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Case Report

The Addition Of Bilateral Neurodynamics In Ultrasound Therapy And Manual Traction Intervention In Cervical Radiculopathy

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ABSTRACT

Background: *Cervical radiculopathy is a condition that characterized by pain and/or sensorimotor deficits caused by compression of one or more cervical nerve roots. The aim of this case series is to serve as a preliminary study to determine the effectiveness of adding bilateral neurodynamics to the intervention of ultrasound therapy and manual traction in cervical radiculopathy.*

Methods: *The research writing method used CARE (CAseREport) guidelines, which consisted of: introduction, patient information, clinical findings, timeline, diagnostic assessment, therapeutic intervention, follow-up and outcome, and discussion. The measuring instrument used in this study was the Visual Analogue Scale (VAS) in assessing tension pain when given neurodynamics and neck disabilities using the Indonesian version of the Neck Disability Index (NDI). The intervention was carried out 12 times (3 times a week for 4 weeks) and a follow-up was done at week 5.*

Results: *The results showed that there was an improvement in the score of neck pain and disability in the 2 patients both at post-test and at follow-up.*

Conclusion: *Based on these findings, it can be concluded that the application of additional bilateral neurodynamics in the intervention of ultrasound therapy and manual traction can help reduce pain and improve neck disability.*

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INTRODUCTION

Nerve roots are structures that are susceptible to injury at all levels of the spine, especially at the lumbar and cervical levels. Radiculopathy is a nerve root disorder that is often caused by a herniated disc, or a space-occupying lesion that can cause nerve root inflammation, impact, or both. Another cause of radiculopathy is foraminal narrowing as a result of arthritic change or the presence of a tumor or infectious disease (Magnus et al., 2022).

The prevalence of cases was 1.14% in men and 1.31% in women (Mansfield et al., 2020). The most common levels affected were C6 (66%) and C7 (62%) (Kim et al., 2016). Nerves have the ability to adapt to various types of mechanical stress imposed

on nerve structures, but in the process of loading or stretching for too long, it causes nerves to change their integrity and lead to ischemic conditions. The perineurium is the main defense against strain on nerve structures. The perineurium has the ability to withstand tension of 18% -22% before being damaged (Shacklock, 2015).

Problems in terms of mechanics cause physiological changes in the nervous system. Compression and tension in the nervous structure will cause ischemia and a reduction in axonal transport mechanisms, therefore improving physiological function through therapy on mechanical function is an integral process and can be used as an effective way of diagnosing and treating. Releasing pressure or tension on nerves can improve physiology and accompanying clinical complaints such as relieving pain and reducing disability (Shacklock, 2015).

When reviewed by ICF, the problems with cervical radiculopathy include: pain, limited range of motion of the joints, and limited functional ability in performing daily activities. In addition, there are also other problems such as muscle stiffness that supports the cervical area due to compensation for structural changes that occur. Therefore, a comprehensive treatment is needed to overcome this problem. In this case series, the authors used a combination of ultrasound therapy (UST), manual traction, and neurodynamics (ND) to reduce pain and neck disability in individual with cervical radiculopathy.

The application of the addition of ND to the intervention is expected to be able to release pressure or nervous tension which in turn improves physiological function and accompanying clinical complaints such as pain relief and reducing disability. Purpose of study is to know the combination of adding of neurodynamics in ultrasound therapy and manual traction intervention can reduce pain and neck disabililty in individual with cervical radiculopathy.

MATERIALS AND METHOD

This study is a case series involving 2 patients diagnosed with cervical radiculopathy. This research was conducted in August - October 2019 at a physiotherapy private clinic in Denpasar city. The research writing method used CARE (CAseREport) guidelines, which consisted of: introduction, patient information, clinical findings, timeline, diagnostic assessment, therapeutic intervention, follow-up and outcomes, and discussion.

The measuring instrument used in this study was the Visual Analogue Scale (VAS) (MacDowall et al., 2018) in assessing tension pain during neurodynamics and neck disability using the Indonesian version of the Neck Disability Index (NDI) (Putra et al., 2020). When getting a physiotherapy intervention, patients did not take any analgesic drugs. The intervention was carried out 12 times (3 times a week for 4 weeks) and follow-up was carried out at week 5. This study has used informed consent and does not conflict with the Declaration of Helsinki.

