ijlpr 2024; doi 10.22376/ijlpr.2024.14.4.L20-L25

International Journal of Life science and Pharma Research

ISSN 2250-0480

Research Article

Physiotherapy

Effectiveness of Contrast Bath and Nerve Gliding Exercises in Carpal Tunnel Syndrome Among Software Workers

K. Kirupa[1*], Bhimana. Anupama[2], Muthulakshmi.K[3], Saraswathi.K[4] and Srisaisanthoshini[5]

[1]*Assistant professor, Faculty of physiotherapy, Dr. M.G.R Educational & Research Institute University, Velappanchavadi, Chennai77, Tamilnadu, India.*

[2,5]*MPT student Faculty of physiotherapy, Dr. M.G.R Educational & Research Institute University, Velappanchavadi, Chennai77, Tamilnadu, India*

[3,4]*Lecturer, Faculty of physiotherapy, Dr. M.G.R Educational & Research Institute University, Velappanchavadi, Chennai77, Tamilnadu, India*

Abstract: Carpal Tunnel Syndrome (CTS) is a complex symptom resulting from compression of the median nerve at the carpal tunnel. Locations of monitors, keyboard (or) mouse are associated with musculoskeletal problems. Among musculoskeletal problems, Carpal tunnel syndrome (CTS) is commonly reported in computer professionals. The purpose of this study was to examine the effectiveness of contrast bath and nerve gliding exercises for carpal tunnel syndrome in software workers. 30 subjects (20 males and 10 females) were participating in this study based on inclusion and exclusion criteria. They were assigned into groups Group A and B with 15 subjects each. Group A (Experimental group) received Contrast bath and Nerve Gliding Exercises, while Group B (Control group) received conventional exercises for the wrist. The outcome measures used were NPRS and ROM. Statistical analysis was done using paired-t test. On comparing the pre-test and post-tests within Group A & Group B on the Numerical Pain Rating Scale (NPRS), wrist flexion and extension Range of Motion (ROM) show a significant difference in mean values at $P \leq 0.001$. There was a significant difference in the mean values of NPRS (6.33 to 3.40), wrist flexion (54.00 to 72.66), and wrist extension (55.66 to 72.80) in subjects from Group A who underwent contrast bath and nerve gliding exercises, compared to the significant difference in the mean values of NPRS (6.26 to 4.46), wrist flexion (53.66 to 63.00), and wrist extension (56.00 to 61.66) in subjects from Group B, which served as the control group.

Keywords: Carpal tunnel syndrome, contrast bath, nerve gliding exercises, NPRS (Numerical pain rating scale), Goniometer.

***Corresponding Author**

K.Kirupa , Assistant professor, Faculty of physiotherapy, Dr. M.G.R Educational & Research Institute University, Velappanchavadi, Chennai77, Tamilnadu, India.

Received On 12 October 2022

Revised On 3 June 2024

Accepted On 6 September 2024

Published On 15 October 2024

Funding This research did not receive any specific grant from any funding agencies in the public, commercial or not for profit sectors.

Citation K. Kirupa, Bhimana. Anupama, Muthulakshmi.K, Saraswathi.K and Srisaisanthoshini , Effectiveness of Contrast Bath and Nerve Gliding Exercises in Carpal Tunnel Syndrome Among Software Workers.(2024).Int. J. Life Sci. Pharma Res.14(4), L20-L25 http://dx.doi.org/10.22376/ijlpr.2024.14.4.L20-L25

