Article published online: 2022-06-23

Dorsal Wrist Ganglia: Influence of Arthroscopic Dorsal Capsulodesis – A Pilot Study

Ganglios dorsales de la muñeca: La influencia de la capsulodesis dorsal artroscópica – un estudio piloto

Melanie Ribau[1] Elisabete Fernanda Magalhães Ribeiro[1] Cecília Alexandra Sá Barros[1] Juvenália Martins Ribeiro[1] Pedro Miguel Sousa Varanda[1] Luis Filipe Pacheco Rodrigues[1]

[1] Department of Orthopedic Surgery and Trauma, Hospital de Braga, Braga, Portugal

Rev Iberam Cir Mano 2022;50(1):e34–e42.

Address for correspondence Melanie Ribau, MD, Departamento de Cirurgia Ortopédica e Trauma, Hospital de Braga, Rua de Sete Fontes, São Victor, 4170-243, Braga, Portugal (e-mail: melanieribaudacosta@gmail.com).

Abstract

Background Dorsal wrist ganglia are the commonest soft tissue tumor in the upper extremity. Management with arthroscopic excision yields good results and few complications, but recurrence is still a matter of concern.

Purpose To address the influence of dorsal capsulodesis in postoperative results.

Patients and Methods Two groups with eight patients each were evaluated: group A – simple arthroscopic resection (SAR), and group B – arthroscopic resection combined with dorsal capsulodesis (ARDC).

Results The mean age of group A was of 36.10 ± 7.96 (range: 28–53) years, and that of group B was of 34.17 ± 29.60 (range 18–44) years. The duration of the follow-up was of 30.67 ± 13.90 (range: 13.45–53.55) months and 29.60 ± 16.80 (range 12.68–62.13) months, respectively. Both groups achieved a a significant decrease in the postoperative score on the Visual Analog Scale (VAS) (of around 2/10), and the scores on the Disabilities of the Arm, Shoulder and Hand (DASH) questionnaire were below 5/100. All the functional parameters (range of motion and strength) were above 80% on the contralateral side, with no differences between groups. More than 75% of the patients were completely satisfied. Group A (37.5%) had a significantly higher recurrence rate than that of group B (12.5%).

Conclusions In conclusion, SAR and ARDC provided good clinical results, with no significant differences. Dorsal capsulodesis resulted in an important decrease in the recurrence rate.

Level of Evidence Level III (Retrospective Comparative Study).

Keywords
- dorsal wrist ganglia
- arthroscopy
- dorsal capsuloscapholunate septum

received
January 10, 2022
accepted
March 22, 2022

DOI https://doi.org/10.1055/s-0042-1748852.
ISSN 1698-8396.

Thieme Revinter Publicações Ltda., Rua do Matoso 170, Rio de Janeiro, RJ, CEP 20270-135, Brazil

Resumen

Antecedentes Los ganglios dorsales de la muñeca son el tumor de tejidos blandos más común en el miembro superior. El manejo con resección artroscópica proporciona buenos resultados y pocas complicaciones, pero la recurrencia sigue siendo motivo de preocupación.

Objetivo Comprender la influencia de la capsulodesis dorsal en los resultados postoperatorios.

Pacientes y métodos Se evaluaron dos grupos con ocho pacientes cada uno: el grupo A, de resección artroscópica simple (RAS), y el grupo B, de resección artroscópica combinada con capsulodesis dorsal (RACD).

Resultados La edad media del grupo A fue de 36,10 ± 7,96 (rango: 28–53) años, y la del grupo B fue de 34,17 ± 29,60 (rango: 18–44) años. El período de seguimiento fue de 30,67 ± 13,90 (rango: 13,45–53,55) meses y 29,60 ± 16,80 (rango: 12,68–62,13) meses, respectivamente. Para ambos grupos, se logró una disminución significativa en la escala visual analógica (EVA) posoperatoria (alrededor de 2/10), y los valores del cuestionario de Discapacidades del Brazo, Hombro y Mano (*Disabilities of the Arm, Shoulder and Hand*, DASH, en inglés) estuvieron por debajo de 5/100. Todos los parámetros funcionales (rango de movimiento y fuerza) estuvieron por encima del 80% del lado contralateral, sin diferencias entre grupos. Más del 75% de los pacientes quedaron completamente satisfechos. Hubo una diferencia estadísticamente significativa para la tasa de recurrencia entre el grupo A (37,5%) y el grupo B (12,5%).

Conclusiones En conclusión, RAS y RACD proporcionaron buenos resultados clínicos sin diferencias significativas. La capsulodesis dorsal dio como resultado una disminución importante en la tasa de recurrencia.

Nivel Evidencia Nivel III (Estudio Comparativo Restrospectivo).

