


CLINICAL ARTICLE

Two-Year Clinical Outcomes after Arthroscopic Re-Excision of Recurrent Dorsal Wrist Ganglion Cyst

Tong Zheng, MD¹ , Xingjian Huang, MD², Yong Yang, MD², Bin Li, MD², Feng Li, MD², Zhongzhe Li, MD²

¹Sports Medicine Service and ²Hand Surgery Department, Beijing Jishuitan Hospital, Beijing, China

Objectives: Arthroscopic excision of dorsal wrist ganglion (DWG) cysts has recently become an alternative to open surgery, with the advantage of lower recurrence. However, in recurrent cases, whether re-excision using an arthroscopic approach would achieve favorable outcomes has not been determined. This study aimed to evaluate the clinical outcomes of function evaluation and recurrence rate after arthroscopic excision of recurrent DWG cysts.

Methods: A total of 11 consecutive patients with clinically diagnosed recurrent DWG cysts were retrospectively reviewed between November 2017 and March 2020. Extensive re-excision of the ganglion cyst and its surrounding pathological capsule was performed using an arthroscopic approach. Magnetic resonance imaging (MRI) was routinely performed before surgery to identify the location and limits of the cyst. All patients were followed up for a minimum of 2 years. A second recurrence was recorded if a mass reappeared at the same site with a positive transillumination test. Pain during activity was evaluated using the visual analog scale (VAS). The active range of motion (ROM) of the wrist was measured using a goniometer, and the hand grip strength was measured using a digital dynamometer. Comparative analysis between the pre- and postoperative indexes was performed using Student's *t*-test.

Results: After a mean follow-up period of 29.3 months (range, 24–34 months), no second recurrence of the cyst was recorded. The VAS score improved from 1.4 to 0.3 ($t = 3.833$, $p = 0.003$), and residual pain was reported by three patients (VAS score = 1 for each). Active wrist flexion increased from 73.6° to 78.2° ($t = 2.887$, $p = 0.016$). No significant changes were found in active wrist extension or hand grip strength ($p > 0.05$). No major complications occurred during the study.

Conclusion: Arthroscopic excision of a recurrent DWG cyst yielded satisfactory results with no second recurrence, significant pain relief, and good wrist function at a minimum of 2-year follow-up. Clear identification of the location and limits of the ganglion based on preoperative MRI could be helpful to achieve complete excision and therefore prevent a second recurrence.

Key words: Arthroscopy; Ganglion Cyst; Ganglionectomy; Recurrence; Wrist

Introduction

Dorsal wrist ganglion (DWG) cysts are one of the most common masses afflicting the wrist, with a reported incidence of 43/100,000 in females and 25/100,000 in males.¹ As most of these benign masses are asymptomatic and spontaneously resolve with time,² nonsurgical interventions such as observation or needle aspiration represent the

primary treatment approaches.³ However, in patients with persistent symptoms, such as pain, weakness, limited range of motion, and increasing size, and who have failed conservative treatments, surgical excision is often recommended.³

Recurrence is the most frequently reported complication of any form of treatment and may result from inadequate excision of the stalk of the ganglion.^{4–7} Although

Address for correspondence: Yong Yang, MD, Hand Surgery Department, Beijing Jishuitan Hospital, No 31, Xin Jie Kou East Street, Xi Cheng District, Beijing 100035, China. Email: 0414yang@sina.com

Tong Zheng and Xingjian Huang should be considered joint first author.

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traditional ganglion excision in an open approach is considered the gold standard and has yielded satisfactory outcomes with pain relief and functional improvement according to previous studies,^{8,9} a high postoperative recurrence rate of approximately 40% was still reported.¹⁰ Therefore, recurrent DWG cysts may frequently be encountered in clinical practice, and the treatment decision and benefit of re-excision should be evaluated with caution.

Recently, arthroscopic DWG excision has become an alternative to open surgery because of its advantages of a smaller scar, less pain, and earlier return to work.^{3,11} Meanwhile, recurrence following arthroscopic DWG excision was reported to be approximately 10% at >1-year follow-up,^{4,11-16} indicating the possible superiority of the arthroscopic approach in lowering the recurrence rate of DWG. However, indications for arthroscopic excision of recurrent cysts have not been addressed in the current literature; therefore, it is unclear whether re-excision under arthroscopy would achieve low recurrence as the primary surgery.

Currently, only one study has reported the surgical outcomes of recurrent ganglion cysts.¹⁰ In this study, 20 recurrent cases underwent ganglion re-excision using the open technique. The second recurrence rate within 1 year postoperatively was 15%, and none of the recurrences occurred on the dorsal wrist. However, regarding re-excision using the arthroscopic approach, there are no available data on patient-reported outcomes and second recurrence.

