proceedings

MDPI

Proceeding Paper

The Effect of Ultrasound Therapy and Muscle Energy Technique on a Case of a Young Adult with Thoracic Outlet Syndrome †

Iman Santoso *, Triana Karnadipa and Safitry Eka Putri

Physiotherapy Department, Vocational Education Program, University of Indonesia, Depok City 16424, Indonesia
* Correspondence: imansantoso17@ui.ac.id

† Presented at the 5th International Conference on Vocational Education Applied Science and Technology 2022, Teluk Betung, Indonesia, 26–28 October 2022.

Abstract: Case description. This case study evaluates an adult male, 24 years old, diagnosed with thoracic outlet syndrome and referred to a physiotherapy clinic because of pain and stiffness in the forearm and an inability to lift a heavy object. A physiotherapy session was given twice a week for three weeks. In the first week, ultrasound and reciprocal inhibition were applied, in the second week ultrasound therapy and post-isometric relaxation were applied and in the last week, ultrasound therapy and a post-contraction stretch were applied. After five interventions, the combination of ultrasound therapy and muscle energy techniques improved the functional ability by about 86.97% (from 19.2 to 2.5) measured with the *Disabilities of the Arm Shoulder and Hand* questionnaire (DASH). This case study suggests that the combination of ultrasound therapy and muscle energy techniques used for thoracic outlet syndrome, including a home exercise plan with the continuous monitoring of posture correction, could allow the patient to return to work.

Keywords: thoracic outlet syndrome; pectoralis minor tightness; ultrasound therapy; muscle energy technique; DASH

check for updates

Citation: Santoso, I.; Karnadipa, T.; Putri, S.E. The Effect of Ultrasound Therapy and Muscle Energy Technique on a Case of a Young Adult with Thoracic Outlet Syndrome. *Proceedings* **2022**, *83*, 55. https://doi.org/10.3390/proceedings2022083055

Academic Editors: Ari Nurfikri, Karin Amelia Safitri, Debrina Vita and Widyo Swasto

Published: 18 January 2023

Copyright: © 2023 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

1. Introduction

The shoulder has an important role in daily activities, especially in activities that involve arm movement such as when performing homework, self-care, work, school, sports, and so on. Many people, however, sometimes do not realize that the activities or work that they usually undertake continuously can result in muscle tension or changes in posture, resulting in pressure or pulling on several components that are between the first rib and the clavicle bone, called the "Thoracic Outlet". This compression is known as thoracic outlet syndrome (TOS).

Thoracic outlet syndrome is a collection of symptoms caused by compression of the blood vessels (subclavian arteries and veins) and the brachial plexus. There are three anatomical spaces where TOS occurs, namely, the interscalene triangle, costoclavicular space, and the subcoracoid or retropectoral space. This can occur due to congenital abnormalities, trauma, or certain work-related activities that involve the elevation or continuous use of the arm [1]. Globally, TOS has an incidence of 1–2% [2]. In the United States, the incidence of TOS reaches 3–80 cases per 1000 people, and occurs three times more in women than in men. This condition is often found in patients of a productive age of 20–40 years. Thoracic outlet syndrome can be classified into three types, with the most common type of TOS being neurogenic TOS, representing as much as 95% of cases, while venous TOS involves 3–5% of cases and arterial TOS represents the least number with 1–2% of cases [3]. Symptoms that appear in TOS can vary according to the structural abnormalities involved, whether they be arteries, veins or nerves. The symptoms that appear can be divided into two groups, namely, neurological symptoms and vascular symptoms. Neurological

symptoms are more common, such as pain in the upper and lower arms, tingling, a loss of the sense of touch, and motor weakness. Meanwhile the vascular symptoms that appear include paleness, coldness, swelling, and changes in the skin color [4]. Physiotherapy problems commonly found in TOS are pain, edema, spasm, a decreased range of motion, decreased muscle strength, abnormal posture and a decreased functional ability.

