

Original Article With Video Illustrations

Arthroscopic Resection of Dorsal Wrist Ganglia: 114 Cases With Minimum Follow-Up of 2 Years

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Purpose: The objective of this study was to review the results of arthroscopic resection of dorsal wrist ganglion (DWG), as well as to describe the senior author's technique and technical details to minimize potential complications. **Methods:** Between September 1999 and May 2004, 114 patients underwent arthroscopic resection of DWG with a minimum follow-up of 24 months. We describe the surgical technique and discuss our results and complications. **Results:** A total of 114 patients (87 female patients and 27 male patients) with a mean age of 33.1 years were treated with our operative technique. The symptoms at presentation were unsightly appearance in 63 (55.2%), pain in 33 (28.9%), and both unsightly appearance and pain in 18 (15.8%). The patients presented between 1 and 96 months before surgery (mean, 17.81 months). Of the patients, 66 (57.9%) had been treated previously with nonsurgical modalities (aspiration) and 1 had undergone open surgery. The origin of the DWG was more commonly related to the midcarpal joint (85 patients [74.6%]). Our surgery brought about a significant improvement in flexion and extension after surgery ($P < .005$). Similarly, our surgery brought about a significant improvement in grip strength ($P < .005$). In patients with preoperative pain, treatment also showed a significant impact. At 2 years' follow-up, there were 14 recurrences (12.3%), diagnosed at a mean of 16.86 months after surgery (range, 2 to 25 months). Complications were identified in 6 patients (5.26%), and the mean time off work was 11 days, with a majority of patients returning in less than 1 week. **Conclusions:** Arthroscopic DWG resection showed an improvement in functional measurements in addition to relief of pain in a significant proportion of patients. Complications related to the operative technique did not cause any significant long-term functional deficit. The recurrence rate was 12.3%, and patient satisfaction was high. Arthroscopic technique allows patients to use their hand immediately. The results of this study support the use of arthroscopy as primary treatment for DWG resection. **Level of Evidence:** Level IV, therapeutic case series.

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Diagnostic wrist arthroscopy has been a major innovation in recent years. There has been an increase in its use and acceptance among hand surgeons for the purpose of treating several wrist conditions.¹⁻³ Wrist arthroscopy requires dedicated surgical training;^{4,5} once the surgeon becomes familiarized with the technique, it offers several advantages compared with classical open approaches. A thorough understanding of wrist anatomy is an essential prerequisite for wrist arthroscopy. Proper portal placement, identification of pathology, and successful treatment all rely on a thorough understanding of the structures at risk, as well as recognition of pathologic abnormalities.⁵ Dorsal wrist ganglion (DWG) is a relatively common condition, and it is known to be the most common soft-tissue tumor in the hand.^{1,4,5} Its treatment has been controversial. Many modalities of treat-

ment have been proposed, among which are observation, percutaneous aspiration, sclerotherapy, and open surgery.^{1,5} Of the cysts, 50% will spontaneously resolve with time and some may recur.⁶ Surgical resection is the most effective treatment. It is classically used after multiple nonsurgical treatments whose recurrence rates vary from 1% to 40%. These treatments can be associated with joint stiffness and unsightly/painful scars. These complications result in suboptimal outcomes and dissatisfied patients. Recent articles have described the use of arthroscopic resection of wrist ganglia with promising results with respect to recurrence rates (0% to 20%), morbidity, and esthetic and functional outcome.³⁻¹² Arthroscopy provides a minimally invasive means to safely resect the mass while avoiding the large scars associated with open resection. Arthroscopic DWG excision affords a more complete assessment with respect to the pathologic anatomy, etiology, and concomitant wrist pathology. Arthroscopic resection averts the occurrence of some of the classical complications associated with open exposure, as well as having a lower recurrence rate.³⁻¹²

The purpose of this study was to review the results of a large clinical series with a long follow-up (minimum, 2 years) operated on by the same surgeon. Our results show a significant decrease in the incidence of the classical complications of open surgery (unsightly scar, flexion stiffness). On the other hand, the rate of recurrence appears to be similar to that for open surgery. We believe that this is because of our long follow-up period of 2 years. Our hypothesis was that arthroscopic ganglionectomy can be a safe and reliable procedure associated with high patient satisfaction levels, a lower complication rate, and a low recurrence rate compared with open surgery.