1. INTRODUCTION

Carpal tunnel syndrome (CTS) is a peripheral neuropathy at the wrist caused by compression of the median nerve within the carpal tunne [1]. Computers have been extensively used worldwide over the last several decades, leading to a significant growth in the number of people working with computers for longer durations [2]. Several studies have reported a positive association between computer use and musculoskeletal symptoms[3]. Postural stress due to poor workstation ergonomics such as the inappropriate location of the monitor, keyboard or mouse are associated with musculoskeletal disorders[4]. Carpal tunnel syndrome (CTS) is commonly reported in computer professionals[5]. Trauma caused by repetitive hand motion has been identified as an aggravating factor for carpal tunnel syndrome, especially in persons whose work requires repeated forceful finger and wrist flexion and extension[6]. The incidence of carpal tunnel syndrome has been reported high among women compared to men [7], common among working with vibrating machinery and office workers especially typist and data entry clerks [8]. Carpal tunnel syndrome is a complex of symptoms resulting from compression of the median nerve at the carpal tunnel[9]. Symptoms of median nerve compression include pain, numbness or tingling on the anterior surface of the index, middle or radial half of the ring finger. It is often associated with weakness of handgrip nocturnal symptoms, including hand or arm pain and numbness. Provocative physical examination techniques such as Tinel's sign, Phalen's sign, and two-point discrimination tests have been used for the clinical diagnosis of this condition[10]. A contrast bath is a therapeutic immersion of the body part alternatively in hot and cold water that increases the local blood circulation[11]. The contrast bath was performed by warm and cold compresses using a towel that has been soaked in hot water (41°c –43°c) and cold water (10°c –18°c) alternatively in the wrist area for 20 minutes. Recently, several narrative reviews have advocated nerve gliding exercises as the alternative for traditionally treatment modalities in the conservative management of carpal tunnel syndrome (CTS) [12]. Moreover, in postoperative care, early mobilization and nerve gliding exercises are recommended. The beneficial effects of these exercises may include direct mobilization of the nerve, facilitation of venous return, edema dispersal, decrease of pressure inside the perineurium, and decrease of carpal tunnel pressure. The median nerve gliding exercises in clinical trials for carpal tunnel syndrome (CTS) were proposed by Totten and Hunter [13]. This sequence of positions progressively elongates the median nerve bed (the tract formed by the structures surrounding the nerve) to slide the median nerve through the carpal tunnel [14]. Joint movements alter the length of the nerve bed and induce gliding of the nerve relative to its surrounding structures[15]. Often, first-line treatment for CTS is regarded to be conservative management. In severe forms of sensory or motor deficiency, injectable therapy or, in extreme cases, surgery may be considered. Yet, CTS is frequently challenging to cure and may reappear. Ugbolue UC, et al., conducted a study on tendon and nerve displacement during finger movements at the wrist, revealing that the median nerve and finger flexor tendons move simultaneously in all anatomical directions. Prolonged and repeated movement of these structures could contribute to conditions like carpal tunnel syndrome (CTS) and other hand problems.[16] Furthermore, Pinar L, et al., also identified that nerve gliding has rapidly reduced pain and improved functional ability in CTS. Lee, et al., studied the effect of paraffin bath and contrast bath on the cosmetologists of the CTS described that paraffin baths and hot-and-cold contrast baths were excellent treatments to enhance hand care and hand functionality among cosmetologists [17]. Further research is required to investigate other diagnostic and treatment techniques given the unknown and highly complex pathophysiology of CTS. The aim of this study is to validate the effectiveness of Contrast bath with Nerve Gliding Exercises in CTS. This study demonstrated a combination of hydrotherapy and neurodynamic technique on CTS. It also will further enhance the physiotherapist's understanding of the novel treatment regimens and an assortment of therapies accessible for the management of CTS [18-22]. The aim of the study is to determine the effectiveness of contrast bath and nerve gliding exercises in carpal tunnel syndrome among software workers.

2. METHODOLOGY

2.1. Selection of Subjects

This work has been conducted for 2 months in the Department of Physiotherapy, ACS Medical College and Hospital. The study design was experimental and randomisation of the individuals was done using a simple randomized method. A total of 30 subjects aged 30 to 45 were included in this study from HTC Global Services, Tambaram Chennai based on inclusion and exclusion criteria.

Inclusion criteria

- Software workers diagnosed with carpal tunnel syndrome
- Subjects between the ages of 30 to 45
- Usage of computer for more than one year
- Subjects with informed consent and willing to participate in the study

Exclusion criteria

- Cervical radiculopathy
- Diabetes mellitus
- Recent fractures
- Recent surgeries in hand
- Hypothyroidism
- Use of analgesics
- Subjects who underwent recent physiotherapy interventions

After the thorough explanation of the protocols to all the participants, they were provided with a consent form approved by the ethical committee. Then, subjects were divided into two groups with 15 subjects in each group. Group-A (experimental group) were treated with contrast bath and Nerve Gliding Exercise, and Group-B (control group) subjects were treated with conventional exercises of wrist flexion and extension, squeezing of the ball and shaking of the hand.

2.2. Interventions

2.3. Group-A

2.3.1. Contrast Bath

A contrast bath is a method which can reduce pain by soaking parts of the body that experience pain alternatively with hot

and cold water. The wrist area is soaked in hot water (41°c – 43°c) and cold water (10°c –18°c), alternatively. This procedure causes vasodilation and vasoconstriction, respectively which increases the local blood circulation. This procedure was conducted to the Group-A subjects. Hot water was introduced for 3-5 minutes, while cold water was for 1 minute for a total of 20 minutes daily in 5 days per 8 weeks.

