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Carpal Tunnel Syndrome Treated by Release of Carpal Tunnel Through a Small Transverse Incision

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Abstract: ***Background:*** Carpal Tunnel Syndrome (CTS) is the most common entrapment neuropathy, caused by compression of the median nerve under the flexor retinaculum at the wrist. ***Objective:*** This study aims to evaluate the effectiveness of carpal tunnel release through a small transverse incision in alleviating symptoms in patients with CTS who did not respond to conservative treatments. ***Method:*** A prospective interventional study was conducted on 30 patients at Rajshahi Medical College Hospital from January 2019 to December 2022. Patients underwent open carpal tunnel release through a 1.5 cm transverse incision at the proximal palmar crease. Outcomes were measured through clinical assessments (Phalen's test, Tinel's sign) and post-operative follow-ups at 30 days. Results: Of the 30 patients treated, 24 (80%) were female, and 6 (20%) were male, with ages ranging from 30 to 60 years. The duration of symptoms was less than one year in 6 patients (20%), between one to two years in 17 patients (56.67%), and more than two years in 7 patients (23.33%). Satisfactory outcomes were observed in 29 patients (96.67%), with improvement in paresthesia, numbness, and pain. One patient (3.33%) had persistent symptoms post-surgery. No major complications, such as infection or motor nerve injury, were reported. ***Conclusions:*** Carpal tunnel release through a small transverse incision is a safe, low-cost, and effective treatment for CTS, offering rapid recovery with minimal complications.

Keywords: Carpal Tunnel Syndrome, Small Transverse Incision, Median Nerve Compression, Carpal Tunnel Release, Surgical Outcome.

Original Research Article

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Article at a glance:

Study Purpose: *To evaluate the effectiveness and safety of open carpal tunnel release using a small transverse incision in patients with Carpal Tunnel Syndrome who failed conservative treatments.*

Key findings: *96.67% of patients experienced significant symptom relief, with minimal complications such as haematoma and no major nerve injuries.*

Newer findings: *This study confirms that the small transverse incision technique offers comparable results to endoscopic approaches, with reduced complications and faster recovery, making it a viable option in resource-limited settings.*

Abbreviations: *CTS: Carpal Tunnel Syndrome, OCTR: Open Carpal Tunnel Release, NCV: Nerve Conduction Velocity, NSAIDs: Non-Steroidal Anti-Inflammatory Drugs.*

INTRODUCTION

Carpal Tunnel Syndrome (CTS) is one of the most common peripheral nerve disorders, characterized by compression of the median nerve within the carpal tunnel at the wrist.[1] The condition predominantly affects individuals in their middle age, with a higher prevalence among women than men. As a neuropathic condition, CTS presents symptoms such as pain, numbness, and paresthesia in the hand, along with a progressive weakening of the thenar muscles, which can significantly affect fine motor skills and the overall quality of life.[2]

Although the etiology of CTS remains multifactorial and sometimes idiopathic, the underlying pathology involves increased pressure within the carpal tunnel, leading to the compression of the median nerve. Initial treatment for CTS generally consists of non-surgical options such as the use of nonsteroidal anti-inflammatory drugs (NSAIDs), wrist splinting, physiotherapy, and corticosteroid injections.[3] These conservative methods aim to reduce inflammation and pressure within the carpal tunnel. However, in severe cases or when conservative management fails, surgical intervention becomes necessary. The traditional surgical approach involves carpal tunnel release (CTR), where the transverse carpal ligament is cut to decompress the median nerve, thus providing symptomatic relief.