Ultrasound therapy is one of the electrotherapy modalities that uses a vibration mechanism from sound waves with a frequency of more than 20,000 hertz (Hz). Ultrasound therapy aims to reduce pain and muscle spasm [5]. Meanwhile, the muscle energy technique is a form of manual therapy which consists of three principles, namely, a reciprocal inhibition, post isometric relaxation and post contraction stretch to reduce pain, reduce muscle tightness or spasm, reduce muscle tone, increase the local circulation, increase muscle strength, and increase the ability for a joint range of motion so as to improve the patient's functional ability [6]. The evaluation parameter used is the *Disabilities of the Arm Shoulder and Hand* (DASH) questionnaire. The DASH consists of 30 items regarding the health status in daily activities, symptoms, social functioning and a patient's psychology during the previous week. Each item has five answer choices, from a score of 1, meaning there is no difficulty, up to 5, which means that the item cannot be performed. The final scores range from 0 to 100, with a high DASH score indicating a severe disability. The DASH has a good intraclass correlation coefficient with an r or ICC = 0.74–0.95. The minimum detectable change (MDC) for the DASH is 11 points. That is, a change of more than 11 points is a change that is actually or is said to be successful in the patient's condition. While the minimum clinically important difference (MCID) for the DASH is 10.83 points. This means that a physiotherapist can be reasonably sure that a change of more than 10.83 points is a clinically significant functional change [7].

This case study aims to explain how ultrasound therapy and muscle energy techniques can improve functional ability in Thoracic Outlet Syndrome cases with the *Disabilities of the Arm Shoulder and Hand* questionnaire parameters. The benefits of this case study are found in using it as learning material to increase the knowledge about thoracic outlet syndrome cases and to apply good and correct physiotherapy management in these cases.

2. Patient Information

This case involved a 24 year old man—a cameraman by profession—who was diagnosed with thoracic outlet syndrome. In July 2021, the patient felt pain and stiffness in the right forearm and the feeling of an electric shock when lifting heavy objects. Initially, the patient thought that the complaints were only an effect of work fatigue; therefore, the patient did not receive any treatment. In September 2021, the patient began to feel pain and stiffness in the forearm when the patient had worked more than four hours. When the patient was working and wanting to lift a camera stabilizer weighing three kilograms, suddenly he felt an electric shock sensation in his right forearm and he had difficulty in gripping because he felt a weakness. Consequently, on 2 December 2021, the patient decided to have an examination at a hospital, a doctor advised the patient to undertake a radiology examination and then suggested he undergo physiotherapy related to his complaints.

3. Clinical Findings

On 15 December 2021 the patient underwent several examinations to determine the diagnosis, with the results of the following examinations.

3.1. Posture

A posture examination was performed on three aspects, namely, the anterior, lateral and posterior, in a sitting position. On the anterior aspect there was a right protracted scapula. On the lateral aspect there was a protracted forward head and right scapula, while the posterior aspect looked normal.

3.2. Active, Passive and Resistive Movement Tests

Active and passive ROMs were measured with a goniometer in a sitting position. Meanwhile, the visual analog scale (VAS) was used to measure the patient's pain level. In Tables 1 and 2, it is shown that there was a limited ROM and motion pain in the shoulder region with a flexion, extension, abduction and right exorotation. Examination of the motion with resistance was used to check the muscle strength called manual muscle testing (MMT). In Table 3, it can be seen that the muscle strength of the shoulder region in extension, abduction and right exorotation movements could not be measured in terms of pain.

Table 1. Shoulder Dextra Active Motion Examination.

Joint	Movement	Normal ROM	ROM	Pain (VAS)	Description (Altered Movement)
Shoulder	Flexion	90°–0°–45°	130°–0°–30°	Positive (3.4/10)	Negative
	Extension			Positive (4.6/10)	Negative
	Abduction	180°–0°–45°	105°–0°–45°	Positive (3.5/10)	Negative
	Adduction			Negative	Negative
	Endorotation	35°–0°–40°	35°–0°–35°	Negative	Negative
	Exorotation			Positive (3.5/10)	Negative

Table 2. Right Shoulder Passive Motion Examination.

Joint	Movement	ROM Normal	ROM	End Feel	Pain (VAS)
Shoulder	Flexion	90°–0°–45°	145°–0°–35°	Firm	Positive (2.4/10)
	Extension			Firm	Positive (2.5/10)
	Abduction	180°–0°–45°	120°–0°–45°	Firm	Positive (2.2/10)
	Adduction			Firm	Negative
	Endorotation	35°–0°–40°	35°–0°–40°	Firm	Negative
	Exorotation			Firm	Positive (2/10)

Table 3. Right shoulder Resisted Motion Examination.

Joint	Movement	MMT	VAS
Shoulder	Flexion	5	Positive (3.4/10)
	Extension	*	Positive (4.6/10)
	Abduction	*	Positive (3.5/10)
	Adduction	5	Negative
	Endorotation	*	Positive (3.5/10)
	Exorotation	5	Negative

* could not be measured because of pain.