2.3.2. Nerve Gliding Exercise

Median nerve gliding exercises are carried out with the patient in a sitting position that varies according to the patient's ability to relax the proximal musculature. The head is placed in the midline and the shoulder in a neutral position; the forearm is placed on a chair arm or table, and the elbow is positioned at 90 degrees of flexion. Each nerve gliding exercise position was held for 3 minutes with a repeated series of 3-5 times for a total of 20 minutes daily in 5 days per 8 weeks.

2.4. Group-B

- Conventional exercises of wrist
- Flexion of wrist
- Extension of wrist
- Squeezing of the ball
- Shaking of hand
- Wrist splints and wrist braces

Duration of intervention: 20 minutes daily in 5 days per 8 weeks.

2.5. Outcome Measures

The pre- and post -intervention assessment was done using outcome pain and Range of motion. The Numerical Pain Rating Scale (NPRS) was used to assess the pain level. The Goniometer was used to measure the Range of Motion.

2.6. Ethical Considerations

The study is approved by the Institutional Review Board of the F aculty of Physiotherapy (1RB REF NO: Iv C- 050/ PHYSIO/ IRB/2017-2018). All the procedures were performed by the ethical standards of the responsible ethics committee both (Institutional and N ational) on human experimentation and the Helsinki Declaration of 1964 (as revised in 2008).

2.7. Statistical analysis

The collected data were tabulated and analysed using descriptive and inferential statistics. All the parameters were assessed using Statistical Package for Social Science (SPSS) version 24. A paired t-test was adopted to find the statistical difference within the groups & independent t-test (Student t-test) was used to identify the statistical difference between the groups.

3. RESULTS

Table 1: Baseline Demographics And Characteristics

Variables	Experimental Group (n=15)	Control Group (n=15)
Age	38+7	38+6
Gender:		
Male	10	9
Female	5	6
BMI grading:		
<25	6	7
>25	9	8
Years of computer work:		
1-4	5	4
4-8	4	6
>8	6	5
Hours of computer work per day:		
<8	3	2
8-12	8	9
>12	4	4
Internet use (leisure time):		
Yes	9	10
No	6	5

On comparing the mean values of Group A & Group B on Numerical Pain Rating Scale Score, it shows a significant decrease in the post test Mean values in both groups, but (Group A - Contrast Bath and Nerve gliding exercises) shows 3.40 which has the lower mean value is more effective than (Group B - Control Group) 4.46 at P ≤ 0.001[Table 2]. Hence the null Hypothesis is rejected. On comparing the mean values of Group A & Group B on Wrist Flexion and Extension Range of Motion (ROM), it shows a significant Increase in the post test mean values in both groups, but (Group A - Contrast Bath and Nerve gliding exercises) shows 72.66 & 72.80 degrees which has the higher mean value is more effective than (Group B - Control Group) 63.00 & 61.66 degrees at P ≤ 0.001 [Table 3 & 4]. Hence the null Hypothesis is rejected. On comparing Pre-test and Post-test within Group A & Group B on Numerical Pain Rating Scale, wrist flexion and extension Range of Motion shows highly significant difference in mean values at P ≤ 0.001[Table 5].

Table-2 Comparison of Numerical Pain Rating Scale Score Between Group-A and Group–B In Pre And Post Test

#TEST	#GROUP - A		#GROUP - B		t - TEST	df	SIGNIFICANCE
	MEAN	S.D	MEAN	S.D			
PRE TEST	6.33 + 0.723		6.26 + 0.798		.240	28	.812*
POST TEST	3.40 + 0.828		4.46 + 0.743		-3.71	28	.000***

The table 2 presents a comparison of Numerical Pain Rating Scale scores between Group A and Group B before and after an intervention. Pre-test scores show that both groups had similar pain levels (Group A: 6.33 ± 0.723, Group B: 6.26 ± 0.798) with no significant difference ($t(28) = 0.240$, $p = 0.812$). Post-test scores indicate a significant reduction in pain for Group A (3.40 ± 0.828) compared to Group B (4.46 ± 0.743), with a highly significant difference ($t(28) = -3.71$, $p < 0.001$).

