



Safety and Efficacy of Arthroscopic Volar Carpal Ganglion Excision: An Anatomic and Clinical Study

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ABSTRACT

Purpose: Arthroscopic ganglionectomy is a viable alternative to open treatment and has widely been applied to treatment of dorsal ganglion pathology. The technique of arthroscopic volar carpal ganglion excision has recently been developed, and there is little peer-reviewed clinical evidence detailing its safety and efficacy. This study aims to present our experience with the development and implementation of this technique.

Materials and methods: In the anatomic portion of the study, three cadaver arms were positioned for wrist arthroscopy and dissected to determine the distance between the volar capsule and adjacent vital structures. Ten axial wrist MRIs were reviewed to further define the distance between the volar capsule and adjacent vital structures.

In the clinical portion of the study, 15 patients (mean age 47 years) treated with arthroscopic volar carpal ganglion excision were evaluated. Final follow-up occurred at an average of 48 months (21-68 months). Fourteen patients completed a MHQ and 12 patients were able to return for clinical evaluation.

Results: The wrist dissection and the MRI both showed the radial artery, FPL and FCR to all be within 1 cm of the working area. The radial artery was adjacent to the capsule and at risk when the capsule was approached from the 6 R portal.

Clinically, there was a small but significant difference in the Michigan Hand Questionnaire scores between the operative and nonoperative wrists postoperatively (93.3 vs 98.5, $p = 0.004$). There was one recurrence (6.7%), not requiring further surgery, and 1 complication (6.7%), which did require a secondary procedure. Mean time to return to work was 11.2 days (1-91 days, $N = 11$). Mean time to return to maximum function was 5.6 weeks ($N = 11$). There was a significant difference in mean wrist extension of the operative vs nonoperative wrist (58.8 vs 66.3°, $p = 0.01$, $N = 12$). There was no significant difference in mean flexion of the operative vs nonoperative wrist (71.7 vs 71.3°, $p = 0.7$, $N = 11$) or grip strength between operative and nonoperative wrists (31.8 vs 34.9 kg, $p = 0.06$, $N = 12$).

Conclusion: This small anatomic and clinical series demonstrates that arthroscopic volar carpal ganglion excision is a safe and effective procedure with a low recurrence rate. We no longer use the 6R portal when excising volar carpal ganglions.

Level of evidence: IV therapeutic

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INTRODUCTION

Volar carpal ganglion cysts account for approximately 20% of wrist ganglion cysts.¹ Many volar cysts have an intra-articular origin,^{2,3} specifically from the structurally deficient area between the extrinsic wrist ligaments; the radioscaphocapitate (RSC) ligament and the long radiolunate (LRL) ligament.^{4,5} Ho observed that 75% of intra-articular volar ganglion cysts arose from this interval and that 25% originated between the LRL ligament and short radiolunate (SRL) ligaments.² Others cysts are extra-articular and originate from tendon sheaths.⁶ Mathoulin's histologic analysis showed that the base of the carpal cysts originates in the layer between the synovium and the joint capsule.⁷ Stress in this area leads to mucoid degeneration with production of mucin and cyst formation.

Several options exist for the treatment of volar carpal ganglion cysts. The use of arthroscopy to manage wrist pathology has advanced significantly since Roth first described the technique in 1988.⁸ In 1995, Osterman and Raphael presented a technique for the treatment of the dorsal carpal ganglion,⁹ and arthroscopic treatment of dorsal ganglion cysts is now routine for the experienced arthroscopist.^{10,11} For volar cysts, open excision is most commonly performed. However, with increasing experience and comfort with wrist arthroscopy, arthroscopic excision of volar carpal ganglion cysts is being performed more commonly. Arthroscopic treatment of these cysts is technically feasible and facile.⁴ This study aims to demonstrate the anatomic feasibility and the clinical safety and efficacy of this procedure.

MATERIALS AND METHODS

This was a two phase, institutional review board-approved study involving an anatomic phase and a clinical phase. In the anatomic phase, three cadaver arms with no wrist

pathology or prior evident procedures were positioned for wrist arthroscopy in traction towers. Standard 3-4, 4-5 and 6R portals were established. Using arthroscopic visualization, a trochar was then placed against the capsule between the radioscapocapitate (RSC) and long radiolunate ligaments (LRL) ligaments. The arms were then dissected with the trochar in place. Measurements were obtained from the tip of the trochar to the radial artery, FPL and FCR. This was repeated with the trochar in each of the three portals with the tip still in the RSC and LRL interval (Fig. 1). Ten axial wrist MRIs from healthy subjects (subjects without volar wrist pathology) were reviewed to further define the distance between the volar capsule and the radial artery, flexor pollicis longus (FPL), and flexor carpi radialis (FCR) (Fig. 2). Measurements were obtained using standard picture archiving and communications system (PACS).