METHODS

We report a retrospective observational clinical series of 114 patients who underwent arthroscopic surgical excision of DWG between September 1999 and January 2004 at the same center by the same surgeon using a standardized technique.^{5,13} Inclusion criteria consisted of a confirmed clinical diagnostic of DWG originating from either the radiocarpal or midcarpal joint. Patients with scapholunate (SL) ligament lesions (based on clinical features and radiographic criteria) were excluded. Also excluded were ganglia in sites other than the previously mentioned location, as well as those in children. The series consisted of 87 female patients (76.3%) and 27 male patients (23.7%) with a

mean age of 33.1 years (range, 12 to 63 years) with a diagnosis of DWG.

We developed a questionnaire to record demographic data, main cyst location, onset, and previously applied treatments/recurrences. We also recorded preoperative and postoperative clinical features, recurrences, and return to work after surgery.

Preoperative and postoperative data were gathered from patients' charts and physical examination findings at the initial and discharge clinical assessments. Objective functional parameters included range of motion (ROM) in degrees evaluated with a goniometer; grip strength, measured with the Jamar dynamometer (Lafayette Instruments, Lafayette, IN); and pain evaluated with a visual analog scale from 0 (no pain) to 10 (worst pain ever felt). We noted the presence or absence of recurrences during follow-up and recorded patient satisfaction parameters. All patients were asked, "Are you satisfied with the results of the used technique and would you use it again if needed?" There were 3 possible responses: yes, with no doubts; yes, with doubts; and no, I would prefer another technique.

All patients had a complete clinical examination in both wrists.¹¹ In addition, all patients had standard plain wrist radiographs (anteroposterior and lateral views) to exclude bony pathology or carpal instability (SL gap, measurement of SL angle),¹ as well as magnetic resonance imaging (MRI) to confirm both the diagnosis and the anatomic location of the cyst.⁷ The indications for preoperative MRI were wrists in which the anatomic location of the cyst was unclear and painful wrists (61 cases [53.5%]).

Surgical Technique

All patients underwent ultrasound-assisted regional nerve block by trained anesthesiologists. A pneumatic tourniquet was used in all cases (250 mm Hg of pressure).

Wrist arthroscopy was undertaken with the patient in the supine position, with the arm fixed to the table and the elbow flexed to 90° with the wrist in a vertical traction tower applying 3 to 5 kg, connected through a "Chinese hand." We used a 2.4-mm arthroscope with a visual angle of 30° and a wet technique with normal saline solution provided through the arthroscope cannula. The ganglion was excised with a 2.5-mm shaver with an aggressive cutter.

We marked the standard landmarks that assist in portal placement: Lister tubercle, extensor carpi ulnaris tendon, and 3-4, 6 radial (6R), and ulnar and

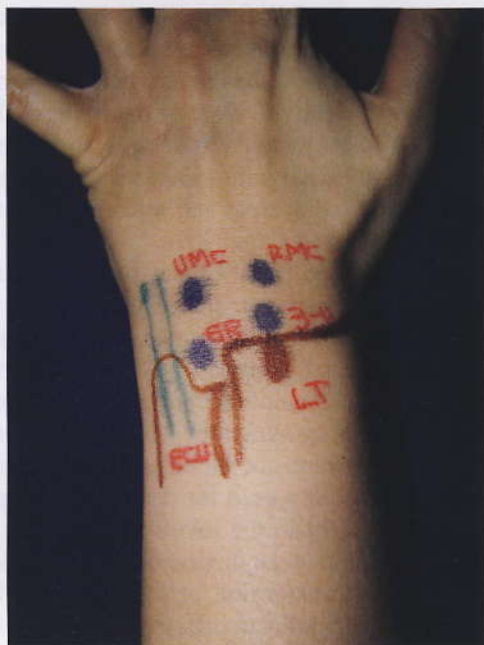


FIGURE 1. Skin portal landmarks. (ECU, extensor carpi ulnaris tendon; LT, Lister's tubercle; 6R, 6 radial portal; 3-4, 3-4 portal; UMC, ulnar midcarpal portal; RMC, radial midcarpal portal.)

