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Comparison of clinical efficacy of open and single channel carpal tunnel release in the treatment of carpal tunnel syndrome

Zhe-ming Cao[1], Fioni[2], Yolanda Eliza Putri Lubis[2]

[1]Master Program of Clinical Medicine, Faculty of Medicine, Dentistry, and Health Science, Universitas Prima Indonesia, Medan, Indonesia
[2]Faculty of Medicine, Universitas Prima Indonesia, Medan, Indonesia

Zhe-ming Cao **ORCID ID:** 0000-0003-1801-9538
Fioni **ORCID ID:** 0009-0004-7254-7555
Yolanda Eliza Putri Lubis **ORCID ID:** 0000-0001-7551-2690

ABSTRACT

Background. Open or wrist arthroscopic release of carpal tunnel is a relatively safe and reliable method. However, there is still some debate as to which of these various surgical methods is superior. Therefore, this study provides more clinical evidence by comparing the clinical efficacy of open and endoscopic single-channel bowl release in the treatment of carpal tunnel syndrome.

Methods. The study conducted a retrospective analysis from January 2010 to January 2021. A total of 105 patients met the inclusion criteria, including 56 patients in the open carpal tunnel Release (OCTR) group and 49 patients in the single channel carpal tunnel release (SCCTR) group. The preoperative, intraoperative, and postoperative symptom improvement and functional recovery of the patients were compared.

Results. The results of this study showed that the surgical incision healed well in all patients and complete remission of entrapment symptoms. Compared with the OCTR group, the SCCTR group had reduced surgical and hospital duration, intraoperative blood loss, postoperative scar pain score, and time required to return to normal lifestyle, and the SCCTR group had a lower incidence of sympathetic dystrophy and significantly improved clinical symptoms.

Conclusion. Single Channel Carpal Tunnel Release under Carpal Arthroscopy in the treatment of carpal tunnel syndrome can achieve reliable clinical efficacy. It can relieve symptoms such as hand numbness and improve hand function. Postoperative pain and other complications are low, and worthy of clinical promotion.

Keywords: carpal tunnel syndrome, open, single channel, carpal tunnel release

List of abbreviations

BMI	– Cortical lesions	SCCTR	– Single Channel Carpal Tunnel Release
CTS	– Carpal Tunnel Syndrome		
OCTR	– Open Carpal Tunnel Release	VAS	– Visual Analogue Scale

INTRODUCTION

Carpal tunnel syndrome (CTS) is a common hand surgery disease, which presents a series of clinical symptoms due to increased pressure in the carpal canal or decreased relative volume, resulting in compression of the median nerve [1]. Paget first described median nerve compression in 1854 when he diagnosed and treated 2 patients with distal radius fractures, and Kremer was the first to use CTS to describe this clinical condition. Its main clinical manifestations are: finger

Corresponding author:
Fioni
E-mail: dr.fioni@unprimdn.ac.id

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end disorder innervated by the median nerve, numbness, and pain of the thumb, indicator finger, middle finger, radial half of the ring finger, often accompanied by varying degrees of atrophy of the thenar muscle in the later stage; The pain is more obvious at night and early in the morning, and the pain period can radiate to the upper arm and elbow, and the palms of the thumbs are weak during abduction, reducing the flexibility of the toes [2]. Risk factors include advanced age, obesity, femininity, pregnancy, diabetes, hypothyroidism, rheumatoid arthritis, and repetitive wrist work [3]. CTS has been widely concerned because of its disability and high treatment cost. Among them, the early carpal tunnel syndrome is usually treated with a drug conservatively, and when there is poor efficacy and progressive aggravation, surgery is needed [4].