3.3. Sensibility

A sharp–blunt examination and fine–coarse touch examination were performed, and the results showed that the sensory was still within the normal limits in the C5–C8 dermatome area.

3.4. Special Test

This test aims to strengthen the diagnosis in TOS patients. The specific tests performed were:

- Adsense Test: positive.
- ULTT: positive, on the radial nerve.
- Wright/hyperabduction test: positive.
- EAST/Roos test: positive.
- Phalen test: negative.
- Cervical compression test: negative.
- Palpation: spasm of M. pectoralis minor dextra.

3.5. DASH Questionnaire

The patient's total DASH score was 53/150 or 19.2, which means the patient had a mild disability.

4. Results

The authors conducted an assessment in the form of an evaluation taken from patient complaints, followed by an assessment using the DASH parameters. In five evaluations, the authors obtained the results in the form of a decrease in the DASH score. In Figure 1, the pre-intervention DASH score was 19.2, while in the first evaluation it was 15 and in the fifth evaluation it was 2.5. These results indicate that the combination of ultrasound therapy and the muscle energy technique reduced the DASH score by a difference of 12.5. The minimum detection change in the DASH was around 10.83. This shows that the intervention provided by the authors provided a significant change.

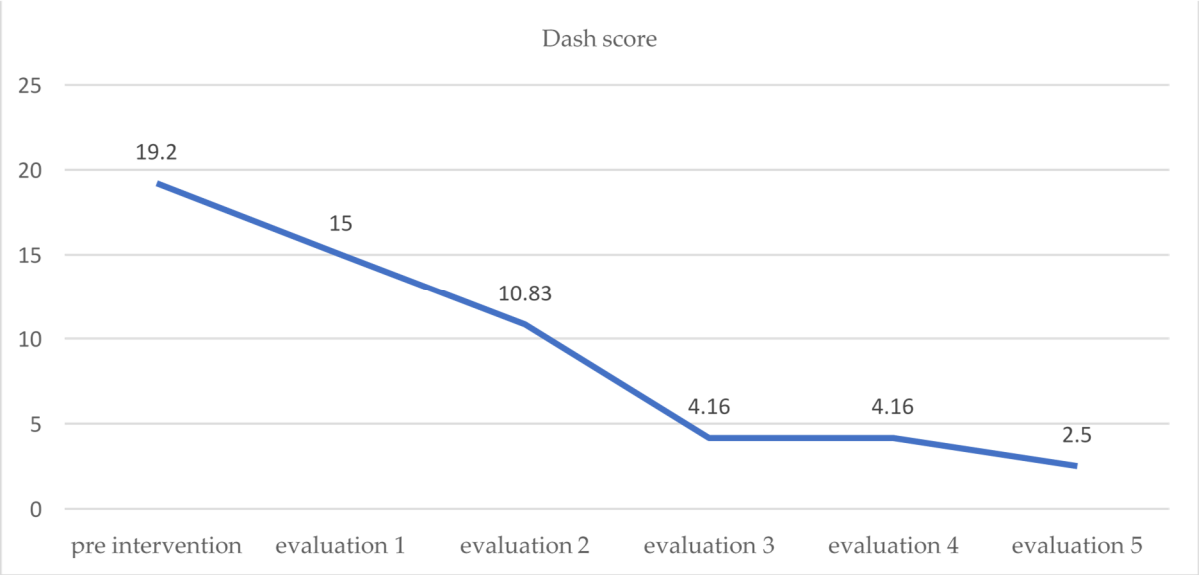

Figure 1. DASH Score Evaluation.

5. Discussion

5.1. Ultrasound Therapy Mechanism for DASH Decrease

Ultrasound therapy produces both thermal and non-thermal effects. In the thermal effect, there is an increase in the tissue temperature, which will provide local heat to the muscle which will then have an impact on increasing the circulation and metabolism in the muscle, so that it can transport metabolic waste and improve the blood flow. With an adequate supply of oxygen, it can reduce pain and muscle tension. The resulting thermal effect can also increase the elasticity of the muscle fibers, thereby increasing the range of motion of the joints [8].

The non-thermal effects of ultrasound therapy are cavitation and microstreaming. Cavitation is the process of forming air bubbles that can enlarge in the tissue to increase plasma flow in the tissue. Microstreaming is the insistence of sound waves on cell membranes

that can increase the work of the cell's sodium pump which can accelerate the healing process [8].

