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Effect of Muscle Energy Technique versus Graston Technique on non-specific neck pain

Efecto de la técnica de energía muscular versus la técnica de Graston sobre el dolor de cuello inespecífico

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ABSTRACT

Background: Numerous researches have been carried out in order to determine the most effective physical therapy strategy for treating nonspecific neck pain (NSNP). **Purpose**: To contrast between the outcomes of Graston Technique (GT) and Muscle Energy Technique (MET) on both pain intensity and functional disability in patients with NSNP. **Methods**: Forty-two (30 males and 12 females) patients with NSNP divided randomly into three groups: Group A*:* received Graston Technique and traditional physiotherapy treatment (TPT), Group B*:* received muscle energy technique and TPT, and

Group C*:* received TPT only. Intervention lasted for 12 sessions (3 per week). At the start and finish of the fourth week, a visual analogue scale was used to quantify pain intensity and a neck disability index (NDI) questionnaire was used to measure functional disability. **Results**: There were significant mean effects of time (pre/post) and intervention group (Graston, MET, conventional) and significant interaction on pain and disability ($p<0.05$). MET group had higher changes in the pain than both Graston and control groups ($p<0.05$). However, no significant differences among groups in the functional change. **Conclusion:** GT and MET had similar effects on the function in patients with NSNP, but MET had higher effects on reducing pain.

KEYWORDS

Non-specific neck pain; Neck disability; Graston Technique; Instrument-assisted soft tissue mobilization; Muscle energy technique

RESUMEN

Antecedentes: Numerosas investigaciones se han llevado a cabo con el fin de determinar la estrategia de fisioterapia más eficaz para el tratamiento del dolor de cuello inespecífico (NSNP). **Propósito:** contrastar los resultados de la Técnica de Graston (GT) y la Técnica de Energía Muscular (MET) tanto en la intensidad del dolor como en la discapacidad funcional en pacientes con NSNP. **Métodos:** Cuarenta y dos (30 hombres y 12 mujeres) pacientes con NSNP divididos aleatoriamente en tres grupos: Grupo A: recibieron técnica de Graston y tratamiento de fisioterapia tradicional (TPT), Grupo B: recibieron técnica de energía muscular y TPT, y Grupo C: recibieron TPT solamente. La intervención tuvo una duración de 12 sesiones (3 por semana). Al inicio y al final de la cuarta semana, se utilizó una escala analógica visual para cuantificar la intensidad del dolor y un cuestionario de índice de discapacidad del cuello (NDI) para medir la discapacidad funcional. **Resultados:** Hubo efectos significativos de tiempo (pre/post) y grupo de intervención (Graston, MET, convencional) e interacción significativa sobre el dolor y la discapacidad ($p<0,05$). El grupo MET tuvo mayores cambios en el dolor que los grupos Graston y control ($p<0,05$). Sin embargo, no hubo diferencias significativas entre grupos en el cambio funcional. **Conclusión:** GT y MET tuvieron efectos similares sobre la función en pacientes con NSNP, pero MET tuvo efectos más altos sobre la reducción del dolor.

PALABRAS CLAVE

Dolor de cuello inespecífico; discapacidad del cuello; Técnica de Graston; Movilización de tejidos blandos asistida por instrumentos; Técnica de energía muscular

1. INTRODUCTION

Neck pain affects 22 to 30% of the population (Yesim et al., 2009). Nonspecific neck pain (NSNP) is an ache in the neck whose cause and underlying pathophysiology are unknown (Bogduk, 2011). Certain professions have more persistent nonspecific neck discomfort suffering from ache or discomfort with lack of mobility in the cervical spine of unclear cause (Hidalgo et al., 2017). Poor biomechanical working conditions might induce nonspecific neck pain (Lv et al., 2018). As a result of muscle imbalances (upper crossed syndrome), the upper trapezius and levator scapulae muscles were overworking and needed to be restrained. Physical therapy is one of the most effective treatments of NSNP. Conventional physical therapies, including manual therapy technique have been shown to be effective in the management of chronic nonspecific neck pain in previous systematic reviews (Leaver et al., 2010). Muscle energy technique (MET) is a term composed of various types of active muscular relaxation and stretching procedures. The two cornerstone forms of MET are reciprocal inhibition and post isometric relaxation (Tsakitzidis et al., 2018). In theory, reciprocal inhibition takes advantage of the neurological phenomena of muscular contraction, which results in an inhibitory effect on the antagonistic muscles. For example, a contraction of the knee extensors will result in inhibition or relaxation of the knee flexors (Anthony, 2002). This is thought to be mediated by the muscle spindle afferent. The effect of post isometric relaxation, on the other hand, is said to be mediated by afferent input from the Golgi tendon organ. When a muscle is held in an isometric contraction, the afferent feedback leads to inhibition of the given muscle, which is thought to result in relaxation of the muscle when the contraction is released (Chaitow, 2006). Muscle energy technique is particularly effective in patients who have severe pain from acute somatic dysfunction, such as those with a whiplash injury from a car accident, or a patient with severe muscle spasm from a fall. MET is also an excellent treatment modality for hospitalized or bedridden patient. They can be used in older patients who may have severely restricted motion from arthritis, or who have brittle osteoporotic bones (Wilson & Donegan, 2003). The function of any articulation in the body which can be moved by voluntary muscle action, either directly or indirectly, can be influenced by MET procedures. MET can be used to lengthen a shortened, contracture or spastic muscle. It was used also to strengthen a physiologically weakened muscle or group of muscles, to reduce localized edema, and to mobilize an articulation with restricted mobility (Schenk et al., 1994). So it is an effective manual therapy technique in which hands-on therapy uses the patient's own voluntary muscle contractions to relieve discomfort, release tight muscles and fascia, enhance motor control, and increasing range of motion (Gupta et al., 2008). Studies on the effects of the muscular energy technique on NSNP have shown that both pain and functional disability are greatly reduced (Sharmila, 2014).