radial midcarpal portals⁵ (Fig 1). Systematic thorough evaluation of the wrist joint was done following a sequence from radial to ulnar, distal to proximal, and volar to dorsal, evaluating the capsuloligamentous structures first and, finally, the cartilage itself so as not to miss any concomitant pathology. This evaluation was done before any manipulation of the ganglion stalk. Transverse 2-mm incisions were made with a No. 15 blade only through the skin, followed by blunt perforation to the capsule to avoid intra-articular lesions. The No. 11 blades used in knee arthroscopy are too sharp, and they can cause damage when entering directly to the wrist joint; hence we do not use them.¹⁰ The 6R portal and ulnar-midcarpal portal were established to introduce the arthroscope because the ganglion usually lies directly over the radial side and its stalk is best visualized from the ulnar side of the wrist.

The localization of the proximal and distal limits of the cyst was done with the aid of intramuscular needles located at these borders to accurately delineate the area of pathologic involvement of the capsule (Video 1, available at www.arthroscopyjournal.org). Gentle external pressure was applied over the mass to localize the stalk, which appeared pearly gray and opalescent most of the time at the junction of the SL ligament and the dorsal capsule. The shaver was then placed directly

into the ganglion within the marked limits of the stalk, which in most cases was in the midcarpal joint (Fig 2). Some cases required a radiocarpal approach in combination with the midcarpal portal, thus enabling a complete resection. The area of the ganglion's implantation in the SL ligament was excised, leaving a 1-cm² hole in the dorsal capsule (Video 2, available at www.arthroscopyjournal.org). Decompression of the cyst is usually evidenced by the extrusion of gelatinous material. Resection of dorsal synovitis, when present, was performed. Care should be taken to preserve the dorsal component of the SL ligament as well as the extensor tendons, which should be visualized once the capsular resection is complete (Video 3, available at www.arthroscopyjournal.org). Immediate disappearance of the ganglion mass should be confirmed, and this is especially important for multi-lobulated cysts to avoid early recurrence due to inadequate resection.⁵

The 2-mm portal sites were left open to drain excess fluid from the joint. A bulky dressing was applied. In the immediate postoperative period, patients were encouraged to gently use their hands after they had recovered from anesthesia, taking care to avoid strenuous work and weight lifting for several weeks. Physical therapy was recommended to all patients.

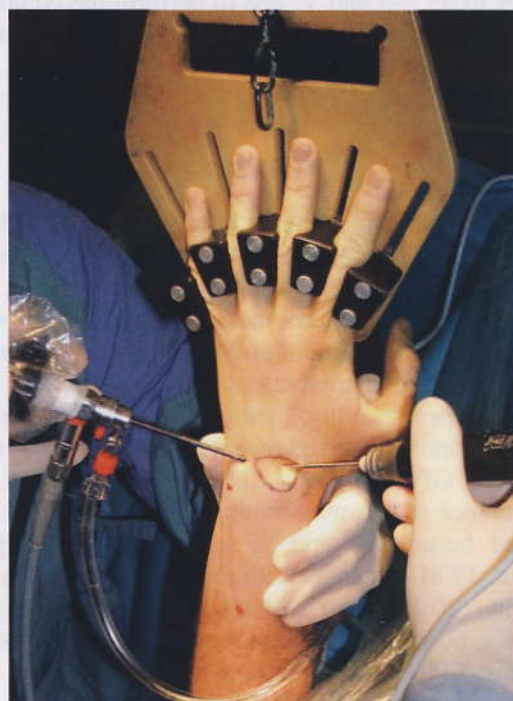


FIGURE 2. The arthroscope is in the ulnar midcarpal portal, and the shaver is directly through the ganglion.