Palabras clave

- ganglios dorsales de la muñeca
- artroscopia
- septo capsuloescafolunar dorsal

Introduction

Dorsal wrist ganglia are the commonest soft tissue tumor in the upper extremity (with a rate of 70% in proportion).[1] They typically occur between the third and fourth decades of life, affecting women in a 3:1 ratio,[1] and are usually asymptomatic, with preserved range of motion (ROM) and function.[1] Among patients searching for medical support, many claim pain (71%),[2] cosmetic concern (34%), or weakness (27%).[2]

The current treatment for dorsal wrist ganglia remains controversial.[3] In most of the cases, dorsal ganglia have a benign behavior and disappear in six months,[4] with spontaneous resolution in 40% to 58% of the patients.[4] Simple aspiration has a recurrence rate of 59%.[5] For patients with painful or unsightly ganglia or those with a cosmetic concern, surgery is currently an option.[4] Open surgical resection often leads to recurrence rate as high as 40%[1] and well-described complications in 14% of the cases,[2,4] such as scarring, joint stiffness,[4] scar sensitivity,[4] infection, impaired wound healing, neuroma, reduction in ROM and grip strength,[6] and carpal instability due to scapholunate (SL) ligament injury.[1] Arthroscopic resection was first described by Osterman and Raphael[7] in 1995, and it currently plays an important role in surgical management. It poses as a simple and minimally-invasive technique with low postoperative morbidity, lower levels of scarring, fast functional recovery, lower levels of postoperative pain, and low complication rate.[4] It also enables the simultaneous assessment and management of intraarticular pathology.[4] Interestingly, some series of arthroscopic resections still present quite high values of recurrence, of around 30%.[1] One of the current challenges is to know why this is happening.

Most dorsal wrist ganglia are anatomically related to the interval of the SL ligament.[8] Also, when symptomatic, they are often associated with generalized ligamentous hyperlaxity and a positive scaphoid shift test.[1] A possible explanation for their appearance relies in mucoid dysplasia at the level of the SL ligament, in its dorsal part.[4] Ganglia are thought to communicate with the contiguous joint capsule through sinuous ducts with unidirectional valvular flow. Previous literature regarding SL instability and ganglia is sparse and diverse, but it is thought that higher intercarpal laxity could contribute to ganglia formation.[6] Many authors[4,9] are pointing out the importance of the dorsal capsuloscapholunate septum (DCSS) in the mechanism of onset of dorsal ganglia. This idea has been popularized by Gustavo Mantovani Ruggiero in several conferences (unpublished data). As the DCSS is an important stabilizer of the dorsal capsule and it is linked to the SL ligament, when treating dorsal wrist ganglia, surgeons might have to treat ligament hyperlaxity. One way to address SL laxity is the dorsal capsulodesis described by Mathoulin.[10]

The current work is based on the hypothesis that higher intercarpal laxity is in the origin of ganglia formation,[6] which could be present even before the Geissler classification enables us to classify the instability, thus making dorsal

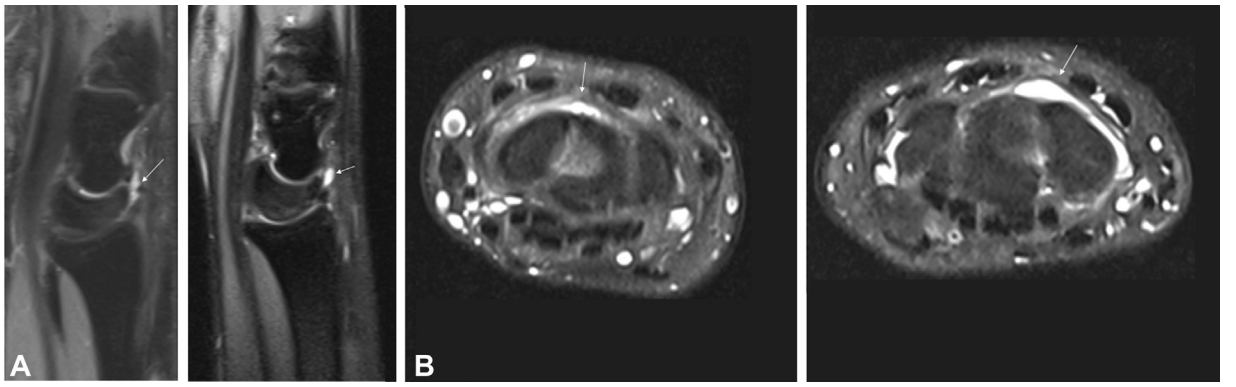

Fig. 1 Magnetic resonance imaging scan evidencing two different dorsal wrist ganglia. (**A**) The arrow shows a small dorsal wrist ganglia on sagittal (1) and coronal (2) views. (**B**) The arrow shows a large cyst on sagittal (1) and coronal (2) views.

capsulodesis potentially beneficial to every patient. The present study aimed to compare arthroscopic resection when treating dorsal wrist ganglia with or without the combination with dorsal capsulodesis. We present a pilot study with a series of cases treated with these techniques and a final analysis of the results.

