarthritis in 14. Ulnar nerve decompression was performed in 1 patient. Loose bodies were identified in 12 patients. All patients were followed up for a mean period of 54.5 months (range, 27-86 months).

Clinical assessments

The VAS improved from 8.0 ± 1.4 (range, 6-10) preoperatively to 1.3 ± 1.1 (range, 0-3) at the final follow-up ($P < .001$), degree of flexion from 115.2° ± 12.0° (range, 90°-135°) to 130.6° ± 6.3° (range, 120°-140°) ($P < .001$), extension loss from 31.2° ± 15.0° (range, 10°-60°) to 10.2° ± 7.7° (range, 0°-30°) ($P < .001$), arc of motion from 84.0° ± 18.8° (range, 55°-120°) to 120.4° ± 9.3° (range, 105°-135°) ($P < .001$), and MEPS from 55.8 ± 8.1 (range, 40-70) to 88.4 ± 7.2 (range, 70-100) ($P < .001$). There was no difference between primary and post-traumatic osteoarthritis in the improvement of VAS (6.6 ± 1.2 vs. 6.8 ± 1.1, $P = .744$), degree of flexion (18.2° ± 11.5° vs. 13.2° ± 10.1°, $P = .262$), extension loss (25.0° ± 12.0° vs. 17.9° ± 15.7°, $P = .224$), arc of motion (43.2° ± 15.2° vs. 31.1° ± 16.1°, $P = .068$), and MEPS (32.7 ± 6.1 vs. 32.5 ± 7.0, $P = .933$) at the final follow-up. Functional outcome was excellent in 15 patients (60%), good in 9 (36%), and fair in 1 (4%) (Table I). Subjectively, the patients' satisfaction was much better in 12 patients (48%) and better in 13 (52%). No patients were worse or got stiffer after this surgery; all of them had improvement in pain, elbow motion, and functional outcome. The immediate postoperative radiographs showed a correctly placed foramen with complete osteophyte resection in all the patients. Radiographs at the final follow-up showed that the fenestration was "open" in 10 patients (40%), "partial closed" in 6 (24%), and "closed" in 9 (36%) (Fig. 3). Although 9 patients (36%) had significant radiologic evidence of recurrence of bone formation within the fenestration of the olecranon fossa, there was no relationship between the apparent amount of recurrence and clinical outcomes. One patient developed delayed-onset ulnar neuropathy with only slight numbness in the ulnar nerve distribution 6 months after surgery, he remained satisfied with the results of the surgery, and the ulnar nerve symptom gradually resolved without reoperation. No complications such as neurovascular injury, distal humerus fracture, infection, hematomas, seromas, heterotopic ossification, and stiffness were found in the series.

Discussion

Although various management options are available, the most suitable treatment for symptomatic elbow osteoarthritis remains controversial. The O-K procedure and

Table I Clinical outcomes of the modified O-K procedure

Variable	Preoperative	Postoperative	Statistic	*P* value
VAS score, points	8.0 ± 1.4 (6-10)	1.3 ± 1.1 (0-3)	$t = 30.545$	<.001
ROM, degrees				
Degree of flexion	115.2 ± 12.0 (90-135)	130.6 ± 6.3 (120-140)	$t = -7.134$	<.001
Extension loss	31.2 ± 15.0 (10-60)	10.2 ± 7.7 (0-30)	$t = 7.311$	<.001
Arc of motion	84.0 ± 18.8 (55-120)	120.4 ± 9.3 (105-135)	$t = -10.995$	<.001
Functional score				
MEPS, points	55.8 ± 8.1 (40-70)	88.4 ± 7.2 (70-100)	$t = -25.176$	<.001
MEPS, excellent/good/fair/poor	15/9/1/0	0/0/11/14	$\chi^2 = 46.333$	<.001

O-K, Outerbridge-Kashiwagi; *VAS*, visual analog scale; *ROM*, range of motion; *MEPS*, Mayo Elbow Performance Score.
Values are expressed as mean ± standard deviation unless otherwise specified.