TABLE 1. *Population Characteristics*

Characteristic	Data
Gender [No. of patients (%)]	
Male	27 (23.7)
Female	87 (76.3)
Age [mean (range)] (yr)	33.1 (12-63)
Cyst location [No. of patients (%)]	
Midcarpal	85 (74.6)
Radiocarpal	13 (11.4)
Combined midcarpal and radiocarpal	16 (14)
Affected side [No. of patients (%)]	
Right	60 (52.6)
Left	54 (47.4)
Bilateral	1
Previous treatment [No. of patients (%)]	
None	47 (41.2)
Open surgery	1 (0.9)
Nonsurgical	66 (57.9)
Duration of symptoms [mean (range)] (mo)	17.81 (1-96)

NOTE. Each cyst was included separately on statistic analysis.

Statistical Analysis

Data were recorded from questionnaires by use of Excel 2003 software (Microsoft, Redmond, WA), and we performed statistical analysis using SPSS software (version 16.0; SPSS, Chicago, IL) and applied the Fisher exact test and χ^2 test to perform the comparative analysis with significance at $P < .005$ and a confidence interval (CI) of 95%.

RESULTS

All 114 patients included in the study with a diagnosis of DWG between September 1999 and January 2004 underwent arthroscopic resection with the described technique. The mean follow-up was 42.3 months, with a minimum of 24 months and maximum of 74 months. Symptoms at presentation were unsightly appearance in 63 patients (55.2%), pain in 33 (28.9%), and both unsightly appearance and pain in 18 (15.8%). Of the patients, 11 (9.6%) associated the appearance of the mass with trauma. Symptoms appeared between 1 and 96 months before surgery (mean, 17.81 months). With regard to occupation, 23 patients (20.2%) were students, 21 (18.4%) were secretaries, 60 (52.6%) reported a wide variety of occupations, and 10 (8.8%) reported no occupation.

Of the patients, 105 (92.1%) were right handed and 9 (7.9%) were left handed. There were 60 right hands (52.6%) and 54 left hands (47.4%) involved. Two

patients had bilateral DWG, one had a mass described as voluminous, and one had an intra-articular ganglion that was diagnosed with the aid of MRI. The ganglion location was classically in front of the midcarpal joint in 85 cases (74.6%), whereas it was sometimes in front of the radiocarpal joint (13 cases [11.4%]) or in front of both the radiocarpal and midcarpal joints (16 cases [14%]) (Table 1).

Of the patients, 66 (57.9%) had previously undergone nonsurgical treatment, and recurrence was noted after a mean of 21.6 months (range, 5 to 96 months). The previously used methods of treatment are described in Table 2. Patient characteristics, occupation, dominance, time since symptom presentation, and previous treatments were not included in the statistical analysis and were only used for descriptive purposes.

Preoperative ROM in the involved hand was measured, and we found mean flexion of 59.9° (range, 40° to 100°) and mean extension of 69.7° (range, 40° to 90°). We noted a significant difference compared with the opposite side (mean flexion of 75.1° and mean extension of 78°) ($P < .005$, 95% CI). Postoperative ROM of both wrists was similar and without significant difference ($P = .317$, 95% CI). Comparison of preoperative and postoperative ROM showed a significant difference of 15° in flexion (59.9° v 75.3°) and 11.1° in extension (69.8° v 77.9°) with a P value of .001 (95% CI) (Fig 3).

