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Mulligan Versus Conventional Neurodynamic Mobilization in Patients with Cervical Radiculopathy - A Randomized Controlled Trial

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ABSTRACT

Background: Cervical radiculopathy is a type of neck disorder. Here a nerve root in the cervical spine becomes inflamed or impinged, resulting in neurological functions. They may radiate anywhere from the neck into the shoulder, arm, hand, or fingers. While the clinical diagnostic tests of cervical radiculopathy are well established in the literature, studies finding the usefulness of rehabilitation interventions are few. Therefore, the objective of the present study was to compare the effectiveness of mulligan mobilization versus conventional neurodynamics in cervical radiculopathy.

Methods: 30 subjects with age group 30 – 55 years who were clinically diagnosed with cervical radiculopathy & having one Upper Limb Tension Test positive were included in the study. They were randomized to Mulligan Neurodynamic Mobilization Group or Conventional Neurodynamics Group. The treatment sessions (3 repetitions, 3 sets) in both groups lasted for 5 consecutive days. Outcomes were measured using the Numerical Pain Rating Scale (NPRS) for pain, Cervical ranges, and patient-specific functional scale (PSFS) for disability.

Results: Wilcoxon test was used for within-group whereas the Mann-Whitney test was used for between-group comparisons. The test revealed similar improvements in pain and disability in both groups ($p > 0.05$); however, the Mulligan Neurodynamic Mobilization Group showed better results in terms of cervical ranges ($p < 0.05$).

Conclusion: Both the techniques were equally effective, but Mulligan Group had better cervical ranges, especially extension, rotation, and lateral flexion.

Keywords: Mulligan concept, Neck pain, Patient-Specific Functional Scale, Upper Limb Tension Test.

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INTRODUCTION

Cervical radiculopathy falls under the subgroup of neck disorders. It is defined as the clinical description of when a nerve root in the cervical spine becomes inflamed or impinged, resulting in a change in neurological functions such as numbness, pins and needles sensation, altered reflexes, or numbness that may radiate anywhere from the neck into the shoulder, arm, hand or fingers [1]. The annual incidence rate of cervical radiculopathy is 83 per 100,000 with a prevalence rate of 3.3 cases per 1000 persons and a peak incidence of its occurrence in the 4th & 5th decades of life [2]. Although it has less prevalence than general neck pain, it causes more severe neck pain with disability. The commonest etiology for cervical radiculopathy follows an injury that reduces the intervertebral space and resulting in inflamed cervical nerve root [1]. The main causative factors are cervical disc herniation and spondylosis. Though both genders have equal affliction, the condition presents greater in the 4th and 5th decades of life [3]. A study reported that C5-C6 and C6-C7 are the most commonly involved regions in cervical radiculopathy due to greater mobility permitted in these regions [4].

The shock absorption function is compromised with the loss of water content in disc substances, introducing secondary changes in the adjacent bone and soft tissues. These secondary changes present as osteophytes which, when causing nerve impingement, give rise to cervical radiculopathy symptoms [4]. Patients with cervical radiculopathy exhibit typical symptoms of pain in the cervical region which radiates to the upper limb and all the way down till the fingers, as well as neurological signs along the nerve root distribution [1].

History and physical examination and certain clinical tests such as spurling's compression test, distraction test, Upper Limb Tension Test (ULTT), and same side cervical rotation less than sixty degrees aids with a diagnosis of the pathology [1]. According to the literature, there is a greater sensitivity of the ULTT test and specificity of Spurling's test [5].

There are various pharmacological & non-pharmacological options available for the treatment of cervical radiculopathy. Though clinically various diagnostic tests of cervical radiculopathy are established in the literature, studies finding the effectiveness of rehabilitation interventions are very sparse. Hence, in our study, we have looked upon the effectiveness of mulligan mobilization & neurodynamics in patients with cervical radiculopathy. Neurodynamics, also called neural flossing, works to restore the relative gliding of neural tissues on the adjacent mechanical interfaces. This facilitates reduction of nerve mobility restriction, adherence along with promoting neurovascularity [3]. Mulligan mobilization works on the concept of 'positional fault theory' by correcting any micro-malalignment present in the joint surfaces, resulting in decreased pain and increased the affected ranges [6]. With Mulligan, neurodynamic Sustained Natural Apophyseal Glides (SNAGs) and neurodynamic Spinal Mobilization with Arm

movement can be used. In the Mulligan Neurodynamic Spinal Mobilization with Arm movement technique sustained transverse glide at affected spinous process level is given from affected to unaffected side with patient performing the desired upper limb nerve mobilization test. In the other technique, i.e., Mulligan neurodynamic SNAGs, the affected arm is maintained in the desired neurodynamic test position. The therapist performs SNAGs at the affected facet joint level, with the patient performing the neck movements, which facilitates the opening of the foraminal space [6].