Graston technique (Gt) is a technique of mobilization of soft tissue using instruments which consider myofascial release instrument that has been reported to relieve pain, improve overall function, and increase range of motion (Garrett et al., 2019; Cheatham et al., 2019; Thompson et al., 2018). It enhances the ability of physical therapists to detect altered tissue properties, through the vibration sense within the instrument, and to treat soft tissue dysfunction. It also enhances the patient's perception of altered sensations of tissues which have been treated (Lee et al., 2014). As it is a tool of myofascial release can reduce the symptoms of NSNP (Kharwandikar & Shende., 2019; Arab & Ramezani, 2018). However, the Gt reduces the overall rehabilitation time (Kim et al., 2017). Allows less pressure and energy to be used, and increases the depth of treatable tissues (Carey, 2001). Also, the GT does not compress the tissues as the superficial fascial layer is easily mobilized to make the deeper restrictions more accessible (Crothers et al., 2008; McKivigan & Tulimero, 2020) reported that clinically significant improvements were achieved only when the GT was combined with the exercises.

Comparing the effect of MET versus Graston techniques, give clear feedback on the best technique to be added to the traditional physical therapy protocol in treatment of NSNP. Up to my knowledge there is lack in studies between Graston techniques and MET in NSNP. So, the aim of this study is to contrast between the outcomes of GT and MET on both pain intensity and functional disability in patients with NSNP.

2. METHODS

2.1. Design

A randomized controlled experimental pre-post measurement that performed at Helwan University Hospital's Physical Therapy Outpatient Clinic in Cairo, Egypt. Carried out to examine GT and MET impact on Nonspecific neck pain compared to conventional treatment. This study was approved by the ethical research committee, faculty of physical therapy, Cairo University and was conducted according code of ethics of Declaration of Helsinki (PT.REC/012/003998).

2.2. Participants

This study included forty-two (30 males and 12 females) patients with NSNP, diagnosed by the orthopedist. As, it is a pain originating in the neck region with unknown cause, their age between 40 and 60 years old. This study excluded any patient with: Symptoms or signs of upper motor neuron disease, vestibulobasilar insufficiency, and amyotrophic lateral sclerosis. Cervical spine fracture (Strunk & Hondras, 2008), Cases of disc prolapse that have been diagnosed (Ylinen et al., 2007), prior cervical or thoracic spine surgery (Nagrale et al., 2010). Patients with inclusive criteria, asked to sign the written consent form to participate in the study.

2.3. Randomization and allocation

Each participant was assigned a unique number, and then those numbers were randomly divided into three groups. **Group A:** received GT and (TPT). **Group B:** received MET treatment and (TPT). **Group C:** received traditional physiotherapy (TPT). All participants received 12 sessions over the course of four weeks (three sessions per week).

