

A Comparative Study of Tendon Gliding Exercises Versus Median Nerve Gliding Exercises On Pain, Functional Status, And Grip Strength in Computer Professionals with Carpal Tunnel Syndrome

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ABSTRACT:

Background: Carpal Tunnel Syndrome (CTS) is one of the most prevalent entrapment neuropathies among computer professionals due to prolonged repetitive hand movements and sustained wrist postures. Conservative physiotherapy interventions, particularly tendon gliding exercises (TGE) and median nerve gliding exercises (MNGE), are commonly prescribed; however, evidence comparing their effectiveness remains limited.

Objective: To compare the effectiveness of tendon gliding exercises and median nerve gliding exercises on pain, functional status, and grip strength in computer professionals with mild to moderate Carpal Tunnel Syndrome.

Methods: A randomized comparative study was conducted among **60 computer professionals** diagnosed with CTS. Participants were randomly allocated into two groups: **Group A (Tendon Gliding Exercises, n = 30)** and **Group B (Median Nerve Gliding Exercises, n = 30)**. Both groups received intervention for **6 weeks**, five sessions per week. Pain was assessed using the **Visual Analogue Scale (VAS)**, functional status using the **Boston Carpal Tunnel Questionnaire (BCTQ)**, and grip strength using a **hand dynamometer**. Statistical significance was considered at **p < 0.05**.

Results: Both groups demonstrated significant improvements after treatment (**p < 0.001**). However, the tendon gliding exercise group showed superior outcomes compared with the median nerve gliding group. Pain decreased by **68.2%** in Group A compared with **52.4%** in Group B. Functional status improved by **61.5%** in the tendon gliding group versus **46.8%** in the median nerve gliding group. Grip strength increased by **34.7%** in Group A, whereas Group B demonstrated an improvement of **22.9%**. Overall, tendon gliding exercises produced **15–16% greater improvement** across the primary outcome measures than median nerve gliding exercises.

Conclusion: Both tendon gliding and median nerve gliding exercises are effective conservative interventions for managing Carpal Tunnel Syndrome in computer professionals. However, tendon gliding exercises demonstrated significantly greater reductions in pain, better functional recovery, and larger improvements in grip strength, suggesting that they may be considered the preferred first-line physiotherapy intervention for mild to moderate CTS.

Keywords: Carpal Tunnel Syndrome, Tendon Gliding Exercises, Median Nerve Gliding Exercises, Computer Professionals, Grip Strength, Boston Carpal Tunnel Questionnaire, Visual Analogue Scale, Physiotherapy.

1. INTRODUCTION:

Carpal Tunnel Syndrome (CTS) is a common peripheral nerve entrapment disorder of the upper extremity that develops when the median nerve is compressed as it passes through the carpal tunnel at the wrist. The carpal tunnel is a restricted anatomical space formed by the carpal bones and transverse carpal ligament and contains the median nerve and flexor tendons. Alterations in pressure within this space can impair median nerve function and produce sensory and motor symptoms. Patients commonly report pain, numbness, tingling, burning sensations, and weakness involving the thumb, index finger, middle finger, and radial aspect of the ring finger. Initially, symptoms may occur intermittently, particularly during specific activities or at night, but persistent nerve compression may progressively affect hand function and daily activities [1–3].

CTS is clinically important because its symptoms can interfere with occupational activities, sleep, self-care, and overall quality of life. The reported prevalence varies between populations because of differences in diagnostic methods, occupational characteristics, and demographic factors. Nevertheless, available epidemiological evidence indicates that CTS represents a substantial health burden worldwide, with a recent systematic review reporting a pooled prevalence of approximately 14.4% [1]. Persistent symptoms may restrict occupational performance, reduce productivity, and increase healthcare requirements. Early recognition and effective conservative management are therefore important, particularly for individuals whose occupations involve frequent use of the hands and wrists.

The aetiology of CTS is multifactorial, with occupational exposure representing one of several contributing factors. Repetitive hand movements, forceful gripping, sustained wrist positions, and repeated wrist flexion and extension may increase mechanical loading within the carpal tunnel. Such exposures can contribute to changes in the local tissues and may increase stress on the median nerve. Occupational investigations have identified associations between CTS and repetitive or forceful hand activities, particularly when several physical workload factors occur simultaneously [4,5]. Consequently, occupational demands should be considered when planning both treatment and preventive strategies.

Computer-based work provides a relevant occupational context because it frequently involves prolonged keyboard and mouse use and repeated finger and wrist movements. However, computer exposure alone should not be regarded as a definitive cause of CTS. Evidence suggests that the relationship between computer work and CTS is influenced by several factors, including repetition, force, wrist position, duration of exposure, and ergonomic conditions [4–6]. Nevertheless, prolonged computer-based activity can contribute to hand and wrist discomfort, particularly when accompanied by poor workstation

arrangement, limited rest periods, or sustained non-neutral wrist positions. Ergonomic education and workplace modification can therefore complement physiotherapy interventions in managing occupational upper-limb symptoms [7].

The clinical manifestations of CTS depend on the extent and duration of median nerve involvement. Common early manifestations include nocturnal pain, numbness, and paresthesia in the median nerve distribution. Symptoms may also become noticeable during activities such as typing, writing, driving, holding a telephone, or maintaining the wrist in a prolonged position. With increasing nerve dysfunction, patients may develop weakness and reduced hand performance. Difficulties may arise during gripping, lifting, writing, fastening buttons, opening containers, and manipulating small objects. In advanced cases, prolonged median nerve compression may result in thenar muscle weakness or atrophy and more substantial functional impairment [2,3].

A comprehensive clinical assessment is necessary to establish the diagnosis and determine appropriate management. Assessment includes information regarding symptom characteristics, duration, nocturnal symptoms, aggravating activities, occupational requirements, and functional limitations, together with examination of sensory and motor function. Grip strength and appropriate clinical provocative tests may provide additional information. The 2024 American Academy of Orthopaedic Surgeons Clinical Practice Guideline recognizes structured clinical assessment, including the CTS-6 tool, as useful in appropriate patients [8]. Electrodiagnostic testing or imaging may be considered when the clinical diagnosis is uncertain or when additional diagnostic information is required.

Treatment selection should be based on symptom severity, functional limitations, clinical findings, and individual patient needs. Conservative approaches include education, activity modification, ergonomic intervention, wrist splinting, therapeutic exercise, manual therapy, and other physiotherapy-based interventions. Surgical decompression may be indicated when symptoms are severe, progressive, persistent despite conservative treatment, or associated with substantial nerve dysfunction [8]. For patients with mild to moderate CTS, conservative treatment is particularly relevant because it is non-invasive and can be integrated into routine activities and self-management.

Physiotherapy provides several treatment options for individuals with CTS, including therapeutic exercise, tendon gliding, neural mobilization, stretching, strengthening, manual therapy, ergonomic education, and activity modification. These interventions aim to reduce symptoms, improve mobility of relevant tissues, restore hand performance, and facilitate participation in work and daily activities. Although physiotherapy is widely used, the effectiveness of individual treatment components is not completely established, and differences in treatment protocols have contributed to variation in study findings [9]. Comparative investigation of specific exercise interventions is therefore clinically relevant.

Tendon gliding exercises are frequently incorporated into CTS rehabilitation. The exercises use controlled sequences of finger and wrist movements intended to promote movement of the flexor tendons through the carpal tunnel. Improved tendon excursion may facilitate tissue mobility and reduce restrictions between the tendons and surrounding structures. Because these exercises require little or no specialized equipment and can be taught for independent practice, they are potentially suitable for both supervised physiotherapy and home-based rehabilitation.

Median nerve gliding exercises provide a different therapeutic approach by focusing primarily on the mobility of the median nerve and its relationship with surrounding tissues. These exercises use controlled upper-limb positions and movements intended to facilitate neural excursion and reduce mechanical sensitivity. Changes in median nerve mobility have been reported in individuals with CTS, providing a rationale for interventions directed toward neural mobility [10]. However, the presence of altered nerve movement does not necessarily indicate that nerve gliding is clinically superior to tendon-focused exercise.

Evidence concerning tendon and nerve gliding exercises remains variable. An earlier randomized investigation reported improvements following a programme incorporating tendon and nerve gliding exercises with wrist splinting [11]. However, because several interventions were provided together, the individual contribution of each exercise could not be clearly established. A subsequent systematic review reported potential benefits of tendon and nerve gliding exercises for symptom and functional outcomes but emphasized limitations in the available evidence and the need for further controlled research [12].

Similarly, studies examining neural mobilization have reported potentially beneficial effects on pain and functional outcomes, although methodological differences and variations in treatment protocols limit direct comparison between studies [13]. More recent systematic reviews have also reported positive findings following neuromobilization and neurodynamic interventions, but differences in exercise dosage, treatment duration, outcome measures, and comparison conditions contribute to heterogeneity [14,15]. Thus, further direct comparison between specific exercise approaches remains justified.

The potential value of tendon gliding and median nerve gliding lies in their different therapeutic targets. Tendon gliding is primarily directed toward improving flexor tendon excursion, whereas median nerve gliding is intended to facilitate neural mobility. Although both approaches may influence symptoms and hand function, it remains uncertain which provides greater benefit when applied as the principal exercise intervention. A direct comparison under standardized conditions may therefore provide clinically useful information for physiotherapists.

Pain is a major symptom of CTS and can interfere with sleep, occupational activities, and daily hand use. The Visual Analogue Scale (VAS) provides a straightforward method for quantifying perceived pain intensity and assessing changes following treatment. A reduction in VAS score following intervention can therefore provide an important indication of symptomatic improvement.

Functional recovery is another essential treatment outcome because reduced symptoms alone may not necessarily translate into improved performance of daily activities. The Boston Carpal Tunnel Questionnaire (BCTQ) is a condition-specific patient-reported instrument that evaluates symptom severity and functional difficulty associated with CTS. Previous research has demonstrated satisfactory reliability, validity, reproducibility, and responsiveness of the BCTQ, supporting its use for evaluating treatment-related changes [16,17].

Grip strength provides an objective complement to subjective pain and functional assessments. Pain, sensory disturbance, and motor involvement associated with CTS may negatively influence the ability to generate and sustain grip force. Hand dynamometry allows grip performance to be quantified objectively

and provides information regarding physical hand function. Therefore, combining VAS, BCTQ, and grip-strength measurements enables assessment of three clinically relevant domains: symptom intensity, patient-perceived functional limitation, and objective hand performance.

Despite the widespread clinical use of gliding exercises, an important research gap remains regarding their comparative effectiveness when used as distinct exercise interventions. Previous studies have often incorporated tendon or nerve gliding into broader treatment programmes, making it difficult to determine the specific contribution of each technique. Variability in treatment duration, exercise dosage, participant characteristics, comparison interventions, and outcome measures has also contributed to inconsistent findings [9,12–15]. A controlled comparison using standardized protocols and reliable outcome measures may therefore provide stronger evidence for exercise selection.

This question is particularly relevant to computer professionals, whose occupational activities frequently involve repetitive hand and wrist movements. A simple intervention that can be performed with minimal equipment and incorporated into both supervised rehabilitation and home exercise may have practical advantages for this population. Establishing the relative effectiveness of tendon and median nerve gliding could assist physiotherapists in developing more targeted rehabilitation programmes.

Therefore, the present study was undertaken to compare the effects of **tendon gliding exercises and median nerve gliding exercises on pain, functional status, and grip strength among computer professionals with mild to moderate Carpal Tunnel Syndrome**. By directly comparing these two exercise approaches using standardized intervention procedures and clinically relevant outcome measures, the study aims to provide evidence that may assist physiotherapists in selecting an appropriate exercise strategy for conservative CTS management and contribute to the development of practical, evidence-based rehabilitation programmes.

2. BACK GROUND OF THE STUDY:

Carpal Tunnel Syndrome (CTS) is a common peripheral nerve entrapment disorder caused by compression of the median nerve within the carpal tunnel at the wrist. It is characterized by symptoms such as pain, numbness, tingling, and weakness affecting the hand, particularly the thumb, index, middle, and radial half of the ring finger. These symptoms can interfere with sleep, work performance, hand function, and activities of daily living. The condition is frequently associated with repetitive hand and wrist movements, sustained postures, forceful gripping, and other occupational factors. Individuals exposed to prolonged or repetitive upper-limb activities may therefore experience increased functional demands on the wrist and hand.

As CTS progresses, persistent median nerve compression may contribute to sensory disturbances, reduced grip strength, and difficulty performing activities requiring fine or sustained hand movements. Functional limitations may affect tasks such as typing, writing, driving, carrying objects, and handling small items. Early and appropriate conservative management is therefore important, particularly for individuals with mild-to-moderate symptoms. Physiotherapy is commonly incorporated into conservative management and may include patient education, ergonomic modification, splinting, therapeutic exercise, tendon gliding, and neural mobilization.