Carpal Tunnel Syndrome affects a wide demographic, but studies suggest that women between the ages of 30 and 60 are more frequently diagnosed, likely due to hormonal changes and repetitive hand activities.[4] Despite the success of conservative treatments, a significant percentage of patients require surgery for lasting relief. Surgical interventions are typically considered when there is a failure of conservative measures or in cases of muscle wasting in the thenar eminence, indicating more advanced nerve damage.[5] The surgical method chosen can have a significant impact on both recovery time and patient outcomes. Among the surgical options available, open carpal tunnel release (OCTR) through a small transverse incision has emerged as an effective technique with a high success rate and low complication profile. CTS has also been linked to occupational risk factors, particularly among individuals whose jobs involve repetitive wrist and hand movements. According to research, workers who perform tasks that require forceful gripping or frequent use of vibrating tools are at a higher risk of developing CTS.[6] As a result, occupational health has become a critical focus in preventing and managing CTS. Given that the condition can lead to significant disability if untreated, early diagnosis and intervention are essential for mitigating the long-term effects of median nerve compression. The surgical treatment of CTS is designed to relieve the pressure on the median nerve by severing the transverse carpal ligament. Several techniques have been developed, ranging from traditional open procedures to minimally invasive endoscopic methods. Open carpal tunnel release remains the gold standard for treating severe or refractory cases. The procedure can be performed under local, regional, or general anesthesia, depending on patient factors and surgical preferences.[7] The open approach, especially with a small transverse incision, allows for direct visualization of the transverse carpal ligament, facilitating an accurate and complete release. Although endoscopic techniques are gaining popularity due to their minimally invasive nature, they require specialized equipment and skills, which are not always available in all clinical settings.

One of the main advantages of using a small transverse incision in OCTR is the reduced postoperative morbidity compared to traditional large incisions. The technique involves a 1.5 cm incision at the proximal palmar crease, minimizing tissue trauma and enabling quicker recovery. This approach has been demonstrated to result in a low rate of complications such as infection, nerve injury, or hematoma formation.[8] In addition, the aesthetic outcome is often superior due to the smaller incision size, which leaves a less conspicuous scar. Patients undergoing this technique typically experience less postoperative pain and regain functionality more rapidly compared to those treated with larger incisions or more invasive procedures. The results from various studies on small-incision carpal tunnel release have consistently shown high rates of patient satisfaction and symptom relief. A Brazilian study reported a 100% success rate in resolving nocturnal pain and paresthesia symptoms following this surgical technique. Similarly, other international studies have echoed these findings, highlighting the efficacy and safety of this procedure in comparison to both endoscopic and traditional open methods. The ability to achieve symptom relief with minimal complications and a short recovery time makes the small transverse incision technique an attractive option for both surgeons and patients.

Despite its effectiveness, carpal tunnel release through a small transverse incision is not without its challenges. The proximity of critical structures such as the median nerve and flexor tendons makes precision essential during surgery. In rare cases, the incomplete release of the

transverse carpal ligament or injury to the median nerve may lead to persistent symptoms postoperatively. However, the risk of such complications is minimized when the procedure is performed by an experienced surgeon familiar with the anatomy and nuances of the technique.[9] In this prospective study, we aimed to evaluate the outcomes of 30 patients treated for CTS through a small transverse incision at Rajshahi Medical College Hospital. All patients had failed to respond to conservative treatments and were experiencing moderate to severe symptoms. By focusing on this particular surgical method, we sought to provide insights into the efficacy, safety, and recovery profiles associated with the procedure in a resource-limited setting. The findings from this study contribute to the growing body of evidence supporting the use of small-incision carpal tunnel release as a viable treatment option for CTS, with high rates of success and patient satisfaction.

Aims and Objective

The aim of this study is to evaluate the effectiveness of carpal tunnel release through a small transverse incision in patients with Carpal Tunnel Syndrome (CTS). The objective is to assess the surgical outcomes, including symptom relief, complication rates, and patient satisfaction, in those unresponsive to conservative treatments.

MATERIAL AND METHODS

Study Design

This prospective interventional study was conducted at Rajshahi Medical College Hospital from January 2019 to December 2022. A total of 30 patients diagnosed with Carpal Tunnel Syndrome (CTS) were included. All patients underwent open carpal tunnel release surgery through a small transverse incision. The study aimed to evaluate the efficacy of the procedure by assessing clinical outcomes and complication rates post-surgery, with a follow-up at 30 days. Data were collected through clinical assessments and patient feedback.