To the best of our knowledge, this is the first study to review a cohort of recurrent DWG cysts that underwent arthroscopic excision. Therefore, the purpose of this study was to (i) evaluate clinical outcomes regarding pain and function after arthroscopic excision of recurrent DWG cysts and (ii) report the recurrence rate of cysts during the study period. The hypothesis was that ganglionectomy using an arthroscopic approach would be a reliable procedure with favorable clinical outcomes and a low recurrence rate for patients with recurrent DWG.

Materials and Methods

Patient Selection

Patients were eligible for inclusion in this study if they: (i) had a recurrent DWG cyst following open or arthroscopic cyst excision (Figure 1); (ii) underwent a DWG cyst re-excision using an arthroscopic approach at the same center by the same surgeon between November 2017 and March 2020; (iii) were clinically followed up for a minimum of 2 years. A recurrent DWG cyst was defined as a reappearance of the cyst from the radiocarpal or midcarpal joint in the same area as before and was confirmed by both ultrasonography (US) and magnetic resonance imaging (MRI). The exclusion criteria were as follows: (i) presence of other wrist pathologies, including fracture or ligamentous tear, and (ii) conversion to open surgery during arthroscopic re-excision. This study followed the Declaration of Helsinki on medical protocol and ethics, and was approved by our

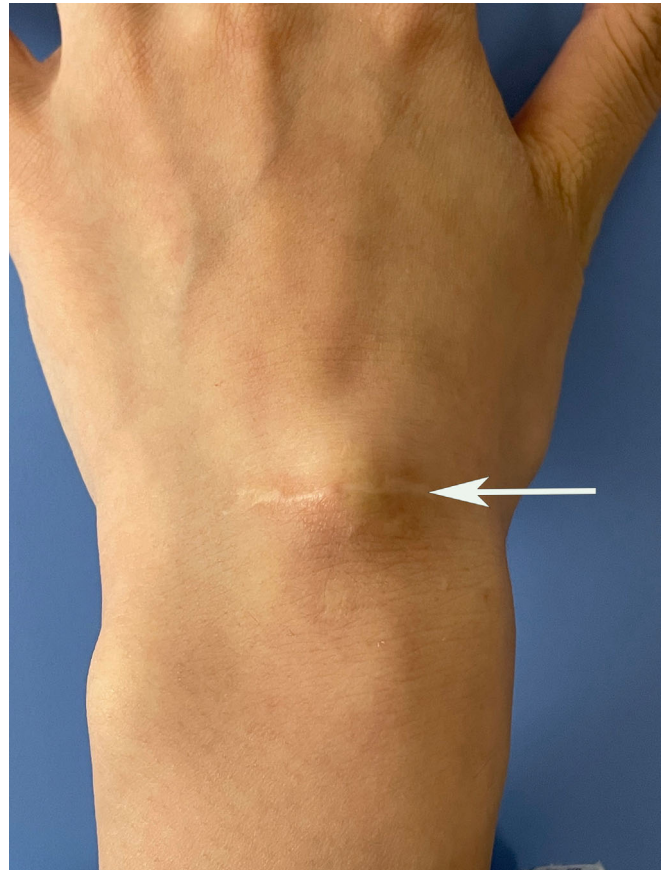


Fig. 1 A typical case of recurrent DWG cyst. A 35-year-old woman who underwent open excision (white arrow) of a DWG cyst 27 months ago complained of a mass appearing at the previous surgical site. Ultrasound examination confirmed a recurrent DWG cyst with the largest diameter of 13 mm. DWG, dorsal wrist ganglion

Institutional Ethics Board (IRB approval number: JST20211018). Informed consent was obtained from all the participants.

Preoperative Evaluation

Ultrasonography

Wrist US examination was routinely performed before re-excision by an expert musculoskeletal sonographer using a color Doppler ultrasound system (LOGIQ E9, GE Medical Systems, USA). The criteria used to diagnose a ganglion cyst were well-defined, anechoic or hypoechoic, and unilocular or multilocular fluid collection not representing an anatomic bursa or joint recess, as described in the literature.¹⁷ The largest diameter of the ganglion cyst was measured (Figure 1).

Magnetic Resonance Imaging

All patients underwent routine MRI examinations before re-excision. MRI scanning was performed using a 3.0-T

superconducting magnet (Signa, GE Medical Systems, USA) according to a standardized institutional protocol. MRI protocols included coronal, sagittal, and axial sequences. Each sequence included the T1- and T2-weighted phases. MRI scans were first evaluated by an expert musculoskeletal radiologist, and a ganglion cyst was defined as a focal lesion in the soft tissue with a signal isointense to fluid.¹⁸ The location and limits of the cyst were then evaluated on the T2-weighted axial and sagittal planes by the surgeon. It should be noted that the cyst was probably multilocular due to local scarring in patients undergoing previous excision^{4,14}; therefore, the limits of the cyst and location of the extensor tendons should be identified carefully on MRI scans (Figure 2).