Patients and Methods

Study Design

We conducted a retrospective observational study in patients diagnosed with dorsal wrist ganglia submitted to surgery at our center between April 2012 and April 2017. The inclusion criteria were: patients aged between 18 and 65 years at the time of the surgery, symptomatic ganglia (pain or weakness), refractory to previous conservative treatment (observation or aspiration) or previous open surgery, anatomic relation to the SL ligament on diagnostic magnetic resonance imaging (MRI) (►**Fig. 1**), postoperative follow-up longer than 12 months, consent to enrollment, and understanding and willingness to participate in the physical examination. The exclusion criteria were: patients under 18 or over 65 years of age, dorsal wrist ganglia other than those anatomically related to the SL ligament on diagnostic MRI, previous arthroscopic surgery, refusal to participate in the study, and lack of autonomy to collaborate with physical assessment tests. A total of 19 patients were selected (3 men and 16 women); 1 patient refused to participate, and 2 were not able to be contacted (and were considered lost to follow-up). From a total of 16 patients, 2 groups were created: group A – simple arthroscopic resection (SAR), with 8 patients (2 men and 6 women); and group B – arthroscopic resection combined with dorsal capsulodesis (ARDC), with 8 patients (1 man and 7 women).

Surgical Technique

All surgeries were performed with the patient under general anesthesia, and a pneumatic tourniquet was used on the affected limb (250 mmHg of pressure). The patients were placed in the supine position, with the upper arm fixed to the table and 90° of shoulder abduction and elbow flexion. The wrist was positioned in a vertical traction tower applying 6 kg of traction through a hand trap. Surgery was performed through the dry technique using a 30°-angle, 2.4-mm arthroscope, and a 2.5-mm shaver. Normal saline solution was occasionally injected through the arthroscope cannula. Portals were made with 2-mm transverse incisions with a No. 11 blade.

The first portal performed was 3–4 for optics, to systematically examine the wrist. The second one was 6R to perform a systematic evaluation with a probe and inspect the dorsal capsule and capsular fold at the SL ligament (►**Fig. 2**). Ganglion debridement was performed with the arthroscope from the 6R portal and shaver introduced into the 3–4 portal. The third (midcarpal radial portal [MRP]) and fourth (midcarpal ulnar portal [MCU]) portals were performed. By inserting the arthroscope in the MCU and a probe in the MCR, we obtained a capsular window to perform a midcarpal exploration of the dorsal synovial bulge at the scapholunate interosseous ligament (SLIL) corresponding to the intraarticular portion of the ganglion. The stalk was located after applying mild external compression over the ganglion. The

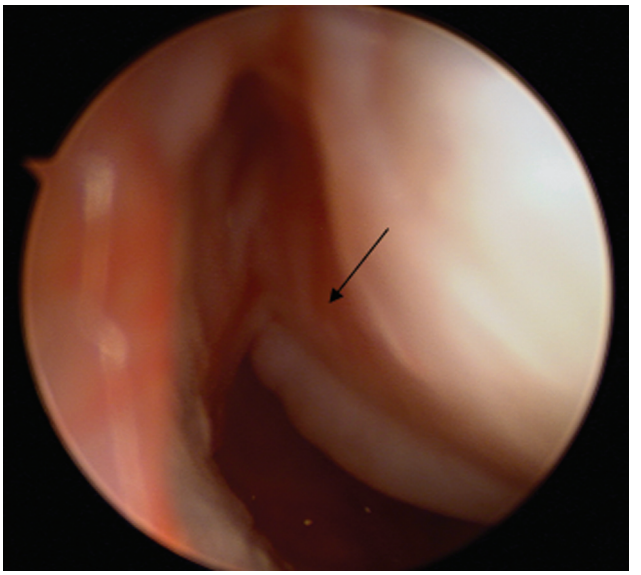

Fig. 2 Arthroscopic image from the 6R portal showing the capsular fold at the scapholunate ligament (arrow) between the scaphoid (left) and lunate (right).