Inclusion Criteria

Patients aged between 30 and 60 years with clinically diagnosed idiopathic Carpal Tunnel Syndrome (CTS) were included in this study. Only patients who had failed to respond to conservative treatments such as NSAIDs, wrist splinting, physiotherapy, and local steroid injections were considered. Additionally, patients experiencing significant symptoms, including nocturnal pain, paresthesia, and muscle atrophy, were selected for surgical intervention. All patients provided informed consent before participation.

Exclusion Criteria

Patients with CTS due to secondary causes, such as trauma, arthritis, diabetes, or thyroid disorders, were excluded from the study. Those with a history of previous wrist surgery or other neuropathies that could confound the diagnosis were also not included. Pregnant women, patients with systemic infections, and those with contraindications to surgery or anesthesia were excluded to ensure a homogenous study group for accurate outcome assessment.

Data Collection

Data were collected preoperatively through a detailed history and clinical examination, including Phalen's test, Tinel's sign, and nerve conduction velocity (NCV) tests. Postoperative data were collected through patient evaluations at 30 days, assessing symptom relief, recovery, and complications. Laboratory tests like blood counts and X-rays were done to exclude other conditions. The patients' feedback on symptoms like pain, numbness, and nocturnal discomfort was recorded.

Data Analysis

Data analysis was performed using SPSS version 26. Descriptive statistics, including frequencies and percentages, were used to summarize demographic data, surgical outcomes, and complications. Continuous variables like age and duration of symptoms were analyzed using means and standard deviations. Comparative analysis was conducted to assess the correlation between surgical outcomes and demographic factors such as age, sex, and symptom duration. Chi-square tests were employed to determine the significance of outcome differences between the groups, with a p-value of less than 0.05 considered statistically significant.

Ethical Considerations

This study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki. Approval was obtained from the Ethical Review Board of Rajshahi Medical

College Hospital prior to the study. All patients were fully informed about the nature, benefits, and potential risks of the procedure, and written consent was obtained from each participant. Patient confidentiality was strictly maintained, and participation was entirely voluntary, with the option to withdraw from the study at any time without any consequences.

A total of 30 patients diagnosed with Carpal Tunnel Syndrome (CTS) underwent open carpal tunnel release surgery through a small transverse incision. The data were analyzed to assess the demographic characteristics, duration of symptoms, side involvement, functional outcomes, and complications. The results indicate that the surgical procedure was effective, with a high rate of symptom relief and minimal complications.

RESULTS

Table 1: Demographic Characteristics

Variable	Number of Patients	Percentage (%)
Total Patients	30	100
Gender		
Male	6	20
Female	24	80
Age Range		
30-40	10	33.33
41-50	14	46.67
51-60	6	20

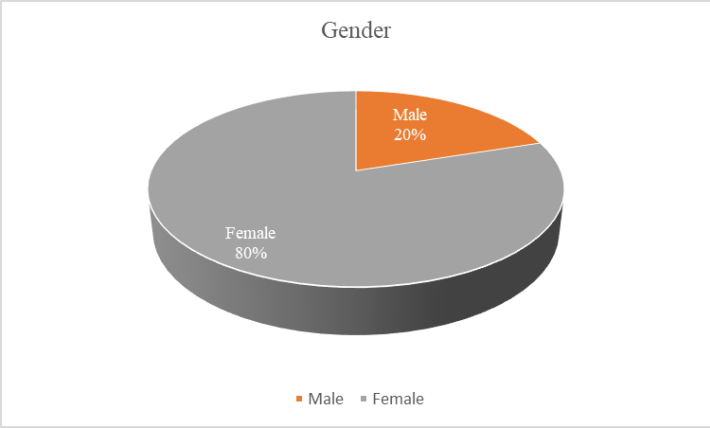

Figure 1: Distribution of patients according to Sex

The demographic data show that out of the 30 patients, 24 (80%) were female, and 6 (20%) were male. The patients' ages ranged from 30 to 60 years, with the highest percentage (46.67%) of patients in the 41-50 age group. This finding aligns with existing literature, which suggests that CTS is more prevalent in women and typically occurs in middle age.