The main treatment of carpal tunnel syndrome is to cut the transverse ligament of the wrist to effectively relieve the compression of the median nerve [5-8]. To achieve this goal, new surgical methods have been explored to solve this problem, including traditional open incision release, single small incision release, double incision release, and wrist arthroscopic release [9-12]. Although the traditional open incision is completely released, the surgical scar is large, the length of the operative mouth is about 8cm, and it is gradually abandoned due to postoperative complications such as scar pain [9,10]. Compared with the traditional incision release, the improved minimally invasive incision has the advantages of smaller incision and faster postoperative recovery. However, because the surgical incision is located in the palm, the palmar cutaneous branch of the median nerve may be damaged during the operation, and the postoperative pain in the columnar area may be caused by scar stimulation in the palm of the patient during the operation, which seriously affects the quality of life of the patient after the operation. In addition, the field of view of minimally invasive incision is relatively limited, and the internal structure of carpal tunnel cannot be fully explored, which may lead to incomplete intraoperative release or accidental injury of important blood vessels and nerves, resulting in irreversible iatrogenic injury [11]. In recent years, with the development of minimally invasive technology of wrist arthroscopy, wrist arthroscopy-assisted single channel carpal tunnel release has the advantages of clear intraoperative field of view, small wound, exact efficacy and low risk, and wrist arthroscopic carpal tunnel release has gradually become a hot direction in basic research and clinical work [12]. However, minimally invasive surgery through endoscopy requires expensive medical equipment support and a lengthy learning and training process required to perform this technique, leading to its limited use. The research center found in the clinical application that open or wrist arthroscopic release of carpal tunnel is a relatively safe and effective hand method. However, there is still some debate as to which of these various surgical methods is superior [13]. Therefore, this study provides more clinical evidence by comparing the clinical efficacy of open and endoscopic single-channel bowl release in the treatment of carpal tunnel syndrome.

PATIENTS AND METHODS

This study was a retrospective analysis of patients diagnosed with carpal tunnel syndrome who were admitted to our hospital from January 2010 to January 2021. A total of 105 patients met the inclusion criteria, including 56 patients (25 males and 31 females) in the OCTR group, with an average age of 49.2 ± 4.1 years and an average course of disease of 12.8 ± 1.7 months. There were 49 patients (21 males and 31 females) in the SCCTR group, with a mean age of 49.5 ± 4.7 years and a mean course of disease of 12.9 ± 1.7 months. All patients included in this study presented with functional and sensory disorders of the three hemispherical digits, including hypoesthesia, numbness, weak grip, and no hyperalgesia. All patients received conventional conservative treatment (e.g. oral non-steroidal anti-inflammatory drugs and adequate rest) for ≥ 3 months before surgery. The electromyography showed that the sensory nerve conduction velocity was slow and the motor conduction terminal latency was prolonged. This study was approved by the Ethics Committee of Universitas Prima Indonesia. All patients were operated on by the same surgeon and team.

Inclusion and exclusion criteria

Inclusion criteria: (1) CTS was diagnosed: the physical examination showed typical CTS manifestations, including paresthesia in the three and a half fingers of the radial side (fingers 1 - 4), Tinel sign and Phalen sign (+) in the left wrist, and some patients had weakened thumb opposite palm muscle strength or thenar great muscle atrophy; The Doppler ultrasound of the wrist showed that the transverse ligament of the wrist was thickened and the median nerve of the wrist was thicker than that of the opposite side. The electrophysiological examination of the wrist nerve indicated that the conduction of the median wrist nerve was slowed down. (2) After regular non-surgical treatment for 3 months, the symptoms do not relieve, repeated attacks or even aggravated symptoms; (3) Hamada grade I or II patients. Exclusion criteria: (1) Combined with other peripheral nerve disorders, such as brachial plexus injury, median nerve injury, diabetic peripheral neuritis, etc.; (2) The wrist has a history of surgery or trauma, affecting the re-operation; (3) Wrist tumor, wrist huge cyst resulting in median nerve compression; (4) Hamada

FIGURE 1. A 45-year-old male with carpal tunnel syndrome was treated with OCTR. (A) Preoperative incision design; (B, C) The transverse carpal ligament and free median nerve were incised intraoperatively

grade III patients: decreased skin sensation in the median innervation area, atrophy of the great thenar muscle, and dysfunction of the thumb opposite the palm (often requiring functional reconstruction of the affected thumb, so it was not considered in this study); (5) People with mental disorders who do not receive surgical treatment.

Surgical technique

In the OCTR group (Figure 1), patients were placed in the supine position and anesthesia was performed using a brachial plexus block. The surgery could be performed after 25 minutes of anesthesia injection to check the skin sensation disappeared in the incision area. After the upper limb tourniquet was used to stop bleeding, a Z-shaped incision was made at the wrist stripe first (to prevent scar contracture), and then a parallel incision was made along the wrist stripe 2 mm along the ulnar side of the thenar stripe with a length of about 3.0 - 5.0 cm. The skin tissue and the palmar aponeurosis were cut open so that the transverse ligament of the wrist was completely exposed. The transverse ligament of the wrist was cut longitudinally in the operation area, and the residual ligament was cut along the ulnar margin of the median nerve after flexion of the wrist joint, and the epineural membrane was appropriately released. Finally, the tourniquet was released, the hemostasis was completely stopped by double-clicking electrocoagulation, and the skin was sutured.