In the case of thoracic outlet syndrome, the pressure on the pectoralis minor muscle area can result in a lack of blood supply, and this is a major problem because it can cause pain, spasm, and disability. The existence of thermal and non-thermal effects from ultrasound therapy can overcome these problems so that there is an increase in the functional ability. Based on the results of Graph 1, it was found that the administration of ultrasound therapy can reduce the pain scale which will ultimately affect a patient's activity tolerance and functional ability, thereby reducing the DASH scale. This is supported by the research of Imran in 2017 [9] which stated that the addition of ultrasound therapy has benefits in reducing pain and increasing the ROM compared to only performing physical shoulder exercises.

Another study conducted by Santoso [10] stated that the thermal effect of ultrasound therapy increases the vasodilation of blood vessels so that the blood flow improves and ischemia is reduced. With an increase in the blood flow and an increased oxygen supply, this can reduce the pain, spasm and joint range of motion which will have a positive effect on decreasing the DASH score.

5.2. Muscle Energy Technique Mechanism for DASH Decrease

The muscle energy technique works by relaxing the muscles without causing pain and tissue damage through light and gentle pressure, so that it does not irritate and stretch the tissue. The muscle energy technique has three basic principles that utilize physiological mechanisms to improve the musculoskeletal function and reduce pain, namely, the reciprocal inhibition, post isometric relaxation and post contraction stretch methods [11].

In reciprocal inhibition, this technique refers to the inhibition of antagonist muscle tone, namely, the M. pectoralis minor with an isometric contraction of the M. rhomboideus, through an inhibition of alpha motor neurons. When the muscle contracts isometrically, the antagonist muscle will be inhibited, and the muscle tone will decrease so that muscle relaxation is achieved. The presence of muscle relaxation in the case of TOS can reduce the pressure on the nerves so that the felt symptoms can be reduced. This is supported by research conducted by Kim [12] which stated that the results of research conducted in weeks 1 and 2 showed a significant decrease in the PIR and RI in a comparison of the muscle activity to reduce a forward head posture due to a muscle shortening. Although the PIR value was greater, there was no difference in the comparison of the muscle activity. Therefore, in that study it was recommended to apply the PIR and RI methods so that the increase could be said to be effective.

Post isometric relaxation can be used after RI because this technique has the main focus of muscle imbalance by reducing the muscle tone after an isometric contraction. Post isometric relaxation inhibits the tone after a short period of post isometric contraction of the M. pectoralis minor, so that muscle relaxation is achieved and it reduces nerve compression. The presence of strong muscle contractions during exercise can activate the muscle stretch receptors that cause endogenous opioids to be released and also the release of beta endorphins from the pituitary gland, namely, secretions that can cause pain reduction. This is supported by research conducted by Junaid [13] which stated that the results of a study conducted for 4 weeks showed a significant change in a group given PIR compared to a group given myofascial trigger point release and routine physical therapy. These changes could be seen from a decrease in pain (VAS), an increase in the ROM (goniometer) and the disability scale (NDI).

In a post contraction stretch, the focus is on a muscle contraction followed by stretching. The presence of isotonic contractions of the pectoralis minor will result in an increased tension in the Golgi tendon muscle (GTO). The Golgi tendon muscle is sensitive to changes in tension and assesses the average tension in the muscle. When the spread of stress expands, the GTO accelerates and causes relaxation of the M. pectoralis minor. When the M. pectoralis minor is stretched actively, slowly and gently, the Golgi tendon will be

optimally stimulated so that muscle relaxation is achieved which can reduce the pressure on the nerve. This is supported by research conducted by Widodo) [14] which stated that isotonic contractions consisting of eccentric and concentric contractions positively affected an increase in the muscle strength, flexibility and muscle stiffness. Therefore, performing isotonic exercises can help increase the muscle capacity, improve performance, and reduce the risk of injury.

Based on the several studies that have been described above, the intervention of ultrasound and MET therapy in TOS cases can provide benefits, especially in reducing motion pain, increasing the joint range of motion, decreasing spasm, and improving the posture. This can have a good impact in the form of decreasing the DASH scale in the subscale of the activity section that involves functional abilities, such as the points for carrying heavy items or activities that require the arm to move freely. Moreover, it also has a good impact on decreasing the DASH subscale of the symptom section, such as reduced arm pain when undertaking exercise, including tingling and stiffness.

6. Conclusions

Five rounds of physiotherapy interventions were evaluated using ultrasound therapy and the muscle energy technique, and the results showed a decrease in the DASH score of 12.5. In the first evaluation, the DASH score was 15 and in the fifth evaluation it was 2.5, where the decrease in the score crossed the minimum limit. Thus, it can be concluded that the administration of ultrasound therapy and the muscle energy technique has been proven to provide significant changes to improve the functional ability in cases of Thoracic Outlet Syndrome.