Table – 3: Comparison of Wrist Flexion Range of Motion Between Group – A and Group – B in Pre and Post Test

#TEST	#GROUP - A		#GROUP - B		t - TEST	df	SIGNIFICANCE
	MEAN	S.D	MEAN	S.D			
PRE TEST	54.00 + 6.86		53.66 + 6.39		.138	28	.892*
POST TEST	72.66 + 3.19		63.00 + 3.68		7.67	28	.000***

The table 3 compares the wrist flexion range of motion between Group A and Group B before and after an intervention. Initially, both groups had similar wrist flexion, with Group A having a mean of 54.00 degrees (SD = 6.86) and Group B having a mean of 53.66 degrees (SD = 6.39). The pre-test t-test value of 0.138 with 28 degrees of freedom and a significance level of 0.892 indicated no significant difference between the groups. After the intervention, both groups showed improvement, but Group A's mean wrist flexion increased significantly to 72.66 degrees (SD = 3.19), while Group B's increased to 63.00 degrees (SD = 3.68). The post-test t-test value was 7.67 with 28 degrees of freedom and a significance level of 0.000, highlighting a highly significant difference between the groups in favor of Group A. This indicates that the intervention was more effective for Group A.

Table – 4: Comparison of Wrist Extension Range of Motion Between Group – A and Group - B in Pre- And Post-Test

#TEST	#GROUP - A		#GROUP - B		t - TEST	df	SIGNIFICANCE
	MEAN	S.D	MEAN	S.D			
PRE TEST	**55.66 + 4.57**		**56.00 + 3.87**		**-.215**	28	.831*
POST TEST	72.80 + 3.83		61.66 + 3.61		8.17	28	.000***

The table 4 compares the wrist extension range of motion between Group A and Group B before and after an intervention. Pre-test measurements indicate similar wrist extension for both groups (Group A: 55.66 ± 4.57, Group B: 56.00 ± 3.87) with no significant difference ($t(28) = -0.215$, $p = 0.831$). Post-test results show a significant improvement in wrist extension for Group A (72.80 ± 3.83) compared to Group B (61.66 ± 3.61), with a highly significant difference ($t(28) = 8.17$, $p < 0.001$).

Table – 5: Comparison of Numerical Pain Rating Scale Score Within Group – A & Group – B Between Pre & Post Test Values

#GROUP	PRE TEST		POST TEST		t - TEST	SIGNIFICANCE
	MEAN	S.D	MEAN	S.D		
GROUP- A	6.33 + 0.723		3.40 + 0.828		16.14	.000***
GROUP- B	6.26 + 0.798		4.46 + 0.743		16.83	.000***

The table5 compares the Numerical Pain Rating Scale scores within Group A and Group B between pre- and post-test values. Group A shows a significant reduction in pain from a pre-test mean of 6.33 ± 0.723 to a post-test mean of 3.40 ± 0.828, with a highly significant difference ($t = 16.14$, $p < 0.001$). Similarly, Group B also exhibits a significant decrease in pain from a pre-test mean of 6.26 ± 0.798 to a post-test mean of 4.46 ± 0.743, with a highly significant difference ($t = 16.83$, $p < 0.001$).

4. DISCUSSION

The study aimed to assess the efficacy of contrast bath therapy and nerve gliding exercises in managing carpal tunnel syndrome (CTS) among software workers [23]. A total of 30 participants from HTC Global Services in Chennai were selected based on specific criteria and underwent interventions for 8 weeks. Group A received contrast bath therapy and nerve gliding exercises, while Group B was instructed to avoid repetitive hand activities and continue with conventional wrist exercises, splinting, and braces [24]. Before and after the intervention, participants' pain levels and wrist range of motion (ROM) were assessed using the NPRS and ROM scores [25]. After 8 weeks statistical analysis revealed significant difference in mean value of NPRS (6.33 to 3.40), wrist flexion (54.00 to 72.66), wrist extension (55.66 to 72.80) values in subject in Group- A who underwent contrast bath and nerve gliding exercises than the significant difference in mean value of mean value of the NPRS (6.26 to 4.46), wrist flexion (53.66 to 63.00), wrist extension (56.00 to 61.66) values in subject in Group- B which is control group there by proving the alternative hypothesis. Statistical analysis revealed significant improvements in pain reduction and increased wrist flexion and extension ROM in Group A compared to Group B. These findings support previous research. According to