Surgical Technique

Anesthesia and Position

The surgery was performed under ultrasound-guided brachial plexus block, and a pneumatic tourniquet was used with 260 mmHg of pressure to provide a good view on arthroscopy. All patients underwent wrist arthroscopy in the supine position, with the arm fixed to the table and the elbow flexed to 90° with the wrist in a vertical distraction of 10–12 lbs (approximately 5 kg), using a traction tower. A 2.5-mm arthroscope with a visual angle of 30° (ConMed Linvatec, USA) was used, and a normal saline solution was provided through the arthroscopic cannula.

Arthroscopic Inspection

As most recurrent DWG cysts originate from the dorsal part of the scapholunate ligament, it is relatively easy to inspect and excise the pedicle of this ganglion cyst from the midcarpal portal. Arthroscopic inspection was performed through the midcarpal ulnar (MCU) portal using the arthroscope, systematically evaluating the wrist following a sequence from radial to ulnar, distal to proximal, and volar to dorsal to avoid missing any concomitant pathology (Figure 3A). The dorsal capsule in the region of the scapholunate interosseous ligament was carefully checked,

and a ganglion stalk was often identified, which usually appeared transparent, gray, or opalescent. Sometimes, a real stalk was not present, and external pressure applied over the mass was helpful to localize the ganglion base.

Ganglion Cyst Excision

Once the stalk was visualized, a needle was introduced through the ganglion into the midcarpal joint from the midcarpal radial (MCR) portal (Figure 3B). The extrusion of gelatinous material is usually evidence of successful decompression of the cyst (Figure 3C). A transcystic MCR approach was created, and a 2.9-mm shaver (ConMed Linvatec, USA) was introduced through the ganglion into the joint (Figure 3D). Based on the location and limits of the cyst on preoperative MRI, the ganglion stalk and adjacent pathological dorsal capsule were excised under arthroscopic vision until the extensor carpi radialis brevis (ECRB) and extensor digitorum communis (EDC) of the index finger were exposed (Figure 3E). Because of the thick scarring after previous surgery, clear visualization of the inner wall of a recurrent cyst could be difficult, and the ganglion could be multilocular. Percutaneous squeezes of the ganglion in multiple directions can help locate the limits of the cyst, followed by complete excision of the ganglion wall and stalk. Great caution should be taken to prevent injuries to the ECRB and EDC tendons when ganglion excision is performed under external pressure. After ganglionectomy was completed, the disappearance of the ganglion was confirmed arthroscopically, followed by palpation of the dorsal wrist to reconfirm after the arthroscope was removed. The portals were closed using nylon sutures (Figure 4).

Postoperative Management

A soft pressure dressing was applied for 48 h to avoid swelling caused by saline perfusion. No plasters or braces were used. Patients were encouraged to gently use their hands as tolerated, immediately after the procedure, but were advised to avoid strenuous work and weight lifting for 4 weeks. Physical therapy was recommended for all patients.

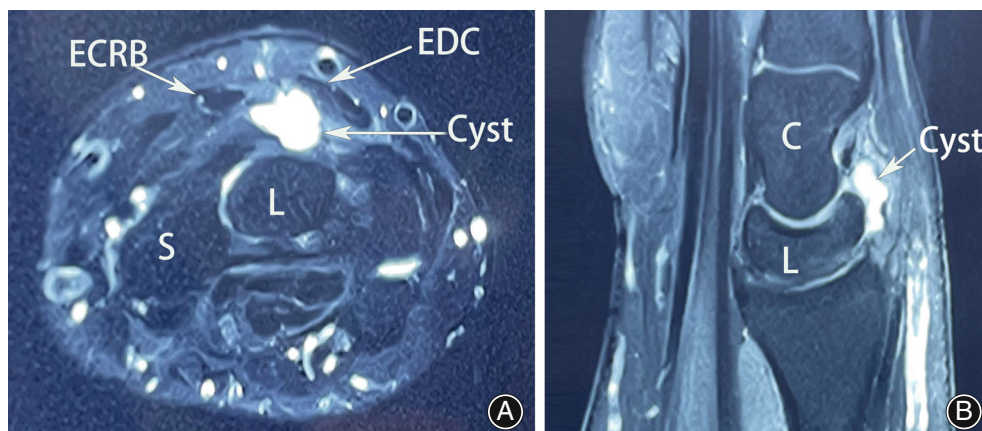


Fig. 2 Preoperative magnetic resonance imaging of the same case in Figure 1. The T2-weighted axial (A) and sagittal (B) images demonstrated a recurrent DWG cyst on the dorsal side of the scapholunate interval, adjacent to the ECRB and EDC of the index finger. DWG, dorsal wrist ganglion; S, scaphoid; L, lunate; C, capitate; ECRB, extensor carpi radialis brevis; EDC, extensor digitorum communis