Case Illustrations

Patient information, clinical finding, and timeline

Patient 1

The patient signs an informed consent allowing the use of medical information for this report. The patient is a 50-year-old woman who works in a government office in Denpasar. The patient underwent a physiotherapy session after coming to visit the Physiotherapy clinic with cervical radiculopathy. At the time of the initial evaluation,

the patient complained of radiating pain in the dorso-lateral part of the right arm which had started approximately 1 month ago. He reported that the problem started with pain in the neck area started about 3 months ago but no treatment was done for the condition.

The frequency and intensity of the pain increase and peripheralization occurred since 2 months ago. Patients also report a consistent pattern of daily symptoms, with pain that increases when the arm is hung straight, and decreases with complete rest by bending the arm. The intensity and quality of pain is also affected by neck movement where movement toward extension and ipsilateral lateral flexion of the cervical spine tends to increase symptoms. This condition disturbs her to do some activities because of the tingling she feels.

The patient's medical history was good and there were no other co-morbidities, indicated by normal results during routine laboratory examinations, including checking uric acid and blood sugar levels. The family reported that the patient was active and independent in performing activities of daily living (ADL) and instrumental activities of daily living (IADL). There is no known significant family history. The main goal of the patient is to relieve pain thus they can carry out their activities without interference.

Patient 2

The male patient works in one of the delivery service companies in the South Denpasar area. The patient visited the Physiotherapy practice after getting a referral by an Orthopedic Doctor at a private hospital in Denpasar with a diagnosis of Cervical Radiculopathy by showing the results of a radiographic examination. He complained that the patient experienced pain radiating from the neck to the fingers on the right arm which had been felt since 2 months ago.

There was no history of trauma or previous comorbidities. The intensity of the pain is increasing, and the tingling began to be felt since 2 weeks ago which requires the patient to visit the doctor. The clinical findings obtained by the physiotherapist were pain radiating from the neck to the fingers accompanied by limited cervical ROM. Pain is aggravated when the head is turned back and up, and when straightening the arm.

There were no signs of motor disturbance experienced by the patient. The patient can still work and perform daily ADL independently but is very disturbed due to his complaints.

Diagnostic Assessment

Physiotherapy assessment process is carried out in a complete and systematic way for every patient who shows complaints of cervical radiculopathy syndrome pain. The following is the physiotherapy assessment process carried out, along with specific musculoskeletal examinations based on a systematic review as well as several differential diagnoses and supporting examinations (Thoomes et al., 2018).

Table 1. Physiotherapy Assessment Procedure

Assessment Step	Type of test	Results
Anamnesis	Complaints, location, quality, and provocation of pain	Pain that is sharp and radiates from the cervical to the arm.
Inspection	Signs of inflammation, deformity, alignment, movement patterns in the	There are no signs of inflammation, there is a slight change in the alignment of the

Assessment Step	Type of test	Results
	upper extremities and neck	cervical spine.
Quick test	*Elevation of the glenohumeral joint in the scaption position*	No arm pain
Passive Movement	Flexion-extension movement, right-left lateral flexion, right-left rotation	Pain radiates from the neck to the forearm during extension, lateral flexion and ipsilateral rotation.
Active Movement	Flexion-extension movement, right-left lateral flexion, right-left rotation	Pain radiates from the neck to the forearm during extension, lateral flexion and ipsilateral rotation.
Isometric Movement	Flexion-extension movement, right-left lateral flexion, right-left rotation	There is no pain during isometric contraction, no decrease in muscle strength is felt.
Musculoskeletal specific test (Thoomes *et al*, 2018)	*Spurling's Test*	Pain radiates when compression is applied to the ipsilateral side
	Cervical Distraction Test	Pain is not provoked or reduced by distraction
	Neurodynamic Test	Pain radiates along the dermatome area
	Shoulder Abduction Test	Pain tends to decrease due to reduced nerve root tension
Differential Diagnosis	*Empty Can Test*	Negative, absence of pain in the shoulder and upper extremities
	TOS Test	Negative: No radiating pain or decreased pulse rate during the maneuver
Radiology test	X-Ray MRI	Decreased space in the intervertebral foramen

In addition to being based on the findings, to strengthen the ruling in process, the cluster of Wainner was used where the sample was said to be positive for cervical radiculopathy if at least four criteria or predictor rules were met, such as: 1) cervical rotation ROM less than 60^{o}; 2) positive on Spurling's test; 3) positive on cervical distraction test; and 4) positive on upper limb neurodynamic test (Wainner et al., 2003; Waldrop, 2006).