In the SCCTR group (Figure 2), patients were placed in the supine position, and the tourniquet was applied after successful anesthesia. A transverse incision,

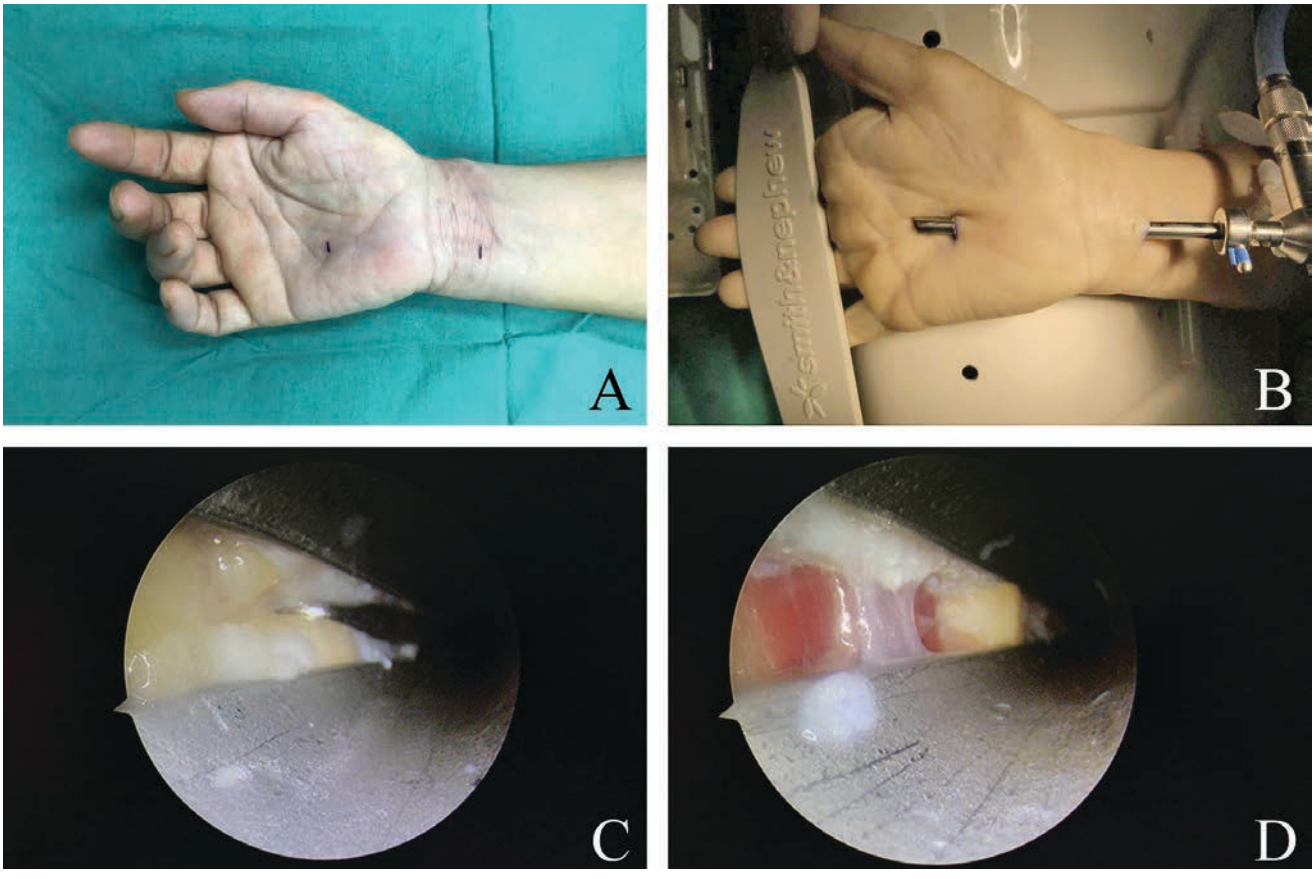

FIGURE 2. A 47-year-old woman with carpal tunnel syndrome was treated with SCCTR. (A) Preoperative incision design; (B) Arthroscopic positioning of wrist; (C, D) The transverse ligament of the wrist was incised with a hook knife