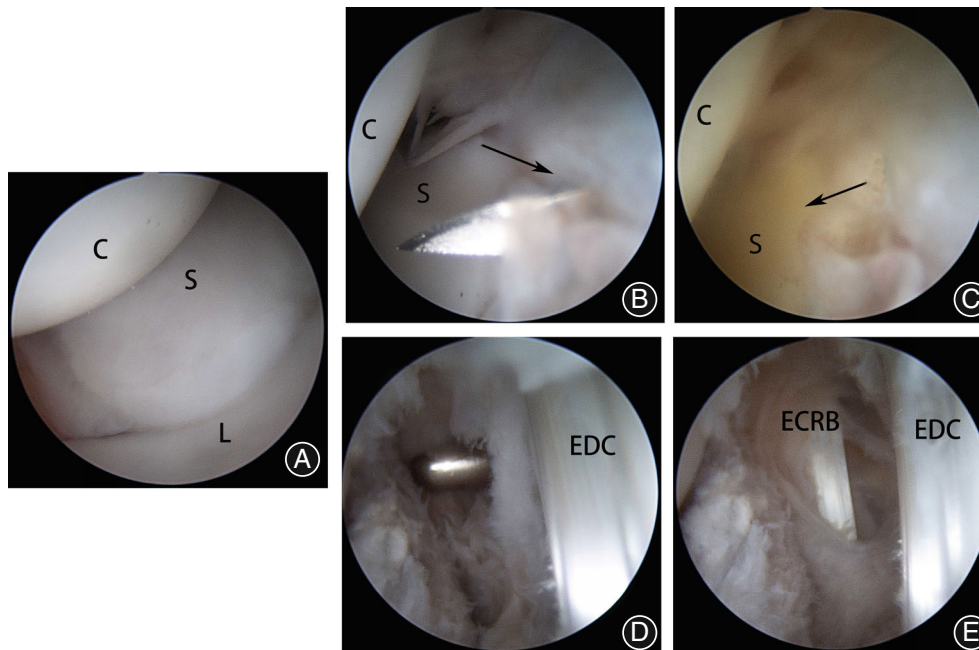


Fig. 3 Arthroscopic images (viewing through the midcarpal ulnar portal) of the same case in Figure 1. (A) The scapholunate interval was clearly visualized. (B) A needle was introduced through the ganglion (black arrow) in the dorsal capsule into the midcarpal joint from the midcarpal radial portal. (C) The extrusion of gelatinous material into the midcarpal joint indicated the breakage of the ganglion wall (black arrow). (D) A shaver was introduced through the midcarpal radial portal to excise the ganglion and adjacent pathological dorsal capsule. (E) An extensive excision proceeded until the ECRB and EDC of the index finger were exposed. S, scaphoid; L, lunate; C, capitate. ECRB, extensor carpi radialis brevis; EDC, extensor digitorum communis

Data Collection

Demographic Data and Medical History

A questionnaire was used to record age, sex, dominant side, affected side, prior surgical approach, and time of recurrence. The time of recurrence was documented by patient recall and determined by the interval between the primary excision and the first reappearance of the cyst. The operative time for arthroscopic re-excision was also documented.

Pain and Function Evaluation

Pain during activity was evaluated using a visual analog scale (VAS) ranging from 0 (no pain) to 10 (worst pain ever felt), and residual pain was recorded if the VAS score was >0 at the final follow-up. The active range of motion (ROM) of the wrist in flexion and extension was measured in degrees using a goniometer, and the hand grip strength was measured in kilograms using a digital dynamometer. The above evaluations were performed before the surgery and at the final visit. Postoperative evaluation was performed for a minimum of 24 months.

Second Recurrence

After arthroscopic re-excision, a second recurrence was defined as the reappearance of the mass at the same site, with a positive transillumination test.¹⁴ The time of the

second recurrence was recorded based on the patient's first observation instead of the surgeon's confirmation. At the final visit, all patients were asked to undergo wrist US to confirm recurrence.