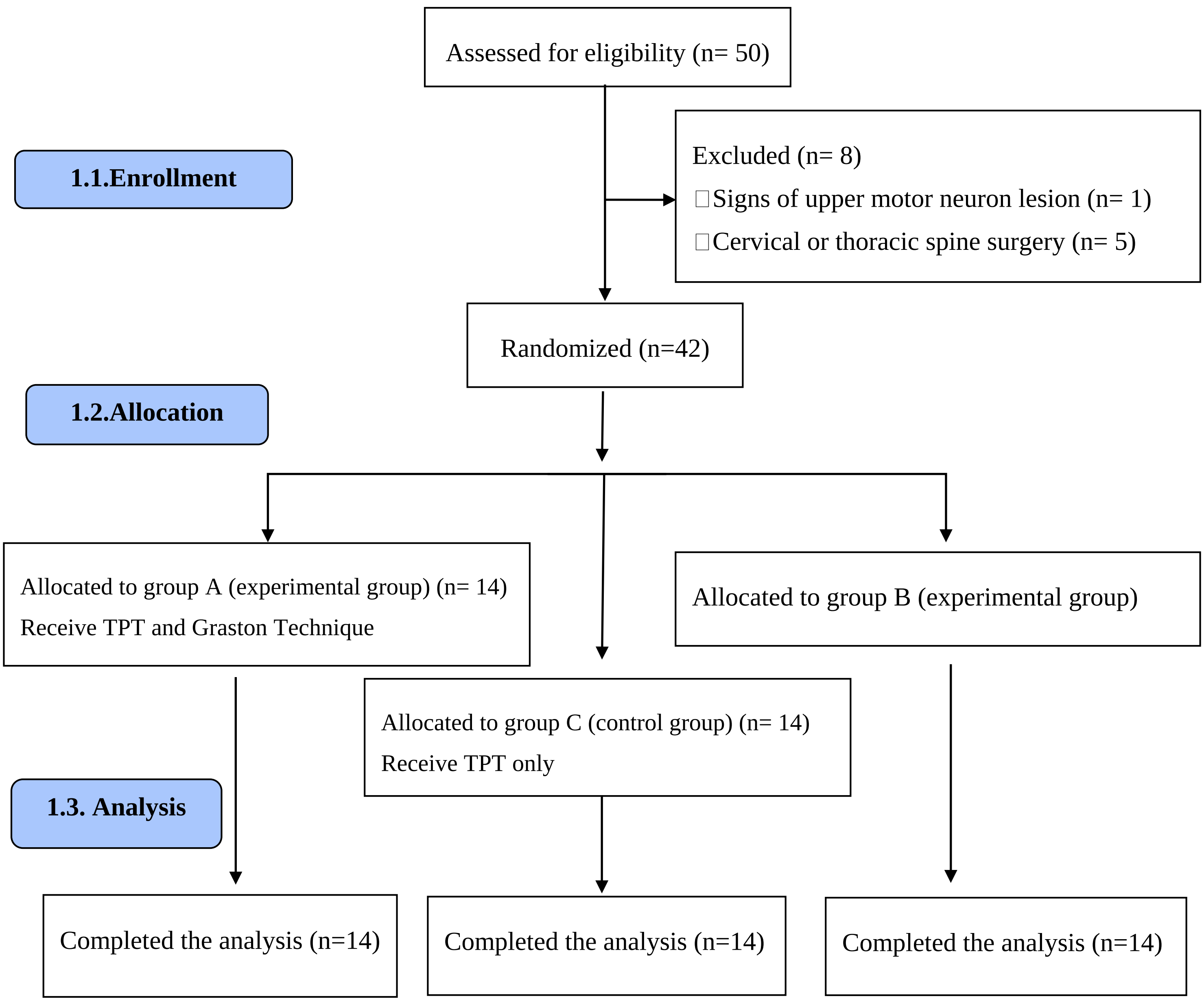

Figure 1. Flow chart of the participants

2.4. Treatment procedures

2.4.1. Traditional physiotherapy treatment (TPT) for control group

Infrared radiation was used for 15 minutes/session on back of neck region, 12-week program of treatment during which patient was positioned in prone position for the three sessions per week (Larson, 1999), with strengthening exercise of levator scapulae, upper fiber of trapezius. Two sets per session, each set consist of 10 repetitions.

2.4.2. Procedures for GT

Graston technique instrument was used to treat the affected area for 30 to 60 seconds per treated area. The procedure was applied to the superficial cervical fascia and investing the layers of deep cervical fascia that surround all the structures in the neck. Strokes were applied on the levator scapulae and upper fibers of trapezius muscles. The Graston technique was applied at a 45° angle in a direction parallel to the treated muscle fibers for 20 seconds, followed immediately by an additional 20-seconds application at a 45° angle in a perpendicular direction to the muscle fibers, resulting in a total treatment time of approximately 40 seconds. The patients were advised that they might be sore, bruised, or have small red dots, called petechiae, on the treated area. ice was applied for 15 to 20min after the treatment if there was a massive soreness (Baker, 2013; Kim et al.,2017; Gulick, 2014).

2.4.3. Procedures for MET

Patients in this group received traditional physiotherapy (TPT) in addition to muscle energy technique (as reciprocal inhibition technique type) for the upper trapezius and levator scapulae muscles. MET included stretching of the affected muscle, isometric contraction of the antagonist muscles with the 50% of total patient's effort was followed. This position holds for 10 seconds, while agonist's muscle was still in the stretched position, with 5 seconds of rest after every repetition. This procedure was repeated 5 times. The treatments occurred three times per week for a total of four weeks (Arif et al., 2020).