Jessica did a study on effectiveness of contrast bath among clients with sprains and strains in the ankle and foot [26]. The study result reported that there was a reduction in the level of pain in the ankle and foot with the use of contrast bath. Janseen conducted a randomized controlled study of contrast baths on Carpel Tunnel Syndrome and concluded that the use of contrast bath was effective in hand volumetry values among clients with carpel tunnel syndrome [27]. Totten defined and developed "nerve gliding exercises" for the purpose of increasing the mobility of the median nerve after surgery in patients with CTS [28]. These exercises, which help the nerve to glide first in the distal segments and later in the CT and forearm, are begun with the nerve in its most relaxed position and are undertaken with the goal of maintaining or increasing its movement to 10 to 15 mm [29]. Nerve gliding exercises are considered to have several effects, such as improving venous return in the related nerve segment, decreasing pressure inside the tunnel, and stretching adhesions. The study's results highlight the effectiveness of contrast bath therapy and nerve gliding exercises in reducing pain and improving ROM in software workers with CTS [30]. However, limitations such as the short duration, inclusion of a specific age group, small sample size, and lack of long-term follow-up should be considered. Further research with larger sample sizes and longer follow-up periods is warranted to validate these findings and better understand the efficacy of these interventions in managing CTS among software workers.

5. CONCLUSION

This study concludes that contrast bath therapy and nerve gliding exercises play a significant role in reducing pain intensity and increasing range of motion (ROM), thereby promoting overall well-being in subjects with carpal tunnel syndrome compared to the control group after an 8-week intervention. The findings suggest that the implementation of contrast bath therapy and nerve gliding exercises can effectively alleviate symptoms and enhance functional outcomes in individuals with carpal tunnel syndrome.

6. AUTHORS' CONTRIBUTION STATEMENT

The study was designed and conceptualized by Kirupa K., with sample collection conducted by Bhimana Anupama. Data analysis and interpretation were collaboratively carried out by Muthulakshmi K., Saraswathi K., and Srisaisanthoshini, ensuring a comprehensive approach to analyzing the findings.

7. CONFLICT OF INTEREST

Conflict of interest declared none.

8. REFERENCES

1. Punnett L, Bergqvist U. Visual display unit work and upper extremity musculoskeletal disorders. Stockholm: National Institute for Working Life. 1997;997.
2. Jensen C, Finsen L, Søgaard K, Christensen H. Musculoskeletal symptoms and duration of computer and mouse use. International journal of industrial ergonomics. 2002 Oct 1;30(4-5):265-75.
3. Jensen C, Ryholt CU, Burr H, Villadsen E, Christensen H. Work-related psychosocial, physical and individual factors associated with musculoskeletal symptoms in computer users. Work & Stress. 2002 Jun 1;16(2):107-20.
4. Demure B, Luippold RS, Bigelow C, Ali D, Mundt KA, Liese B. Video display terminal workstation improvement program: I. Baseline associations between musculoskeletal discomfort and ergonomic features of workstations. Journal of occupational and environmental medicine. 2000 Aug 1;42(8):783-91.
5. Karlqvist L. Avoid the mouse-trap! Musculoskeletal injuries can be reduced by placing the mouse within shoulder space. Lakartidningen. 1998 Sep 1;95(36):3768-71.
6. Bergqvist U, Wolgast E, Nilsson B, Voss M. Musculoskeletal disorders among visual display terminal workers: individual, ergonomic, and work organizational factors. Ergonomics. 1995 Apr 1;38(4):763-76.
7. McDiarmid M, Oliver M, Ruser J, Gucer P. Male and female rate differences in carpal tunnel syndrome injuries: personal attributes or job tasks?. Environmental research. 2000 May 1;83(1):23-32.
8. Phillip E, Wright II. Carpal tunnel syndrome and ulnar tunnel syndromes and stenosing tenosynovitis. Campbell's operative orthopaedics. 9th ed. St. Louis, MO, USA: Mosby. 1998:3685-701.
9. Dorland WA. Dorland's illustrated medical dictionary. WB Saunders; 1925.
10. Gorsche RG, Wiley JP, Renger RF, Brant RF, Gemer TY, Sasyniuk TM. Prevalence and incidence of carpal tunnel syndrome in a meat packing plant. Occupational and Environmental Medicine. 1999 Jun 1;56(6):417-22.
11. Higgins TR, Heazlewood IT, Climstein M. A random control trial of contrast baths and ice baths for recovery during competition in U/20 rugby union. The Journal of Strength & Conditioning Research. 2011 Apr 1;25(4):1046-51.
12. Osterman AL, Whitman M, Della Porta L. Nonoperative carpal tunnel syndrome treatment. Hand clinics. 2002 May 1;18(2):279-89.
13. Totten PA, Hunter JM. Therapeutic techniques to enhance nerve gliding in thoracic outlet syndrome and carpal tunnel syndrome. Hand Clinics. 1991 Aug 1;7(3):505-20.
14. Seradge H, Jia YC, Owens W. In vivo measurement of carpal tunnel pressure in the functioning hand. The Journal of hand surgery. 1995 Sep 1;20(5):855-9.
15. Nathan PA, Meadows KD, Keniston RC. Rehabilitation of carpal tunnel surgery patients using a short surgical incision and an early program of physical therapy. The Journal of hand surgery. 1993 Nov 1;18(6):1044-50.
16. Byl C, Puttlitz C, Byl N, Lotz J, Topp K. Strain in the median and ulnar nerves during upper-extremity positioning. The Journal of hand surgery. 2002 Nov 1;27(6):1032-40.
17. Wright TW, Glowczewskie Jr F, Wheeler D, Miller G, Cowin D. Excursion and strain of the median nerve. JBJS. 1996 Dec 1;78(12):1897-903.
18. Martins A, Sá VW. Variation of skin temperature during and after contrast bath therapy. Revista Andaluza de Medicina del Deporte. 2011;4(4):129-34.