The clinical portion of this study involved a retrospective investigation of clinical outcomes following arthroscopic excision of volar carpal ganglion cysts. All patients who had arthroscopic volar carpal ganglion excision between January of 2007 and January of 2012 were identified through a computerized database search by Current Procedural Terminology codes. All procedures were performed by one fellowship-trained hand surgeon at one institution. Patients would have been excluded if they had prior open ganglion excision, prior serious injury to the carpus, or prior surgery on the carpus. However, no patient met these criteria for exclusion. No patients under age 18 underwent an operation, and thus, no patients under age 18 were included. Minimum follow-up was 1 year. Twenty patients (20 wrists) met the study inclusion criteria after thorough review of their medical records and operative reports.

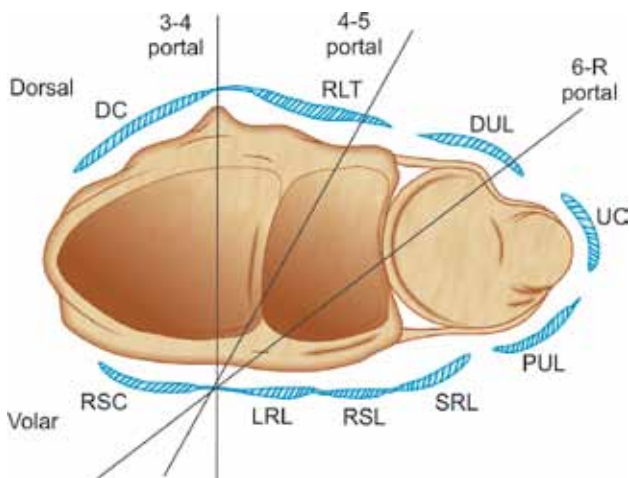


Fig. 1: Trochar placement through the RSC-LRL interval—DC: Dorsal capsule; RLT: Radio lunotriquetral ligament; DUL: Dorsal ulnolunate ligament; UC: Ulnocarpal ligament; RSC: Radioscapocapitate ligament; LRL: Long radiolunate ligament; RSL: Radioisapholunate ligament; SRL: Short radiolunate ligament; PUL: Palmar ulnolunate ligament

Technique

Using the technique described by the senior author (JCV)⁶ we began all cases with a standard diagnostic wrist arthroscopy. We used upper arm tourniquet control with an arthroscopic traction tower and sterile finger traps. Portal sites were defined using surface anatomy. The volar ganglion was also marked and defined in relation to surrounding surface anatomy which would later help with confirming that the cyst has been decompressed. The wrists were insufflated with saline through the 3-4 portal. The 3-4 portal was established, and under direct visualization, the 4-5 and 6R portals were subsequently established. The 3-4 portal was the viewing portal, and the 4-5 portal was the working portal. We did not use the shaver through the 6R portal due to trajectory and proximity of the radial artery as seen in the anatomic portion of the study. The angle of the portal was critical, because a portal placed to proximal or distal would make access to the volar capsular origin of the cyst very difficult. The joint was then assessed for any associated pathology. A full-radius shaver was introduced through the 4-5 portal, and a synovectomy was performed. Commonly, the ligamentous interval between the RSC ligament and LRL was obscured by a vascular leash known as the radioscapolunate ligament or ligament of Testut (Fig. 3). In other cases, the base of the ganglion was more evident (Fig. 4).