2.5. Outcome

2.5.1. Pain intensity (VAS)

It was utilized to evaluate the degree of pain both before and after treatment. Subjects were asked to rate their pain on a scale from 0 (no pain) to 10 (extreme pain). Specifically, a line representing 10 centimeters was used as the scale's visual representation. Distance from zero to the respondent's mark was then used to approximate the sufferer's level of discomfort (Tosteson, 2000; Lunderberg et al., 2001).

2.5.2. Functional Disability (NDI)

The Neck Disability Index (NDI) is a 10-item questionnaire used to assess the functional impairment caused by neck pain. The questionnaire covers a wide range of topics related to one's everyday life, including but not limited to: personal care, heavy lifting, work, driving, sleeping, playing, recreational, pain level, concentration, and headache. Scores range from 0 (no disability) to 5 (severe disability) for each question, with the total score out of 100 determined by adding and doubling the scores for each question. If a patient has a high NDI score, they report being more disabled as a result of their neck pain. Patients have identified a 5–10% improvement as the "minimally clinically meaningful change." (Ettlin, 2013; Hall et al., 2008).

2.6. Statistical analysis

All analyses were done using SPSS (version 20). Statistical information was shown in the form of means and standard deviations. One-Way ANOVA was used to test the differences between the three groups: GT group (A), MET group (B) and Control group (C) in baseline characteristics (age, weight and height). 3x2 Mixed Multivariate Analysis of Variance (MANOVA) test was used to test differences within and between the three groups A, B and C. Multiple pairwise comparison tests or Post hoc tests (Tukey HSD) were used to determine which pair caused the difference.

3. RESULTS

The baseline characteristics (demographics) for all patients of the three groups were presented in table 1. There were no significant differences among the three groups in the baseline characteristics (p-value>0.05).

Table 1. Baseline characteristics (demographics) in the three groups

Variables	Group A (Mean±SD)	Group B (Mean±SD)	Group C (Mean±SD)	F-value	P-value
Age (years)	51.21±6.98	48.35±7.36	48.35±6.23	0.340	0.714
Weight (kg)	72.85±6.19	71.64±6.42	71.28±6.99	0.027	0.973
Height (cm)	171.57±5.95	169.57±5.95	170.57±5.95	0.000	1.00

SD: standard deviation; NS: non-significant; kg: kilograms; cm: centimeter; P: probability

A 3x2 mixed MANOVA was conducted to assess if there was a difference between patients of the three groups (GRASTON, MET, CONTROL) in the amount of change in their scores on two dependent variables (pain and disability). Descriptive statistics of both outcomes pre- and post-treatment in the three groups is presented in tables 2 & 3. As shown in table 4, significant multivariate effects were found for the main effects of time F (2,38) = 74.5, $p<0.001$ and group, F (4,78) = 4.7, $p=$ 0.002, as well as for the interaction between group and time, F (4,78) = 2.9, $p=0.029$. Follow-up ANOVAs (as shown in tables 5 & 6) reveal that the significant change from pretest to posttest was significant for pain, F (l,39) = 105.6, p<0.001, and that the change in pain was different for the three groups, F (2,39) = 3.33, $p=0.046$. As well, significant change from pretest to posttest was significant for disability, F (l,39) = 88, p<0.001, and that the change in disability was different for the three groups, F (2,39) = 3.6, $p=0.037$. As shown in table 7, post hoc analysis (Tukey HSD) revealed that group B differed significantly from group A (mean difference=1.5, p=0.001) and control (mean difference=0.92, p=0.041) in the pain change. However, groups did not differ in the disability change.

Table 2. Descriptive statistics of pain scores in the three groups pre- and post-treatment

Pain	**Group A** **Mean±SD**	**Group B** **Mean±SD**	**Group C** **Mean±SD**
Pre	5.57±1.4	4.29±0.47	5.36±1
Post	4.8±1.4	3.14±0.86	3.93±0.73

SD: standard deviation

Table 3. Descriptive statistics of disability scores in the three groups pre- and post-treatment

Disability	**Group A** **Mean±SD**	**Group B** **Mean±SD**	**Group C** **Mean±SD**
Pre	24.29 ±8.52	22.14 ±7	20±4.39
Post	21.1±8.36	15.36±7.2	14.36±5.44

SD: standard deviation

Table 4. 3x2 Mixed MANOVA (Wilks' Lambda) overall effects of time and intervention on the pain and disability

	F	P	Partial eta squared
Time	74.5	<0.001	0.19
Intervention group	4.6	0.002	0.8
Time*group interaction	2.9	0.029	0.13