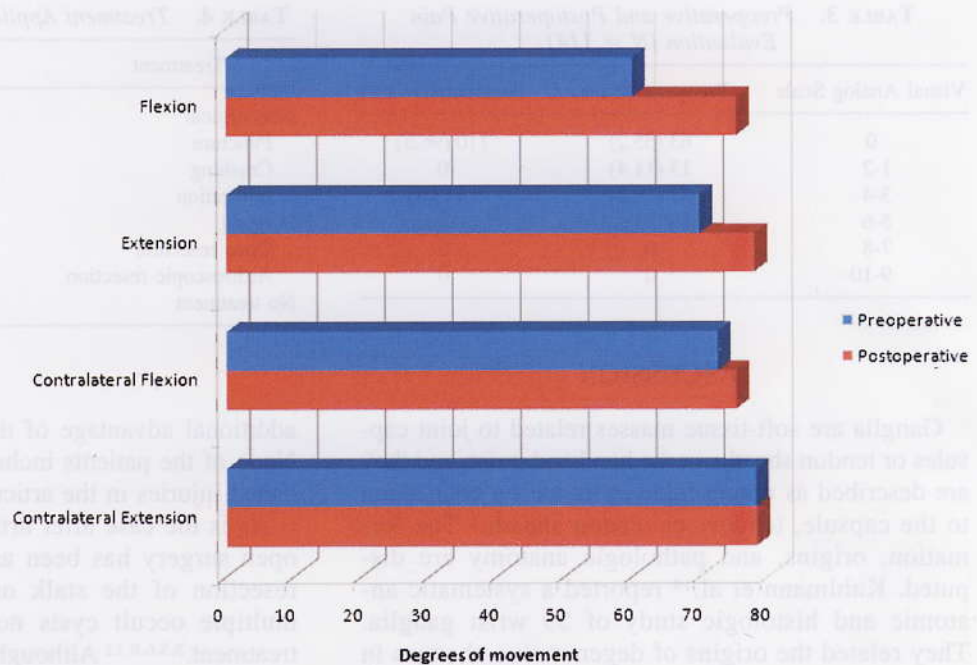
Grip strength, tested with the Jamar dynamometer, showed an objective improvement from a mean of 22.2 mm Hg in the preoperative period to 31.9 mm Hg in the postoperative period ($P < .005$, with a 95% CI) equivalent to the mean contralateral measures (28.9 mm Hg v 31.7 mm Hg) (Fig 4).

All 51 patients (44.7%) with painful wrists preoperatively noted that their pain completely disappeared. No statistically significant difference in preoperative versus postoperative pain was observed ($P = .089$, 95% CI), possibly because of the 66 patients (55.3%) without pain in the preoperative period (Table 3).

TABLE 2. *Method of Treatment Used Before Arthroscopy*

Treatment	No. of Patients (%)
Nonsurgical	
Puncture	40 (35.1)
Crushing	26 (22.8)
Surgical	
Open resection	1 (0.9)
Arthroscopic resection	0
No treatment	47 (41.2)

FIGURE 3. Preoperative and postoperative comparison of mean ROM in degrees.



Complications were seen in 20 patients (17.5%). We had 6 minor complications: 2 hematomas that required surgical drainage, 1 synovitis of the extensor pollicis longus tendon, 1 case of tendinitis of the extensor digitorum communis tendon, and 2 patients with transitory anesthesia of the dorsal nerves.

The other complications were 14 recurrences (12.3%) after a mean of 16.86 months (range, 2 to 25 months). It is interesting to note that 6 recurrences

were seen at under 2 years of follow-up (5.26%) and 8 more were seen after 2 years of follow-up. Seven of the patients with recurrence were successfully treated again arthroscopically without sequela (Table 4).

The mean time off work was 11 days for the 114 patients, but most of them (43 cases) returned to work immediately. Only 4 patients had more than 45 days off work (Fig 5). Patient satisfaction with the technique is reported in Table 5.