Author Contributions: Conception and design of study: I.S., T.K. and S.E.P.; acquisition of data: I.S. and S.E.P.; analysis and/or interpretation of data: I.S. and S.E.P.; Drafting the manuscript: I.S. and T.K.; revising the manuscript critically for important intellectual content: I.S. and T.K. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Informed consent was obtained from the subjects involved in the study.

Data Availability Statement: The data presented in this study are available on request from the corresponding author.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Franklin, G.M. Work-related neurogenic thoracic outlet syndrome: Diagnosis and treatment. *Phys. Med. Rehabil. Clin. N. Am.* **2015**, *26*, 551–561. [CrossRef] [PubMed]
2. Amper, J.M. Sindrom Outlet Dada. *Jurnal Ilmiah Kesehatan Sandi Husada* **2020**, *9*, 1083–1087. [CrossRef]
3. Jones, M.R.; Prabhakar, A.; Viswanath, O.; Urits, I.; Green, J.B.; Kendrick, J.B.; Brunk, A.J.; Eng, M.R.; Orhurhu, V.; Cornett, E.M.; et al. Thoracic Outlet Syndrome: A comprehensive review of pathophysiology, diagnosis, and treatment—Pain and therapy. *Pain Ther.* **2019**, *8*, 5–18. [CrossRef] [PubMed]
4. Podlaha, J. Thoracic outlet syndrome—24 years of experience. *Bratisl Lek Listy.* **2007**, *108*, 429–432. [PubMed]
5. Kuswardani, K.; Amanati, S.; Yudhanto, N.U. Pengaruh Infrared, Ultrasound dan Terapi Latihan Pada Faciitis Plantaris. *Jurnal Fisioterapi dan Rehabilitasi.* **2018**, *2*, 77–86. [CrossRef]
6. Patel, J.K.; Kansagara, P.R. A Study to Find out Immediate Effect of Muscle Energy Technique on Pectoralis Minor Tightness in Healthy Collegiate Individuals-An Interventional Study. *Indian J. Physiother. Occup. Ther. Int. J.* **2019**, *13*, 48. [CrossRef]
7. Franchignoni, F. Minimal clinically important difference between the disabilities of the arm, shoulder, and hand outcome measure (DASH) and its shortened version (QuickDASH). *J. Orthop. Sport. Phys. Ther.* **2014**, *44*, 30–39. [CrossRef] [PubMed]
8. Starkey, C. *Therapeutic Modalities*; F. A. Davis: Philadelphia, PA, USA, 2013; p. 429.
9. Imran, M. Effects of therapeutic ultrasound and manual physiotherapy in shoulder impingement syndrome in volleyball players. *J. Islamabad MedDent. Coll.* **2017**, *6*, 178–181.

10. Santoso, I.; Satriyasa, B.K.; Munawaroh, M.; Sandi, I.N.; Muliarta, M.W. Kombinasi ultrasound Dan Dry needling LEBIH Menurunkan disabilitas Leher Dari Pada kombinasi ultrasound Dan Hold Relax Pada myofascial pain syndrom otot upper trapezius. *Sport Fit. J.* **2018**, *6*, 11–22. [CrossRef]
11. Thomas, E.; Cavallaro, A.R.; Mani, D.; Bianco, A.; Palma, A. The efficacy of muscle energy techniques in symptomatic and asymptomatic subjects: A systematic review. *Chiropr. Man. Ther.* **2019**, *27*, 35. [CrossRef] [PubMed]
12. Kim, H.-S.; Lee, K.-C. The effect of applying the muscle energy technique to neck muscles on the forward head posture. *J. Korean Soc. Integr. Med.* **2021**, *9*, 173–181.
13. Junaid, M.; Yaqoob, I.; Shakil Ur Rehman, S.; Ghous, M. Effects of post-isometric relaxation, myofascial trigger point release and routine physical therapy in management of acute mechanical neck pain: A randomized controlled trial. *J. Pak. Med. Assoc.* **2020**, *70*, 1688–1692. [CrossRef] [PubMed]
14. Widodo, A.F.; Tien, C.-W.; Chen, C.-W.; Lai, S.-C. Isotonic and isometric exercise interventions improve the hamstring muscles' strength and flexibility: A narrative review. *Healthcare* **2022**, *10*, 811. [CrossRef] [PubMed]

Disclaimer/Publisher's Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.