about 1.0 cm long, was made at the ulnar edge of the palmar longus tendon at the position of the transverse wrist of the patient's proximal wrist. The skin and subcutaneous tissue were cut from shallow to deep successively, the flexor support band was exposed, and the flexor support band was bluntly separated with the Wen's forceps in the direction of the flexor support band, and the median nerve below was exposed. The wrist arthroscope monitoring system was connected, the wrist arthroscope was placed above the baffle, and the transverse wrist ligament and the operating channel were observed under the surveillance of the arthroscope. When there was no important structure in the operating channel formed by the self-made transparent baffle and the transverse wrist ligament, carpal tunnel incision and release were performed by cutting the transverse wrist ligament from near to far with blunt end fine scissors. During the operation, the transverse ligament of the wrist should be completely severed to avoid incomplete release and surgical failure. Attention should also be paid to protecting the surrounding blood vessels and nerves, especially the distal superficial volar arch of the transverse ligament of the wrist and the recurrent branch of the median nerve. The incision was washed with normal saline and carefully explored. No active bleeding was found. Subcutaneous and skin layers were sutured cosmetically with absorbable soft tissue sutures. The incision was wrapped with a sterile dressing.

After the operation, the affected limb was strictly elevated for 48 hours, and then the affected limb clenched, and wrist flexion and extension activities were performed regularly under the guidance of the competent doctor and professional rehabilitation personnel, and even manual treatment could be combined to promote the rehabilitation of the affected hand, to avoid postoperative tendon or nerve scar adhesion, causing hand numbness and other symptoms to occur again. In general, patients can return to normal wrist work within 1 month after surgery.

Evaluation of outcomes

All patients were followed up for at least 12 months. Intraoperative conditions, including incision length, operation time, and blood loss, were collected in both groups. And post-operative conditions, including length of stay, incidence of secondary injury (nerve, blood vessel, tendon injury), incidence of incision infection, time required to return to normal lifestyle, grip strength and pinch recovery, incidence of scar pain, two-point identification (3 months after surgery), VAS (1 months after surgery), symptoms of sympathetic dystrophy and clinical symptom amelioration (6 months after surgery) [14-16] (Kelly grade, excellent: symptoms completely disappeared, returned to the original work, and no recurrence; Good: the original symptoms disappeared, return to the original work, but there is discomfort in case of rain; Middle: Although the original symptoms have improved, there are still residual symptoms of nerve involvement; Poor: the operation is ineffective or temporarily ineffective, and the symptoms are not improved or even aggravated.

STATISTICAL ANALYSIS

SPSS 23.0 software (SPSS Inc., US) was used for statistical analysis. Quantitative data of preoperative, intraoperative, and postoperative conditions were analyzed using two independent sample T-tests (results were expressed as mean ± standard deviation). Qualitative data of preoperative and postoperative conditions were expressed as numbers or percentages and compared with Chi-square (χ^2) test and Fisher exact test. $P < 0.05$ was considered statistically significant.

RESULTS

The results of this study showed that the surgical incision healed well in all patients and complete remission of entrapment symptoms. Preoperative basic data (age, smoking history, drinking history, BMI, Hamada score, etc.) were compared between the two groups, and the results showed no statistical difference. Therefore, it can be considered that the study is homogeneous and comparable ($P > 0.05$) (Table 1).

TABLE 1. Demographic data

Variable	OCTR group (N = 56)	SCCTR group (N = 49)	P Value*
Age (year)	49.2 ± 4.1	49.5 ± 4.7	0.669
Gender			1.000
Male	25	21	
Female	31	28	
Smoking History			0.679
No	36	34	
Yes	20	15	
Alcohol History			0.832
No	38	35	
Yes	18	14	
BMI			0.819
<25 kg/m^2	33	27	
≥25–29.9 kg/m^2	18	19	
≥30 kg/m^2	5	4	
Hamada grades			1.000
I	24	21	
II	32	28	
III	0	0	
Course of disease (months)	12.8 ± 1.7	12.9 ± 1.7	0.650
Affected hand			0.695
Left	27	21	
Right	29	28	

BMI, body mass index; SCCTR, single channel carpal tunnel release; OCTR, open carpal tunnel release; #Two-sided Fisher's exact test or Student's t-test

TABLE 2. Intraoperative data, short-term and long-term follow-up results of soft tissue repair surgery