The shaver was used to resect this vascular leash so the volar capsule could be easily seen. At this point, the ganglion could be visualized in the interval. If the cyst was not visualized, external pressure on the previously marked volar mass usually produced and in-pouching that could be dynamically seen entering the joint in the RSC and LRL interval. The full-radius shaver was used to carefully resect the capsular origin of the mass. The shaver was used more as a probe with passed through the capsuloligamentous interval to avoid

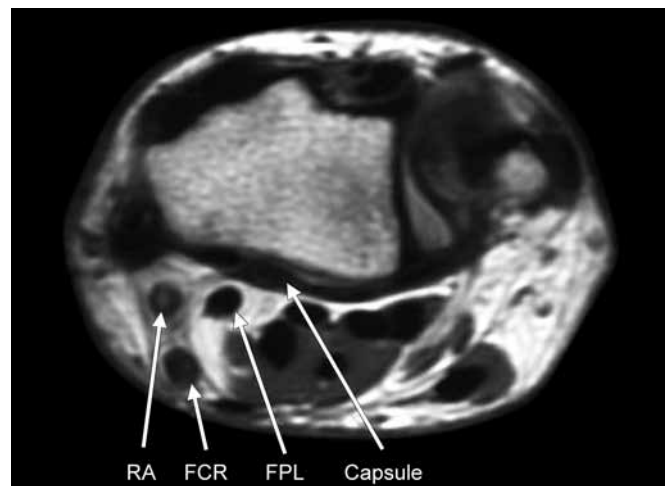


Fig. 2: MRI demonstrating proximity of vital structures to the volar wrist capsule—RA: Radial artery; FCR: Flexor carpi radialis; FPL: Flexor pollicis longus



Fig. 3: Arthroscopic view of radioscapholunate ligament (ligament of Testut)



Fig. 4: Arthroscopic view of base of ganglion cyst

injury to vital structures. As the cyst base was removed, a distinct fluid blush was usually, but not always, seen as the ganglion fluid decompressed into the radiocarpal joint. This fluid movement could be enhanced by external pressure on the cyst. Resection continued until a window measuring approximately 1×1 cm was created (Fig. 5). The FPL tendon was visualized in this window. Externally, decompression of the cyst was verified visually and with palpation. The instruments were removed and the portals were closed with nonabsorbable sutures. Postoperative dressings and splints were removed after 10 days. Range-of-motion exercises and modalities to control edema were initiated with resumption of activities as tolerated.

For data collection, patients were initially contacted by phone. Consent was obtained in all cases before data was collected. For the clinical evaluation, subjects returned to the office where they were evaluated by either a hand fellow or a certified hand therapist. Evaluations included measurements of wrist flexion, extension, radial and ulnar deviation measured with a hand-held goniometer (rounded to the nearest 5°), grip strength measured with a Jamar Dynamometer on second setting (Jamar, Boling Brook, IL), two point discrimination, presence of a radial pulse, and recurrence of ganglion. The Michigan Hand Questionnaire (MHQ) was also completed at this visit. Patients also completed an additional form regarding time to return to work, time to return to full function, and occurrence of complications. Complications were defined as events including paresthesias, nerve injury, superficial and deep infections, tendon rupture, arterial injury, or any additional reason necessitating return to the operating room other than recurrence.

Of the 20 subjects identified, one patient could not be contacted. Four patients declined to participate. One patient provided limited data by telephone but did not return a mailed questionnaire. Two patients could only complete the



Fig. 5: Arthroscopic view after excision of base of cyst

MHQ by mail, and 12 patients returned for a full clinical evaluation. Thus, there was limited data on 15 wrists, MHQs for 14 wrists, and full clinical evaluation for 12 wrists.

Statistical Analysis

Statistical significance between the operative and non-operative sides for wrist flexion, wrist extension, radial deviation, ulnar deviation, grip strength, and 2-point discrimination was determined using a student t-test with p values set at 0.05. MHQ scores were determined using a downloadable Excel program from the MHQ website (<http://sitemaker.umich.edu/mhq/scoring>). Significant differences between MHQ scores for the operative vs nonoperative hands were tested for with a student t-test. No power analysis was conducted as this was a case series.

RESULTS

The radial artery was found to lie 6 mm ulnar to the trochar in the ligamentous interval the 3-4 portal, 2 mm ulnar for

the 4-5 portal, and 0 mm for the 6R portal (see Fig. 1). Extrapolating this data, a shaver placed through the 6R portal for capsular resection in the RSC-LRL interval would be 0 mm from the radial artery. Therefore, we no longer use the shaver through the 6R portal while performing this procedure. The FPL was 2 mm ulnar to the trochar in the ligamentous interval for the 3-4 portal, 2 mm radial for the 4-5 portal, and 6 mm radial for the 6R portal. The distance between the trochar and the FCR was 0 mm for the 3-4 portal, 2 mm radial for the 4-5 portal, and 4 mm radial for the 6R portal. Based on the MRI measurements, the average volar capsule thickness was 3 mm. The radial artery was 6 mm volar to the capsule. The FPL was adjacent to the capsule (0 mm distance), and the FCR was 7 mm volar to the capsule.