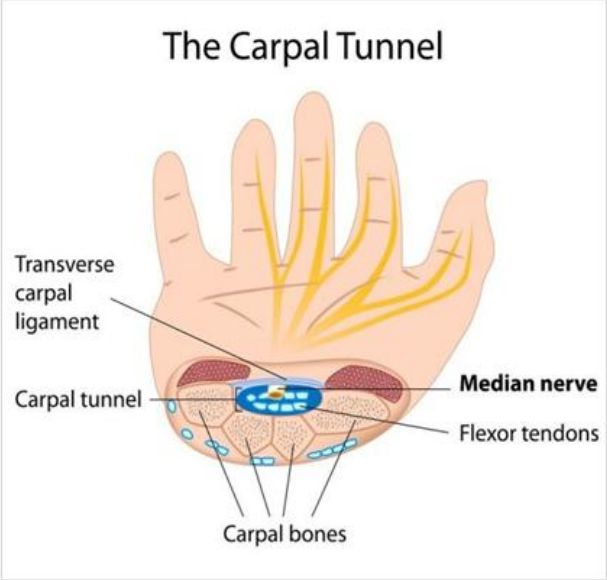

Figure 2: Anatomy of carpal tunnel

Figure 3: Clinical photograph of carpal tunnel

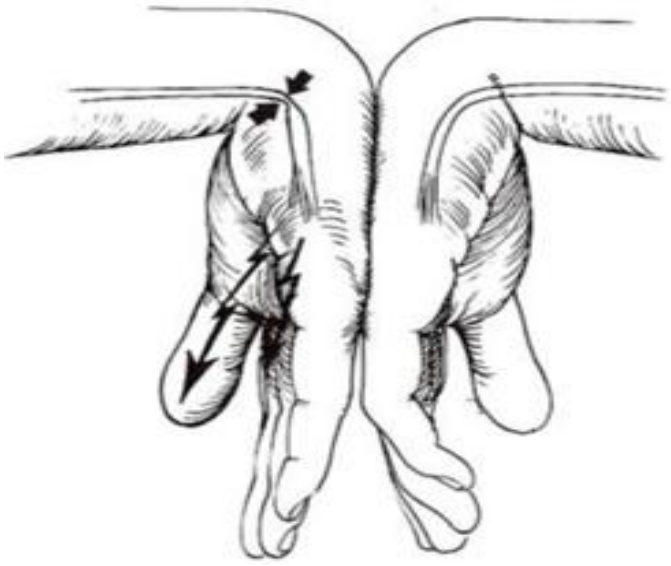

Figure 4: Phalen's test

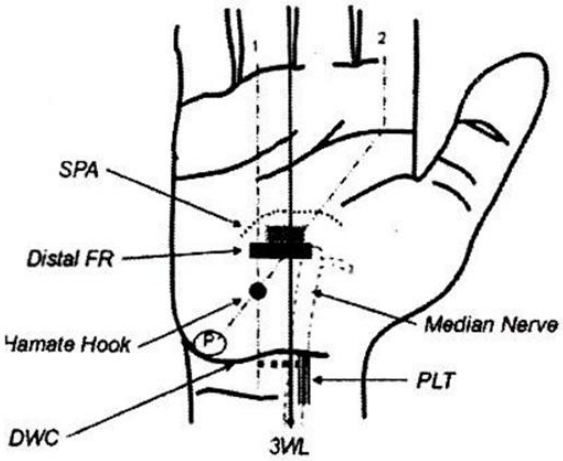

Figure 5: Landmarks for orientation during surgery

Transverse interrupted line: incision; Dashed area: safe zone after the FR, DWC: distal wrist crease; P: pisiform; SPA: superficial palmar arch; PLT: almar longus tendon; FR: flexor retinaculum; 3 WL:3 web space line; DWC: distal wrist crease; (1) ring-metacarpal line, (2) index-metacarpal- pisiform line.