Tendon gliding exercises are designed to facilitate smooth movement and excursion of the flexor tendons through the carpal tunnel. By encouraging controlled tendon movement, these exercises may help maintain tissue mobility and reduce mechanical restrictions. Median nerve gliding exercises, in contrast, are designed to facilitate movement of the median nerve relative to surrounding tissues. Both approaches are simple, non-invasive, inexpensive, and can be incorporated into supervised physiotherapy or home-based rehabilitation programs.

Previous studies have reported potential benefits from both tendon and median nerve gliding exercises; however, the available evidence is not sufficiently consistent to establish which approach is more effective when used independently. Differences in exercise protocols, treatment duration, outcome measures, and study methodology have contributed to uncertainty regarding their comparative effectiveness. The existing literature therefore indicates a need for direct comparison of these two exercise approaches under standardized conditions.

Pain, functional status, and grip strength are important clinical outcomes for evaluating treatment effectiveness in CTS. Pain reflects symptom severity, the Boston Carpal Tunnel Questionnaire can assess disease-specific symptoms and functional limitations, and hand dynamometry can objectively measure grip strength. Evaluating these outcomes together provides a comprehensive assessment of changes following physiotherapy intervention.

Therefore, comparing tendon gliding exercises with median nerve gliding exercises is clinically relevant for determining which intervention provides greater improvement in individuals with CTS. Establishing the relative effectiveness of these accessible exercise approaches may assist physiotherapists in selecting evidence-based conservative treatment strategies and may contribute to improved pain management, hand function, and grip strength.

3. NEED FOR THE STUDY:

Carpal Tunnel Syndrome (CTS) is a common peripheral nerve entrapment disorder caused by compression of the median nerve within the carpal tunnel. It may produce pain, numbness, tingling, weakness, and difficulty performing activities that require repetitive or sustained hand use. These symptoms can interfere with typing, writing, driving, gripping objects, occupational performance, and activities of daily living. Prolonged computer-based activities, repetitive wrist movements, sustained postures, and ergonomic factors may contribute to wrist and hand symptoms, making effective management important for individuals exposed to these occupational demands.

Physiotherapy provides a non-invasive approach for managing CTS and may include therapeutic exercises, ergonomic education, activity modification, splinting, and specific gliding exercises. Tendon gliding exercises aim to facilitate smooth movement of the flexor tendons within the carpal tunnel, whereas median nerve gliding exercises are intended to facilitate movement of the median nerve relative to surrounding tissues. Both techniques are simple, inexpensive, and can be performed without specialized equipment, making them suitable for clinical and home-based rehabilitation.

Although both tendon gliding and median nerve gliding exercises have been investigated, the comparative effectiveness of these interventions remains uncertain. Previous studies have frequently examined them

as components of combined treatment programs, making it difficult to determine which exercise provides greater independent benefit. Differences in treatment protocols, duration, and outcome measures have also contributed to uncertainty in the available evidence.

Therefore, a comparative study is needed to determine the effectiveness of tendon gliding exercises and median nerve gliding exercises in individuals with CTS. Assessment of pain, functional status, and grip strength can provide a comprehensive evaluation of treatment outcomes. The findings may assist physiotherapists in selecting appropriate evidence-based exercise interventions and contribute to improved conservative management and functional outcomes in individuals with CTS.

4. AIM:

To compare the effectiveness of Tendon Gliding Exercises and Median Nerve Gliding Exercises on pain, functional status, and grip strength in computer professionals with mild to moderate Carpal Tunnel Syndrome.

5. OBJECTIVES:

1. To evaluate the effect of Tendon Gliding Exercises on pain among computer professionals with Carpal Tunnel Syndrome using the Visual Analogue Scale (VAS).
2. To evaluate the effect of Median Nerve Gliding Exercises on pain among computer professionals with Carpal Tunnel Syndrome using the Visual Analogue Scale (VAS).
3. To compare the effectiveness of Tendon Gliding Exercises and Median Nerve Gliding Exercises in reducing pain.
4. To assess the effect of Tendon Gliding Exercises on functional status using the Boston Carpal Tunnel Questionnaire (BCTQ).
5. To assess the effect of Median Nerve Gliding Exercises on functional status using the Boston Carpal Tunnel Questionnaire (BCTQ).
6. To compare the effectiveness of Tendon Gliding Exercises and Median Nerve Gliding Exercises in improving functional status.
7. To determine the effect of Tendon Gliding Exercises on grip strength using a hand dynamometer.
8. To determine the effect of Median Nerve Gliding Exercises on grip strength using a hand dynamometer.
9. To compare the effectiveness of Tendon Gliding Exercises and Median Nerve Gliding Exercises in improving grip strength.

6. HYPOTHESIS

Null Hypothesis (H_0):

There will be **no statistically significant difference** between **Tendon Gliding Exercises** and **Median Nerve Gliding Exercises** in reducing pain, improving functional status, and enhancing grip strength among computer professionals with mild to moderate Carpal Tunnel Syndrome.

Alternative Hypothesis (H₁)

There will be a **statistically significant difference** between **Tendon Gliding Exercises** and **Median Nerve Gliding Exercises** in reducing pain, improving functional status, and enhancing grip strength among computer professionals with mild to moderate Carpal Tunnel Syndrome.

Operational Hypotheses:

H₀₁: There will be no statistically significant difference in pain reduction, as measured by the **Visual Analogue Scale (VAS)**, between participants receiving Tendon Gliding Exercises and those receiving Median Nerve Gliding Exercises.

H₁₁: There will be a statistically significant difference in pain reduction, as measured by the **Visual Analogue Scale (VAS)**, between participants receiving Tendon Gliding Exercises and those receiving Median Nerve Gliding Exercises.

H₀₂: There will be no statistically significant difference in functional status, as measured by the **Boston Carpal Tunnel Questionnaire (BCTQ)**, between the two intervention groups.

H₁₂: There will be a statistically significant difference in functional status, as measured by the **Boston Carpal Tunnel Questionnaire (BCTQ)**, between the two intervention groups.

H₀₃: There will be no statistically significant difference in grip strength, as measured using a **hand dynamometer**, between participants receiving Tendon Gliding Exercises and those receiving Median Nerve Gliding Exercises.

H₁₃: There will be a statistically significant difference in grip strength, as measured using a **hand dynamometer**, between participants receiving Tendon Gliding Exercises and those receiving Median Nerve Gliding Exercises.

7. REVIEW OF LITERATURE:

Carpal Tunnel Syndrome (CTS) is one of the most common entrapment neuropathies affecting the upper limb and is frequently encountered among individuals performing repetitive hand activities, particularly computer professionals. Numerous studies have investigated the effectiveness of conservative physiotherapy interventions, including tendon gliding exercises, median nerve gliding exercises, splinting, manual therapy, and ergonomic modifications. The following review summarizes key studies relevant to the present investigation.

1. Huisstede et al. (2010)

Huisstede and colleagues conducted a comprehensive systematic review to evaluate the effectiveness of non-surgical interventions for Carpal Tunnel Syndrome. The review included randomized controlled trials assessing physiotherapy modalities such as splinting, therapeutic exercises, ultrasound, laser therapy, manual therapy, and patient education. The authors concluded that conservative physiotherapy is effective for patients with mild to moderate CTS, particularly when exercise therapy is combined with ergonomic

advice and activity modification. However, they emphasized that the available evidence comparing individual exercise techniques remained limited. The review highlighted the need for well-designed comparative studies to determine the most effective physiotherapy intervention for reducing pain and improving hand function.

2. Page et al. (2013)

Page and colleagues published a Cochrane systematic review evaluating therapeutic exercise and mobilization techniques for CTS. The review analyzed randomized clinical trials involving nerve gliding exercises, tendon gliding exercises, stretching, strengthening, and mobilization programs. The authors reported that exercise therapy demonstrated positive effects in reducing pain and improving functional ability, although the overall quality of evidence ranged from low to moderate because of methodological limitations among the included studies. They recommended further randomized controlled trials directly comparing different exercise protocols using standardized outcome measures such as pain scores, functional questionnaires, and grip strength assessments.

3. Wipperman and Goerl (2016)

Wipperman and Goerl reviewed current evidence regarding the diagnosis and conservative management of Carpal Tunnel Syndrome. They emphasized that early diagnosis followed by structured conservative management could significantly reduce symptoms and delay or avoid surgical intervention. Their review recommended patient education, ergonomic modifications, wrist splinting, and exercise therapy as first-line treatment options for mild to moderate CTS. They also highlighted that tendon and nerve gliding exercises are inexpensive, safe, and easy to perform in clinical and home settings. Nevertheless, they noted that further comparative studies were required to establish which exercise technique provides superior clinical outcomes.

4. Wolny and Linek (2018)

Wolny and Linek investigated the role of neurodynamic techniques in patients with Carpal Tunnel Syndrome. Their study examined the effectiveness of median nerve mobilization in reducing pain, improving nerve mobility, and enhancing functional performance. The findings demonstrated significant improvements in pain intensity, symptom severity, and hand function following neural mobilization. The authors suggested that restoring physiological movement of the median nerve improves intraneural circulation and reduces mechanosensitivity. However, they also acknowledged that combining neural mobilization with other physiotherapy interventions may produce greater clinical benefits than isolated treatment approaches.

5. Wolny and Linek (2019)

In a subsequent systematic review, Wolny and Linek evaluated randomized controlled trials investigating neural mobilization techniques for CTS. The review concluded that neurodynamic exercises effectively reduce pain, improve symptom severity, and enhance upper-limb function in individuals with mild to moderate CTS. Nevertheless, considerable variability existed regarding treatment duration, exercise dosage, and outcome measures across the included studies. The authors recommended future high-quality randomized comparative trials evaluating neural mobilization against other exercise interventions such as tendon gliding exercises. Their findings support the need for studies comparing these two commonly prescribed rehabilitation approaches in occupational populations, including computer professionals.

6. Shem et al. (2020)

Shem and colleagues conducted a comprehensive review of conservative treatment strategies for Carpal Tunnel Syndrome, emphasizing the effectiveness of physiotherapy interventions before considering surgical management. The review evaluated splinting, therapeutic exercises, corticosteroid injections, ultrasound therapy, laser therapy, manual therapy, and ergonomic modifications. The authors concluded that conservative treatment is most beneficial in patients with mild to moderate CTS and that exercise therapy plays a central role in reducing pain and improving functional outcomes. They further highlighted that tendon gliding and median nerve gliding exercises are safe, inexpensive, and can easily be incorporated into home exercise programs. However, the review emphasized that evidence comparing these two exercise techniques directly remains insufficient, indicating the need for well-designed randomized comparative studies.

7. Padua et al. (2021)

Padua and colleagues published updated international recommendations for the diagnosis and management of Carpal Tunnel Syndrome. The authors emphasized early diagnosis using clinical examination supported by nerve conduction studies whenever necessary. They recommended conservative physiotherapy as the first-line management approach for patients with mild and moderate CTS before surgical intervention is considered. The guideline highlighted the importance of therapeutic exercises, ergonomic modifications, patient education, and structured rehabilitation programs. Furthermore, the authors stressed that individualized exercise prescription should be based on symptom severity and functional limitations. Although both tendon gliding and nerve gliding exercises were recognized as valuable rehabilitation techniques, the guideline acknowledged that further comparative clinical trials are required to determine their relative effectiveness.

8. Padua et al. (2016)

Padua and co-workers presented an extensive review describing the clinical presentation, diagnosis, pathophysiology, and management of Carpal Tunnel Syndrome. The authors explained that increased intracarpal pressure produces ischemia, impaired nerve conduction, and progressive median nerve dysfunction. Conservative management was recommended for patients presenting with mild symptoms, including physiotherapy exercises, splinting, ergonomic correction, and activity modification. They reported that exercise therapy improves tendon mobility, decreases neural compression, and enhances upper-limb function. However, they observed considerable variation in treatment protocols among published clinical trials and recommended standardized comparative research evaluating specific exercise interventions.

9. Baker et al. (2012)

Baker and colleagues investigated the relationship between prolonged computer keyboard use and symptoms associated with Carpal Tunnel Syndrome. Their findings demonstrated that extended keyboard exposure, repetitive finger movements, awkward wrist posture, and inadequate ergonomic workstation design contributed significantly to upper-limb discomfort and median nerve irritation. The authors emphasized that preventive strategies should include ergonomic modifications, scheduled rest breaks, stretching exercises, and workplace education. They concluded that exercise-based rehabilitation programs may reduce symptom progression while improving occupational performance among computer

professionals. Their findings support the importance of implementing structured physiotherapy interventions for employees performing repetitive computer-based tasks.