shaver was inserted into the MCR portal and debridement of the ganglion and pf the dorsal pathologic capsule was performed, including the mucoid dysplasia herniated into the midcarpal joint, leaving a 1-cm^2 hole. At this point, all the efforts were made to preserve the DCSS, the dorsal intercarpal (DIC) ligament, and the extensor tendons. Instability of the SLIL was evaluated with a probe and classified according to he Geissler classification. For Group B, a capsuloligamentous repair was performed according to the Mathoulin technique[12] of radiocarpal portals. The arthroscope was introduced into the 6R portal. Two needles carrying PDS (Ethicon, Inc., Raritan, NJ, US) 4–0 sutures were slipped through the 3–4 portal; then, they were anteriorly and distally shifted into the capsule and SLIL toward the midcarpal joint. With the scope in the MCU portal and a hemostat in the MCR portal, the sutures were grasped and the needles, removed. After removal of the sutures, a knot was tight outside the articulation. The sutures were removed from the 3–4 portal and the knot was settled at the SLIL (►**Fig. 3**). With the arthroscope into the 6R portal, another knot was tight subcutaneously at the 3–4 portal in the capsule, with no traction and the wrist in extension. The portal sites were closed with adhesive sutures (Steri-Strips, 3M, Saint Paul, MN, US), and a bulky dressing was applied.

Postoperative Treatment

Immediate postoperative wrist movements were allowed for both groups without any immobilization prescribed by routine. Patients with documented SL instability (patients 1 and 5 in group B) required 6 weeks of wrist restriction with an anterior splint. Physical rehabilitation was not needed.

Outcome Measures

A single independent investigator performed the data collection and analysis. The preoperative data was reviewed, and the clinical data was accessed at the final follow-up visit. Pain was assessed using the Visual Analogue Scale (VAS), and global hand function was measured according to the Disabilities of the Arm, Shoulder and Hand (DASH) questionnaire properly validated for the Portuguese population. The wrist ROM (extension, flexion, and radial and ulnar deviations) was measured with a classic goniometer. Grip and pinch strengths (N) were evaluated according to the mean of three consecutive measurements using a dynamometer (Hand-Held Dynamometer, model 01165, Lafayette Instrument, Lafayette, IN, US). Overall satisfaction with the procedure was graded from 0 (dissatisfied) to 5 (very satisfied). The recurrence rate was accessed clinically when, after a pain-free interval, symptoms reoccurred, with the reappearance of a cyst at the same site as before, and then confirmed intraoperatively in each patient. Any postoperative complications were recorded.

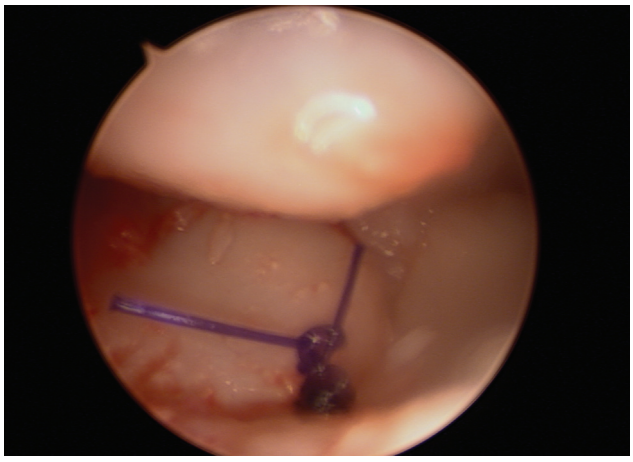

Fig. 3 Arthroscopic image from the MCU portal showing the final aspect of the capsulodesis with the knot settled at the scapholunate interosseous ligament.

Statistical Analysis

Sample variability was tested with the Wilcoxon signed-rank non-parametric test, with a 95% confidence interval and $p < 0.05$ for age, gender, duration of the follow-up, primary surgery or surgery for recurrence, and the presence of associated lesions. The quantitative variables were described as means and standard deviations according to the Prism (GraphPad Software, San Diego, CA, US) software, version 8 for Windows 10. Strength and ROM values were expressed as percentages of the unaffected limb. The differences between the groups were assessed by the Wilcoxon signed-rank non-parametric test with a 95% confidence interval and $p < 0.05$. The differences between preoperative and postoperative pain within the same group were evaluated by the Mann-Whitney U test as a non-parametric test with a 95% confidence interval and $p < 0.05$. The differences in recurrence rates were obtained through the Fisher exact test.

Results

The variability results were not statistically significant regarding each of the tested parameters. The demographic features of both groups are displayed in ►**Table 1**. In Group A, all the patients had a primary diagnosis. There were 2 cases of lunotriquetral (LT) instability identified during the wrist arthroscopy assessment (Geissler 3 in patient 4 and Geissler 1 in patient 6). Both patients were asymptomatic, and no additional gestures were performed. In Group B, 6 out of 8 patients had a primary diagnosis, and 2 out of 8 were reinterventions after a previous open resection. During wrist arthroscopy, 2 cases of SL instability (patients 1 and 5, both Geissler 2) were diagnosed and promptly treated. In addition, 1 case of triangular fibrocartilage complex (TFCC) lesion (1D according to the Palmer classification) and LT instability (Geissler 1; patient 2) was submitted to debridement. There was also 1 case of LT instability (Geissler 1; patient 6) in an asymptomatic patient with no additional gestures needed. These data are detailed in ►**Table 2**.