Table 5. ANOVA for effects of time and intervention group on the pain

	F	P	Partial eta squared
Time	105.6	<0.001	0.73
Time*group interaction	3.33	0.046	0.146

Table 6. ANOVA for effects of time and intervention group on the disability

	F	P	Partial eta squared
Time	88	<0.001	0.69
Time*group interaction	3.6	0.037	0.155

Table 7. Multiple comparisons or post-hoc test (Tukey HSD) between groups on pain and disability

Outcome	Comparison	Mean Difference	P
Pain	A versus B	1.4821*	0.001
	A versus C	.55	0.3
	B versus C	-.93*	0.041
Disability	A versus B	3.93	0.28
	A versus C	5.5	.091
	B versus C	1.57	.81

4. DISCUSSION

In this study forty-two patients diagnosed as nonspecific neck pain, by their orthopedist. Random assignment was used to place patients in one of three groups: Graston technique (GT) group (A): formed of 14 patients who received GT and TPT, MET group(B): formed of 14 patients who received MET and TPT, Control group(C): formed of 14 patients who received TPT only. Treatment lasted for four weeks and consisted of 12 sessions (3 per week). Both the level of pain (as measured by a visual analogue scale, VAS) and functional disability (as measured by the Neck Disability Index (NDI) Questionnaire) were evaluated at the start and finish of the fourth week to determine the final results.

There is a wide range of physiotherapy approaches that can be used to treat nonspecific neck pain. The aim of this study is to contrast between the outcomes of GT and MET on both pain intensity and functional disability in patients with NSNP.

Individuals with non-specific neck pain who meet the diagnostic criteria have shown impressive outcomes from traditional physical therapy, which combines elements of manual treatment and exercise (Binder, 2007). Strains and sprains, among other mechanical variables, are the most common causes of non-specific neck pain in the general population. Microtrauma in tendons and ligaments can result from too much stress on the body, and stress hormones can cause muscles tighten up (Rodriguez & Burns, 2008).

Suboccipitals, levator scapulae, upper trapezius, sternocleidomastoid, pectoralis major and minor, the deep neck flexors and middle trapezius are tight while the deep neck flexors and lower trapezius are weak and all are involved in upper crossed syndrome., often accompanies non-specific neck pain (Tsakitzidis et al., 2018). Muscle energy technique can be used therapeutically to release tight muscles and fascia, strengthen weak muscles, enhance musculoskeletal function, mobilize joints with restricted movement, and promote range of motion and pain tolerance (Wilson & Donegan, 2003; Schenk et al., 1994).

The activation of Golgi tendon organs and their inhibitory action on the pool of a-motor neurons causes reflexive relaxation of the contracted muscle (Chaitow, 2006). High evidence of efficacy for multimodal conventional therapy (mobilization and supervised exercises) was reported in a recent comprehensive review of the literature on therapies for nonspecific neck pain, which was differ from the results of the current investigation **.** In addition, a therapy plan comprising a variety of mobilization modalities and targeted therapeutic exercises may account for these gains (Leaver et al., 2010).

Research from the last few years shows that doing MET and Deep neck flexors exercises together is better than doing either one alone for relieving pain and disability and fixing rounded shoulders (Sakshi et al., 2014) The results of this study were the same as those of (Arif et al., 2020) that compared the efficacy of Muscle Energy Techniques (MET) in treating upper cross syndrome to that of conventional physical therapy found that both modalities were helpful, but that MET was more effective in reducing neck pain and disability. Also, the result of this study agreed with Hassan et al. (2021), who confirmed the effect of MET technique with conventional physical therapy consisting of thoracic and cervical spine mobilization on non-specific neck pain in military air crew.

Investigated the impacts of Muscle Energy Techniques (MET) with isometric exercises and integrated neuromuscular inhibition approaches. Similar to our findings, they found that the muscle energy technique group experienced greater reductions in pain and better functional status than the control group (Sharma et al., 2010). In addition, a study by Sharmila (2014) resulted in the conclusion that MET was a more successful regime than conventional physical therapy for patients with non-specific neck pain in terms of lowering pain and improving impairment. It was found that the present study's findings were consistent with those of a study by Mahajan et al. (2012), who favored using MET for mechanical neck pain by demonstrating its efficacy in reducing pain and enhancing neck functioning. Applying a heat pack, stretching, mobilizing, and strengthening are all examples of conventional therapy, but they can be affected by imbalance and hence require careful attention (Knight et al., 2001).

Musculoskeletal impairments are associated with an increase in the prevalence of pain and disability (Lambert et al., 2017). So, it is important to use the most effective interventions to enhance patient outcomes, to improve the quality of life, and decrease the burden on society. Using the Graston technique provides the therapist with the mechanical advantage to reduce the pressure on the fingers and hand while allowing deep penetration into the affected soft tissues (Baker, 2013).