Statistical Analysis

Statistical analyses were performed using the SPSS software package (version 25.0, SPSS Inc., IBM, USA). Descriptive statistics were used for all variables. Continuous variables (age, time of recurrence, largest cyst diameter, length of follow-up, VAS score, active ROM, hand grip strength, and time of the second recurrence) are reported as mean \pm standard deviation (SD), and the comparative analysis between pre- and post-operation was performed using Student's *t*-test or Mann-Whitney *U* test according to the assumption of normality and homoscedasticity. Categorical variables (sex, dominant side, affected side, prior surgical approach, and residual pain) are reported as numbers (percentages). Statistical significance was set at $p < 0.05$ for all analyses.

A post hoc power analysis was performed using the G*Power software (version 3.1, Franz Paul, Kiel, Germany). With an α of 0.05, the sample size of 11 was sufficient to detect the difference between the pre- and postoperative VAS scores with an effect size of 1.16 and a power of 0.97, and the difference between the pre- and postoperative active wrist flexion with an effect size of 0.87 and a power of 0.85.

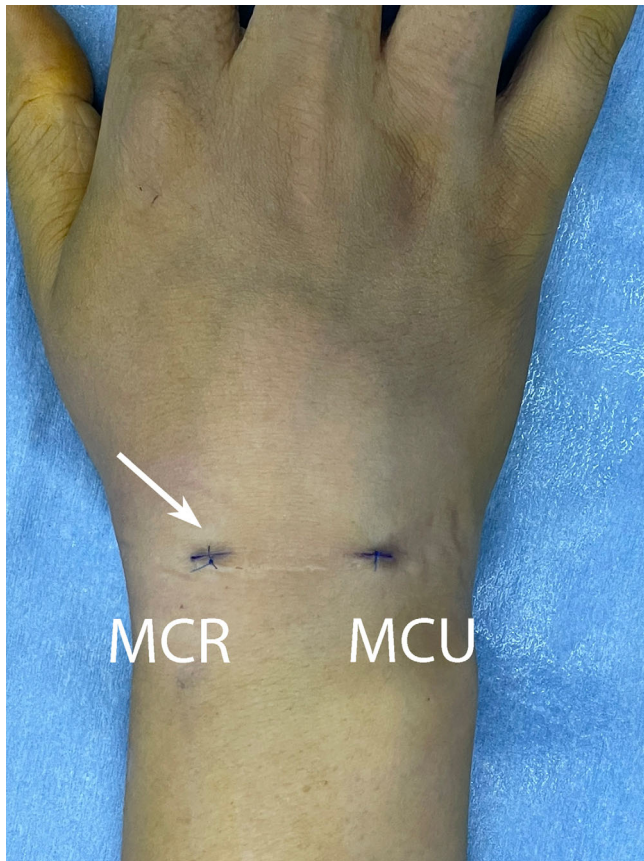


Fig. 4 Macroscopy confirmed the disappearance of the cyst (white arrow) after arthroscopic ganglion excision was completed. The MCU and MCR portal was closed with single nylon sutures. MCU, midcarpal ulnar; MCR, midcarpal radial

Results

Patient Characteristics

All the 11 patients who underwent arthroscopic cyst re-excision completed the final follow-up of a minimum of 24 months. The study cohort consisted of four males and seven females with a mean age of 38.2 years. All patients were dextral, and the dominant side of the 4/11 patients was affected. At the time of arthroscopic re-excision, the largest cyst diameter was 15.8 mm on preoperative US. The mean operative time was 48.9 min (Table 1).

Prior Surgery and Recurrence

Primary ganglion excision was performed using an open technique in nine cases and an arthroscopic approach in two cases. The time of recurrence of the ganglion after prior surgery was 20.5 months on average, ranging from 2 months to 4.7 years. Specifically, it was <1 year in four cases, 1–2 years in four cases, and >2 years in three cases (Table 2).

TABLE 1 Patient characteristics

Variables	Value
Patients, n	11
Sex, n (%)	
Male	4 (36.4)
Female	7 (63.6)
Age, years	
Mean \pm SD	38.2 \pm 8.8
Range	21–51
Dominant side, n (%)	
Left	0 (0.0)
Right	11 (100.0)
Affected side, n (%)	
Left	7 (63.6)
Right	4 (36.4)
Largest cyst diameter, mm	
Mean \pm SD	15.8 \pm 4.1
Range	11–24
Operative time, min	
Mean \pm SD	48.9 \pm 6.8
Range	40–58

Note: Values are presented as mean \pm SD, n (%), or range (minimum–maximum).