At the last follow-up visit, the score on the VAS for pain was of 2.13 ± 2.95 for group A, and of 2.00 ± 2.14 for group B (►**Table 2**). The mean DASH score was of 4.38 ± 8.65 for group A, and of 3.23 ± 3.71 for group B. In total, 75% of the patients in group A and 88% of the patients in group B were satisfied (4/5) or completely satisfied (5/5) with the treatment. These results are detailed in ►**Table 2**. The mean values of the functional parameters in percentages of the contralateral side were, for

Table 1 Demographic features of the sampel

	Group A – SAR		*Group B – ARDC*	
	N	**%**	**N**	**%**
Patients included	8	–	8	–
Female patients	6	75%	7	88%
Male patients	2	25%	1	13%
Left side	4	50%	4	50%
Right side	4	50%	4	50%
Dominant side	5	63%	6	75%
Primary surgery	8	100%	6	75%
Reintervention	0	0%	2	25%
SL ligament instability	0	0%	2	25%
LT ligament instability	2	25%	2	25%
TFCC lesions	0	0%	1	13%
	Mean	**SD**	**Mean**	**SD**
Age (years)	36.10	7.96	34.17	9.20
Follow-up (months)	30.67	13.90	29.60	16.80

Abbreviations: ARDC, arthroscopic resection and dorsal capsulodesis; LT, lunotriquetral; SAR, simple arthroscopic resection; SD, standard deviation; SL, scapholunate; TFCC, triangular fibrocartilage complex.

Table 2 Clinical Results in detail

		Primary surgery (yes/no)	Associated lesions	Preop. VAS (0–10)	Postop. VAS (0–10)	DASH (0–100)	Satisfaction (0–5)	Recurrence (yes/no)
Group A – SAR	**Patient 1**	Yes	No	6	8	0.00	3	Yes
	Patient 2	Yes	No	9	0	0.00	5	No
	Patient 3	Yes	No	8	2	0.00	5	No
	Patient 4	Yes	LT Geissler 3	3	0	25.00	5	No
	Patient 5	Yes	No	6	5	6.67	3	Yes
	Patient 6	Yes	LT Geissler 1	9	2	2.50	4	Yes
	Patient 7	Yes	No	8	0	0.83	5	No
	Patient 8	Yes	No	6	0	0.00	5	No
	Mean	–	–	6.88	2.13	4.38	4.38	-
	SD	–	–	2.03	2.95	8.65	0.92	–
Group B – ARDC	**Patient 1**	Yes	SL Geissler 2	8	2	3.33	5	No
	Patient 2	No (o.r.)	LT Geissler 1; TFCC Palmer 1D	6	0	0.00	5	No
	Patient 3	Yes	No	8	0	0.00	5	No
	Patient 4	Yes	No	6	4	3.33	3	No
	Patient 5	No (o.r.)	SL Geissler 2	5	2	2.50	4	Yes
	Patient 6	Yes	LT Geissler 1	9	2	5.83	5	No
	Patient 7	Yes	No	9	6	10.83	4	No
	Patient 8	Yes	No	4	0	0.00	5	No
	Mean	–		6.88	**2.00**	**3.23**	4.44	-
	SD	–		1.89	2.14	3.71	0.82	–

groups A and B respectively: grip strength –110 ± 36% and 82 ± 26%; and pinch strength – 103 ± 19% and 94 ± 25%. The mean values for the wrist ROM parameters in percentages of the contralateral side were, for groups A and B respectively: extension – 110 ± 22% and 89 ± 26%; flexion – 112 ± 45% and 93 ± 20%; radial deviation – 100 ± 13% and 115 ± 98%; and ulnar deviation – 90 ± 27% and 84 ± 30%. These results further detailed in ►**Table 3**.

For both groups, there was a significant decrease in the pain scores (the preoperative and *p* values for groups A and B were of 6.88 ± 2.03, $p = 0.0234$, and 6.88 ± 1.89, $p = 0.0078$ respectively). There were no differences regarding preoperative and postoperative VAS scores, DASH scores, satisfaction, ROM, and grip and pinch strengths between groups A and B. These data are detailed in ►**Tables 4** and **5**.