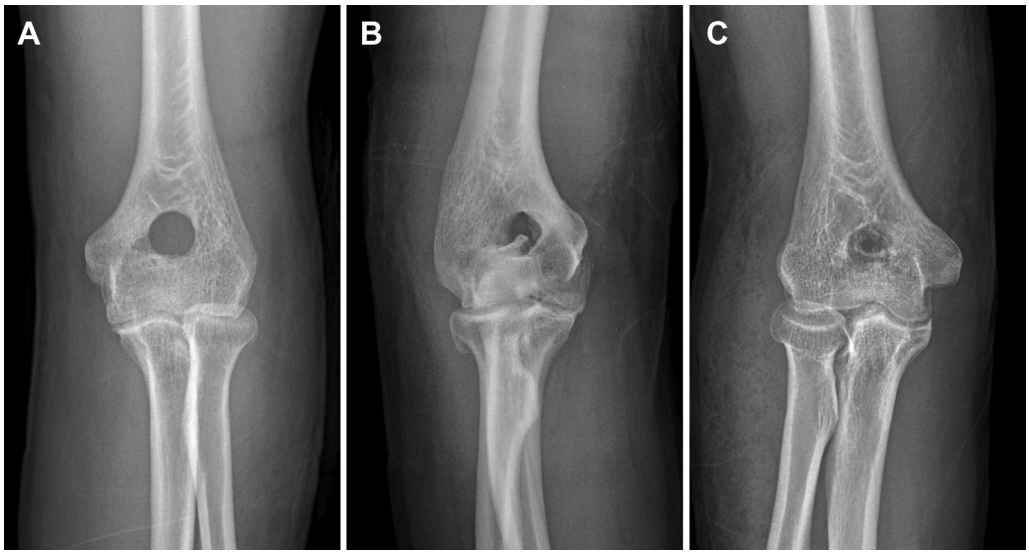

Figure 3 The postoperative radiographs of 3 patients treated with the modified O-K procedure. Radiographs at the final follow-up showed that the fenestration was (**A**) open, (**B**) partial closed, and (**C**) closed in the 3 patients, respectively. *O-K*, Outerbridge-Kashiwagi.

arthroscopic débridement have both been shown to improve pain and ROM significantly and have low complication rates.[2,12,25,28,31] The main advantage of the O-K procedure is that it allows access to both the anterior and posterior compartments of the elbow joint without extensive soft tissue dissection, but it does not allow access to either the anterior or posterior radiocapitellar joint. Fenestration of the distal humerus may also give an osteotomy effect because of changes in venous pressure and denervation of the distal humerus.[13] Elbow arthroscopy is a less invasive approach allowing access to the whole joint.[8] To combine the efficacy of these 2 approaches, we developed a modified O-K procedure combining mini-open and arthroscopic technique for the treatment of elbow osteoarthritis.

Despite the variability of pathology and severity in our cases, it is evident that the modified O-K procedure can achieve reliable clinical outcomes, with the VAS improved by 6.7, degree of flexion by 15.4°, extension loss by 21.0°, arc of motion by 36.4°, and MEPS by 32.6. Promising outcomes of our series are in accordance with those reported in previous studies. Antuna et al[2] reviewed 46 patients who underwent ulnohumeral arthroplasty for primary osteoarthritis and found that the mean arc of flexion-extension improved by 22°, 76% had no pain or only mild pain, and 74% had excellent or good MEPS after a mean follow-up of 80 months. Krishnan et al[18] performed all-arthroscopic ulnohumeral arthroplasty for degenerative arthritis of the elbow in 11 patients younger than 50 years, in whom the mean flexion, extension, total arc of motion, and VAS, respectively, improved by 40°, 33°, 73°, and 7.5 after a mean follow-up of 26 months. In our series, there was no difference between primary and post-traumatic osteoarthritis in the improvement of VAS, degree of flexion, extension loss, arc of motion, and MEPS, suggesting that the modified O-K procedure can provide satisfactory results regardless of primary or post-traumatic etiology. This is consistent with that reported by Carlier et al,[5] who found no difference between primary and post-traumatic

osteoarthritis in the preoperative profiles and the efficacy of arthroscopic débridement. Although extension was significantly improved in our series, residual extension loss still remained in some patients. This reflects the belief that extension loss partly results from long-standing contracture of the anterior soft tissues and possibly joint surface remodeling from chronic deformity.[8] Thus, elbow extension is likely to be further improved if this modified O-K procedure is combined with an anterior capsulectomy, which has been reported to be effective in previous studies.[1,21] Adams et al[1] reviewed 41 patients (42 elbows) who underwent arthroscopic osteophyte resection and capsulectomy for primary osteoarthritis. At an average follow-up of 176.3 weeks, the mean level of pain, flexion, extension, supination, and MEPS significantly improved by 1.43, 14.3°, 13°, 7.9°, and 18.9, respectively, with 81% good or excellent results in MEPS. MacLean et al[21] retrospectively assessed 20 patients (21 elbows) with primary osteoarthritis after arthroscopic débridement and capsulectomy. At a mean follow-up of 5.5 years, the Disabilities of the Arm, Shoulder, and Hand score was significantly improved from 34.0 to 12.7, and the MEPS was good or excellent in 76% elbows, suggesting capsulectomy may work as a partial neurectomy to denervate pain sensation in the joint.