Variable	OCTR group (N = 56)	SCCTR group (N = 49)	P Value*
Length of incision (cm)	7.3 ± 1.3	1.0 ± 0.0	0.001
Operative time (min)	33.1 ± 3.0	13.4 ± 2.6	0.001
Operative blood loss(ml)	31.9 ± 8.3	6.0 ± 2.0	0.001
Hospitalization time (days)	5.6 ± 0.9	2.71 ± 0.6	0.001
Return to work/normal life (days)	30.3 ± 3.1	11.7 ± 1.2	0.001
Grip strength (g/mm²)	22.9 ± 2.2	22.9 ± 2.1	0.934
Pinch strength (g/mm²)	6.8 ± 1.2	6.7 ± 1.2	0.709
Two point discrimination (mm)	5.6 ± 1.5	5.1 ± 1.4	0.091
VAS (points)	2.2 ± 0.8	1.8 ± 0.9	0.008
Sympathetic dystrophy	8/48	1/48	0.035
Kelly excellent or good	45/11	47/2	0.018
Incidence of scar pain	13/43	2/47	0.005
Follow up duration (months)	25.6 ± 3.1	26.4 ± 3.6	0.183

SCCTR, single channel carpal tunnel release; OCTR, open carpal tunnel release; VAS, visual analogue scale

A total of 105 eligible patients with carpal tunnel syndrome were included in this study, and the follow-up time was 18-33 months, with an average follow-up time of 26.0 months. The results of statistical analysis of intraoperative data between the two groups showed that the length of surgical incision in the OCTR group was significantly longer than that in the SCCTR group (7.3 ± 1.3 vs 1.0 ± 0.0cm, P<0.001), the time required for surgery in the OCTR group was significantly longer than that in the SCCTR group (33.1 ± 3.0 vs 13.4 ± 2.6 min, P<0.001), and the amount of intraoperative bleeding in the OCTR group was significantly higher than that in the SCCTR group (31.9 ± 8.3 vs 6.0 ± 2.0 ml, P<0.001). In addition, the length of hospital stay and the time to return to work/normal life after discharge were significantly longer in the OCTR group than in the SCCTR group (P<0.001) (Table 2).

Long-term postoperative follow-up between the two groups showed that the visual analog scale (VAS) of the OCTR group was significantly higher than that of the SCCTR group one month after surgery (2.2 ± 0.8 vs 1.8 ± 0.9, P = 0.008), the incidence of sympathetic dystrophy of the OCTR group six months after surgery was significantly higher than that of the SCCTR group (14.3 vs 2.0%; P = 0.035), the Kelly score of the OCTR group six months after surgery was significantly lower than that of the SCCTR group (80.4 vs 96.9%; P = 0.018), the incidence of scar pain in OCTR group was significantly higher than that in SCCTR group (23.2 vs 4.1%; P = 0.005). The incision condition, grip strength, pinch strength, and two-point recognition ability of the two groups were all restored to a good state, and there was no statistical significance between the two groups (P > 0.05) (Table 2).

DISCUSSION

Carpal tunnel syndrome (CTS) is a common peripheral nerve entrapment syndrome. When the relative volume of the carpal canal becomes smaller and seriously compresses the median nerve, it will lead to numbness, pain and paresthesia in the distribution area of the median nerve of the hand, and some patients may also have progressive atrophy of the thenar muscle and fine motor insufficiency of the hand [1-2]. For CTS patients with mild symptoms and a short course of disease, conservative treatment can be used [17], such as hormone injection in the wrist to treat CTS, although the symptoms of hand anesthesia can be relieved, the remission time is not long, and many patients still need surgical treatment [18]. For patients with moderate and severe carpal tunnel syndrome, such as those with ineffective conservative treatment and severe atrophy of thenar muscle, timely surgical treatment should be performed [19]. At present, open carpal tunnel release (OCTR) is still considered the gold standard surgery for CTS in patients with poor response to conservative treatment [20-22]. The procedure has been criticized by doctors and patients because of the high risk of postoperative complications. With the introduction of new surgical techniques and equipment, surgical procedures are gradually becoming more precise and less invasive [23].