One recurrence was recorded in 3 out of 8 patients (37.5%) in group A, and in 1 out of 8 patients (12.5%) in group B. The differences between the groups were statistically significant ($p < 0.0001$). These data are detailed in ►**Table 6**. Subsequently, open resection was proposed for patients from group A: 2 of them (patients 5 and 6) with good outcomes, with no subsequent recurrence; and another (patient 1) experienced recurrence after open resection and is currently awaiting reintervention. A reintervention was proposed to patient 5 from group B, who is currently awaiting surgery. No other complications were recorded.

Discussion

Arthroscopy has emerged as a keystone regarding the surgical management of dorsal wrist ganglia due to its low postoperative morbidity, fewer complications, faster functional recovery, and lower levels of scarring and pain.[4] Nevertheless, recurrence rates are still a matter of concern.[1,4] Regarding this, many authors[6] are currently confirming the role of the simultaneous treatment of ligament hyperlaxity, specifically of the SL ligament, when resecting ganglia. Our group believes that the routine performance of the DCSS repair could lower the recurrence rate.

Our primary purpose was to compare the clinical and functional results of SAR and ARDC. Two groups of patients were formed with no significant differences regarding age, gender, duration of the follow-up, primary surgery or surgery for recurrence, and the presence of associated lesions. Groups A and B were not comparable in terms of ligamentous laxity. For both groups, the postoperative VAS score was of around 2/10, and the DASH score was below 5/100 (►**Table 2**). In both groups, more than 75% of the patients were completely satisfied with the treatment (►**Table 2**). All the functional parameters (ROM, grip and pinch strengths) reached more than 80% comparing to the contralateral side (►**Table 3**). These data overlap that of the current literature.[1,3,4] There were no differences between the groups regarding any of these parameters (►**Table 4**). In conclusion, SAR and ARDC enabled us to achieve good results, with no statistical differences between adding or not dorsal capsulodesis.

There was a significant reduction in postoperative pain when comparing to the preoperative values (►**Table 5**), as it has been well described in previous studies.[11–13] Since one of the main reasons to seek for medical assistance is pain,[14] this is a major goal when treating ganglia. It is important to note that our group avoids electrocautery during arthroscopy due to the risk of damaging the cartilage and extensor tendons. Thus, this decrease in pain was perhaps attributed either to resolution of the compression of the posterior interosseous nerve (PIN), which can occur in a few patients,[5] or to the resolution of the dorsal capsular impingement triggered by the ganglion itself. As a matter of fact, recent studies[17] present arthroscopic debridement for redundant and impinging dorsal capsular tissue as an isolated disorder.

The most important result of the present study is related to the recurrence rate. In the present study, the mean follow-up was of 30.67 ± 13.90 months in group A, and of 29.60 ± 16.80 months in group B. All the patients had at least 12 months of follow-up. In Group A, 3 patients (37.5%) reported recurrence, whereas, in group B, it only occurred in 1 patient (12.5%). This difference is statistically significant (►**Table 6**). Besides, patients who experienced recurrence in group A did not have SL ligament instability recorded in the arthroscopy. The only patient that experienced recurrence in group B had grade-2 SL instability on the Geissler classification. Perhaps, besides SL hyperlaxity itself, recurrence could be related to other reasons, namely the role of the DCSS as a stabilizer. In Group B, by routinely performing dorsal capsulodesis, we assured DCSS stabilization even when it was not torn or damaged. The present study provides a starting point for additional studies to understand if dorsal capsulodesis might significantly reduce recurrence rates when treating ganglia arthroscopically.

The present study has some important limitations. First, a power analysis was not performed, which makes the study weak regarding type-II errors. Additionally, our samples are small (only 8 subjects per group), which could have contributed for the groups not being comparable regarding ligamentous laxity. We also found some differences regarding the pre- and intraoperative ligamentous laxity, which further favors the value of diagnostic arthroscopy in such cases. Also, for group A, it was not possible to collect data on ROM and grip and pinch strengths for 2 out of 8 patients at the latest follow-up visit due to their unavailability to come to our clinic in person. On the other hand, in group B, 2 out of 8 patients were undergoing a secondary surgery. Perhaps these subjects had more complex etiologies along with a revision surgery that was more challenging, which might favor associated techniques, such as the dorsal capsulodesis, to make them less prone to recurrence. Still, this adds to the differences among individuals and, hence, to the limitations of the study.