With current advances in elbow arthroscopy, all-arthroscopic débridement without fenestration of the olecranon fossa has now been reported in multiple studies to be highly effective in experienced surgeons' hands.[31] Lim et al[20] retrospectively evaluated 43 patients treated with arthroscopic débridement for elbow osteoarthritis, the mean VAS, flexion, extension, and MEPS, respectively, improved by 2.3, 13°, 7°, and 23.9 after a mean follow-up of 38 months. Based on the fact that preoperative motion arc is the independent prognostic factor for clinical outcome, arthroscopic débridement is highly recommended for patients who have a motion arc of 80° or more as it yields reliable results. Additionally, there is now good data showing the posterior compartment can adequately be handled with modern arthroscopic techniques. Koh et al[16] performed arthroscopic débridement in 36 consecutive patients with posterior elbow impingement and found that it was a safe and effective treatment to relieve pain, improve function, and assist in returning patients, including professional athletes, to their previous level of activity.

The immediate postoperative radiographs showed a correctly placed foramen with a diameter of 1.5 cm in all our cases. It has been proven that a foramen with such a size can better improve the effectiveness of this surgical procedure without exacerbating the risk of distal humerus fracture.[15,22] Additionally, the follow-up radiographs showed that an adequate débridement was routinely achievable in most patients. All loose bodies were addressed after using this procedure, including posterolateral loose bodies in the radiocapitellar joint. However, there were residual osteophytes still left unaddressed in some patients, including osteophytes behind the capitellum which has been commonly reported as a frequent manifestation in patients with elbow osteoarthritis. Radiographs at the final follow-up showed that recurrence of bone formation and progressive closure of the fenestration of the olecranon fossa was not associated with deteriorating function in our series. This finding is consistent with that observed by Phillips et al,[25] who also found no correlation between the functional assessment and the disappearance of the fenestration on radiographs. This is probably linked to the fact that the membrane of the olecranon fossa is grossly thickened preoperatively, and regrowth of bone occurs from the circumference of the opening as the fenestration begins to close postoperatively. Although the fenestration may close completely with time, the regrown membrane does not thicken to the same extent as that present before surgery.[25] Furthermore, re-formation of other osteophytes was also found at the final follow-up in addition to those in the fenestration. However, as there was not an objective method to quantify re-formation of other osteophytes, and recurrence of degenerative changes was evaluated by radiographs rather than a computed tomographic scan—a more precise method to assess the osteophytes—we were not able to determine whether there was a correlation between the functional outcomes and re-formation of other osteophytes.

The modified O-K procedure applied in our series has several advantages. As the débridement of the anterior compartment is conducted under direct visualization via arthroscopy, it ensures an adequate débridement of loose bodies and osteophytes that cannot be visualized through the fenestration of the olecranon fossa. A mini-open posterior triceps-splitting approach ensures a thorough débridement of the posterior compartment and simultaneously gives access to ulnar nerve decompression, and it is unlikely to result in a large scar and extensive soft tissue contracture. This procedure is more efficient than all-arthroscopic ulnohumeral arthroplasty using multiple drill bits of increasing size. A single trephine is used without the need to drill a pilot hole in the olecranon fossa; this reduces the operative time and results in a uniform fenestration that can be modeled according to surgeon preference. The excised bone is contained within the core of the trephine, and less bone debris is produced than when using sequential drill bits of increasing size or a high-speed bone burr. Additionally, a mini-open approach is more efficient in washing out bone debris than the minimally invasive portals. This should result in a lower risk of heterotopic ossification. Owing to adequate débridement of bone debris, thorough hemostasis under arthroscopy, and use of anti-inflammatory medications, we did not see any evidence of heterotopic ossification in our follow-up radiographs. A Wissinger rod was passed through the anterolateral and anteromedial portals before fenestration of the olecranon fossa. This could provide the tactile feedback required to avoid plunging the trephine too far into the anterior compartment once the fenestration is completed, so as to prevent anterior neurovascular injury. As

the modified O-K procedure consists of arthroscopic and mini-open O-K procedure, the former is technically more demanding and requires a high learning curve, whereas the latter is much easier for surgeons to master, the modified O-K procedure can still achieve reliable clinical outcomes even when the additional arthroscopic débridement is performed by inexperienced surgeons. These advantages described above can make the modified O-K procedure more appealing to surgeons.

Limitations

This study has some limitations. First, it is a non-randomized retrospective series rather than a prospective one, and selection bias might arise from unblinded surgeons and patients. Second, the relatively small sample size in this study may increase the possibility of type II error. Third, lack of direct comparison with another technique may discount the credibility of the results. Fourth, this is a single-surgeon series at a single center, and therefore the generalizability of these results will require further validation. Finally, despite the promising short-term clinical outcomes in our study, longer-term follow-up is necessary to identify if there is significant deterioration in the long-term clinical outcomes.

Conclusions

The modified O-K procedure is safe and effective in pain relief and function restoration in patients with elbow osteoarthritis.

Disclaimer

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