With the development of sports medicine, the technology of large arthroscopy (such as shoulder and knee arthroscopy) has gradually matured, but the technology of small arthroscopy (such as wrist arthroscopy) has lagged behind. In recent years, wrist arthroscopy technology has also been continuously developed, and many research institutions have gradually purchased wrist arthroscopy equipment, and endoscopic carpal tunnel release has been applied in clinical practice [24]. At present, there are two kinds of treatment for carpal tunnel syndrome: two-channel wrist arthroscopic release and single-channel wrist arthroscopic release, but there are few reports. The treatment of carpal tunnel syndrome with dual-channel arthroscopic wrist release, which was invented several years ago, has achieved certain clinical development [32]. However, due to the need to open two minimally invasive channels in the palm and wrist, postoperative patients reported complications such as pain in the palm incision, and dual-channel wrist arthroscopic release was gradually replaced by single-channel carpal tunnel release [29-31]. Therefore, the objective of this study was to compare the efficacy of OCTR and SCCTR in the treatment of carpal tunnel syndrome.

OCTR is one of the most common and successful surgical procedures for primary CTS. However, there are corresponding disadvantages, including postoperative incision infection, longer time required to re-

turn to normal, high incidence of pain due to scar hyperplasia, and soft tissue adhesion in the surgical area. In this study, 13 patients in the OCTR group and 2 patients in the SCCTR group had postoperative scar pain. There were no postoperative infection and soft tissue adhesion in all patients in both groups, so it is very important to use double-click electrocoagulation to completely hemostasis during the operation. By comparing the intraoperative and postoperative variables, the results showed that SCCTR was superior to OCTR in terms of operation time, intraoperative blood loss, incision length, incision healing time, return to work and normal life. The reasons for this are as follows: Due to the large incision of OCTR surgery, the invasive surgical procedure will cause increased soft tissue injury of the wrist, which will lead to an increased risk of the above complications. Zheng et al. [25] compared the clinical effects of modified transforaminal minimally invasive release and traditional open release of transverse carpal ligaments, and the results showed that the modified transforaminal minimally invasive release had better therapeutic advantages in terms of operation time, incision length, incidence of scar pain, and time to return to normal life, which was consistent with the results of this study. Larsen et al. [26] showed that minimally invasive endoscopic transverse-carpal ligamentolysis could effectively restore patients to work/normal life in a significantly shorter time than patients undergoing traditional transverse-carpal ligamentotomy. At the same time, Kang et al. conducted a postoperative satisfaction survey of patients, and the results showed that most patients were more inclined to release the transverse wrist ligament under wrist arthroscopy, and the main concern was obvious postoperative scars and incision pain [27]. Shin et al. [28] demonstrated that endoscopic carpal resection of transverse carpal ligaments was an effective method for the treatment of CTS, and was comparable to open carpal tunnel release in terms of symptom improvement, VAS score, and functional recovery during postoperative follow-up. However, Chen et al. [24] showed that modified carpal tunnel release could significantly improve postoperative symptoms, VAS score and functional recovery due to OCTR, which was basically consistent with the results of this study. Considering whether the main reason was postoperative recovery or whether surgery had a direct impact on soft tissue trauma, the differences in postoperative symptom improvement, VAS score, and functional recovery between the two groups were closely related to the follow-up time node. Compared with other operations, the single channel small incision approach, due to the magnification effect of arthroscope, can observe the transverse ligament of the wrist and the median nerve throughout the operation, and selectively cut the transverse ligament of the wrist during the operation, which can avoid the injury of important vascular tissues by intraoperative instruments to the greatest extent, and has higher safety [29]. In addition, postoperative wrist scars are small and functional recovery is rapid, which is of great significance for female and athlete patients [24].

Although wrist arthroscopy has many advantages in the treatment of carpal tunnel syndrome, this technique still needs to undergo a curve process. OCTR is also a desirable technical means in primary care institutions that lack medical technology and equipment. This study is a retrospective study, and it is also a gradual exploration of this technology to treat this disease. There are limitations of sample selection and information bias. A randomized controlled study will be conducted to investigate both procedures to increase the reliability of the results.

CONCLUSIONS

In summary, compared with open carpal tunnel release (OCTR), single channel carpal tunnel release under wrist arthroscopy (SCCTR) has the characteristics of simple operation and less trauma. This effectively reduces the incidence of postoperative complications and helps to significantly improve symptoms, pain scores, functional recovery (return to work/normal life) in a short period of time. Therefore, the operation has broad clinical application prospects, and is worth the application and promotion of clinical staff.

Level of evidence:
III, Case–control study.

Conflict of interest:
The authors declare no conflicts of interest.

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