The mean age of the 15 patients consented for the study was 47 years (Table 1—demographics). There were 9 females and 6 males, and the dominant hand was involved in 5 of the 15 cases. The cysts had been present for an average of 15 months (2-36 months) before surgical intervention. The mean length of follow-up was 48 months (21-68 months).

Among the 15 subjects enrolled, there was one recurrence (6.7%), and she did not elect for repeat excision (Table 2). Likewise there was one complication (6.7%) involving a neuroma of the palmar cutaneous branch of the median nerve. This patient had a second procedure to address the neuroma which subsequently resolved. All 12 patients clinically evaluated had a patent radial artery. Mean time to return to work was 11.2 days (1-91 days) based on responses of 11 patients. The mode was 1 day and the median was 3 days, indicating the outlier of 91 days. The patient who required 91 days to return to work was involved in lawn-care and had his surgery at the end of the season, so he did not return to his job until the next spring. If he was excluded,

the average return to work time was 3.9 days. Means time to achieve maximum function was 5.6 weeks (N = 11). The mode was 1 week to achieve maximum function and median of 3 weeks to achieve maximum function.

There was a significant difference in mean extension of the operative vs nonoperative wrist (58.8 vs 66.3°, p = 0.01, N = 12) (Table 3—ROM and MHQ). There was no significant difference in mean flexion of the operative vs nonoperative wrist (71.7 vs 71.3°, p = 0.7, N = 11). Likewise, there was no significant difference in ulnar deviation between the operative and nonoperative wrists (40.0 vs 40.8°, p = 0.17, N = 12) or radial deviation (26.7 vs 28.8°, p = 0.54, N = 12). There was no significant difference in grip strength between operative and nonoperative wrists (31.8 vs 34.9 kg, p = 0.06, N = 12), and the mean two-point discrimination was 4.6 mm (range 4-6 mm, N = 12).

There was a significant difference in the MHQ scores (see Table 3) with the operative hands scoring an average of 93.3 and the nonoperative hands scoring 98.5 (p = 0.004, N = 14). The hand with the lowest score occurred in the one patient with a recurrence. The patient who underwent neuroma excision ultimately achieved a score of 100 on the operative wrist.

DISCUSSION

When the volar ganglion cysts originates from the radio-scaphoid joint, it usually arises from the volar capsule in the relatively deficient area between the RSC and LRL ligaments (see Fig. 1).⁴ Traditionally, volar ganglion cysts are excised through an open volar approach, developing the interval between the radial artery and FCR tendon. The ganglion is then excised along with a segment of volar capsule. Arthroscopic excision of volar ganglion cysts has potential

Table 1: Demographics

	<i>f/u (mo)</i>	<i>Age</i>	<i>Dominant hand</i>	<i>Operative hand</i>	<i>Sex</i>	<i>Ethnicity</i>	<i>Occupation</i>
1	21	49	R	R	F	White	Administrator
2	25	47	R	L	M	White	Engineer
3	40	34	R	L	F	White	Health instructor
4	40	48	R	L	F	Pacific	Information technology
5	43	55	R	R	F	White	School bus driver
6	47	62	R	L	F	Black	Postmaster
7	44	43	R	L	M	White	Lawn care
8	45	48	R	L	F	White	Homemaker
9	45	46	L	L	M	Black	Construction
10	56	48	R	L	F	White	Postal worker
11	56	61	R	R	M	White	Teacher
12	62	50	R	R	F	White	Homemaker
13	62	45	R	R	F	White	PE teacher
14	66	35	R	L	M	White	Sales
15	68	34	R	L	M	White	Tape cutter