Table 2: Symptom Duration

Duration of Symptoms	Number of Patients	Percentage (%)
Less than 1 year	6	20
1 to 2 years	17	56.67
More than 2 years	7	23.33

The duration of symptoms was categorized into three groups: less than 1 year, 1 to 2 years, and more than 2 years. The majority of patients (56.67%) reported having symptoms for 1 to 2 years. Only 6 patients (20%) had symptoms for less than 1 year, while 7 patients (23.33%) experienced symptoms for more than 2 years. This distribution suggests that patients often seek surgical intervention after experiencing symptoms for a prolonged period and after conservative treatments have failed.

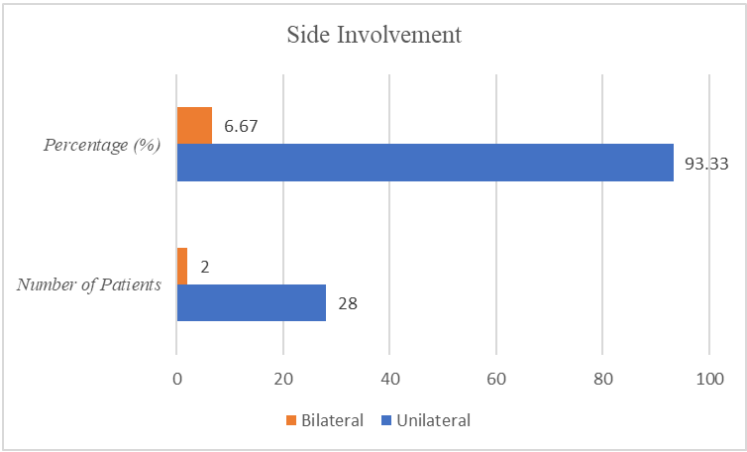

Figure 6: Side Involvement

Most patients (93.33%) presented with unilateral CTS, affecting only one hand. Bilateral involvement, affecting both hands, was observed in only 2 patients (6.67%). This reflects the common clinical presentation of CTS, where unilateral symptoms are more frequent, although bilateral cases are also not uncommon.

Table 4: Functional Outcomes and Complications

Outcome	Number of Patients	Percentage (%)	p-value
Satisfactory	29	96.67	<0.05
Unsatisfactory	1	3.33	<0.05
Complications			
Persistent Symptoms	1	3.33	<0.05
Haematoma	1	3.33	<0.05
Superficial Nerve Injury	0	0	<0.05
Motor Nerve Injury	0	0	<0.05
Infection	0	0	<0.05

The surgical outcomes were overwhelmingly positive. Out of the 30 patients, 29 (96.67%) reported a satisfactory outcome, characterized by significant improvement in symptoms, including relief from nocturnal pain, paresthesia, and numbness. Only 1 patient (3.33%) had an unsatisfactory outcome, with persistent symptoms postoperatively. The single unsatisfactory case involved continued symptoms, likely due to incomplete decompression or other underlying issues not addressed by the surgery.The complication rate was low. One patient (3.33%) developed a small haematoma on the first postoperative day, which resolved spontaneously without requiring any further intervention. No patients experienced infections, motor nerve injuries, or superficial sensory nerve injuries. These findings suggest that open carpal tunnel release through a small transverse incision is a safe procedure with a low complication rate, aligning with other studies reporting minimal adverse outcomes. The results of this study indicate that open carpal tunnel release through a small transverse incision is highly effective for the treatment of Carpal Tunnel Syndrome.

The majority of patients (96.67%) experienced significant improvement in their symptoms, including relief from pain, numbness, and paresthesia. Only one patient (3.33%) had persistent symptoms following surgery, representing an unsatisfactory outcome. Complications were minimal, with only one case of haematoma and no incidences of infection, motor nerve injury, or sensory nerve injury. The demographic analysis revealed that the majority of patients were female (80%) and between the ages of 41 and 50 (46.67%), which is consistent with previous findings that CTS is more common in middle-aged women. Most patients had experienced symptoms for 1 to 2 years before seeking surgical intervention, suggesting that prolonged symptoms often lead to surgical treatment when conservative measures fail. The procedure was performed safely, with a low complication rate and excellent overall outcomes, making it a viable option for treating patients with CTS who are unresponsive to conservative treatments. These findings reinforce the efficacy and safety of open carpal tunnel release using a small transverse incision, contributing to the growing body of evidence that supports this method as a gold standard in CTS surgical management.