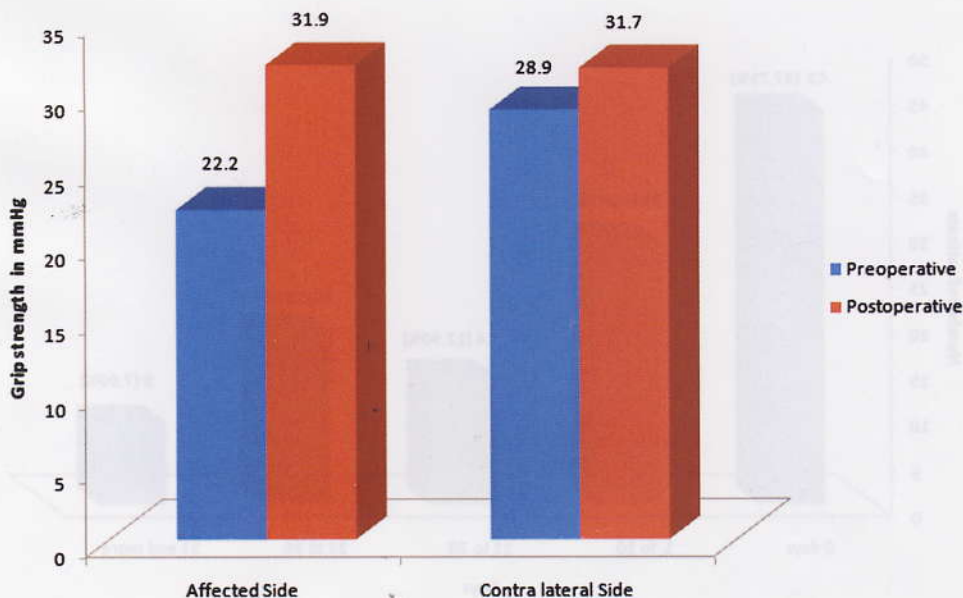


FIGURE 4. Comparative mean values of grip strength in millimeters of mercury between preoperative and postoperative periods.

TABLE 3. Preoperative and Postoperative Pain Evaluation (*N* = 114)

Visual Analog Scale	Preoperative (%)	Postoperative (%)
0	63 (55.2)	110 (96.5)
1-2	13 (11.4)	0
3-4	22 (19.2)	4 (3.5)
5-6	16 (14)	0
7-8	0	0
9-10	0	0

TABLE 4. Treatment Applied After Recurrence (*n* = 14)

Treatment	No. of Patients (%)
Nonsurgical	
Puncture	0
Crushing	0
Infiltration	2 (1.8)
Surgical	
Open resection	1 (0.9)
Arthroscopic resection	7 (6.1)
No treatment	4 (3.5)

DISCUSSION

Ganglia are soft-tissue masses related to joint capsules or tendon sheaths in the hand and wrist, and they are described as mucin-filled cysts with a connection to the capsule, tendon, or tendon sheath.¹ The formation, origins, and pathologic anatomy are disputed. Kuhlmann et al.¹⁴ reported a systematic anatomic and histologic study of 59 wrist ganglia. They related the origins of degenerative changes in the wrist ligaments starting at their osseous site of attachment.

Initially described by Osterman and Raphael¹⁵ in 1995,^{5,12} arthroscopic ganglionectomy represents a minimally invasive procedure with a lower rate of complications from the technique (2.9%).³ There was no SL ligament instability, contrary to reports with open surgery,^{2,16} and a low recurrence rate (0% to 15%), as shown by previous articles.^{3-5,7-12} As with open procedures, arthroscopic ganglionectomy allows for excision of the ganglion stalk based at the SL ligament with a dorsal capsular window and has the

additional advantage of the *in vivo* evaluation.^{5-11,17} None of the patients included in our series had associated injuries in the articular structures.

As is the case after arthroscopy, recurrence after open surgery has been associated with incomplete resection of the stalk or due to the presence of multiple occult cysts not resected during formal treatment.^{3,5,6,8,12} Although 40% to 50% of DWG may disappear with time, up to 58% may persist or recur in the long term.^{6,8} According to Westbrook et al.,¹⁸ patients seek medical attention to improve appearance (38%), to relieve pain (26%), or because of their concern that the ganglion can be a malignant growth (28%). It is now accepted that open surgery is associated with a lower recurrence rate compared with conservative treatments or observation.¹⁹ In our series the reason for consultation was a complaint of unsightly appearance in 63 patients (55.2%), the presence of pain in 33 (28.9%), and both unsightly appearance and pain in 18 (15.8%).