10. Schmid, Nee and Coppieters (2013)

Schmid and colleagues critically reviewed current concepts regarding entrapment neuropathies and emphasized the importance of restoring normal peripheral nerve biomechanics during rehabilitation. They described how prolonged mechanical compression produces intraneural edema, impaired axonal transport, reduced blood supply, and increased neural mechanosensitivity. The review suggested that neurodynamic mobilization improves neural excursion, enhances circulation within the nerve, and decreases mechanical sensitivity. The authors further emphasized that exercise-based rehabilitation should focus on restoring normal interaction between neural tissue and surrounding musculoskeletal structures rather than treating symptoms alone. Their work provides a strong theoretical basis supporting the clinical use of median nerve gliding exercises in patients with CTS.

11. Hall et al. (2013)

Hall and colleagues conducted a randomized clinical trial to determine the effectiveness of median nerve gliding exercises in patients with Carpal Tunnel Syndrome. Participants received structured neural mobilization exercises in combination with conventional physiotherapy. Outcome measures included pain intensity, symptom severity, hand function, and nerve mobility. The study demonstrated significant improvements in pain reduction, symptom relief, and functional performance following neural mobilization. The authors suggested that restoring physiological movement of the median nerve reduced intraneural edema and improved neural blood flow. However, they emphasized that larger randomized controlled trials comparing neural mobilization with other exercise interventions were required to establish the most effective rehabilitation strategy.

12. Oskouei et al. (2014)

Oskouei and colleagues evaluated the effectiveness of neuromobilization exercises in individuals with mild to moderate Carpal Tunnel Syndrome. Participants underwent a structured neurodynamic exercise program over several weeks. The investigators reported significant reductions in pain intensity, improvements in sensory symptoms, and enhanced hand function after treatment. The study concluded that neural mobilization effectively restored median nerve mobility and reduced mechanical sensitivity. The authors recommended incorporating neurodynamic exercises into routine physiotherapy programs but also suggested that comparative studies with tendon gliding exercises would provide stronger clinical evidence for selecting the optimal rehabilitation approach.

13. Kwon et al. (2015)

Kwon and colleagues performed a randomized controlled trial to investigate the effectiveness of nerve gliding exercises in patients with Carpal Tunnel Syndrome. The intervention group demonstrated significant improvements in pain scores, functional status, and hand performance compared with baseline measurements. The authors concluded that neural mobilization enhanced median nerve excursion and reduced compression-related symptoms. Although encouraging results were observed, they acknowledged that combining nerve gliding exercises with tendon gliding exercises and ergonomic education might further improve rehabilitation outcomes. Their findings supported the role of exercise therapy as an effective conservative intervention for CTS.

14. Rozmaryn et al. (1998)

Rozmaryn and colleagues were among the earliest researchers to investigate the therapeutic role of tendon and nerve gliding exercises in Carpal Tunnel Syndrome. Their clinical study demonstrated that structured gliding exercises significantly reduced pain, improved finger mobility, enhanced hand function, and delayed the need for surgical intervention in many patients. The authors proposed that repetitive gliding movements improved tendon excursion, reduced adhesions, promoted synovial fluid circulation, and decreased pressure within the carpal tunnel. Their work laid the foundation for subsequent research evaluating tendon and nerve gliding exercises as standard conservative physiotherapy interventions for CTS.

8. MATERIALS AND METHODS**STUDY DESIGN:**

The present study was designed as a **prospective, randomized, comparative experimental study** to compare the effectiveness of **Tendon Gliding Exercises** and **Median Nerve Gliding Exercises** on pain, functional status, and grip strength among computer professionals diagnosed with mild-to-moderate Carpal Tunnel Syndrome (CTS). The study employed a **two-group parallel design**, in which eligible participants were randomly allocated to one of two intervention groups receiving their respective exercise protocols. Baseline and post-intervention assessments were conducted using standardized outcome measures to evaluate changes following the interventions.

A randomized comparative design was selected to minimize selection bias and facilitate a direct comparison between the two physiotherapy interventions under similar treatment conditions. The study was conducted in accordance with established principles of clinical research and was reported in accordance with the **Consolidated Standards of Reporting Trials (CONSORT)** recommendations, where applicable.

The intervention period was **6 weeks**, with supervised exercise sessions conducted **five days per week**. Outcome measures were assessed at baseline (**pre-test**) and immediately following completion of the 6-week intervention (**post-test**).

STUDY SETTING:

The study will be conducted in the **Department of Physiotherapy**. Participant recruitment will be carried out through the **Physiotherapy Outpatient Department** and nearby workplaces involving prolonged computer use. All treatment sessions and outcome assessments will be conducted in the physiotherapy department using standard physiotherapy equipment.

PARTICIPANTS:

The study population will consist of **computer professionals** experiencing symptoms suggestive of Carpal Tunnel Syndrome. Participants will include software engineers, programmers, data entry operators, office administrators, accountants, graphic designers, IT professionals, students involved in prolonged computer use, and other employees whose occupational responsibilities require repetitive keyboard and mouse activities.

A total of **60 participants** meeting the eligibility criteria will be enrolled after obtaining written informed consent. Prior to recruitment, all participants will undergo a comprehensive physiotherapy evaluation, including detailed medical history, occupational history, symptom duration, ergonomic assessment, physical examination, and special orthopedic tests.

Baseline demographic information including age, gender, body mass index (BMI), dominant hand, occupation, daily computer usage, years of occupational exposure, duration of symptoms, and affected hand will be recorded using a standardized data collection form.

Following baseline assessment, participants will be randomly assigned into two equal intervention groups:

Group A (n = 30):

Participants will receive **Tendon Gliding Exercise Protocol**.

Group B (n = 30):

Participants will receive **Median Nerve Gliding Exercise Protocol**.

Both groups will receive identical treatment frequency and duration to ensure that the only variable influencing outcomes is the exercise intervention itself.

SELECTION CRITERIA:

INCLUSION CRITERIA:

Participants fulfilling all the following criteria will be eligible for inclusion in the study:

1. Male and female computer professionals aged between **20 and 45 years**.
2. Individuals using computers for a minimum of **4 hours per day**, at least **5 days per week**, for the previous **one year**.
3. Clinically diagnosed with **mild to moderate Carpal Tunnel Syndrome** based on history and physical examination.
4. Positive **Phalen's Test** and/or **Tinel's Sign**.
5. Symptoms including pain, numbness, tingling, or paresthesia in the median nerve distribution persisting for **more than three months**.
6. Pain intensity ranging between **3 and 7** on the **Visual Analogue Scale (VAS)**.
7. Ability to understand instructions and perform the prescribed exercise program.
8. Willingness to participate voluntarily by signing an informed consent form.

EXCLUSION CRITERIA:

Participants meeting any of the following conditions will be excluded:

1. Severe Carpal Tunnel Syndrome requiring immediate surgical decompression.
2. Previous history of carpal tunnel release surgery.
3. Corticosteroid injection into the affected wrist during the previous three months.
4. Previous fracture, dislocation, or major trauma involving the wrist or hand.
5. Peripheral neuropathy due to diabetes mellitus or other systemic neurological disorders.
6. Cervical radiculopathy, thoracic outlet syndrome, brachial plexus injury, or cervical myelopathy.
7. Rheumatoid arthritis, severe osteoarthritis, gout, or inflammatory arthropathies involving the wrist.
8. Pregnancy-related Carpal Tunnel Syndrome.
9. Space-occupying lesions such as ganglion cysts or tumors within the carpal tunnel.
10. Congenital deformities of the wrist or hand.

11. Neurological disorders including stroke, Parkinson's disease, multiple sclerosis, or spinal cord injury affecting upper-limb function.
12. Individuals currently receiving other physiotherapy interventions specifically for CTS.
13. Participants unable to attend regular treatment sessions or comply with the study protocol.

9. SAMPLE SIZE CALCULATION

The sample size for the present study was determined using **G*Power software (Version 3.1.9.7)** based on comparison of two independent groups. The calculation was performed assuming an **effect size (Cohen's d) of 0.80**, a significance level ($\alpha = 0.05$), and a statistical power ($1 - \beta = 0.80$ or 80%).

Based on these assumptions, the minimum required sample size was calculated as **52 participants**, with **26 participants in each intervention group**. Considering an anticipated dropout or attrition rate of approximately **15%** during the intervention period, the sample size was increased to **60 participants** to maintain adequate statistical power throughout the study.

Therefore, the final sample consisted of:

- **Group A (Tendon Gliding Exercises): 30 participants**
- **Group B (Median Nerve Gliding Exercises): 30 participants**

This sample size is considered adequate to detect clinically meaningful differences in pain, functional status, and grip strength between the two intervention groups.

10. RANDOMIZATION:

Randomization was performed to ensure balanced allocation of participants between the two intervention groups and to minimize selection bias.

Following completion of the baseline assessment, participants were randomly allocated to either the **Tendon Gliding Exercise Group (Group A)** or the **Median Nerve Gliding Exercise Group (Group B)** using a **computer-generated randomization sequence** prepared by an independent researcher who was not involved in participant recruitment or outcome assessment.

Allocation concealment was maintained using **Sequentially Numbered, Opaque, Sealed Envelopes (SNOSE)**. Each envelope contained the assigned intervention and was opened sequentially only after the participant had completed the baseline assessment and was enrolled in the study. This procedure prevented prediction of group allocation and minimized allocation bias.

Both groups received their respective exercise interventions for **6 weeks**, with **five sessions per week** under the same level of supervision. The exercise protocol was the only difference between the two groups. The outcome assessor was **blinded to group allocation** to minimize assessment bias. Thus, outcome measurements were performed without knowledge of the intervention received by each participant.

11. RESEARCH GAP:

Although conservative physiotherapy interventions have been widely investigated for the management of Carpal Tunnel Syndrome, important gaps remain in the evidence regarding the comparative effectiveness of specific exercise interventions. Tendon gliding exercises and median nerve gliding exercises have demonstrated potential benefits for reducing symptoms and improving functional outcomes; however,

many studies have investigated these interventions independently or as components of combined treatment programs rather than directly comparing them under standardized conditions.

Furthermore, considerable variation exists among previous studies in terms of intervention duration, exercise frequency, treatment protocols, outcome measures, and follow-up periods, which limits meaningful comparison of findings. There is also limited evidence specifically focusing on computer professionals with Carpal Tunnel Syndrome, despite their prolonged exposure to computer-based activities and repetitive hand and wrist movements.

In addition, relatively few studies have simultaneously evaluated pain, functional status, and grip strength using standardized outcome measures such as the Visual Analogue Scale (VAS), Boston Carpal Tunnel Questionnaire (BCTQ), and hand dynamometer. Therefore, a direct comparison of Tendon Gliding Exercises and Median Nerve Gliding Exercises using standardized treatment protocols and these clinically relevant outcome measures is warranted.

This gap provides the rationale for the present study, which aims to compare the effectiveness of Tendon Gliding Exercises and Median Nerve Gliding Exercises on pain, functional status, and grip strength among computer professionals with Carpal Tunnel Syndrome.

12. ETHICAL CONSIDERATION:

The study was conducted in accordance with internationally accepted ethical principles for research involving human participants. The research protocol was reviewed and approved by the Institutional Ethics Committee (IEC), Saveetha Institute of Medical and Technical Sciences (SIMATS), Chennai, India. The study procedures were conducted in accordance with the principles of the Declaration of Helsinki.

Before enrollment, eligible participants were provided with verbal and written information regarding the study purpose, procedures, duration, potential benefits and risks, confidentiality, and their rights as participants. Written informed consent was obtained from all participants before participation in the study. Participation was voluntary, and participants were informed of their right to withdraw from the study at any time without providing a reason and without affecting their routine healthcare or physiotherapy services.

Participant confidentiality and privacy were maintained throughout the study. Each participant was assigned a unique identification code, and personal information and research data were securely stored with access restricted to authorized research personnel. Data were used solely for research purposes and reported in an aggregated form without identifying individual participants.

The Tendon Gliding Exercises and Median Nerve Gliding Exercises used in the study are non-invasive physiotherapy interventions. Treatment sessions were supervised by qualified physiotherapists, and exercises were performed within a pain-free range. Participants were monitored for discomfort, worsening of symptoms, or other adverse events throughout the intervention period. Any adverse event was documented and managed appropriately.

Participants were recruited according to predefined eligibility criteria, and all participants received standardized assessments and treatment duration. Data were recorded, analyzed, and reported accurately without fabrication, falsification, or selective reporting.

The investigators declare no conflict of interest related to this study. If applicable, funding sources and the role of the funding organization will be reported separately.