DISCUSSION

The results of this study revealed that 29 out of 30 patients (96.67%) achieved significant symptomatic relief following the open carpal tunnel release surgery. This included relief from paresthesia, pain, and numbness, with no major complications like infections or motor nerve injuries. Only 1 patient (3.33%) reported an unsatisfactory outcome, experiencing persistent symptoms despite the procedure. The high rate of success observed in this study is consistent with the findings from Amin *et al*., who reported a 100% success rate in their study of patients undergoing the same procedure.[10] In both studies, patients demonstrated rapid recovery, with a notable improvement in hand function and a return to daily activities within weeks of surgery. One of the major factors contributing to the high success rate in this study is the precision of the small transverse incision technique. By using a 1.5 cm incision, this method minimizes tissue trauma while allowing for effective decompression of the median nerve. The reduced incision size not only leads to quicker

recovery but also limits the risk of complications such as wound infections, which are often associated with larger incisions in traditional open carpal tunnel release surgeries. This is supported by Wright *et al*., who argued that minimally invasive approaches in CTS surgery reduce postoperative morbidity, particularly in relation to scarring, pain, and infection risks.[11]

Comparison with Existing Literature

The success rate observed in this study aligns with existing research that highlights the efficacy of open carpal tunnel release surgery. For instance, Mališ *et al*., reported a 95% success rate with minimal complications in their analysis of open surgical decompression, which parallels the findings in our study.[12] However, a comparison with endoscopic techniques, which have gained popularity due to their minimally invasive nature, suggests that while both methods are effective, open surgery may have a slight advantage in terms of complete visualization of the transverse carpal ligament. According to Li *et al*., endoscopic approaches, though minimally invasive, have a slightly higher risk of incomplete ligament release, which can result in recurrent symptoms, something less frequently observed in open procedures.[13]

The small transverse incision technique used in this study also mirrors findings from international studies, such as those by Wang *et al*., who performed a similar procedure in Brazil and observed a 100% success rate with zero major complications.[14] However, the differences in success rates across studies may be attributed to factors such as sample size, patient demographics, and the skill of the operating surgeon. For example, our study involved a relatively small sample of 30 patients, which may limit the generalizability of the findings. Larger studies, such as those by Curtis *et al*., which included over 100 patients, reported similar success rates but with a broader range of postoperative complications, suggesting that a larger sample size may introduce variability in outcomes.[15] Moreover, the geographical origin and ethnicity of the patients could also play a role in the observed outcomes. Studies have indicated that patients from different racial backgrounds may experience varying degrees of median nerve compression due to anatomical differences in wrist structures. A study by Tulipan *et al*., on Asian patients found that individuals with smaller wrist diameters were more prone to severe median nerve compression, leading to a higher likelihood of complications during surgery.[16] This factor could explain the slight variation in complication rates observed between our study and those conducted in Western countries, where wrist morphology may differ.

Practical Implications

The findings of this study have several important practical implications for the management of CTS, particularly in resource-limited settings. The small transverse incision technique offers a cost-effective, safe, and highly effective treatment option for patients with CTS who do not respond to conservative therapies. In settings where access to endoscopic equipment may be limited, this open surgical technique provides a viable alternative with similar success rates and minimal complications. The simplicity of the procedure, combined with its low cost, makes it accessible to a wider range of patients, particularly in developing countries where healthcare resources may be constrained. Furthermore, the reduced recovery time associated with this technique has significant implications for patient well-being and economic productivity. Most patients in this study returned to their daily activities within weeks of surgery, which is particularly important for individuals whose livelihoods depend on manual labor or repetitive hand tasks. Given the high prevalence of CTS in occupations that require repetitive hand movements, such as assembly line work, carpentry, and typing, rapid recovery is crucial for minimizing work-related disability.[17] The lack of major complications observed in this study also reinforces the safety of this procedure. The absence of infections, nerve injuries, and other significant complications supports the conclusion that open carpal tunnel release with a small transverse incision is a highly safe option for CTS management. This finding is consistent with similar study by Yoshii *et al*., which reported low complication rates with similar open procedures.[18] Given the importance of reducing postoperative complications, especially in patients with comorbidities, this technique's safety profile makes it a preferred option in both general and specialized practice.