Clinical Outcomes

The mean follow-up period was 29.3 months (range, 24–34 months). At the final visit, the VAS score significantly decreased from 1.4 to 0.3 ($t = 3.833$, $p = 0.003$), and residual pain was reported in three patients (VAS score = 1 for each). Moreover, active wrist flexion significantly increased from 73.6° to 78.2° ($t = 2.887$, $p = 0.016$). Although active wrist extension and hand grip strength improved postoperatively, the differences were not statistically significant ($p > 0.05$). No second recurrence of ganglion cysts was confirmed during the follow-up period (Table 3).

Complications

No other major complications, such as extensor tendon rupture, radial artery injury, or neurapraxia of the radial nerve, occurred during the study period.

TABLE 2 Prior surgery and recurrence

Variables	Value
Prior surgical approach, n (%)	
Open	9 (81.8)
Arthroscopic	2 (18.2)
Time of recurrence, months	
Mean \pm SD	20.5 \pm 15.4
Range	2–56

Note: Values are presented as mean \pm SD, n (%), or range (minimum–maximum).

TABLE 3 Clinical Outcomes

Evaluation	Preoperative	Postoperative	Statistical value
Follow-up, months	–	29.3 ± 3.7	–
Visual analog scale	1.4 ± 0.9	0.3 ± 0.5	t = 3.833, p = 0.003
Residual pain, n (%)	–	3 (27.3)	–
Active wrist flexion, °	73.6 ± 8.1	78.2 ± 4.6	t = 2.887, p = 0.016
Active wrist extension, °	75.5 ± 11.3	78.2 ± 5.6	t = 1.322, p = 0.216
Hand grip strength, kg	33.9 ± 10.8	34.1 ± 11.3	t = 0.403, p = 0.695
Second recurrence, n (%)	–	0 (0.0)	–

Note: Values are presented as mean ± SD or n (%).

Discussion

Main Findings of the Study

The most important finding of this study was that arthroscopic excision of recurrent DWG cysts could achieve satisfactory outcomes with pain relief, ROM improvement, and no second recurrence at a minimum of 24-month follow-up.

First Recurrence after Primary Excision

While open excision of DWG cysts led to a lower recurrence rate than conservative treatments such as aspiration and intralesional injection, the reported recurrence rates were variable and worrying.^{2,19} Dias *et al.*² reported 6-year follow-up outcomes after different interventions with reassurance, aspiration, and open excision in patients with DWG. The recurrence rate of open excision was significantly lower than that of reassurance and aspiration; however, it remained as high as 39%. Given the widely developed open excision technique, recurrent DWG cysts could be common in clinical scenarios.

Since it was first described by Osterman and Raphael in 1995,²⁰ arthroscopic excision of DWG cysts has increased in popularity and has shown encouraging results, with a lower recurrence rate of approximately 10%.^{4,11–16} In a study by Gallego and Mathoulin,⁴ 114 patients underwent arthroscopic excisions of DWG cysts, and 14 (12.3%) recurrences at a mean of 16.9 months after surgery were recorded. Borisch¹³ performed 30 arthroscopic DWG excisions and found four (13.3%) cases with recurring symptoms at an average of 28.5-month follow-up. Fernandes *et al.*¹² evaluated 34 cases of DWG cysts in patients who underwent arthroscopic excisions, and only one (2.9%) recurrence was noted (at 3 months postoperatively) within a minimum of 4-year follow-up. These results show the advantage of the arthroscopic approach in primary DWG excision in terms of recurrence reduction. However, the effectiveness of arthroscopic ganglionectomy in cases of recurrent DWG cysts remains unclear.

Second Recurrence after Re-Excision

Currently, only one study performed by Graham *et al.*¹⁰ reported the surgical outcomes of re-excision of recurrent

wrist ganglion cysts. In their study, open excision was performed in 20 patients with recurrence, including eight on the dorsal side and 12 on the volar side. Within the follow-up period of 1 year, three (15%) cases had a second recurrence, but none were on the dorsal side, which is similar to the results of this study. In this study, 11 patients underwent arthroscopic excisions for a recurrent DWG cyst, and no recurrence was confirmed at a minimum 2-year follow-up, indicating that ganglionectomy with an arthroscopic technique was effective in preventing a second recurrence following re-excision.

Reasons for Low Recurrence of the Study

Surgical errors, mainly incomplete removal of the ganglion cyst and its stalk during excision, are considered the most important factors that increase the risk of recurrence after primary excision.^{6,7,9,14} Recent studies have described a color-aided technique to improve visualization of the ganglion stalk during arthroscopic excision, with a low recurrence rate of 3.7%,²¹ implying the importance of the identification and excision of the stalk. In this study, percutaneous squeezes on the mass were repeatedly performed to confirm the stalk and limits of the cyst while excising the ganglion, which could be helpful for complete excision. However, as described in the literature, the ganglion stalk might hardly be identified as a discrete structure in many cases,^{9,14,15,20} especially in recurrent patients undergoing previous surgery. Moreover, Kim *et al.*¹⁴ found that the recurrence rate after arthroscopic excision was similar between patients with and without stalk identification. Therefore, to prevent the recurrence, extensive excision of the ganglion, including the dorsal capsular tissue adjacent to the scapholunate ligament, was performed in this study until the ECRB and EDC of the index finger were visualized. This is noteworthy while performing a re-excision, as the EDC is not necessarily exposed at the primary excision.