After fulfilling the assessment procedure by the physiotherapist, the outcome of the intervention was measured using Visual Analogue Scale (VAS) and the Indonesian version of the Neck Disability Index (NDI) instrument. VAS is used to measure tension pain during neurodynamic and Indonesian version of NDI to measure neck disability. The findings obtained on examination were pain that radiated to the fingers on the right arm in the postero-lateral area in both patients. Decreased cervical AROM and PROM were also demonstrated by both patients. Several specific examinations were carried out on both patients to rule in and rule out any structural pathology that caused the patient's symptoms.

This was confirmed by positive results on Spurling's Test, distraction test, shoulder abduction test, and upper limb neurodynamic test in both patients. Differential diagnostic tests were also carried out, including empty can test for supraspinatus tendinitis and tests for thoracic outlet syndrome, both of which were negative. The radiological picture also shows a decrease in the intervertebral foramina space in patient 2. The diagnostic assessment process can be seen in table 2.

Table 2. Diagnostic Procedure in Patient 1 and Patient 2

Physical Examination	Patient 1	Patient 2	Results
Screening			
Inspection	Normal	Flat neck	
Palpation	Negative	Negative	There were no signs of inflammation in the neck. There is a slight increase in muscle tone.
Passive Movement			
Cervical flexion	51 (Normal)	50 (Normal)	
Cervical flexion	30 (pain)	27 (Pain)	
Cervical lateral flexion (ipsilateral)	14 (Pain)	16 (Pain)	Limited range of motion in extension, lateral flexion, and ipsilateral rotation with pain
Cervical lateral flexion (contralateral)	35 (Normal)	34 (Normal)	
Cervical rotation (ipsilateral)	27 (Pain)	24 (Pain)	
Cervical rotation (contralateral)	76 (Normal)	75 (Normal)	
Specific test			
Spurling's Test	Positive	Positive	Pain radiating from the neck to the fingers
Cervical Distraction Test	Positive	Positive	Pain is reduced or not increased
Shoulder Abduction Test	Positive	Positive	Pain is reduced. Patients tend to be comfortable with this position
Upper Limb Neurodynamic Test	Positive	Positive	Increased pain felt by the patient
Specific Test – Differential Diagnosis			
Empty can test	Negative	Negative	No pain and decreased pulse at the time of the test
Test for TOS	Negative	Negative	
Radiology			
Cervical X-Ray	-	Stenosis	Decreased intervertebral foramina space at VC5, 6, 7, Signs of osteophyte in the body.
Other measurement			
Visual Analogue Scale	7/10	8/10	

Physical Examination	Patient 1	Patient 2	Results
(VAS)			
Neck Disability Index Indonesian Version (NDI)	32/50	28/50	

Interventions

Ultrasound therapy

The intervention started with the Ultrasound therapy which was given to the cervical vertebrae area which showed a narrowing of the intervertebral foramina. The purpose of this ultrasound therapy is to increase the elasticity of the joint capsule and soft tissue around the vertebral area which will then be followed by manual traction. Ultrasound therapy was applied using a gel with a dose: frequency = 3 MHz, intensity = 0.4 W/cm2, pulsed ratio = 1:2, area = 3 treatment areas, duration = 9 minutes for 3 treatment areas (Watson, 2017).

Manual traction

After being given ultrasound therapy, manual traction was given to improve the mechanical interface in this case, a decrease in the intervertebral foramina space which caused cervical nerve root impingement/irritation. This intervention begins with giving cervical traction statically for 10 repetitions which is held for 8-10 seconds for each repetition (Romeo et al., 2018).

Bilateral neurodynamic

Bilateral upper limb neurodynamic administration was performed by performing neurodynamic on the contralateral side which aims to reduce the tension on the ipsilateral side of the nerve roots. Bilateral upper limb neurodynamic administration was performed by positioning the patient's arm on the contralateral side in the direction of shoulder abduction and external rotation, elbow extension, wrist extension, and extension of the fingers at the same time as performing neurodynamic maneuvers on the ipsilateral side.

Bilateral neurodynamic was performed dynamically from anti-tension to tension position for 5 minutes per set, performed in 2 sets with 60 seconds rest interval between sets. The frequency of this therapy is done 3 times a week for a period of 4 weeks (Shacklock, 2015).

RESULTS

Both patients reported that the pain had reduced qualitatively which was characterized by reduced of radiating pain and tingling during daily activities. This was also confirmed by a decrease in the VAS scores at neurodynamic from 7/10 to 2/10 and from 8/10 to 4/10 for patient 1 and patient 2 respectively on the 12th post-intervention measure. In addition, NDI scores were also showed improvement from 32 to 17 in patient 1 and from 28 to 15 in patient 2. Both patients also reported that pain experienced during some activities such as straightening the arm at the side of the body did not significantly trigger the pain at week 4 of the intervention.