Comparison with Endoscopic Techniques

Endoscopic carpal tunnel release (ECTR) is often lauded for its minimal invasiveness and shorter recovery times, but our findings suggest that the small transverse incision technique offers comparable outcomes with less risk of incomplete decompression. According to a study by Azad *et al*., ECTR has a slightly higher risk of recurrent symptoms due to the limited visualization of the transverse carpal ligament.[19,20] In contrast, the open technique allows for direct visualization of the ligament, ensuring complete decompression of the median nerve. Although ECTR may be associated with a quicker initial recovery, the risk of recurrence may require secondary surgeries, thereby negating the long-term benefits of the procedure. In terms of complications, ECTR has been associated with an increased risk of transient nerve injuries due to the limited working space and the proximity of the endoscopic equipment to the nerve structures. In contrast, the open technique, despite being more invasive, provides greater control over the surgical field, minimizing the risk of accidental nerve damage. The findings of this study support the conclusion that while ECTR may be appropriate for certain patients, the small transverse incision technique offers a safer and more definitive treatment option for those with moderate to severe CTS.

Scientific Rationale for Differences in Results

The slight differences in success and complication rates across studies can be attributed to several scientific factors. First, the sample size in our study (30 patients) is relatively small compared to larger studies, which may introduce variability in the outcomes. Larger sample sizes, such as those used in studies by Ulirsch *et al*., provide more statistical power and may reveal a broader range of complications.[20] Second, the demographic characteristics of the patient population, including age, gender, and ethnicity, may also influence the results. Women, who made up 80% of our study sample, are more prone to CTS due to hormonal fluctuations and smaller wrist structures, which may account for the high success rate observed in this study. Moreover, the country of origin and healthcare infrastructure can also impact the results. For instance, the surgical procedures in this study were performed in a resource-limited setting at Rajshahi Medical College Hospital. The absence of advanced endoscopic equipment necessitated the use of open techniques, which may have influenced the results. In contrast, studies conducted in more developed countries with access to advanced surgical technologies may report different outcomes due to the availability of alternative treatment methods. The findings of this study contribute to the growing body of evidence supporting the effectiveness and safety of open carpal tunnel release through a small transverse incision. The high success rate (96.67%) and low complication rate observed in this study align with previous research, reinforcing the utility of this procedure for treating patients with Carpal Tunnel Syndrome who do not respond to conservative therapies. While endoscopic techniques offer certain advantages in terms of invasiveness, the small transverse incision method provides superior visualization of the transverse carpal ligament and ensures complete decompression of the median nerve.

CONCLUSION

The study demonstrates that open carpal tunnel release through a small transverse incision is a highly effective and safe treatment for Carpal Tunnel Syndrome. With a success rate of 96.67% and minimal complications, this procedure provides rapid symptom relief and functional recovery. It is a cost-effective alternative, especially in resource-limited settings.

Recommendations

Implement early surgical intervention for prolonged or severe CTS cases.
Consider this technique in resource-constrained healthcare settings.
Conduct larger studies to further validate these findings.

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Author Contributions

MT Rahman led the study's design and implementation, overseeing surgical procedures and patient management. MM Tarik played a key role in patient care and data collection. R Sharmin contributed to patient follow-ups and detailed clinical assessments. MA Hannan provided expertise in statistical analysis and data interpretation. All authors actively participated in drafting and refining the manuscript.

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