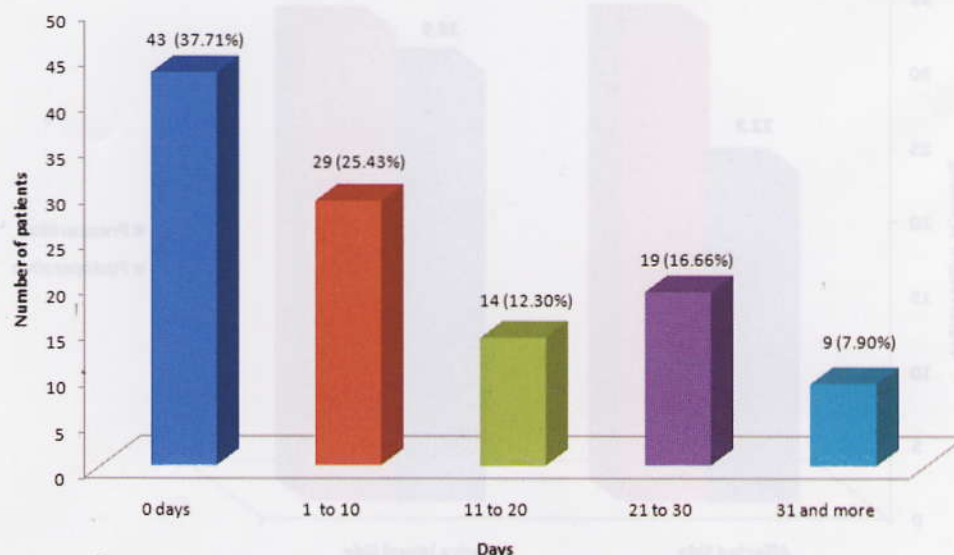
**FIGURE 5.** Days off work after arthroscopic resection of DWG.

TABLE 5. Patient Satisfaction (N = 114)

Response	No. of Patients (%)
Yes, with no doubts	110 (96.5)
Yes, with doubts	0
No, I would prefer another technique	4 (3.5)

NOTE. Patients were asked, "Are you satisfied with the results of the used technique and would you use it again if needed?"

Osterman and Raphael¹⁵ described a diminished movement of 45% before treatment and a significant improvement after resection in 94% of cases. In our patient population preoperative wrist flexion in the involved hand represented a mean of 80% of the contralateral hand. Preoperative wrist extension was at a mean of 90% of the unaffected side. After treatment, we found an improvement of 20% and 14% in flexion and extension, respectively.

Osterman and Raphael¹⁵ showed 20% of the contralateral grip strength in 27% of their patients in the preoperative evaluation and a recovery reaching 90% of the normal contralateral side after resection. Our patients showed a statistically significant improvement between the preoperative and postoperative grip strength, from 78% to 100% of the values of the contralateral side.

The presentation of pain is variable among the reported series, probably as a reflection of the presence or absence of associated injuries. However, improvement in pain is reported in the arthroscopic review series.^{8,15,18,19} Pain was not the principal symptom, but it was present in 51 (44.7%) of our cases. All the patients who had a preoperative pain rating of 2 to 6 on the visual analog scale were relieved of their symptoms after treatment. We did not find significant improvement related to the whole series, probably because of the number of patients without preoperative pain (63 cases [55.3%]).

Although most of the series of arthroscopic resection of DWG have recurrence rates compared with the open technique rates,^{3-5,7,9,10} only 1 study reports a 36% rate of recurrence after arthroscopic resection of DWG. A possible reason for this finding is that only radiocarpal portals were used, thus rendering the excision "laborious." We report 14 recurrences (12.3%): 6 in the first 2 years (5.3%) and 8 (7%) after 2 years. These findings were not present in a series with a shorter follow-up.^{3-5,7,9,10}

After 6 years' follow-up, Dias et al.¹⁹ reported recurrence rates of 39% with open surgery and 58% with aspiration, as well as persistence of 58% in a group with treatment abstention ($P = .002$). They also

reported rates of patient satisfaction of 83% after surgery, 81% after aspiration, and 53% without intervention irrespective of recurrence rates ($P = .001$). Our series has a high rate of patient satisfaction (96.5%), with 7 of the 14 recurrences having been treated successfully by the same technique.

The technique we describe is simple and reproducible, allowing immediate utilization of the hand, comparable to findings in articles by Dumontier et al.⁸ and Kang et al.¹⁰ and similar to findings in patients with no treatment intervention in the article by Dias et al.¹⁹ In our series 43 patients (37.7%) returned to work the day after arthroscopy resection of DWG.