Therefore, it becomes difficult to obtain statistical differences and to have power to generalize our conclusions. We then chose to present these data as a pilot study. Secondly, as a retrospective study, we had no access to some important preoperative scores (such as those pertaining to the DASH, ROM, and strength), except for the VAS score. Thus, one of our greatest limitations is not knowing whether there is a significant improvement in these parameters, as it is stated in the recent literature specifically for extension and flexion.[3,16]

Table 3 Functional Results in detail

		Grip strenght (N)			*Pinch strenght (N)*			*Extension (°)*			*Flexion (°)*			*Radial deviation (°)*			*Ulnar deviation ( )*		
		OS	CS	% OS	OS	CS	% OS	OS	CS	% OS	OS	CS	% OS	OS	CS	% OS	OS	CS	% OS
Group A – SAR	*Patient 1*	81.67	82.10	99	51.10	59.17	86	62.00	60.00	103	62.00	60.00	103	40.00	42.00	95	30.00	40.00	75
	Patient 2	133.37	106.97	125	81.13	67.03	121	82.00	58.00	141	68.00	62.00	110	30.00	30.00	100	40.00	32.00	125
	Patient 3	106.40	125.10	85	54.77	45.63	120	42.00	38.00	111	64.00	32.00	200	18.00	18.00	100	20.00	30.00	67
	Patient 4	280.70	207.77	135	110.67	102.50	108	50.00	68.00	74	64.00	70.00	91	24.00	22.00	109	22.00	38.00	58
	Patient 5	36.70	63.40	58	23.93	31.80	75	34.00	30.00	113	42.00	52.00	81	26.00	22.00	118	30.00	28.00	107
	Patient 6	143.87	90.77	159	77.17	70.53	109	58.00	50.00	116	48.00	56.00	86	22.00	28.00	79	40.00	36.00	111
	Patient 7	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	Patient 8	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	Mean	130.45	112.68	110	66.46	62.78	103	54.67	50.67	110	58.00	55.33	112	26.67	27.00	100	30.33	34.00	90
	SD	83.08	51.13	36	29.88	24.18	19	16.86	14.35	22	10.43	12.94	45	7.66	8.56	13	8.52	4.73	27
Group B – ARDC	*Patient 1*	63.67	80.07	80	26.27	25.03	105	34.00	56.00	61	38.00	56.00	68	28.00	8.00	350	20.00	30.00	67
	Patient 2	171.77	154.53	111	103.20	101.97	101	40.00	42.00	95	50.00	60.00	83	28.00	24.00	117	24.00	42.00	57
	Patient 3	103.20	120.97	85	85.83	72.20	119	72.00	58.00	124	68.00	80.00	85	28.00	30.00	93	32.00	30.00	107
	Patient 4	44.37	110.13	40	25.33	52.77	48	56.00	70.00	80	52.00	52.00	100	40.00	40.00	100	24.00	40.00	60
	Patient 5	76.90	71.27	108	34.63	39.00	89	50.00	40.00	125	72.00	62.00	116	32.00	44.00	73	32.00	28.00	114
	Patient 6	29.53	28.83	102	13.83	15.47	89	20.00	22.00	91	22.00	18.00	122	10.00	28.00	36	10.00	22.00	45
	Patient 7	71.97	148.17	49	43.60	58.33	75	36.00	70.00	51	52.00	72.00	72	24.00	24.00	100	30.00	30.00	100
	Patient 8	62.53	76.97	81	62.97	49.77	127	54.00	64.00	84	60.00	62.00	97	22.00	40.00	55	30.00	24.00	125
	Mean	77.99	98.87	82	49.46	51.82	94	45.25	52.75	89	51.75	57.75	93	26.50	29.75	115	25.25	30.75	84
	SD	43.74	42.50	26	31.71	27.21	25	16.07	16.83	26	16.12	18.34	20	8.60	11.68	98	7.55	7.01	30

Abbreviations: ARDC, arthroscopic resection and dorsal capsulodesis; CS, contralateral side; N, Newtons; OS, operated side; SAR, simple arthroscopic resection; SD, standard deviation.

Table 4 Comparison of clinical and functional parameters between groups

			Group A - SAR	Group B - ARDC	*p*-value
Preop.	VAS (0–10)	Mean	6.88	6.88	$p > 0.05$ ($p = 0.9969$)
		SD	2.03	1.89	
Postop.	VAS (0–10)	Mean	2.13	2.00	$p > 0.05$ ($p = 0.8912$)
		SD	2.95	2.14	
	DASH (0–100)	Mean	4.38	3.23	$p > 0.05$ ($p = 0.6454$)
		SD	8.65	3.71	
	Satisfaction (0–5)	Mean	4.44	4.44	$p > 0.05$ ($p > 0.9999$)
		SD	0.82	0.82	
	Grip strength (%CS)	Mean	110%	82%	$p > 0.05$ ($p = 0.1518$)
		SD	36%	26%	
	Pinch strength (%CS)	Mean	103%	94%	$p > 0.05$ ($p = 0.5092$)
		SD	19%	25%	
	Extension (%CS)	Mean	110%	89%	$p > 0.05$ ($p = 0.2278$)
		SD	22%	26%	
	Flexion (%CS)	Mean	112%	93%	$p > 0.05$ ($p = 0.4855$)
		SD	45%	20%	
	Radial deviation (%CS)	Mean	100%	115%	$p > 0.05$ ($p = 0.4735$)
		SD	13%	98%	
	Ulnar deviation (%CS)	Mean	90%	84%	$p > 0.05$ ($p = 0.5937$)
		SD	27%	30%	