In patients with recurrent DWG cysts, especially those after open surgery, thick scarring commonly occurs between the scapholunate ligament and capsule on the dorsal wrist,^{5,14} which might result in a recurrent cyst with a multilocular feature. Previous studies have demonstrated that a multiloculated ganglion cyst can be clearly identified on MRI

scans.²² In this study, a comprehensive evaluation based on preoperative wrist MRI scans was performed, including the unilocular or multilocular characteristics of the cyst as well as the limits between the ganglion wall and extensor tendons, to direct capsulectomy and cyst excision under arthroscopic view. This could be another reason for the low recurrence rate observed in this study.

Pain and Function Improvement after Re-Excision

Ganglionic pain is postulated to arise from the compression of the terminal branches of the posterior interosseous nerve, and decompression of the ganglion is believed to relieve the pain.¹ Previous studies reported an incidence of residual pain after arthroscopic DWG excision of 3.5% to 21%.^{4,5,9,14} In this study, residual pain under activity was found in 27% of the patients, and the postoperative VAS score was only 1 in each patient. Regarding active wrist ROM in this study, a slight but statistically significant improvement in palmar flexion was found at the final follow-up, which probably resulted from the aforementioned pain relief. Furthermore, hand grip strength was normal preoperatively and maintained postoperatively in this study, indicating that the symptom of weakness could not be very prevalent among recurrent cases.

Strengths of the Study

To our knowledge, this is the first study to report the recurrence rate and functional outcomes after arthroscopic excision of recurrent DWG cysts. The clinical implication of this study is to provide further understanding of the arthroscopic technique for resecting recurrent DWG cysts. Clear identification of the location and limits of the ganglion based on preoperative MRI helps direct arthroscopic excision. To prevent a second recurrence, extensive excision of the ganglion and surrounding pathological capsule should be performed until the ECRB and EDC of the index finger are exposed.

Limitations of the Study

The limitations of this study are summarized as follows. First, the recurrence rate could be underestimated because of the small sample size and short follow-up period. More recurrences might be observed at >2-year follow-up in a larger population, as reported in previous studies.^{2,9} Second, as only two cases in this study cohort received primary surgery in our department and the remaining nine cases came from other institutions, the recurrence rate of primary surgery cannot be accurately counted and explained. Third, no comparison group was included in this study because no patients preferred open excision when the arthroscopic and open approaches were both optional, and no patients receiving nonsurgical interventions completed a follow-up of ≥ 2 years. Fourth, the functional outcome was not evaluated using specialized scales such as the Disabilities of the

Arm, Shoulder, and Hand system, which can measure the meticulous function of the upper extremity. Fifth, medical documents at the time of primary surgery were not collected, so the original features of recurrent cases before any surgical excision are difficult to trace. Finally, the lack of a comparison group is an important limitation. Future studies with a larger cohort and longer follow-up period are required to compare clinical outcomes with traditional open surgery.

Conclusion

For patients with recurrent DWG cysts, arthroscopic re-excision achieved favorable outcomes, with significant pain relief and good wrist function. No second recurrence was observed during the 2-year follow-up. Preoperative MRI could be helpful in identifying the location and limits of the ganglion. Extensive cyst excision and capsulectomy should be performed to prevent second recurrence.

Authors Contributions

T.Z. drafted the manuscript and conducted the statistical analysis. X.H. researched literature and helped to draft the manuscript. Y.Y. conceived the study, gained ethical approval, and performed surgeries. B.L. and F.L. were involved in patient recruitment and data collection. Z.L. participated in the study design. All authors reviewed and edited the manuscript and approved the final version of the manuscript. T.Z. and X.H. should be considered joint first author.

Conflicts of Interest

T.Z. and X.H. contributed equally to this article. Y.Y. has received funding from the Beijing Health System for High-level Technical Scholars (No.2015-3-036). Other authors declare they have no relevant financial or non-financial interests to disclose.

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Ethical Statement

Ethical approval for this study was obtained from our Institutional Ethics Board (IRB approval number: JST20211018). Informed consent was obtained from all individual participants included in the study.