Our technique gives an esthetic advantage in view of the minuscule size of the portals.

Differences in the series' population (age, occupation) and the fact that none of the patients presented associated lesions may influence the final results, and this has to be considered as a bias in our study.

CONCLUSIONS

Arthroscopic DWG resection showed an improvement in functional measurements in addition to relief of pain in a significant proportion of patients. Complications related to the operative technique did not cause any significant long-term functional deficit. The recurrence rate was 12.3%, and patient satisfaction was high. Arthroscopic technique allows patients to use their hand immediately. The results of this study support the use of arthroscopy as primary treatment for DWG resection.

REFERENCES

1. Athanasian EA. Bone and soft tissue tumors. In: Green DP, Hotchkiss R, Pederson C, Wolfe S, eds. *Green's operative hand surgery*. Ed 5. New York: Churchill Livingstone, 2005; 2211-2264.
2. Chloros GD, Wiesler ER, Poehling GG. Current concepts in wrist arthroscopy. *Arthroscopy* 2008;24:343-354.
3. Luchetti R, Atzei A, Rocchi L. Incidence and causes of failures in wrist arthroscopy techniques. *Chir Main* 2006;25:48-53 (in French).
4. Rocchi L, Canal A, Fanfani F, Catalano F. Articular ganglia of the volar aspect of the wrist: Arthroscopic resection compared with open excision. A prospective randomized study. *Scand J Plast Reconstr Surg Hand Surg* 2008;42:253-259.
5. Geissler WB. Excision of dorsal wrist ganglia. In: Wrist arthroscopy. New York: Springer, 2005;139-144.
6. Gude W, Morelli V. Ganglion cyst of the wrist: Pathophysiology, clinical picture and management. *Curr Rev Musculoskelet Med* 2008;1:205-211.

7. Mathoulin C, Hoyos A, Pelaez J. Arthroscopic resection of wrist ganglia. *Hand Surg* 2004;9:159-164.
8. Dumontier C, Chaumeil G, Chassat R, Nourrisat G. Arthroscopic treatment of dorsal wrist ganglia. *Chir Main* 2006;25: S214-S220 (in French).
9. Rocchi L, Canal A, Pelaez J, Fanfani F, Catalano F. Results and complications in dorsal and volar wrist ganglia arthroscopic resection. *Hand Surg* 2006;11:1-6.
10. Kang L, Akelman E, Weiss A. Arthroscopic vs. open dorsal ganglion excision: A prospective, randomized comparison of rates of recurrence and of residual pain. *J Hand Surg Am* 2008;33:471-475.
11. Rizzo M, Berguer RA, Steinmann SP, Bishop AT. Arthroscopic resection in the management of dorsal wrist ganglions: Results with a minimum 2-year follow-up. *J Hand Surg Am* 2004;29:59-62.
12. Mathoulin C, Massarella M. Therapeutic interest of wrist arthroscopy about 1000 cases. *Chir Main* 2006;25:S145-S160 (in French).

13. Hu W. Examen clinique du poignet. In: Le Nen D, Laulan J, eds. *Sémiologie de la main et du poignet*. Ed 1. Montpellier: Sauramps, 2001;55-64.
14. Kuhlmann JN, Luboinski J, Baux S, Mimoun M. Ganglions of the wrist: Proposals for topographical systematization and natural history. *Rev Chir Orthop Reparatrice Appar Mot* 2003; 89:310-319 (in French).
15. Osterman LA, Raphael JS. Arthroscopic resection of dorsal ganglion of the wrist. *Hand Clin* 1995;11:7-12.
16. Mehdian H, McKee MD. Scapholunate instability following dorsal wrist ganglion excision: A case report. *Iowa Orthop J* 2005;25:203-206.
17. Edwards SG, Johansen JA. Prospective outcomes and associations of wrist ganglion cyst resected arthroscopically. *J Hand Surg Am* 2009;34:395-400.
18. Westbrook AP, Stephen AB, Oni J, Davis TR. Ganglia: The patient perception. *J Hand Surg Br* 2000;25:566-567.
19. 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 Vol* 2007;32:502-508.