Table 5 Comparison of preoperative and postoperative pain in both groups

		Preop. VAS (0–10)	Postop. VAS (0–10)	*p*-value
Group A – SAR	Mean	6.88	2.13	$p < 0.05$ ($p = 0.0234$)
	SD	2.03	2.95	
Group B – ARDC	Mean	6.88	2.00	$p < 0.05$ ($p = 0.0078$)
	SD	1.89	2.14	

Abbreviations: ARDC, arthroscopic resection and dorsal capsulodesis; Postop., postoperative; Preop., preoperative; SAR, simple arthroscopic resection; SD, standard deviation; VAS, Visual Analogue Scale for pain.

Table 6 Comparison of recurrence rates between the groups

	Recurrence rate (%)	*p*-value
Group A – SAR	37.5%	$p < 0.05$ ($p < 0.0001$)
Group B – ARDC	12.5%	

Abbreviations: ARDC, arthroscopic resection and dorsal capsulodesis; SAR, simple arthroscopic resection.

In conclusion, SAR and ARDC provided good clinical results with no significant differences. Dorsal capsulodesis may be an option to decrease the long-term recurrence rates, but further studies are warranted.

Ethical Review Committee Statement

The current study took place after revision and approval by Ethical and Health Committee of Hospital de Braga, Braga, Portugal.

Conflict of Interests

The authors have no conflict of interests to declare.

Acknowledgments

The authors would like to thank to the whole team at the Orthopedic Surgery and Trauma Department, Hospital de Braga, Braga, Portugal, for all the support in the clinical practice.

References

1 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(02):236–241

2 Head L, Gencarelli JR, Allen M, Boyd KU. Wrist ganglion treatment: systematic review and meta-analysis. J Hand Surg Am 2015;40 (03):546–53.e8

3 Gallego S, Mathoulin C. Arthroscopic resection of dorsal wrist ganglia: 114 cases with minimum follow-up of 2 years. Arthroscopy 2010;26(12):1675–1682

4 Mathoulin C, Gras M. Arthroscopic Management of Dorsal and Volar Wrist Ganglion. Hand Clin 2017;33(04):769–777

5 Ho PC, Griffiths J, Lo WN, Yen CH, Hung LK. Current treatment of ganglion of the wrist. Hand Surg 2001;6(01):49–58

6 Borisch N. Arthroscopic resection of occult dorsal wrist ganglia. Arch Orthop Trauma Surg 2016;136(10):1473–1480

7 Osterman AL, Raphael J. Arthroscopic resection of dorsal ganglion of the wrist. Hand Clin 1995;11(01):7–12

8 Angelides AC, Wallace PF. The dorsal ganglion of the wrist: its pathogenesis, gross and microscopic anatomy, and surgical treatment. J Hand Surg Am 1976;1(03):228–235

9 Overstraeten LV, Camus EJ, Wahegaonkar A, et al. Anatomical Description of the Dorsal Capsulo-Scapholunate Septum (DCSS)-Arthroscopic Staging of Scapholunate Instability after DCSS Sectioning. J Wrist Surg 2013;2(02):149–154

10 Mathoulin CL. Indications, techniques, and outcomes of arthroscopic repair of scapholunate ligament and triangular fibrocartilage complex. J Hand Surg Eur Vol 2017;42(06):551–566

11 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(04): 471–475

12 Chung SR, Tay SC. Audit of Clinical and Functional Outcomes of Arthroscopic Resection of Wrist Ganglions. Hand Surg 2015;20 (03):415–420

13 Edwards SG, Johansen JA. Prospective outcomes and associations of wrist ganglion cysts resected arthroscopically. J Hand Surg Am 2009;34(03):395–400

14 Westbrook AP, Stephen AB, Oni J, Davis TR. Ganglia: the patient's perception. J Hand Surg [Br] 2000;25(06):566–567

15 Matson AP, Dekker TJ, Lampley AJ, Richard MJ, Leversedge FJ, Ruch DS. Diagnosis and Arthroscopic Management of Dorsal Wrist Capsular Impingement. J Hand Surg Am 2017;42(03):e167–e174

16 Rizzo M, Berger RA, Steinmann SP, Bishop AT. Arthroscopic resection in the management of dorsal wrist ganglions: results with a minimum 2-year follow-up period. J Hand Surg Am 2004; 29(01):59–62