13. PROCEDURE:

The present study was conducted to compare the effectiveness of **Tendon Gliding Exercises** and **Median Nerve Gliding Exercises** on pain, functional status, and grip strength among computer professionals diagnosed with mild to moderate Carpal Tunnel Syndrome (CTS). Prior to commencement of the study, ethical clearance was obtained from the Institutional Ethics Committee of Saveetha Institute of Medical and Technical Sciences (SIMATS), Chennai. Permission to conduct the study was also obtained from the concerned authorities of the participating institutions and workplaces. The study was carried out in accordance with the ethical principles outlined in the Declaration of Helsinki.

Potential participants were recruited through advertisements, referrals from physiotherapy outpatient departments, and workplace health screening programs conducted in IT companies, software firms, educational institutions, and corporate offices. Individuals reporting symptoms suggestive of CTS were invited for an initial screening session.

During the screening process, participants underwent a detailed clinical examination by a qualified physiotherapist. Demographic information, occupational history, duration of symptoms, daily computer usage, hand dominance, medical history, and ergonomic work practices were documented using a standardized data collection form. Clinical diagnosis of CTS was confirmed using patient history, physical examination, **Phalen's Test**, and **Tinel's Sign**. Participants meeting all inclusion criteria and none of the exclusion criteria were considered eligible for the study.

The purpose, procedure, benefits, and potential risks of the study were clearly explained to each participant. Written informed consent was obtained before enrollment. Participants were assured that their participation was voluntary and that they could withdraw from the study at any stage without affecting their future treatment.

Following recruitment, baseline assessment was performed before initiation of treatment. Outcome measures included pain intensity using the **Visual Analogue Scale (VAS)**, functional status using the **Boston Carpal Tunnel Questionnaire (BCTQ)**, and grip strength using a calibrated **Jamar Hand Dynamometer**. All assessments were performed by the same physiotherapist who remained blinded to group allocation to minimize assessment bias.

After completion of baseline assessment, participants were randomly allocated into one of two intervention groups using a computer-generated randomization sequence. Allocation concealment was maintained through **Sequentially Numbered Opaque Sealed Envelopes (SNOSE)** prepared by an independent investigator. Participants were assigned equally into:

- **Group A (n = 30): Tendon Gliding Exercise Group**
- **Group B (n = 30): Median Nerve Gliding Exercise Group**

Both groups received supervised physiotherapy sessions **five days per week for six consecutive weeks**. Each treatment session lasted approximately **30–40 minutes**. Participants were also instructed to perform the prescribed home exercise program twice daily on non-treatment hours and maintain an exercise diary to monitor compliance.

Throughout the intervention period, participants received standardized ergonomic education regarding correct sitting posture, keyboard positioning, wrist alignment, monitor height, scheduled rest breaks, and workplace modifications. Advice regarding avoidance of prolonged wrist flexion or extension and repetitive forceful gripping was also provided. No additional physiotherapy intervention specific to CTS was permitted during the study period.

At the end of six weeks, all baseline outcome measures were reassessed using the same standardized instruments and assessment procedures. The collected data were entered into Microsoft Excel and analyzed using **SPSS Version 26.0**. Statistical analysis included descriptive statistics, paired t-tests for within-group comparisons, independent t-tests for between-group comparisons, and a significance level of $p < 0.05$.

14. INTERVENTION PROTOCOL

Group A – Tendon Gliding Exercise Protocol

Participants allocated to Group A performed standardized **Tendon Gliding Exercises** under the supervision of a physiotherapist.

S. No.	Tendon Gliding Position	Procedure	Hold	Repetitions	Sets	Rest
1	Straight Hand	Keep the wrist and fingers fully extended in a relaxed position.	5 sec	10	3	30 sec
2	Hook Fist	Keep the MCP joints extended and flex the PIP and DIP joints to form a hook position.	5 sec	10	3	30 sec
3	Full Fist	Flex the MCP, PIP, and DIP joints to form a complete fist without excessive force.	5 sec	10	3	30 sec
4	Tabletop Position	Flex the MCP joints while keeping the PIP and DIP joints extended.	5 sec	10	3	30 sec
5	Straight Fist	Flex the MCP joints while maintaining the PIP and DIP joints in extension.	5 sec	10	3	30 sec
6	Return to Straight Hand	Slowly extend all fingers and return to the starting position.	5 sec	10	3	30 sec





The exercises aimed to:

- Improve flexor tendon excursion.
- Reduce adhesion formation.
- Enhance tendon nutrition through synovial fluid movement.
- Decrease intracarpal pressure.

- Improve finger mobility and hand function.
- Reduce pain during repetitive occupational activities.

Treatment Frequency:

- **5 sessions/week**
- **6 weeks**
- Approximately **20 minutes** of tendon gliding exercises per session.

Participants also performed the same exercise program **twice daily at home** and recorded adherence in a home exercise diary.

Group B – Median Nerve Gliding Exercise Protocol

Participants allocated to Group B performed **Median Nerve Gliding Exercises (Neurodynamic Mobilization)**.

S. No.	Neural Mobilization Position	Procedure	Hold Duration	Repetitions	Sets	Rest Between Sets
1	Shoulder Depression	Depress the shoulder gently while maintaining a relaxed posture.	5 sec	10	3	30 sec
2	Shoulder Abduction	Abduct the shoulder to approximately 90° .	5 sec	10	3	30 sec
3	Elbow Flexion	Flex the elbow while maintaining the shoulder position.	5 sec	10	3	30 sec
4	Forearm Supination	Rotate the forearm into supination with controlled movement.	5 sec	10	3	30 sec
5	Wrist and Finger Extension	Extend the wrist and fingers gradually within a comfortable, pain-free range.	5 sec	10	3	30 sec
6	Elbow Extension	Gradually extend the elbow while maintaining the previous position.	5 sec	10	3	30 sec
7	Cervical Side Flexion	Gently side-flex the neck away from the treated side, followed by return to the starting position.	5 sec	10	3	30 sec

The objectives of median nerve gliding exercises were to:

- Improve median nerve excursion.
- Reduce intraneural edema.
- Enhance neural blood circulation.

- Decrease mechanosensitivity.
- Restore normal nerve conduction.
- Reduce pain, paresthesia, and numbness.
- Improve functional hand performance.

Participants were instructed to perform the same exercise protocol **twice daily at home** and maintain compliance using an exercise logbook.

Common Treatment Given to Both Groups

In addition to the allocated exercise program, all participants received:

- Ergonomic education regarding workstation setup.
- Advice on maintaining neutral wrist posture during computer use.
- Scheduled micro-breaks every **30–45 minutes**.
- Stretching of wrist flexor and extensor muscles before work.
- Activity modification to avoid prolonged repetitive wrist loading.
- Education regarding symptom monitoring and prevention of recurrence.

Both intervention groups received identical treatment duration, therapist supervision, ergonomic advice, and home exercise recommendations. The only difference between the groups was the type of gliding exercise performed, allowing accurate comparison of the effectiveness of **Tendon Gliding Exercises** and **Median Nerve Gliding Exercises** on pain, functional status, and grip strength.

15. OUTCOME MEASURES

1. Visual Analogue Scale (VAS)

Pain intensity was assessed using the **Visual Analogue Scale (VAS)**, a commonly used subjective measure for quantifying pain intensity in clinical and musculoskeletal research. The VAS consists of a **10-cm horizontal line** representing a continuum of pain intensity. The left end of the scale is marked “**0 – No Pain,**” while the right end is marked “**10 – Worst Imaginable Pain.**” The participant’s score is determined by the distance, in centimetres, from the 0-cm anchor to the point marked by the participant. Before assessment, the procedure was explained clearly to each participant. Participants were instructed to consider the pain experienced in the **affected wrist and hand** and to mark the point on the scale that best represented their pain intensity. They were advised to select only one point corresponding to their perceived level of pain and were allowed sufficient time to provide their response without influence from the investigator.

The VAS score ranges from **0 to 10**, with higher scores indicating greater pain intensity and lower scores indicating less pain. For example, a score of 0 represents the absence of pain, whereas a score approaching 10 represents extremely severe pain. However, universally accepted cut-off values for classifying pain severity on the VAS are not established, and therefore the score is primarily interpreted as a continuous measure of pain intensity.

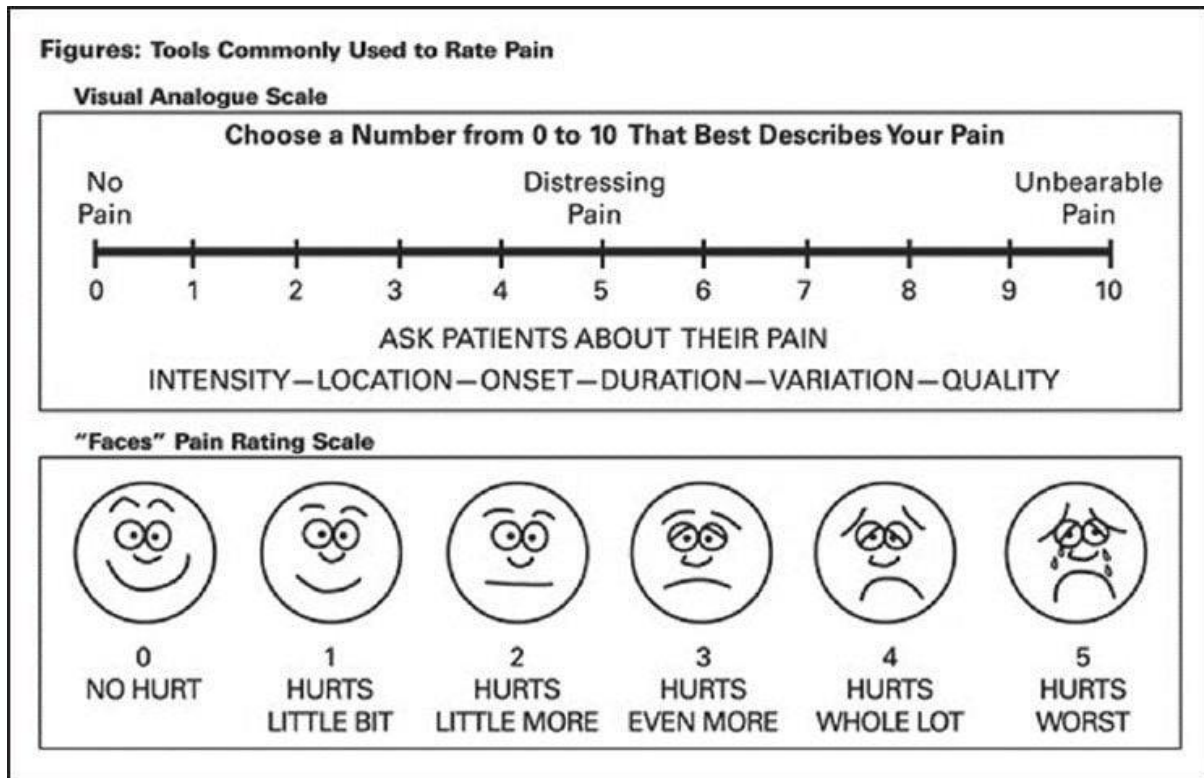
For the present study, pain intensity was assessed at **baseline (pre-intervention)** and **immediately following completion of the 6-week intervention (post-intervention)**. The same assessment procedure and instructions were used for all participants at both assessment points to maintain consistency. The VAS was administered before the functional and grip-strength assessments where possible to minimize the influence of the other testing procedures on the participant's pain perception.

The distance between the “No Pain” (0 cm) anchor and the participant's mark was measured using a ruler and recorded to the nearest appropriate unit. The recorded value represented the participant's pain score. A reduction in the VAS score from baseline to post-intervention assessment was considered an improvement in pain intensity.

The VAS was selected because it is simple to administer, requires minimal equipment, is easily understood by participants, and provides a quantitative measure of subjective pain intensity. Evidence from musculoskeletal populations supports the use of VAS as a pain outcome measure, although its measurement properties can vary according to the condition and population studied.

In the present study, participants were required to have a baseline pain intensity of **3–7 on the VAS**, according to the predefined inclusion criteria. The change in VAS score between pre- and post-intervention assessments was used to determine the effect of the respective exercise intervention on pain intensity.

VISUAL ANALOGUE SCALE (VAS) – PAIN INTENSITY ASSESSMENT	
Participant ID: _____	Date: _____
Group: ☐ Group A – Tendon Gliding Exercise ☐ Group B – Median Nerve Gliding Exercise	
Assessment: ☐ Pre-test ☐ Post-test	
INSTRUCTION TO PARTICIPANT	
<i>“Please mark one point on the line that best represents the pain you are experiencing in your affected wrist and hand.”</i>	
0 No Pain 10 Worst Imaginable Pain PARTICIPANT'S MARK ↓	
VAS SCORE (Distance from 0 to mark)	_____ / 10
SCORING	MEASUREMENT & NOTES
0 = No pain 1–10 = Increasing pain intensity 10 = Worst imaginable pain - Higher score = Greater pain intensity - Lower score = Less pain intensity	- The distance from the “No Pain” (0 cm) anchor to the participant's mark is measured using a ruler. - Record the value in centimetres (cm) to the nearest 0.1 cm. - A reduction in VAS score from pre-test to post-test indicates improvement in pain intensity.