As stated by Paungmali et al. (2003) [7], a hypoalgesic & concurrent sympathoexcitation is produced in the body when a person receives Mobilization With Movement (MWM) glides, same can have an effect on cervical radiculopathy symptoms. Hence, the purpose of our study was to check the effectiveness of mulligan neurodynamic mobilization & conventional neurodynamics in cervical radiculopathy [7].

METHODOLOGY

Study design, Setting & Participants:

The study was a two-group, single-blind, Randomized, Parallel-Group, Active Controlled Trial. After gaining ethical approval from the Regional Ethics Committee in Pune, India (DPU/R & R (P)/448 (9)/19), thirty cervical radiculopathy patients who fulfilled the inclusion criteria (30-55 years, both genders, unilateral radiating pain from neck to upper limb with one ULTT positive, dermatomal involvement of affected nerve root, clinically diagnosed and referred cases of cervical radiculopathy & who had given written informed consent for participation) were taken for the study. The experimental study was conducted in the department of "X." Any patient with recent trauma, fall or injury to the cervical region, myelopathy, Upper Motor Neuron signs like gait changes, fine motor changes & hyperreflexia, severe osteoporosis, hypermobile joints, or vertigo were excluded.

Sample size: The overall sample size calculated was 30. Assuming an effect size of 1.1 with an error of 0.05 & power of 0.8, the sample size worked out to be 15 in each group. Statistical software used was G-Power (version 3.1.9.2)

Randomization, Allocation, and Blinding:

The principal investigator randomized & enrolled the subjects into Mulligan Neurodynamic Group and Conventional Neurodynamic Group by chit method (15 chits for each group respectively). Mulligan Neurodynamic Group was given Neurodynamic SNAGs & Neurodynamic Spinal Mobilization with Arm Movement (3 repetitions 3 sets for 5 days) along with conventional treatment and other Group was given conventional Neurodynamic Mobilization (3 repetitions 3 sets for 5 days) along with conventional treatment. The subjects were evaluated for pain using the Numeric Pain Rating Scale (NPRS), Cervical ranges using a goniometer, and patient-specific functional scale (PSFS) for disability before and after 5 days of intervention. Since this was a single-blinded study, only the participants were

blinded to the intervention.

Fig. 1 shows the CONSORT flow diagram for the study. Forty-three individuals were assessed for eligibility, out of which thirty individuals met the inclusion criteria & were randomly assigned to one of the two groups. Participants were recruited from August 2019 to February 2020.

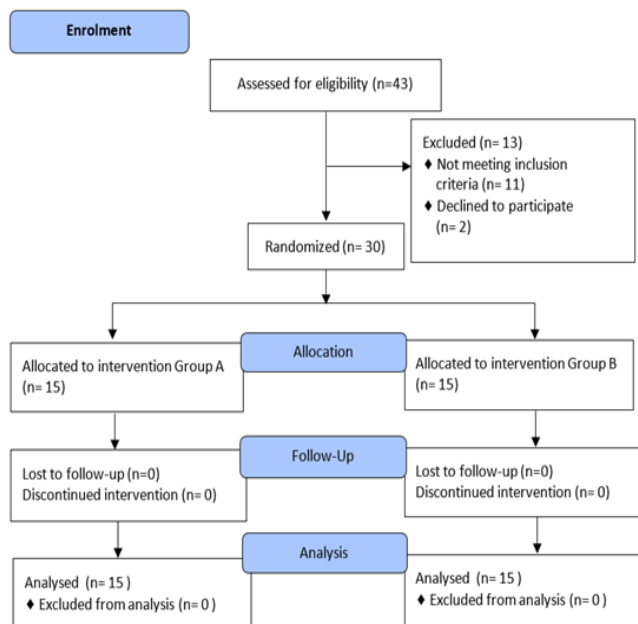


Figure 1: Flow diagram of the screening and eligibility process for the study (Adapted from CONSORT Flow Diagram, 2010).