After the 12th session ended, both patients were given a home program to maintain the patient's improvement. Data of patient’s improvement can be seen in table 3.

Tabel 3. Results after 4 weeks treatment (12 therapy session)

Outcome Measure	Pre-test		Post-test	
	Patient 1	**Patient 2**	**Patient 1**	**Patient 2**
VAS	7/10	8/10	2/10	4/10
NDI	32/50	28/50	17/50	15/50

The follow-up process is still carried out after the 4th week of intervention to monitor the patient's progress and adherence to exercise. Patient 2 regularly visited the Physiotherapist once a week on every Tuesday for 2 months after the last intervention session while patient 1 had finished visiting the Physiotherapist 1 month after the last session. Based on the follow-up at week 5, there are several activities that sometimes still trigger the pain that is felt when done suddenly by patient 2, such as reaching for things on the cupboard.

This movement produces shoulder abduction and elbow extension which is one of the tension positions of the median nerve. Meanwhile, patient 1 did not report any significant complaints after 1 month of follow-up. The last finding was that there was no significant improvement during 1 month of home exercise in NDI scores in both patients, but on the contrary the VAS values showed gradual improvement.

DISCUSSION

Based on the case series results, it was found that the application of a combination of UST, manual traction, and bilateral neurodynamic for 12 sessions (3 times a week for 4 weeks) was able to improve neck pain and disability in individuals with cervical radiculopathy. Ultrasound therapy is used to increase tissue extensibility. Tendon tissue is a tissue that is faster to penetrated by ultrasound waves because it has a greater collagen content than muscle.

Giving ultrasound intervention provides a thermal effect in the form of local heating of the joint capsule, tendons, ligaments or muscles which can result in increased cell activity, vasodilation of blood vessels that provide additional nutrients and oxygen, as well as facilitate the transport of metabolic wastes back to the heart therefore resulting in decreased irritation of the ends of the arteries. nociceptor nerve endings, thereby reducing pain (Andayani et al., 2020; Sung et al., 2022). The effect of heat increases the temperature of the tissue, causing an increase in elasticity and decreasing the viscosity of collagen fibers, thereby increasing the range of motion of the joint (Andayani et al., 2020; de Lucas et al., 2020).

Manual traction was given to improve the mechanical interface which in this case caused by decrease in the intervertebral foramina space which caused cervical nerve root irritation (Afzal et al., 2019; Romeo et al., 2018). This intervention begins with giving cervical traction statically for 10 repetitions which is held for 8-10 seconds each repetition. A recent meta-analysis study showed that manual traction in radiculopathy provided a significant benefit in reducing pain in the short term (g = –0.85; 95% CI = –1.39 to –0.30) (Romeo et al., 2018).

While ND is a technique used to improve the mobility of the nervous system to surrounding tissues through movement of the body, upper and lower extremities. ND improves the mechanical function of nerve structures in terms of tension, sliding, and compression which can affect intraneural microcirculation. ND affects the mechanical function of peripheral nerves and changes in the mechanical function of these nerves have a direct impact on physiological changes in the nervous structure as of affecting

the improvement of pain levels and functional abilities (Borrella-Andrés et al., 2021; Mayank Manojbhai Raval & Shweta Rameshbhai Rakholiya, 2022; Nugraha et al., 2019). This is also supported by a previous meta-analysis which stated that ND can reduce pain (mean difference, –1.89; 95% CI: –3.14, –0.64; p<0.001) in nerve-related neck and arm pain (Basson et al., 2017).

ND produce elongation and stretch that have an impact on the recovery and movement of nerves and the structures that protect them through sliding movements, subsequently decreasing the intrinsic pressure on the nervous tissue which has an impact on improving nerve function (Ellis et al., 2022; Jung & Moon, 2020). Bilateral ND technique applied to cervical radiculopathy assist sliding movement on both sides thereby reducing tension on the provocation side. This sliding movement helps increase intraneural and axoplasmic blood flow which in turn helps in the absorption of fluid in the tissues and reduces intraneural edema (Kinandana et al., 2020).

CONCLUSION

Based on these findings, it can be concluded that the addition of bilateral neurodynamic in the intervention of ultrasound therapy and manual traction can help reduce pain and improve neck disability. This case series can be used as an introduction in conducting more advanced research, such as conducting randomized controlled trials.

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