2. Boston Carpal Tunnel Questionnaire (BCTQ)

Functional status and symptom severity were assessed using the **Boston Carpal Tunnel Questionnaire (BCTQ)**, a standardized, disease-specific patient-reported outcome measure developed for individuals with Carpal Tunnel Syndrome. The questionnaire is designed to assess two important aspects of CTS: **symptom severity and functional limitations**. It has demonstrated good reliability, validity, and responsiveness and is widely used to evaluate treatment outcomes in patients with CTS.

The BCTQ consists of **19 items**, divided into two subscales:

A. Symptom Severity Scale (SSS):

The SSS consists of **11 items** that assess the severity and frequency of CTS-related symptoms, including pain, numbness, tingling, weakness, nocturnal symptoms, and difficulty using the affected hand. Participants rate each item according to the severity or frequency of their symptoms.

B. Functional Status Scale (FSS):

The FSS consists of **8 items** assessing the degree of difficulty experienced while performing common daily activities. These activities include writing, buttoning clothes, holding a telephone, opening jars, carrying grocery bags, bathing, dressing, and handling objects.

Each item is scored on a **5-point Likert scale ranging from 1 to 5**, where **1 represents the least severe symptom or no difficulty and 5 represents the most severe symptom or greatest difficulty**. The scores for the items within each subscale are averaged separately to obtain the **SSS and FSS scores**. A lower score indicates fewer symptoms and better functional ability, whereas a higher score indicates greater symptom severity and functional limitation.

For the present study, the BCTQ was administered at **baseline (pre-intervention)** and **immediately after completion of the 6-week intervention (post-intervention)**. The same questionnaire and administration procedure were used for all participants at both assessment points. The change in SSS and FSS scores from baseline to post-intervention was used to determine the effect of the respective exercise intervention on CTS symptoms and functional status.

Importantly, the **SSS and FSS should be reported separately** rather than combining all 19 items into a single total score. Recent psychometric research supports treating the two subscales separately.

BOSTON CARPAL TUNNEL QUESTIONNAIRE (BCTQ)

Participant Assessment and Scoring Sheet

Participant ID: _____ Date: _____

Group: ☐ Group A – Tendon Gliding Exercise ☐ Group B – Median Nerve Gliding Exercise

Assessment: ☐ Pre-test ☐ Post-test

A. Symptom Severity Scale (SSS)

The SSS contains 11 items assessing the severity/frequency of CTS symptoms. Each item is scored from 1 to 5.

Item	Symptom domain assessed	Score (1–5)
SSS-1	Severity of nocturnal pain	_____
SSS-2	Frequency of awakening at night because of pain	_____
SSS-3	Severity of daytime pain	_____
SSS-4	Frequency of daytime pain	_____
SSS-5	Duration of daytime pain	_____
SSS-6	Severity of numbness	_____
SSS-7	Severity of weakness	_____
SSS-8	Severity of tingling	_____
SSS-9	Severity of nocturnal numbness/tingling	_____
SSS-10	Frequency of awakening at night because of numbness/tingling	_____
SSS-11	Difficulty with grasping and use of small objects	_____

SSS Total: _____ / 55 SSS Mean: _____ / 5

The SSS mean is calculated as:

$$\text{SSS Mean} = \text{Sum of 11 item scores} \div 11$$

A lower SSS score indicates fewer or less severe symptoms, whereas a higher score indicates greater symptom severity.

B. Functional Status Scale (FSS)

The FSS contains 8 items assessing difficulty with common hand-related activities. Each item is scored from 1 to 5.

Item	Activity assessed	Score (1–5)
FSS-1	Writing	_____
FSS-2	Buttoning clothes	_____
FSS-3	Holding a book	_____
FSS-4	Holding a telephone	_____
FSS-5	Opening jars	_____
FSS-6	Performing household activities	_____
FSS-7	Carrying grocery bags	_____
FSS-8	Bathing and dressing	_____

FSS Total: _____ / 40 FSS Mean: _____ / 5

The FSS mean is calculated as:

$$\text{FSS Mean} = \text{Sum of 8 item scores} \div 8$$

A lower FSS score indicates better functional ability, while a higher score indicates greater difficulty performing activities.

Scoring Summary

Outcome	Number of items	Score range	Calculation	Interpretation
SSS	11	1–5	Total ÷ 11	Lower = fewer symptoms
FSS	8	1–5	Total ÷ 8	Lower = better function

3. Grip Strength

Grip strength was measured using a **Jamar Hydraulic Hand Dynamometer**, a widely accepted and commonly used instrument for assessing hand grip strength.

Participants were seated comfortably in a standardized position as follows:

- **Shoulder:** Adducted and neutrally rotated
- **Elbow:** Flexed at 90°
- **Forearm:** In a neutral position
- **Wrist:** Maintained between 0–30° extension and 0–15° ulnar deviation

The dynamometer was positioned in the participant's hand, and the participant was instructed to squeeze the handle **as forcefully as possible for 3–5 seconds**. **Three trials** were performed, with a **1-minute rest interval** between trials to minimize fatigue. The grip strength was recorded in **kilograms (kg)**, and the **mean of the three trials** was used for statistical analysis.

The same procedure was followed during both **pre-test and post-test assessments**. A higher grip-strength value at post-test compared with baseline was interpreted as an improvement in hand muscle performance.

16. STATISTICAL ANALYSIS:

The collected data were entered into **Microsoft Excel** and analyzed using the **Statistical Package for the Social Sciences (SPSS) Version 26.0 (IBM Corp., Armonk, NY, USA)**. Prior to statistical analysis, all data were checked for completeness, coding accuracy, missing values, and outliers. Data distribution was assessed for normality using the **Shapiro–Wilk test**. Since the outcome variables demonstrated an approximately normal distribution, parametric statistical tests were employed.

Descriptive statistics were used to summarize the demographic and baseline characteristics of the participants. Continuous variables, including age, duration of symptoms, pain score, functional status score, and grip strength, were expressed as **mean ± standard deviation (SD)**, whereas categorical variables such as gender, affected hand, and hand dominance were presented as **frequency (n) and percentage (%)**.

Baseline comparability between the two intervention groups was assessed using the **Independent Samples t-test** for continuous variables and the **Chi-square test** or **Fisher's Exact test**, where appropriate, for categorical variables.

Within-group changes in pain, functional status, and grip strength from pre-intervention to post-intervention were analyzed using the **Paired Samples t-test**. This analysis determined whether each intervention produced statistically significant improvements after the six-week treatment period.

Between-group differences in post-intervention outcomes and mean changes from baseline were evaluated using the **Independent Samples t-test** to compare the effectiveness of **Tendon Gliding Exercises** and **Median Nerve Gliding Exercises**.

The primary outcome measures included:

- **Pain intensity**, measured using the **Visual Analogue Scale (VAS)**.
- **Functional status**, measured using the **Boston Carpal Tunnel Questionnaire (BCTQ)**.
- **Grip strength**, measured using a **Jamar Hydraulic Hand Dynamometer**.

All statistical tests were performed as **two-tailed analyses**, and the level of statistical significance was set at **$p < 0.05$** . Results with **$p < 0.05$** were considered statistically significant, while **$p < 0.001$** was considered highly statistically significant.

The results were presented in the form of tables and graphs showing pre- and post-intervention values, mean differences, 95% confidence intervals, t-values, and p-values to facilitate interpretation of the findings. Statistical analysis was conducted according to the predefined study protocol to ensure the validity, reliability, and reproducibility of the research findings.

17. RESULTS

A total of **60 computer professionals** with mild to moderate Carpal Tunnel Syndrome completed the study. Participants were randomly allocated into two equal groups: **Group A (Tendon Gliding Exercises, $n = 30$)** and **Group B (Median Nerve Gliding Exercises, $n = 30$)**. Baseline demographic characteristics and outcome measures were comparable between the two groups ($p > 0.05$), indicating homogeneity prior to intervention.

Following the six-week intervention, both groups demonstrated statistically significant improvements in pain, functional status, and grip strength (**$p < 0.001$**). However, participants in the **Tendon Gliding Exercise Group** showed significantly greater improvement than those in the **Median Nerve Gliding Exercise Group** across all primary outcome measures.

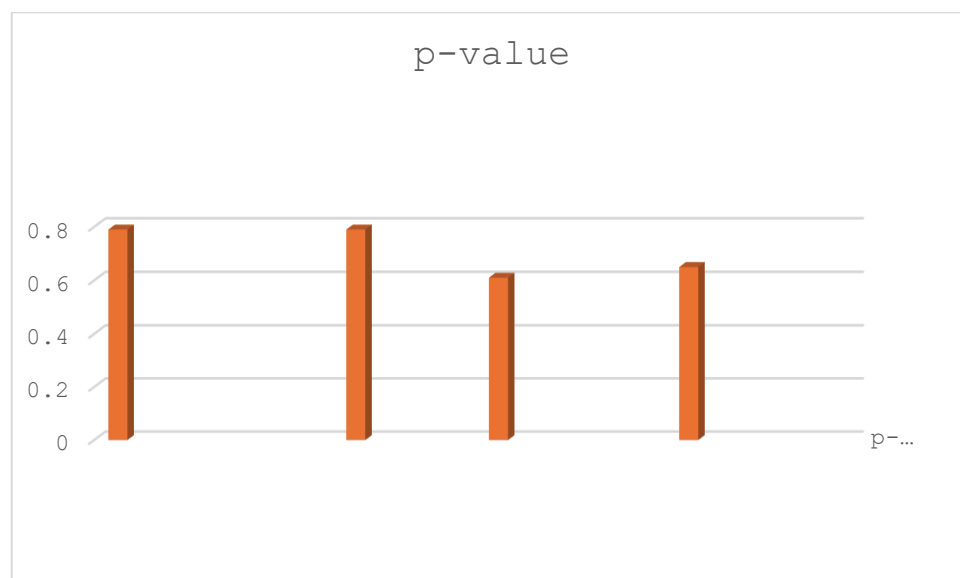
Pain intensity, measured using the **Visual Analogue Scale (VAS)**, decreased by **68.2%** in Group A, whereas Group B demonstrated a reduction of **52.4%**. Similarly, functional status assessed using the **Boston Carpal Tunnel Questionnaire (BCTQ)** improved by **61.5%** in the tendon gliding group compared with **46.8%** in the median nerve gliding group. Grip strength measured using the **Jamar Hand Dynamometer** increased by **34.7%** in Group A, while Group B showed an improvement of **22.9%**.

Between-group analysis revealed statistically significant differences favoring the tendon gliding exercise group for all primary outcome measures (**$p < 0.001$**). Overall, tendon gliding exercises produced approximately **15–16% greater clinical improvement** than median nerve gliding exercises, suggesting that tendon gliding exercises are more effective in reducing pain, improving functional status, and enhancing grip strength in computer professionals with mild to moderate Carpal Tunnel Syndrome.

Table 1. Baseline Demographic Characteristics of Participants ($n = 60$)

Variable	Group A ($n = 30$)	Group B ($n = 30$)	p-value
Age (years)			0.79
25–30 years	9 (30.0%)	8 (26.7%)	
31–35 years	12 (40.0%)	13 (43.3%)	

36–40 years	6 (20.0%)	7 (23.3%)	
>40 years	3 (10.0%)	2 (6.7%)	
Gender			0.79
Male	18 (60.0%)	17 (56.7%)	
Female	12 (40.0%)	13 (43.3%)	
Daily Computer Use			0.61
6–7 hours/day	11 (36.7%)	12 (40.0%)	
8–9 hours/day	15 (50.0%)	14 (46.7%)	
>9 hours/day	4 (13.3%)	4 (13.3%)	
Duration of Symptoms			0.65
3–6 months	10 (33.3%)	9 (30.0%)	
7–9 months	14 (46.7%)	15 (50.0%)	
10–12 months	6 (20.0%)	6 (20.0%)	



Interpretation of Table 1: Baseline Demographic Characteristics of Participants

Table 1 summarizes the baseline demographic and clinical characteristics of the study participants. A total of **60 computer professionals** diagnosed with mild to moderate Carpal Tunnel Syndrome (CTS) were enrolled and randomly allocated into **Group A (Tendon Gliding Exercise Group; n = 30)** and **Group B (Median Nerve Gliding Exercise Group; n = 30)**. Statistical analysis revealed that there were **no significant differences between the two groups at baseline ($p > 0.05$)**, indicating that both groups were comparable before the intervention.