Table 2: Follow-up

	Recurrence	Complication	Radial artery patent	Numbness or tingling	Time to return to work (days)	Time to return to max function (weeks)	Secondary procedures
1	Yes	No	Yes	No	2	—	No
2	No	No	Yes	No	1	1	No
3	No	No	Yes	No	6	4	No
4	No	No	Yes	No	Not working	—	No
5	No	Yes	Yes	Yes	1	1	Neuroma excision
6	No	No	Not applicable	No	—	—	No
7	No	No	Yes	No	91	16-17	No
8	No	No	Yes	No	3	3-4	No
9	No	No	Yes	No	7	4	No
10	No	No	Yes	No	14	2	No
11	No	No	Yes	No	Not working	4	No
12	No	No	Not applicable	No	Not working	2-3	No
13	No	No	Yes	No	7	1	No
14	No	No	Yes	No	1	1	No
15	No	No	Not applicable	No	0	6	No

Table 3: MHQ and ROM

	MHQ		Wrist flexion		Wrist extension		Ulnar deviation		Radial deviation		Grip strength (kg)		2 point (mm)
	Operative	Non-Op	Operative	Non-Op	Operative	Non-Op	Operative	Non-Op	Operative	Non-Op	Operative	Non-Op	
1	81.438	93.869	75	75	50	65	45	45	15	20	18.9	24.9	5
2	88.056	98.833	65	65	60	60	20	20	45	45	37.3	50.7	4
3	84.663	99.107	80	90	60	80	45	45	30	30	24.5	26.4	4
4	94.286	94.147	90	85	60	70	55	60	30	40	25.3	28	5
5	100	100	65	65	50	60	30	30	30	30	22.7	21.5	5
6	88.75	98.333	—	—	—	—	—	—	—	—	—	—	—
7	91.111	99.167	60	60	50	50	50	50	15	15	30	38.6	4
8	90.536	96.508	70	70	70	70	40	40	20	20	31.3	33.3	4
9	98.472	100	60	60	60	60	40	40	20	20	28.4	31.4	4
10	100	100	75	75	55	70	30	30	35	35	30.4	31.3	6
11	89.861	99.167	75	70	60	80	45	45	35	40	49.3	44.3	5
12	100	100	—	—	—	—	—	—	—	—	—	—	—
13	99.702	99.702	70	65	65	65	50	50	20	20	41.3	38	4
14	100	100	75	75	65	65	30	35	25	30	42.2	49.9	5

benefits including less extensive dissection and less capsular damage. Additionally, arthroscopic evaluation allows for identification of associated intra-articular pathology. These benefits may lead to faster recovery and return to activity, less stiffness and less pain from pathology not addressed through an open approach.¹² The purpose of this study was to detail our experience with the development and implementation of the technique of arthroscopic excision of volar carpal ganglion cysts, including its safety and efficacy.

Our data show that this procedure is moderately safe with only one case of neuroma involving the palmar cutaneous branch of the median nerve. Otherwise, there were no infections or tendon or arterial injuries. Our data show that this procedure is effective with complete resolution of all cysts except one. Additionally, patients were able to return to

work quickly. There was a small but significant difference in MHQ scores. It is unknown what the minimal important clinical difference is between operative and nonoperative sides. Likewise there are not preoperative and postoperative MHQ scores to compare. There was also a small difference in wrist extension but not wrist flexion, radial or ulnar deviation or grip strength.

Rocchi reported a randomized, controlled, prospective trial investigating volar carpal ganglion cysts with 20 patients in the open excision group and 20 patients in the arthroscopic excision group. In the open group, there were four injuries to a branch of the radial artery, two cases of partial stiffness of the wrist associated with a painful scar, one case of neurapraxia and one recurrence. In the arthroscopic group, there was one case of neurapraxia, one injury to a branch of

the radial artery and three recurrences. The mean functional recovery time was equal to 15 days in the open group and 6 days in the arthroscopic group. The mean time lost from work was equal to 23 days in the open group and 10 days in the arthroscopic group.¹³ The complication rate appears similar with one case of neuropraxia in the current study compared to two complications out of Rocchi's 20 patients. Our average return to work was slightly longer at 11 days (4 if the outlier was excluded) vs 6 days.

This study supports the contention that arthroscopic volar carpal ganglion excision is safe and effective. The information from this retrospective cohort provides limited yet valuable information regarding the results of this procedure, including rates of recurrence, complications, return to work, and ultimate functional level after 2 years of follow-up.

Limitations of this study include its small size resulting in little power to detect more subtle differences. This study was also retrospective and without a control group. Patients were asked to remember events, such as time off from work (if not documented in the medical record), from 2 to 5 years ago which introduces significant recall bias. Use of a questionnaire also induces some degree of response bias from respondents.

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