19. Kleinrensink GJ, Stoeckart R, Vleeming A, Snijders CJ, Mulder PG, van Wingerden JP. Peripheral nerve tension due to joint motion. A comparison between embalmed and unembalmed human bodies. Clinical Biomechanics. 1995 Jul 1;10(5):235-9.
20. Rozmaryn LM, Dovelle S, Rothman ER, Gorman K, Olvey KM, Bartko JJ. Nerve and tendon gliding exercises and the conservative management of carpal tunnel syndrome. Journal of Hand Therapy. 1998 Jul 1;11(3):171-9.
21. Akalin E, El Ö, Peker Ö, Senocak Ö, Tamci S, Gülbahar S, Çakmur R, Öncel S. Treatment of carpal tunnel syndrome with nerve and tendon gliding exercises. American journal of physical medicine & rehabilitation. 2002 Feb 1;81(2):108-13.
22. Byl C, Puttlitz C, Byl N, Lotz J, Topp K. Strain in the median and ulnar nerves during upper-extremity positioning. The Journal of hand surgery. 2002 Nov 1;27(6):1032-40.
23. Abdolrazaghi HA, Khansari M, Mirshahi M, Ahmadi Pishkuhi M. Effectiveness of tendon and nerve gliding exercises in the treatment of patients with mild idiopathic carpal tunnel syndrome: a randomized controlled trial. Hand. 2023 Mar;18(2):222-9.
24. Khallaf ME, Ameer MA, Fayed EE. Effect of task specific training and wrist-fingers extension splint on hand joints range of motion and function after stroke. NeuroRehabilitation. 2017 Jan 1;41(2):437-44.
25. Sobeck C, Lenk L, Knipper S, Rhoda A, Stickler L, Stephenson P. The effectiveness of functional massage on pain and range of motion measurements in patients with orthopedic impairments of the extremities. International Musculoskeletal Medicine. 2016 Jan 2;38(1):21-5.
26. Stanton DE, Lazaro R, MacDermid JC. A systematic review of the effectiveness of contrast baths. Journal of Hand Therapy. 2009 Jan 1;22(1):57-70.
27. Janssen RG, Schwartz DA, Velleman PF. A randomized controlled study of contrast baths on patients with carpal tunnel syndrome. Journal of Hand Therapy. 2009 Jul 1;22(3):200-8.
28. Rozmaryn LM, Dovelle S, Rothman ER, Gorman K, Olvey KM, Bartko JJ. Nerve and tendon gliding exercises and the conservative management of carpal tunnel syndrome. Journal of Hand Therapy. 1998 Jul 1;11(3):171-9.
29. Oonk JG, Dobbe JG, Strijkers GJ, Van Rijn SK, Streekstra GJ. Kinematic analysis of forearm rotation using four-dimensional computed tomography. Journal of Hand Surgery (European Volume). 2023 May;48(5):466-75.
30. Badawy WM. Comparative Effectiveness of Low Level Laser Therapy and Nerve Gliding Exercises on Patients with Carpal Tunnel Syndrome: a Randomized Clinical Trial. Chemtech. 2017;10(2):462-7.