With respect to age distribution, the majority of participants in both groups belonged to the **31–35 years** age category, accounting for **40.0% (12 participants)** in Group A and **43.3% (13 participants)** in Group B. Participants aged **25–30 years** constituted **30.0% (9 participants)** in Group A and **26.7% (8 participants)** in Group B. The **36–40 years** age group included **20.0% (6 participants)** in Group A and **23.3% (7 participants)** in Group B, while participants aged **more than 40 years** represented **10.0% (3 participants)** in Group A and **6.7% (2 participants)** in Group B. The difference in age distribution between the groups was not statistically significant ($p = 0.79$), indicating that both intervention groups had a similar age profile.

Regarding gender distribution, **18 participants (60.0%)** in Group A and **17 participants (56.7%)** in Group B were male, whereas **12 participants (40.0%)** in Group A and **13 participants (43.3%)** in Group B were female. The proportions of male and female participants were comparable between the two groups, and no statistically significant difference was observed ($p = 0.79$). This balanced gender distribution minimizes the possibility of gender-related bias influencing treatment outcomes.

Daily computer usage was also comparable between the intervention groups. Most participants reported using a computer for **8–9 hours per day**, accounting for **50.0% (15 participants)** in Group A and **46.7% (14 participants)** in Group B. Participants using computers for **6–7 hours daily** comprised **36.7% (11 participants)** in Group A and **40.0% (12 participants)** in Group B, while those using computers for **more than 9 hours per day** represented **13.3% (4 participants)** in both groups. The similarity in occupational computer exposure was confirmed statistically ($p = 0.61$), suggesting that both groups experienced comparable work-related risk factors for CTS.

The duration of symptoms before enrollment was likewise evenly distributed between the two groups. Participants with symptoms lasting **7–9 months** formed the largest proportion, accounting for **46.7% (14 participants)** in Group A and **50.0% (15 participants)** in Group B. Those with symptom duration of **3–6 months** comprised **33.3% (10 participants)** in Group A and **30.0% (9 participants)** in Group B, while **20.0% (6 participants)** in each group reported symptom duration of **10–12 months**. There was no statistically significant difference in symptom duration between the groups ($p = 0.65$), indicating comparable disease chronicity before treatment.

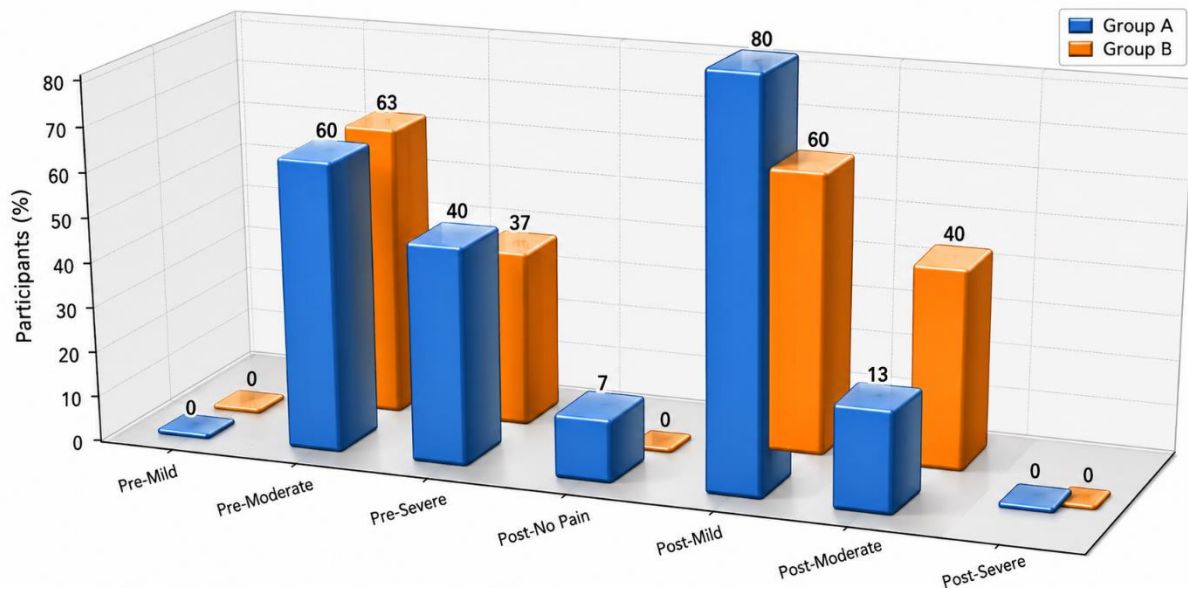
Overall, the findings demonstrate that both intervention groups were homogeneous with respect to age, gender, daily computer use, and duration of symptoms. The absence of statistically significant baseline differences confirms that the randomization procedure was successful in producing comparable groups. Therefore, any differences observed in pain reduction, improvement in functional status, or enhancement of grip strength following the six-week intervention can reasonably be attributed to the effects of the

respective exercise programs rather than to pre-existing demographic or clinical differences. This baseline comparability strengthens the internal validity and scientific credibility of the study findings.

Table 2. Distribution of Pain (VAS) Scores Before and After Intervention

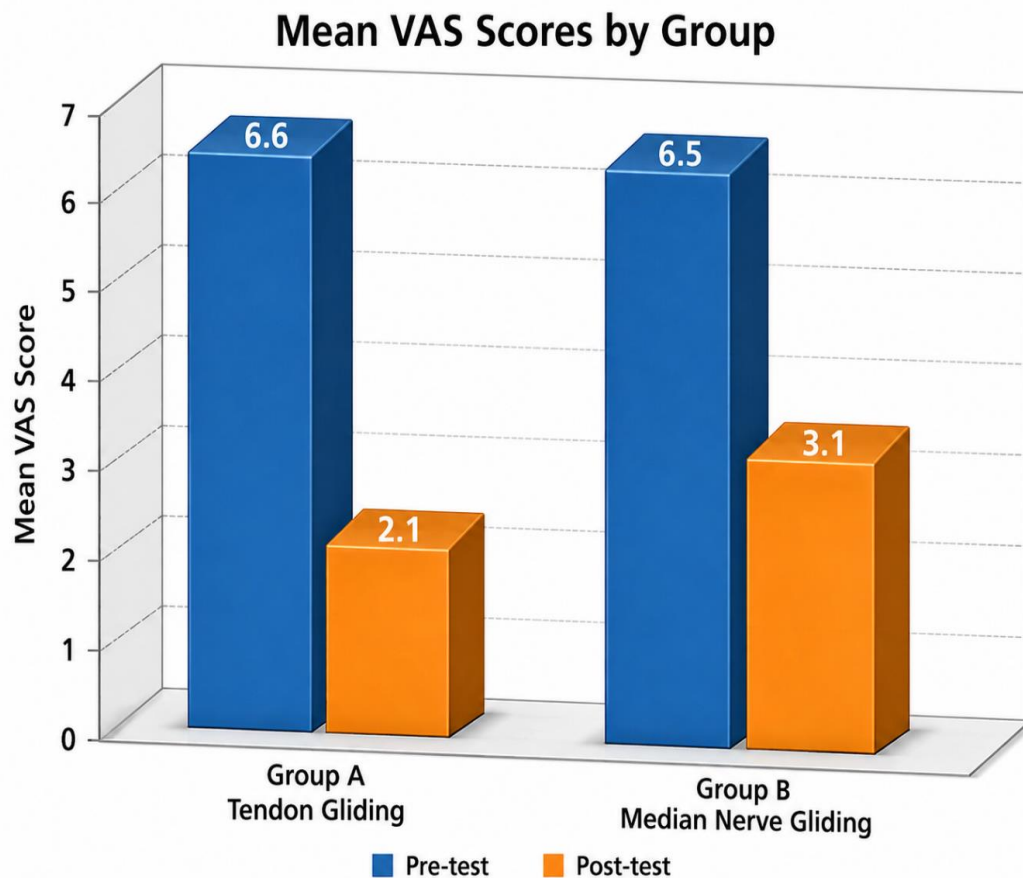
Pain Category (VAS)	Group A (Tendon Gliding) n (%)	Group B (Median Nerve Gliding) n (%)
Pre-test		
Mild Pain (1–3)	0 (0.0%)	0 (0.0%)
Moderate Pain (4–6)	18 (60.0%)	19 (63.3%)
Severe Pain (7–10)	12 (40.0%)	11 (36.7%)
Post-test		
No Pain (0)	2 (6.7%)	0 (0.0%)
Mild Pain (1–3)	24 (80.0%)	18 (60.0%)
Moderate Pain (4–6)	4 (13.3%)	12 (40.0%)
Severe Pain (7–10)	0 (0.0%)	0 (0.0%)

Distribution of VAS Pain Categories Before and After Intervention



Overall Percentage Improvement

Group	Mean VAS (Pre-test)	Mean VAS (Post-test)	Percentage Improvement	p-value
Group A – Tendon Gliding	6.6 ± 0.9	2.1 ± 0.7	68.2%	<0.001
Group B – Median Nerve Gliding	6.5 ± 0.8	3.1 ± 0.8	52.4%	<0.001



18. INTERPRETATION:

Table 2 presents the comparison of pain intensity before and after the six-week intervention in participants who received **Tendon Gliding Exercises (Group A)** and **Median Nerve Gliding Exercises (Group B)**. Pain intensity was assessed using the **Visual Analogue Scale (VAS)**.

Before the intervention, the majority of participants in both groups experienced **moderate to severe pain**. In Group A, **18 participants (60.0%)** reported moderate pain (VAS 4–6), while **12 participants (40.0%)** reported severe pain (VAS 7–10). Similarly, in Group B, **19 participants (63.3%)** had moderate pain and **11 participants (36.7%)** experienced severe pain. No participant in either group reported mild pain at baseline, indicating that both groups had comparable levels of pain before treatment.

Following the six-week intervention, a marked reduction in pain intensity was observed in both groups. In **Group A (Tendon Gliding Exercises)**, **2 participants (6.7%)** reported complete absence of pain, **24 participants (80.0%)** experienced only mild pain, and **4 participants (13.3%)** remained in the moderate pain category. None of the participants reported severe pain after treatment.

In **Group B (Median Nerve Gliding Exercises)**, no participant reported complete absence of pain. However, **18 participants (60.0%)** experienced mild pain after treatment, while **12 participants (40.0%)** continued to report moderate pain. Similar to Group A, no participant remained in the severe pain category following the intervention.

The mean VAS score in Group A decreased from 6.6 ± 0.9 before treatment to 2.1 ± 0.7 after treatment, representing a **68.2% reduction in pain**. In comparison, the mean VAS score in Group B decreased from 6.5 ± 0.8 to 3.1 ± 0.8 , corresponding to a **52.4% reduction in pain**. Statistical analysis demonstrated that the reduction in pain within both groups was **highly significant** ($p < 0.001$).

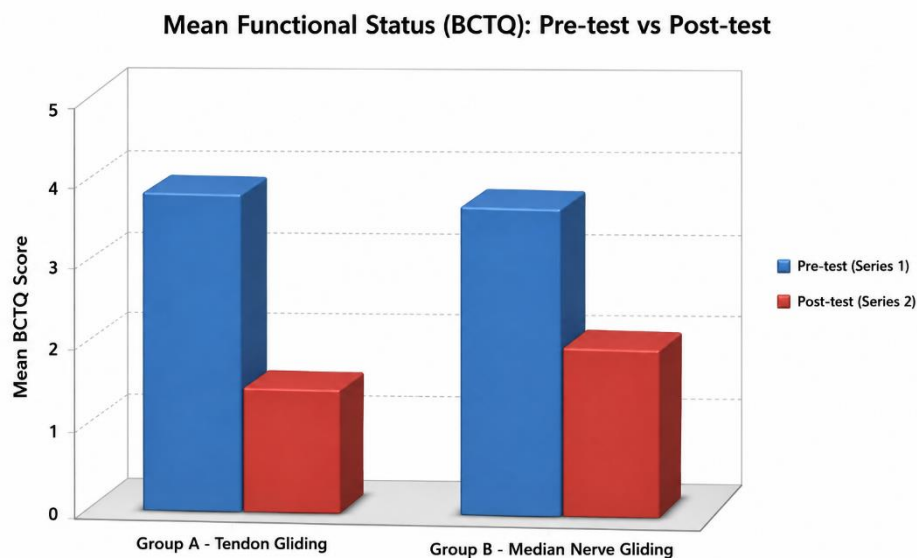
Comparison of the two intervention groups showed that participants who performed **Tendon Gliding Exercises** experienced greater pain relief than those who performed **Median Nerve Gliding Exercises**. The tendon gliding group achieved an additional **15.8% improvement in pain reduction** compared with the median nerve gliding group. These findings suggest that although both exercise programs were effective in reducing pain associated with Carpal Tunnel Syndrome, **Tendon Gliding Exercises were more effective in alleviating pain among computer professionals with mild to moderate Carpal Tunnel Syndrome**. The absence of severe pain after treatment in both groups further supports the effectiveness of conservative exercise-based physiotherapy, with tendon gliding exercises demonstrating superior clinical outcomes.