INTERVENTION PROTOCOL FOR MULLIGAN NEURODYNAMIC GROUP:

In the neurodynamic SNAGs technique, subjects (n=15) sat on a chair; the therapist placed the medial border of distal phalanx of one thumb under the facet joints of the affected level and pulp of another thumb on the lateral side of previous thumb superimposing it. The affected arm is kept in a neurodynamic test position below the pain limit, and a glide was given over the facet joint by pushing it towards the eyeball. The patient was asked to actively perform certain specific neck movements (neck flexion/side-flexion to opposite side/rotation to same side) to facilitate the opening of the foramen. The therapist moved their hand along with the movement of the spine to sustain the glide (Fig.2). In Neurodynamic Spinal Mobilization with Arm Movement, the therapist approached the affected level of the spinous process from the medial aspect of the thumb of one hand, which was reinforced by the index finger of the other hand. Pure transverse glide was given from the affected to the unaffected side. While the glide was sustained, the patient performed the desired neurodynamic movements actively & just below the pain limit (Fig.3) [6]. Adequate soft tissue slack must be taken & then force should be applied in the desired direction to make the glide effective. The glides had been given for three repetitions, three sets for five consecutive days.



Figure 2: Neurodynamic SNAGs for cervical flexion



Figure 3: Neurodynamic Spinal Mobilization with Arm Movement for median nerve (start and end positions)

INTERVENTION PROTOCOL FOR CONVENTIONAL NEURODYNAMIC GROUP:

Subjects lay supine on a plinth. After identifying the affected nerve involved, neural mobilization was given in a specific sequence of movements (Fig.4)[8] for three reps, three sets for five consecutive days.

In addition to the above intervention, both the groups received similar conventional therapy as well, which included Hot pack for the cervical region, Upper trapezius

muscle stretching (30 sec hold with rest for 30sec) [9], Neck isometrics [10], Scapular retractions (3 sets in a day with 10 repetitions of each exercise) [11], chin tucks [4] and Manual traction to the cervical region. In addition, the participants were instructed to report any dizziness, cervical pain, or other symptoms during the application of the treatment to ensure the treatment remained symptom-free.



Figure 4: Conventional neural mobilization for median nerve (start & end positions)

STATISTICAL ANALYSIS

Data analysis & interpretation was done using the statistical package: WinPePi (version 11.65) & Primer of Biostatistics (version 7). Initially, the normality of data was analyzed using the Shapiro Wilk test in Win Pepi software. Then the difference between the pre & post-reading of each component of one group was compared with the difference of the respective component of the other group. The intra-group (within) comparison was done using Wilcoxon Signed Rank Test. In contrast, the inter-group (between) comparison was done using the Mann-Whitney test for not normally distributed data. The level of significance was determined at $p < 0.05$. There was no post-hoc or sub-group analysis carried out.

RESULTS

A total of 30 subjects participated in the study (15 in the Mulligan Neurodynamic group & 15 in the Conventional Neurodynamic group). There were no lost to follow-ups

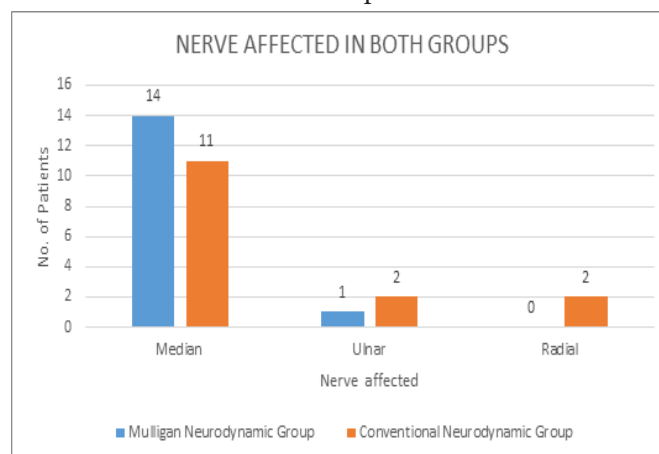
in either group. Statistical differences were seen for all variables within the groups ($p < 0.05$) and also in between-group comparison for cervical extension, rotation & lateral flexion ($p < 0.05$), as shown in the tables below.

Table 1: Descriptive statistics of the patients

Variables		Mulligan Neurodynamic Group (n=15)	Conventional Neurodynamic Group (n=15)
Age (Mean±S.D.)		44.13±8.39	44.67±9.15
Gender(%)	Male	40	13
	Female	60	87
Dominance(%)	Right	93	86
	Left	7	14

Table 1 describes the demographic characteristics of the participants, with the mean age of males being 43.25 years and females being 45 years. Also, the majority of the subjects were females, and most of the subjects were right-handed dominant.

Graph 1: Distribution of nerve affection in Mulligan Neurodynamic Group and Conventional Neurodynamic Group



Graph 1 showed that 25 (83%) subjects had Median nerve affection, 3 (10%) subjects had Ulnar nerve affection, whereas 2 (7%) subjects had Radial nerve affected.