Supporting Information

Additional Supporting Information may be found in the online version of this article on the publisher's web-site:

Table S1. Demographic data and medical history of each case

Table S2. Clinical outcomes of each case

References

1. Meena S, Gupta A. Dorsal wrist ganglion: current review of literature. *J Clin Orthop Trauma*. 2014;5:59–64.
2. Dias JJ, Dhukaram V, Kumar P. The natural history of untreated dorsal wrist ganglia and patient reported outcome 6 years after intervention. *J Hand Surg Eur*. 2007;32:502–8.
3. Mathoulin C, Gras M. Arthroscopic management of dorsal and volar wrist ganglion. *Hand Clin*. 2017;33:769–77.
4. Gallego S, Mathoulin C. Arthroscopic resection of dorsal wrist ganglia: 114 cases with minimum follow-up of 2 years. *Art Ther*. 2010;26:1675–82.
5. Luchetti R, Badia A, Alfarano M, Orbay J, Indriago I, Mustapha B. Arthroscopic resection of dorsal wrist ganglia and treatment of recurrences. *J Hand Surg Br*. 2000;25:38–40.
6. Cluts LM, Fowler JR. Factors impacting recurrence rate after open ganglion cyst excision. *Hand (N Y)*. 2020;17:261–5.
7. Alp NB, Akdag G. Surgical treatment of dorsal carpal ganglions: a retrospective clinical trial. *Cureus*. 2020;12:e10252.
8. Konigsberg MW, Tedesco LJ, Mueller JD, et al. Recurrence rates of dorsal wrist ganglion cysts after arthroscopic versus open surgical excision: a retrospective comparison. *Hand (N Y)*. 2021;15589447211003184.
9. Kang L, Akelman E, Weiss AP. Arthroscopic versus open dorsal ganglion excision: a prospective, randomized comparison of rates of recurrence and of residual pain. *J Hand Surg Am*. 2008;33:471–5.
10. Graham JG, McAlpine L, Medina J, Jawahier PA, Beredjikian PK, Rivlin M. Recurrence of ganglion cysts following Re-excision. *Arch Bone Jt Surg*. 2021;9:387–90.
11. d'Ailly PN, Koopman JE, Selles CA, Rahimtoola ZO, Schep NWL. Patient-related outcomes of arthroscopic resection of ganglion cysts of the wrist. *J Wrist Surg*. 2021;10:31–5.
12. Fernandes CH, Meirelles LM, Raduan Neto J, Fernandes M, Dos Santos JBG, Faloppa F. Arthroscopic resection of dorsal wrist ganglion: results and rate of recurrence over a minimum follow-up of 4 years. *Hand (N Y)*. 2019;14:236–41.
13. Borisch N. Arthroscopic resection of occult dorsal wrist ganglia. *Arch Orthop Trauma Surg*. 2016;136:1473–80.
14. Kim JP, Seo JB, Park HG, Park YH. Arthroscopic excision of dorsal wrist ganglion: factors related to recurrence and postoperative residual pain. *Art Ther*. 2013;29:1019–24.
15. Edwards SG, Johansen JA. Prospective outcomes and associations of wrist ganglion cysts resected arthroscopically. *J Hand Surg Am*. 2009;34:395–400.
16. Abehsera E, Nedellec G, Limousin M, Fontaine C, Strouk G. Arthroscopic resection of wrist ganglia: about 30 cases. *J Orthop*. 2019;16:216–9.
17. Zhang A, Falkowski AL, Jacobson JA, Kim SM, Koh SH, Gaetke-Udager K. Sonography of wrist ganglion cysts: which location is most common? *J Ultrasound Med*. 2019;38:2155–60.
18. Nance EM, Byun DJ, Endo Y, Wolfe SW, Lee SK. Dorsal wrist pain in the extended wrist-loading position: an MRI study. *J Wrist Surg*. 2017;6:276–9.
19. Khan PS, Hayat H. Surgical excision versus aspiration combined with intralesional triamcinolone acetonide injection plus wrist immobilization therapy in the treatment of dorsal wrist ganglion; a randomized controlled trial. *J Hand Microsurg*. 2011;3:55–7.
20. Osterman AL, Raphael J. Arthroscopic resection of dorsal ganglion of the wrist. *Hand Clin*. 1995;11:7–12.
21. Ahsan ZS, Yao J. Arthroscopic dorsal wrist ganglion excision with color-aided visualization of the stalk: minimum 1-year follow-up. *Hand (N Y)*. 2014;9:205–8.
22. Bracken J, Bartlett M. Ganglion cysts in the paediatric wrist: magnetic resonance imaging findings. *Pediatr Radiol*. 2013;43:1622–8.