Musculoskeletal impairments are associated with an increase in the prevalence of pain and disability. So, it is important to use the most effective interventions to enhance patient outcomes, to improve the quality of life, and decrease the burden on society. Using the Graston technique provides the therapist with the mechanical advantage to reduce the pressure on the fingers and hand while allowing deep penetration into the affected soft tissues (Loghmani & Warden, 2013).

The results of this study showed that adding the Graston technique to a TPT program was more effective and clinically relevant than the TPT program alone in function disability, which agreed with

Abdel-Aal et al (2021) and Lee et al. (2016). However, some studies that have positive effects of the Graston technique were single case studies (Gulick, 2018; Howitt et al., 2006) or focused on different populations (Sharma, 2010). Using the Graston technique is hypothesized to relieve the pain by stimulating the mechanoreceptors in the treated soft tissues (Aspegren et al., 2007) also decreased activities of both large and small-fiber neurons, by deformations of the skin, provide an additional form of analgesic response (Moon et al., 2017). On the other hand, other studies (Ge et al., 2017; Moon et al., 2017; Crothers et al., 2016) did not support this study's results, Difference in participants' conditions, cases of diagnosis, sample size of groups, location or area of application intervention and duration of interventions, explain the conflict with our study.

The effect of both MET & GT on pain and function in NSNP, were clear in our study. Which reflect on the clinical outcomes of the treatment strategy of NSNP, improving the progression of those cases, sparing time and effort.

Limitations of the study

This study had some limitations. First, the activity of treated muscles of the neck has not been measured, so further studies to measure EMG muscle activities may be needed. Second, the blindness of the therapist and patients were not attainable due to the nature of the intervention. Third, the current study had a relatively small size; therefore, these findings need to be tested in a larger population. Moreover, 4 weeks' intervention duration is very short so, future studies with long intervention and follow-up periods are warranted.

5. CONCLUSIONS

Adding Muscle Energy Technique or Graston Technique to traditional physical therapy is more effective than applying TPT alone in function disability in NSNP. In addition, GT and MET had similar effects on the function disability in patients with NSNP, but MET had higher effects on the pain.

6. REFERENCES

1. Abdel-Aal, N. B., Elsayyad, M. M., & Megahed, A. A. (2021). Short-term effect of adding Graston technique to exercise program in treatment of patients with cervicogenic headache: a single-blinded, randomized controlled trial. *European Journal of physical and rehabilitation Medicine, 57*(5), 758-766.

2. Anthony, L. (2002). Muscle energy technique in chiropractic practice. *Journal of the American Chiropractic Association*, *21*(1), 1-7.
3. Arab, A. M., & Ramezani, E. (2018). Sub occipital myofascial release technique for the treatment of cervicogenic headache. *Journal of Bodywork and Movement Therapies, 22*(4), 859.
4. Arif, A. R., Ashfaq, A., Syed, A. G., & Muhammad, Q. I. (2020). Effects of conventional physical therapy with and without muscle energy techniques for treatment of Upper Cross Syndrome. *Rawal Medical Journal, 45*(1), 127-131.
5. Aspegren, D., Hyde, T., & Miller, M. (2007). Conservative treatment of a female collegiate volleyball player with costochondritis. *Journal of Manipulative & Physiological Therapeutics, 30,* 321-325.
6. Baker, R. T., Nasypany, A., Seegmiller, J. G., & Baker, J. G. (2013). Instrument-assisted soft tissue mobilization treatment for tissue extensibility dysfunction. *International Journal of Athletic Therapy and Training*, *18*(5), 16-21.
7. Binder, A. (2007). The diagnosis and treatment of nonspecific neck pain and whiplash. *Europa medicophysica*, *43*(1), 79-89.
8. Bogduk, N. (2003). The anatomy and pathophysiology of neck pain. *Physical Medicine and Rehabilitation Clinics*, *14*(3), 455-472.
9. Carey, M. (2001). *Graston technique instruction Manual (2nd ed.).* Indianapolis, Therapy Care Resources.
10. Chaitow, L. (2006). *An introduction to muscle energy techniques: Muscle energy technique. 2nd Ed.* Churchill Livingstone, PP1-17.
11. Cheatham, S. W., Kreiswirth, E., & Baker, R. (2019). Does a light pressure instrument assisted soft tissue mobilization technique modulate tactile discrimination and perceived pain in healthy individuals with DOMS? *The Journal of the Canadian Chiropractic Association, 63*(1), 18-25.
12. Crothers, A. L., French, S. D., Hebert, J. J., & Walker, B. F. (2016). Spinal manipulative therapy, Graston technique® and placebo for non-specific thoracic spine pain: a randomised controlled trial. *Chiropractic & manual therapies, 24,* 1-9.
13. Crothers, A., Walker, B., & French, S. D. (2008). Spinal manipulative therapy versus Graston Technique in the treatment of non-specific thoracic spine pain: Design of a randomised controlled trial. *Chiropractic & osteopathy*, *16*, 1-8.