Table 2: Outcome variables pre & post assessment within Mulligan Neurodynamic Group (n=15)

Variable	Pre (Mean±S.D.)		Post (Mean±S.D.)		P value
NPRS	6.06±1.87		4.4±2.06		<0.05*
PSFS	3.93±1.58		5.53±1.76		<0.05*
Cervical Flexion	35.87±7.73		39.53±6.43		<0.05*
Cervical Extension	38.90±7.51		42.53±7.12		<0.05*
Cervical Rotation	Rt	Lt	Rt	Lt	<0.05*
	53.8±9.36	51.27±10.7	57.33±8.76	56.87±8.3	
Cervical Lat. Flexion	Rt	Lt	Rt	Lt	<0.05*
	34.87±6.72	35.07±7	39±6.39	37.93±6.43	

*statistical significance. NPRS: Numeric pain rating scale, PSFS: Patient-specific functional scale

Table 2 reported various outcome variables measured in the Mulligan Neurodynamic group. For pain mean value of NPRS has decreased from 6.06 to 4.4. For disability, the mean value of PSFS had improved from 3.39 to 5.53. Neck mobility for flexion had increased from 35.87 to 39.53 and for extension 38.90 to 42.53. Also, for cervical rotation on the right side, mean degrees had changed from 53.8 to 57.33, and for the left side, 51.27 to 56.87. Similarly, for cervical lateral flexion, the values on the right had changed from 34.87 to 39 and for the left 35.07 to 37.93. The p-value was statistically significant for all the recorded variables.

Table 3: Outcome variables pre& post assessment within Conventional Neurodynamic Group (n=15)

Variable	Pre (Mean±S.D.)		Post (Mean±S.D.)		P value
NPRS	6±1.73		4.33±2.12		<0.05*
PSFS	3.13±1.35		4.86±1.72		<0.05*
Cervical Flexion	33±8.61		35±7.34		<0.05*
Cervical Extension	42.33±6.16		44±6.8		<0.05*
Cervical Rotation	Rt	Lt	Rt	Lt	<0.05*
	57.6±5.60	57.73±7.28	59.07±6.28	59.07±6.74	
Cervical Lat. Flexion	Rt	Lt	Rt	Lt	<0.05*
	36.33±6.98	36±8.56	37.60±7.14	37±8.36	

*statistical significance. NPRS: numeric pain rating scale, PSFS: patient-specific functional scale

Table 3 reported various outcome variables measured in the conventional Neurodynamic group. For pain mean value of NPRS had decreased from 6 to 4.33. For disability, the mean value of PSFS had improved from 3.13 to 4.86. Neck mobility for flexion had increased from 33 to 35 and for extension 42.33 to 44. Also, for cervical rotation on the right side, mean degrees had changed from 57.6 to 59.07, and for the left side, 57.73 to 59.07. Similarly, for cervical lateral flexion, the values on the right had changed from 36.33 to 37.60 and for the left 36 to 37. The p-value was statistically significant for all the recorded variables.

Table 4: Mean difference Comparison of outcome variables between Mulligan Neurodynamic Group & Conventional Neurodynamic Group.

Variable	Mulligan Neurodynamic Group		Conventional Neurodynamic Group		P value
NPRS	1.69±1.11		1.66±1.11		>0.05
PSFS	1.6±0.91		1.73±0.96		>0.05
Cervical Flexion	3.73±3.13		2.13±2.50		>0.05
Cervical Extension	7±3.92		1.6±2.49		<0.05*
Cervical Rotation	Rt	Lt	Rt	Lt	<0.05*
	6.87±5.02	5.6±8.6	1.46±2.47	1.3±1.4	
Cervical Lat. Flexion	Rt	Lt	Rt	Lt	<0.05*
	4.13±3.04	2.86±2.9	1.26±1.03	0.8±0.9	

*statistical significance

Table 4 showed a between-group comparison of outcome variables. For pain, the mean diff. of NPRS scores for Mulligan Group was 1.69 and for Conventional Group was 1.66. For disability, the mean value of PSFS means diff. of PSFS scores for Mulligan Group was 1.6 and for Conventional Group was 1.73. Mean diff. of Cervical Flexion ranges for Mulligan Group was 3.73 and for other Group was 2.13, for extension mean diff. for Mulligan Group was 7 and for other Group was 1.66. Also, for cervical rotation on the right side, the mean diff. for the Mulligan Group was 6.87 & for the other Group was 1.46; for the left side, mean diff. was 5.6 for Mulligan Group & 1.3 for Conventional Group. Similarly, for cervical lateral flexion of the right side, mean diff. for Mulligan Group was 4.13 & for another Group was 1.26 and for the left side, mean diff. for Mulligan Group was 2.86 & for Conventional Group was 0.8. Outcome variables such as NPRS, PSFS, and Cervical flexion scores had similar effects with $p>0.05$; however, Mulligan Neurodynamic Group showed better outcomes in cervical extension, rotation, and lateral flexion with $p<0.05$.