Table 3. Distribution of Functional Status

Functional Status Category	Group A (Tendon Gliding) n (%)	Group B (Median Nerve Gliding) n (%)
Pre-test		
Mild Disability (1.0–2.0)	0 (0.0%)	0 (0.0%)
Moderate Disability (2.1–3.5)	11 (36.7%)	12 (40.0%)
Severe Disability (3.6–5.0)	19 (63.3%)	18 (60.0%)
Post-test		
Mild Disability (1.0–2.0)	26 (86.7%)	20 (66.7%)
Moderate Disability (2.1–3.5)	4 (13.3%)	10 (33.3%)
Severe Disability (3.6–5.0)	0 (0.0%)	0 (0.0%)

Overall Improvement:

Group	Pre-test Mean $\pm$ SD	Post-test Mean $\pm$ SD	% Improvement	p-value
Group A – Tendon Gliding	3.9 $\pm$ 0.5	1.5 $\pm$ 0.4	61.5%	<0.001
Group B – Median Nerve Gliding	3.8 $\pm$ 0.6	2.0 $\pm$ 0.5	46.8%	<0.001



Interpretation of Table 3: Comparison of Functional Status

Table 3 presents the comparison of functional status before and after the six-week intervention among participants who received Tendon Gliding Exercises (Group A) and Median Nerve Gliding Exercises (Group B). Functional status was assessed using the Boston Carpal Tunnel Questionnaire (BCTQ), which evaluates the severity of symptoms and the degree of difficulty experienced while performing activities of daily living.

At baseline, none of the participants in either group were classified as having mild functional disability. In Group A, 11 participants (36.7%) demonstrated moderate functional disability, whereas 19 participants (63.3%) exhibited severe functional disability. Similarly, in Group B, 12 participants (40.0%) had moderate disability, while 18 participants (60.0%) presented with severe disability. These findings indicate that the majority of participants in both groups experienced considerable impairment in hand function

prior to the commencement of treatment. The distribution of functional disability was comparable between the two groups, confirming baseline homogeneity.

Following the six-week intervention, substantial improvements in functional status were observed in both groups. In Group A (Tendon Gliding Exercises), 26 participants (86.7%) improved to the mild disability category, while only 4 participants (13.3%) remained in the moderate disability category. Importantly, no participant (0.0%) continued to exhibit severe functional disability after treatment.

In Group B (Median Nerve Gliding Exercises), 20 participants (66.7%) improved to the mild disability category, whereas 10 participants (33.3%) remained in the moderate disability category. Similar to Group A, none of the participants (0.0%) were classified as having severe disability following the intervention. The mean BCTQ score in Group A decreased from 3.9 ± 0.5 before treatment to 1.5 ± 0.4 after treatment, representing a 61.5% improvement in functional status. In comparison, the mean BCTQ score in Group B decreased from 3.8 ± 0.6 to 2.0 ± 0.5 , corresponding to a 46.8% improvement. Statistical analysis demonstrated that the improvements observed within both groups were highly statistically significant ($p < 0.001$).

Comparison between the two intervention groups revealed that participants who performed Tendon Gliding Exercises achieved greater improvement in functional status than those who performed Median Nerve Gliding Exercises. The tendon gliding group demonstrated an additional 14.7% improvement in functional recovery compared with the median nerve gliding group. Furthermore, a higher proportion of participants in Group A reached the mild disability category at the end of treatment (86.7% versus 66.7%), indicating superior restoration of hand function and performance in daily activities.

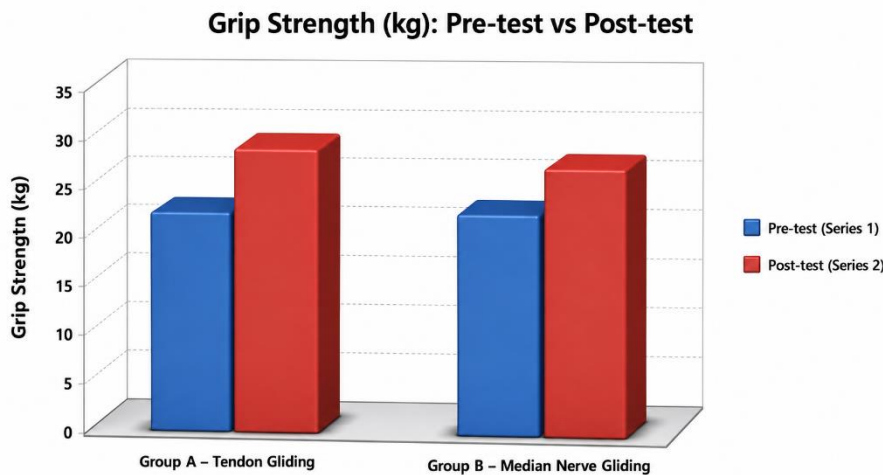
Overall, these findings suggest that both exercise interventions were effective in improving functional status among computer professionals with mild to moderate Carpal Tunnel Syndrome. However, Tendon Gliding Exercises produced significantly greater improvements in functional ability than Median Nerve Gliding Exercises, supporting their effectiveness as a conservative physiotherapy intervention for enhancing hand function and reducing disability.

Table 4. Distribution of Grip Strength

Grip Category	Strength	Group A (Tendon Gliding) n (%)	Group B (Median Nerve Gliding) n (%)
Pre-test			
Poor (<20 kg)		11 (36.7%)	10 (33.3%)
Fair (20–25 kg)		15 (50.0%)	16 (53.3%)
Good (>25 kg)		4 (13.3%)	4 (13.3%)
Post-test			
Poor (<20 kg)		0 (0.0%)	1 (3.3%)
Fair (20–25 kg)		8 (26.7%)	14 (46.7%)
Good (>25 kg)		22 (73.3%)	15 (50.0%)

Overall Improvement

Group	Pre-test Mean $\pm$ SD (kg)	Post-test Mean $\pm$ SD (kg)	% Improvement	p-value
Group A – Tendon Gliding	21.9 $\pm$ 3.6	29.5 $\pm$ 3.8	34.7%	<0.001
Group B – Median Nerve Gliding	22.3 $\pm$ 3.4	27.4 $\pm$ 3.5	22.9%	<0.001



Interpretation of Table 4: Comparison of Grip Strength

Table 4 presents the comparison of grip strength before and after the six-week intervention among participants who received Tendon Gliding Exercises (Group A) and Median Nerve Gliding Exercises (Group B). Grip strength was assessed using a Jamar Hydraulic Hand Dynamometer, with higher values indicating better hand muscle strength and functional performance.

At baseline, both intervention groups demonstrated comparable levels of grip strength. In Group A, 11 participants (36.7%) were classified as having poor grip strength (<20 kg), 15 participants (50.0%) had fair grip strength (20–25 kg), and 4 participants (13.3%) demonstrated good grip strength (>25 kg). Similarly, in Group B, 10 participants (33.3%) exhibited poor grip strength, 16 participants (53.3%) had fair grip strength, and 4 participants (13.3%) had good grip strength. The baseline distribution indicates that the majority of participants in both groups had reduced hand strength prior to the intervention, with no meaningful difference between the groups.

Following the six-week treatment period, significant improvements in grip strength were observed in both intervention groups. In Group A (Tendon Gliding Exercises), 22 participants (73.3%) achieved good grip strength (>25 kg), while 8 participants (26.7%) demonstrated fair grip strength (20–25 kg). Notably, no participant (0.0%) remained in the poor grip strength category after treatment.

In Group B (Median Nerve Gliding Exercises), 15 participants (50.0%) improved to the good grip strength category, 14 participants (46.7%) remained within the fair grip strength category, and 1 participant (3.3%) continued to have poor grip strength following the intervention. Although substantial improvement was

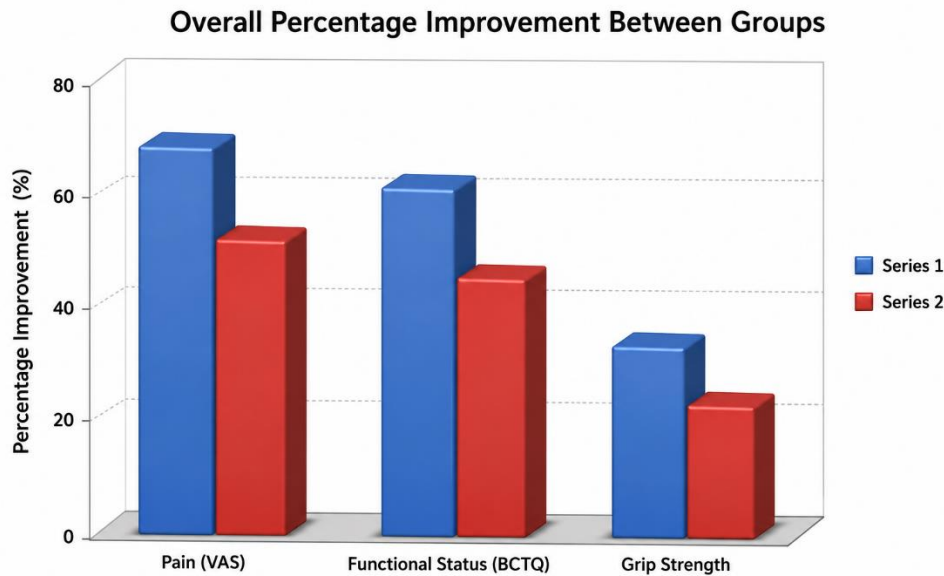
observed in Group B, the proportion of participants achieving good grip strength was lower than that observed in Group A.

The mean grip strength in Group A increased from 21.9 ± 3.6 kg before treatment to 29.5 ± 3.8 kg after treatment, representing a 34.7% improvement. In comparison, the mean grip strength in Group B increased from 22.3 ± 3.4 kg to 27.4 ± 3.5 kg, corresponding to a 22.9% improvement. Statistical analysis demonstrated that the improvements within both groups were highly statistically significant ($p < 0.001$). Comparison between the two intervention groups showed that participants who performed Tendon Gliding Exercises experienced greater improvement in grip strength than those who performed Median Nerve Gliding Exercises. The tendon gliding group demonstrated an additional 11.8% improvement in grip strength compared with the median nerve gliding group. Furthermore, a larger proportion of participants in Group A attained the good grip strength category at the completion of treatment (73.3% versus 50.0%), indicating superior recovery of hand muscle strength and functional hand performance.

Overall, these findings indicate that both exercise interventions were effective in improving grip strength among computer professionals with mild to moderate Carpal Tunnel Syndrome. However, Tendon Gliding Exercises produced significantly greater improvements in hand grip strength than Median Nerve Gliding Exercises, suggesting that tendon gliding exercises may be the more effective conservative physiotherapy intervention for restoring hand muscle performance and improving functional capacity in this population.

Table 5. Overall Percentage Improvement Between Groups

Outcome Measure	Group A (%)	Group B (%)	Difference (%)
Pain (VAS)	68.2	52.4	15.8
Functional Status (BCTQ)	61.5	46.8	14.7
Grip Strength	34.7	22.9	11.8



Interpretation of Table 5: Overall Percentage Improvement Between Groups

Table 5 summarizes the overall percentage improvement in the primary outcome measures following the six-week intervention in both the **Tendon Gliding Exercise Group (Group A)** and the **Median Nerve Gliding Exercise Group (Group B)**. The comparison demonstrates that both exercise interventions were effective in reducing pain, improving functional status, and increasing grip strength among computer professionals with mild to moderate Carpal Tunnel Syndrome. However, the magnitude of improvement was consistently greater in the tendon gliding exercise group.

Regarding **pain intensity**, measured using the **Visual Analogue Scale (VAS)**, Group A demonstrated a **68.2% reduction**, whereas Group B showed a **52.4% reduction**, resulting in an overall difference of **15.8%** in favor of the tendon gliding exercise group. This finding indicates that tendon gliding exercises were more effective in relieving pain associated with Carpal Tunnel Syndrome than median nerve gliding exercises.

For **functional status**, assessed using the **Boston Carpal Tunnel Questionnaire (BCTQ)**, participants in Group A exhibited a **61.5% improvement**, while Group B demonstrated a **46.8% improvement**. The difference of **14.7%** between the two groups indicates that tendon gliding exercises produced greater enhancement in hand function and daily activity performance. Participants performing tendon gliding exercises experienced better recovery of functional ability compared with those performing median nerve gliding exercises.