14. Dusunceli, Y., Ozturk, C., Atamaz, F., Hepguler, S., & Durmaz, B. (2009). Efficacy of neck stabilization exercises for neck pain: a randomized controlled study. *Journal of rehabilitation medicine*, *41*(8), 626-631.
15. Ettlin, D. (2013). Headache Classification Committee of the International Headache Society (IHS). The International Classification of Headache disorders, 3rd edition (beta version). *Cephalalgia, 33*, 629–808.
16. Garrett, T. R., & Neibert, P. J. (2019). Graston Technique® as a treatment for patients with chronic plantar heel pain. *Clinical Practice in Athletic Training*, *2*(3), 35-47.
17. Ge, W., Roth, E., & Sansone, A. (2017). A quasi-experimental study on the effects of instrument assisted soft tissue mobilization on mechanosensitive neurons. *Journal of physical therapy science*, *29*(4), 654-657.
18. Gulick, D. T. (2014). Influence of instrument assisted soft tissue treatment techniques on myofascial trigger points. *Journal of bodywork and movement therapies*, *18*(4), 602-607.
19. Gulick, D. T. (2018). Instrument-assisted soft tissue mobilization increases myofascial trigger point pain threshold. *Journal of bodywork and movement therapies*, *22*(2), 341-345.
20. Gupta, S., Jaiswal, P., & Chhabra, D. (2008). A comparative study between postisometric relaxation and isometric exercises in non-specific neck pain. *Journal of exercise science and physiotherapy*, *4*(2), 88-94.
21. Hall, T., Briffa, K., & Hopper, D. (2008). Clinical evaluation of cervicogenic headache: a clinical perspective. *The Journal of manual & manipulative therapy*, *16*(2), 73-80.
22. Hassan, W., Ali, M. O., Mohamed, R. R., & Baraka, H. M. (2021). Effect of Muscle Energy Technique on non-specific neck pain in military air crew. *Egyptian Journal of Applied Science, 36*(5-6), 68-83.
23. Hidalgo, B., Hall, T., Bossert, J., Dugeny, A., Cagnie, B., & Pitance, L. (2017). The efficacy of manual therapy and exercise for treating non-specific neck pain: A systematic review. *Journal of back and musculoskeletal rehabilitation*, *30*(6), 1149-1169.
24. Howitt, S., Wong, J., & Zabukovec, S. (2006). The conservative treatment of trigger thumb using graston techniques and active release Techniques®. *The Journal of the Canadian Chiropractic Association, 50*(4), 249-254.
25. Kharwandikar, P., Shende, M., & Abdul, A. P. J. (2019). Effectiveness of sub-occipital myofascial release and cervical manipulation in patients with cervicogenic headache. *International Journal of Healthcare and Biomedical Research*, *7*(04), 25-32.

26. Kim, J., Sung, D. J., & Lee, J. (2017). Therapeutic effectiveness of instrument-assisted soft tissue mobilization for soft tissue injury: mechanisms and practical application. *Journal of exercise rehabilitation*, *13*(1), 12-22.
27. Knight, C. A., Rutledge, C. R., Cox, M. E., Acosta, M., & Hall, S. J. (2001). Effect of superficial heat, deep heat, and active exercise warm-up on the extensibility of the plantar flexors. *Physical Therapy*, *81*(6), 1206-1214.
28. Lambert, M., Hitchcock, R., Lavallee, K., Hayford, E., Morazzini, R., Wallace, A., ... & Cleland, J. (2017). The effects of instrument-assisted soft tissue mobilization compared to other interventions on pain and function: a systematic review. *Physical Therapy Reviews*, *22*(1-2), 76-85.
29. Larson J. (1999). *Heat treatments.* Gale Encyclopedia of Medicine.
30. Leaver, A. M., Refshauge, K. M., Maher, C. G., & McAuley, J. H. (2010). Conservative interventions provide short-term relief for non-specific neck pain: a systematic review. *Journal of physiotherapy*, *56*(2), 73-85.
31. Lee, J. H., Lee, D. K., & Oh, J. S. (2016). The effect of Graston technique on the pain and range of motion in patients with chronic low back pain. *Journal of physical therapy science*, *28*(6), 1852-1855.
32. Lee, J. J., Lee, J. J., Kim, D. H., & You, S. J. H. (2014). Inhibitory effects of instrument-assisted neuromobilization on hyperactive gastrocnemius in a hemiparetic stroke patient. *Bio-medical materials and engineering*, *24*(6), 2389-2394.
33. Loghmani, M. T., & Warden, S. J. (2013). Instrument-assisted cross fiber massage increases tissue perfusion and alters microvascular morphology in the vicinity of healing knee ligaments. *BMC complementary and alternative medicine*, *13*(1), 1-9.
34. Lundeberg, T., Lund, I., Dahlin, L., Borg, E., Gustafsson, C., Sandin, L., ... & Eriksson, S. V. (2001). Reliability and responsiveness of three different pain assessments. *Journal of rehabilitation medicine*, *33*(6), 279-283.
35. Lv, Y., Tian, W., Chen, D., Liu, Y., Wang, L., & Duan, F. (2018). The prevalence and associated factors of symptomatic cervical Spondylosis in Chinese adults: a community-based cross-sectional study. *BMC musculoskeletal disorders*, *19*, 1-12.
36. Mahajan, R., Kataria, C., & Bansal, K. (2012). Comparative effectiveness of muscle energy technique and static stretching for treatment of sub-acute mechanical neck pain. *International Journal of Health and Rehabilitation Sciences*, *1*(1), 16-24.