Adverse events

No adverse events were reported in the participants.

DISCUSSION

This study aimed to compare proximal and distal neural mobilization using Mulligan techniques to conventional neural mobilization in cervical radiculopathy subjects. Following the hypothesis on the comparison, statistically significant results were reported in neck extension, rotation, and lateral flexion in the Mulligan group. In the present study, cervical radiculopathy was found associated with involvement of median nerve (83%) much more significant as compared to ulnar (10%) or radial nerve (7%). A study by Oskay et al. found an affection of grip strength in cervical radiculopathy patients due to ulnar and median nerve [12]. According to epidemiologic studies in cervical radiculopathy, C7 nerve roots followed by C8 nerve roots are most commonly affected [13]; depending upon compression level, if C4-C5 and C6-C7 nerve roots were affected, greater chances of median nerve palsy in association with the cervical region can occur.

In the Mulligan technique group, the improvement in pain and functional disability was reported. Mulligan's Mobilization with Movement involved a combination of active movements done by the patient with simultaneous passive mobilization given by the therapist. This promotes increased sympathoexcitator and analgesic effect, as stated by Vincenzo and Paungmali et al. (2007) [7,14]. Also passive gliding technique might give another description for pain modulation through gate control mechanism as same creates activation of afferent nerve fibers. This can influence the spinal cord neurons and cause activation of descending pain inhibitory system through the release of serotonin, adrenaline, etc. A study done by Said et al. (2017) had shown the role of accessory glides in improving circulation and nutrition to the joint with the removal of

metabolite waste [15].

Sustained glide with distal arm movements to glide the affected nerve or maintaining the arm in the neurodynamic glide position and SNAGs and cervical active movements can help correct positional fault. This happens by separating the facet joints and releasing the entrapped meniscoid to return to its intra-articular position [10]. Also, clinical approaches for cervical radiculopathy commonly include interventions that target increasing the foraminal space to release the entrapped nerve root [1]. As a result, in addition to neural mobilization along with glides, the mobility of the neural root at the interface improved, thus releasing the entrapped nerve and improving its gliding ability.

A Conventional Neurodynamic technique in cervical radiculopathy showed altered neurodynamics of the affected nerve root; hence neural mobilization technique can be given. The nervous system should be able to adapt to mechanical loads. It must go through mechanical events like elongation, sliding, angulation, and compression. In the absence of these dynamic mechanisms, the nervous system is prone to neural edema, ischemia, fibrosis, and hypoxia which commonly occurs in cervical radiculopathy. So for restoring the mechanical functions of the affected neural tissues, neural mobilization can be used. Physiologically improved intraneural circulation, axoplasmic flow, and neural connective tissue viscoelasticity help diminish pain and disability [16].

In cervical radiculopathy, cervical pain is present in association with the brachial area. Neural mobilization facilitates nerve gliding by breaking the neural adhesions. This will relax the nerves and improves their mobility. The same can impact joints and soft tissue structure adjacent to the affected nerves, causing some improvement in cervical ranges. The present study found greater affection of the median nerve, especially in the dominant arm. This can further be explored for involvement along its course and the muscles affected. Also, change in the upper limb tension test ranges can act as an objective measure to assess an increase in nerve gliding.

CONCLUSION

Mulligan Neurodynamic Mobilization techniques were found superior in improving neck ranges, especially cervical extension, rotation, and lateral flexion in cervical radiculopathy. Concerning pain and disability, either technique had a similar effect in reducing pain and disability.

LIMITATION

The study had a small sample size; hence the prevalence of median nerve affection could not be found, and trial findings may not be generalized in the population. In addition, there was no long-term follow-up done to see the carryover effects of the two treatment approaches.

Funding/ Support

The study had not received any grant from funding agencies in public, commercial, or not-for-profit sectors.

Declaration of competing interest

The authors of this study have reported no conflicts of interest.

Trial Registration

Clinical Trials Registry – India (ICMR-NIMS) – registration number: CTRI/2019/05/019382. The clinical trial was recorded prior to the recruitment of the first volunteer.

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