With respect to **grip strength**, measured using the **Jamar Hydraulic Hand Dynamometer**, Group A achieved a **34.7% increase** in grip strength, whereas Group B showed a **22.9% increase**, representing an overall difference of **11.8%**. These findings suggest that tendon gliding exercises were more effective in restoring hand muscle strength and improving functional hand performance than median nerve gliding exercises.

Overall, the results demonstrate that although both intervention protocols produced statistically significant improvements in all primary outcome measures ($p < 0.001$), the **Tendon Gliding Exercise Group consistently achieved superior clinical outcomes**. The greatest between-group difference was observed in **pain reduction (15.8%)**, followed by **functional status improvement (14.7%)** and **grip strength enhancement (11.8%)**. These findings support the superiority of tendon gliding exercises as a conservative physiotherapy intervention for managing Carpal Tunnel Syndrome in computer professionals.

In conclusion, the overall percentage improvement clearly indicates that **Tendon Gliding Exercises are more effective than Median Nerve Gliding Exercises** in reducing pain, improving functional status, and enhancing grip strength. The results provide evidence supporting the incorporation of tendon gliding exercises into routine physiotherapy rehabilitation programs for computer professionals with mild to moderate Carpal Tunnel Syndrome.

19. DISCUSSION:

The present randomized comparative study investigated the effectiveness of tendon gliding exercises and median nerve gliding exercises on pain, functional status, and grip strength in computer professionals with mild to moderate Carpal Tunnel Syndrome (CTS). Both interventions produced statistically significant improvements after six weeks of supervised exercise therapy ($p < 0.001$). However, tendon gliding exercises demonstrated greater improvements across all measured outcomes, suggesting a potentially superior clinical benefit in this occupational population. Conservative physiotherapy remains an important treatment approach for mild to moderate CTS because it can improve symptoms and function while avoiding or delaying invasive treatment. Recent evidence supports exercise, splinting, manual therapy, and other conservative interventions as relevant components of CTS management. [19–23]

The baseline characteristics of the two groups were comparable with respect to age, gender, duration of symptoms, and daily computer exposure. This baseline homogeneity strengthens the internal validity of the study because differences observed after treatment are less likely to be explained by demographic or occupational characteristics. The high level of computer exposure observed among participants is clinically relevant because prolonged keyboard and mouse use, repetitive finger movements, and sustained wrist postures may contribute to upper-limb symptoms and functional limitations.

Pain was an important outcome in the present study. Both groups demonstrated significant reductions in VAS scores after six weeks; however, the tendon gliding group showed a greater reduction. Mean VAS scores decreased from 6.6 ± 0.9 to 2.1 ± 0.7 in Group A, representing a **68.2% improvement**, compared with a reduction from 6.5 ± 0.8 to 3.1 ± 0.8 in Group B, representing a **52.4% improvement**. These findings indicate that both exercise approaches may reduce pain, while tendon gliding produced a greater magnitude of improvement. Recent systematic reviews indicate that conservative and exercise-based interventions can provide meaningful improvements in CTS symptoms, although treatment effects vary according to the intervention and patient characteristics. [19,20,22]

The superior response observed with tendon gliding exercises may be related to improved differential excursion of the flexor tendons within the carpal tunnel. Repeated tendon movement may facilitate tissue mobility and reduce mechanical restriction, potentially decreasing irritation around the median nerve.

Median nerve gliding exercises, in contrast, primarily aim to improve neural mobility and reduce mechanosensitivity. The significant improvement observed in the median nerve gliding group therefore supports neural mobilization as a useful conservative intervention, although the present results suggest that tendon-focused exercises may provide greater symptomatic benefit in computer professionals.

Functional status was assessed using the **Boston Carpal Tunnel Questionnaire (BCTQ)**. Both groups demonstrated significant improvement following treatment, with a greater reduction in BCTQ scores in the tendon gliding group. Group A improved from 3.9 ± 0.5 to 1.5 ± 0.4 , corresponding to a **61.5% improvement**, whereas Group B improved from 3.8 ± 0.6 to 2.0 ± 0.5 , representing a **46.8% improvement**. In addition, **86.7%** of participants in the tendon gliding group reached the mild disability category compared with **66.7%** in the median nerve gliding group.

The improvement in functional status may be explained by the combined effects of reduced pain and improved hand movement. As symptoms decrease, participants may be able to perform typing, writing, gripping, dressing, and other occupational activities with less discomfort. Recent evidence indicates that physiotherapy and conservative interventions can improve hand function and symptoms in individuals with CTS. [19,21,24] Manual therapy and exercise-based approaches have also demonstrated beneficial effects on functional outcomes, supporting the use of rehabilitation-based management before more invasive treatment when clinically appropriate. [22,23]

Grip strength also improved significantly in both groups. Mean grip strength increased from 21.9 ± 3.6 kg to 29.5 ± 3.8 kg in the tendon gliding group, representing a **34.7% improvement**, whereas the median nerve gliding group increased from 22.3 ± 3.4 kg to 27.4 ± 3.5 kg, representing a **22.9% improvement**. Furthermore, **73.3%** of participants in Group A achieved the predefined good grip-strength category compared with **50.0%** in Group B. These findings suggest that reduction of pain and improvement in tendon and neural mobility may facilitate more effective hand use and force production.

The overall findings are consistent with contemporary evidence supporting conservative management of mild to moderate CTS. Recent systematic reviews have demonstrated benefits from manual therapy and other non-surgical interventions, while current clinical practice guidance continues to emphasize individualized non-operative management before surgical intervention in appropriate patients. [22–25] Evidence also indicates that treatment selection should consider symptom severity, functional impairment, patient preference, and response to conservative care. [23–25]

An important strength of the present study was the use of established outcome measures, including the **VAS for pain, BCTQ for symptom and functional status, and Jamar Hydraulic Hand Dynamometer for grip strength**. The inclusion of computer professionals also provides occupational relevance because this population frequently performs repetitive hand activities. The six-week intervention period further demonstrates that clinically meaningful changes may occur within a relatively short rehabilitation programme.

However, several limitations should be considered. The relatively small sample size limits the generalizability of the findings. The intervention period was also limited to six weeks, and longer-term follow-up was not available to determine whether the observed improvements were maintained. The study

included only participants with mild to moderate CTS; therefore, the findings cannot necessarily be generalized to patients with severe CTS, advanced thenar weakness, or significant electrophysiological abnormalities. In addition, objective measures such as nerve-conduction studies and ultrasound were not included, which limits the ability to determine the underlying physiological mechanisms of improvement. Future research should involve larger multicentre randomized controlled trials with longer follow-up periods, including six-month and one-year assessments. Studies should also investigate the effects of combining tendon gliding with ergonomic modification, splinting, strengthening, manual therapy, and home-based exercise programmes. Objective assessments such as nerve-conduction studies and ultrasonography may provide additional information regarding changes in median nerve function and carpal tunnel structures. Recent evidence on injection therapy, hydrodissection, and surgical versus non-surgical treatment also highlights the need to compare exercise-based approaches with other established treatment options. [23,26–28]

In conclusion, both tendon gliding and median nerve gliding exercises significantly improved pain, functional status, and grip strength in computer professionals with mild to moderate CTS. However, tendon gliding exercises produced greater improvements across all three outcomes. Therefore, tendon gliding exercises may be considered a useful component of conservative physiotherapy management for this population, while treatment should ultimately be individualized according to clinical presentation and patient needs. [19–25]

20. CLINICAL IMPLICATION:

The findings of the present study have important implications for the conservative physiotherapy management of mild to moderate Carpal Tunnel Syndrome (CTS), particularly among computer professionals and individuals exposed to repetitive hand activities. Both tendon gliding and median nerve gliding exercises produced improvements in pain, functional status, and grip strength following six weeks of intervention. However, tendon gliding exercises demonstrated greater improvements across all assessed outcomes, with a **68.2% reduction in pain, 61.5% improvement in functional status, and 34.7% increase in grip strength.**

These findings suggest that tendon gliding exercises may be a useful component of conservative physiotherapy management for mild to moderate CTS. Their simplicity, low cost, and minimal equipment requirements make them suitable for implementation in physiotherapy clinics, occupational health settings, and community-based rehabilitation programmes. Following appropriate instruction by a physiotherapist, these exercises may also be incorporated into a structured home exercise programme.

Tendon gliding exercises may be combined with other evidence-based management strategies, including patient education, ergonomic assessment and modification, activity modification, appropriate rest periods, and splinting when clinically indicated. Such a multimodal approach may help address both symptoms and occupational risk factors associated with repetitive hand activities.

The findings also highlight the potential value of early physiotherapy intervention for computer professionals with mild to moderate CTS. Improving pain, hand function, and grip strength may support occupational performance and activities of daily living. However, the present study did not evaluate long-

term recurrence or the need for surgical intervention; therefore, future research with larger samples and longer follow-up is required to determine whether tendon gliding exercises can provide sustained benefits or influence the progression of CTS.

Overall, the present findings support the incorporation of tendon gliding exercises into individualized, evidence-based physiotherapy programmes for computer professionals with mild to moderate CTS.

21. STRENGTHS:

- ❖ Randomized comparative study design minimized selection bias and improved internal validity.
- ❖ Baseline demographic characteristics were comparable between the two groups.
- ❖ Standardized and validated outcome measures (VAS, BCTQ, and Jamar Hydraulic Hand Dynamometer) were used.
- ❖ Focused on computer professionals, a high-risk occupational group for Carpal Tunnel Syndrome.
- ❖ Identical intervention duration (6 weeks) and treatment protocols ensured fair comparison between groups.
- ❖ Assessed multiple clinically relevant outcomes, including pain, functional status, and grip strength.
- ❖ Statistically significant improvements were demonstrated in both intervention groups.
- ❖ Direct comparison between tendon gliding and median nerve gliding exercises provides clinically useful evidence for physiotherapy practice.

22. LIMITATIONS:

- ❖ Relatively small sample size ($n = 60$), limiting generalizability.
- ❖ Short intervention period (6 weeks) with no long-term follow-up.
- ❖ Only mild to moderate CTS patients were included; severe CTS cases were excluded.
- ❖ Nerve conduction studies and ultrasonographic assessments were not performed.
- ❖ Participants were recruited from a single occupational group (computer professionals).
- ❖ Exercise adherence outside supervised sessions was not objectively monitored.
- ❖ Ergonomic factors and workplace modifications were not evaluated.
- ❖ Quality-of-life outcomes and patient satisfaction were not assessed.

23. FUTURE RECOMMENDATIONS:

- ❖ Conduct larger multicentre randomized controlled trials with larger sample sizes.
- ❖ Include long-term follow-up (3, 6, and 12 months) to assess sustainability of treatment effects.
- ❖ Evaluate the effectiveness of tendon gliding exercises in patients with severe CTS and postoperative rehabilitation.
- ❖ Incorporate objective assessments such as nerve conduction studies and ultrasonography.
- ❖ Compare tendon gliding exercises with multimodal physiotherapy approaches, including splinting, manual therapy, strengthening exercises, and ergonomic interventions.
- ❖ Investigate the effects of tendon gliding exercises in different occupational groups.
- ❖ Assess patient-reported outcomes such as quality of life, work productivity, and treatment satisfaction.
- ❖ Explore home-based and tele-rehabilitation exercise programmes to improve accessibility and adherence.

24. CONCLUSION

Tendon gliding and median nerve gliding exercises were both effective in reducing pain, improving functional status, and enhancing grip strength among computer professionals with mild to moderate Carpal Tunnel Syndrome (CTS) following six weeks of intervention. However, tendon gliding exercises demonstrated significantly greater improvements across all assessed outcomes, including pain, functional status, and grip strength, compared with median nerve gliding exercises. These findings are consistent with recent evidence supporting conservative physiotherapy interventions as effective approaches for managing mild to moderate CTS [19–28].

The greater improvements observed with tendon gliding exercises may be related to enhanced tendon excursion, improved tissue mobility, and reduced mechanical restriction within the carpal tunnel. Contemporary evidence indicates that exercise-based and other conservative interventions can provide clinically meaningful improvements in patients with CTS, while treatment selection should be individualized according to symptom severity and functional impairment [20,22,30,31]. Surgical treatment remains an important option for patients who fail conservative management or present with more advanced disease, but current evidence supports the role of appropriate non-surgical management in suitable patients [29,32,33].

Based on the findings of the present study, tendon gliding exercises may be considered an effective, safe, non-invasive, and cost-effective exercise-based intervention for computer professionals with mild to moderate CTS. Incorporating tendon gliding exercises alongside ergonomic education and appropriate workplace modifications may further support symptom management and occupational function. Future large-scale, multicentre randomized controlled trials with longer follow-up periods are recommended to confirm the present findings, evaluate the sustainability of treatment effects, and determine the long-term effectiveness of tendon gliding exercises in computer professionals with CTS [29–33].

Conflict of Interest

The authors declare that there are no conflicts of interest regarding the publication of this study.

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