37. McKivigan, J. M., & Tulimero, G. (2020). An analysis of graston technique® for Soft-Tissue therapy. *Rehabilitation Science*, *5*(4), 31-37.
38. Moon, J. H., Jung, J. H., Won, Y. S., & Cho, H. Y. (2017). Immediate effects of Graston Technique on hamstring muscle extensibility and pain intensity in patients with nonspecific low back pain. *Journal of physical therapy science*, *29*(2), 224-227.
39. Nagrale, A. V., Glynn, P., Joshi, A., & Ramteke, G. (2010). The efficacy of an integrated neuromuscular inhibition technique on upper trapezius trigger points in subjects with non-specific neck pain: a randomized controlled trial. *The Journal of manual & manipulative therapy*, *18*(1), 37-43.
40. Rodriquez, A. A., & Burns, S. P. (2008). Assessment of chronic neck pain and a brief trial of cervical strengthening. *American journal of physical medicine & rehabilitation*, *87*(11), 903-909.
41. Sakshi, N., Suman, M., & Geetanjali, S. (2014). Effect of muscle energy technique and deep neck flexors exercise on pain, disability and forward head posture in patients with chronic neck pain. *Indian Journal of Physiotherapy and Occupational Therapy*, *8*(4), 43-48.
42. Schenk, R., Adelman, K., & Rousselle, J. (1994). The effects of muscle energy technique on cervical range of motion. *Journal of manual & manipulative therapy*, *2*(4), 149-155.
43. Sharma, A., Angusamy, R., Kalra, S., & Singh, S. (2010). Efficacy of post-isometric relaxation versus integrated neuromuscular ischaemic technique in the treatment of upper trapezius trigger points. *Indian Journal of Physiotherapy and Occupational Therapy*, *4*(3), 1-5.
44. Sharmila, B. (2014). Isometric Muscle Energy Technique and NonSpecific Neck Pain in Secondary School Teachers- Results of an Experimental Study. *Indian Journal Physiotherapy Occupational Therapy,* 8(2), 58-62.
45. Strunk, R. G., & Hondras, M. A. (2008). A feasibility study assessing manual therapies to different regions of the spine for patients with subacute or chronic neck pain. *Journal of Chiropractic Medicine*, *7*(1), 1-8.
46. Thompson, J., Crowder, L., Le, D., & Roethele, A. (2018). Efficacy of instrument assisted soft tissue mobilization for the treatment of musculotendinous injuries: a systematic review. *Journal of Orthopaedic & Sports Physical Therapy*, *48*, 187.
47. Tosteson, A. N. (2000). Preference-based health outcome measures in low back pain. *Spine*, *25*(24), 3161-3166.
48. Tsakitzidis, G., Remmen, R., Dankaerts, W., & Van Royen, P. (2013). Non-specific neck pain and evidence-based practice. *European scientific journal*, *9*(3), 1-19.

49. Wilson, E., Payton, O., Donegan-Shoaf, L., & Dec, K. (2003). Muscle energy technique in patients with acute low back pain: a pilot clinical trial. *Journal of Orthopaedic & Sports Physical therapy*, *33*(9), 502-512.
50. Ylinen, J., Kautiainen, H., Wirén, K., & Häkkinen, A. (2007). Stretching exercises vs manual therapy in treatment of chronic neck pain: a randomized, controlled cross-over trial. *Journal of rehabilitation medicine*, *39*(2), 126-132.

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CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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