International Journal of
Therapies and Rehabilitation Research [E-ISSN: 2278-0343]
http://www.scopemed.org/?jid=12

IJTRR 2015, 4: 1 I doi: 10.5455/ijtrr.00000048

Original Article Open Access

EFFICACY OF MUSCLE ENERGY TECHNIQUE AND DEEP NECK FLEXORS TRAINING IN MECHANICAL NECK PAIN- A RANDOMIZED CLINICAL TRIAL

Harshita Yadav *, Manu Goyal

Harshita Yadav, Assistant Professor, Maharishi Markandeshwar Institute of Physiotherapy & Rehabilitation, Maharishi Markandeshwar University (MMU) Mullana
Manu Goyal, Assiociate Professor, Markandeshwar Institute of Physiotherapy & Rehabilitation, Maharishi Markandeshwar University (MMU) Mullana.

ABSTRACT

BACKGROUND: A long term habitual posture with abnormal loading of ligaments and muscles, leads to development of neck pain. More recently, muscle based treatments approaches for MNP (Mechanical Neck Pain) evolved from a passive treatment technique such as myofascial release towards more active treatment technique such as MET (Muscle Energy Technique) and DNF (Deep Neck Flexors) training.
METHOD: 33 patients including 18 males and 15 females were selected and randomly allocated into three groups using sealed opaque envelope containing treatment allocation. Group A (n=11) received conventional treatment such as MHP (Moist Heat Pack), Static Stretching exercises, Cervical spine non-thrust mobilization, Cervical spine active ROM (Range of Motion) exercises and Postural exercises. Group B (n=11) received DNF training with conventional treatment. Group C (n=11) received MET in additional to conventional treatment. Primary outcome measure functional disabilities and secondary measure pain and ROM were recorded at baseline, 7^{th} day and 14^{th} day.
RESULTS: One-way ANOVA was used for within group analysis. Repeated measure ANOVA followed by post hoc analysis was employed for between group comparisons. The results suggest that there was a significant improvement in mean change scores of NDI, VAS and ROM after treatment of 2 weeks in all three groups - A, B and C, but significant improvement was found in group B and group C (p value ≤0.05). Between group effect size was medium (f> 0.25) for primary outcome measure NDI.
CONCLUSIONS: Both DNF training and MET have additional therapeutic effects over a standard care by reducing functional disabilities, pain and in improving ROM in mechanical neck pain patients. Whereas, on comparing DNF training group and MET group, the former have statistically more significant improvement than the later.

KEYWORDS: Mechanical neck pain, Muscle energy technique (MET), Soft tissue mobilization, Deep neck flexors training, Static stretching.

Corresponding Author: Harshita Yadav, Ph. No – 9991757696 , E mail: harshitayadav881@gmail.com

INTRODUCTION

Neck pain is a common problem, with an annual incidence estimated at about 15%[1] and second to low back pain in its frequency in general population and musculoskeletal practice.[2] A long term habitual posture can result in abnormal loading of ligaments and muscles, which leads to development of neck pain.[3]

Aetiological factors of Mechanical neck pain (MNP) are poorly understood and are usually multifactorial, including poor posture, anxiety, depression, neck strain, and sporting or occupational activities.[4] The symptoms usually have postural or mechanical basis which are found to be predictably caused by limited range of motion (ROM), stiffness, shortening or lengthening of muscles, tenderness, cervical pain aggravated by neck movements.[3,4] Forward head posture results in muscle imbalance which leads to tightness of neck extensors and weakness of deep neck flexors (DNF).[5]

According to Janda, postural muscles have tendency to get shorten, in both normal and pathological conditions. Upper trapezius, levator scalpulae and scalene are most common postural muscles.[6] Additionally, longus colli and longus capitis (DNF) have important role in postural support and their impaired activation leads to neck pain.[7]

Mechanical restriction between one to more vertebrae, can caused by pain, fiber contracture, bony ankylosis or muscle spasm leads to ROM reduction.[8] Multiple approaches are used for treatment MNP which includes proprioceptive neuromuscular facilitation, stress management, postural advice on daily activities, work and hobbies, pillow position, analgesics and anti-inflammatory, various techniques like yoga, Pilates, Alexander technique are been used for improving neck posture, moist hot pack (MHP), cervical thrust manipulation and non thrust manipulations, thoracic thrust manipulation and non thrust mobilization, kinesio taping, strength training, endurance and co-ordinated exercises.[4,9]

More recently, muscle based treatments approaches for MNP evolved from a passive treatment technique such as myofascial release towards more active treatment technique such as MET and DNF training. Evidences are there which demonstrated beneficial effects for DNF training[10] while less studies could found on MET. Therefore, there is a need to study the adjunctive MET and DNF training program in addition to standard care in MNP patients.

METHODOLOGY

The proposal of the study was approved by the Institutional Research Committee of M.M.I.PR Maharishi Markandeshwar University, Mullana. The present study was, conducted in the Outdoor Patient Department of MM Hospital, Mullana. The clinical study is registered in a database Clinical trials.gov NCT02301871. The patients were explained about the aim of the study and consent was received from the patients prior to the study. The sample size was estimated using the formula given by Zhong B[11] with 80% of power at alpha level =0.05, assuming 5% drop out during the treatment period, through which 33 patients were selected out of which18 were males and 15 were females. Patients were selected by means of purposive sampling based on inclusion and exclusion criteria. Eligible subjects were randomly allocated into three groups using sealed opaque envelope containing the treatment allocation for each participant.

The inclusion criteria includes the participants age 18 to 45 years, neck pain of minimum duration of six weeks, both males and females, signed informed consent form, tightness of upper trapezius, levator scapulae, scalene muscles on painful side, should not be receiving any other therapeutic intervention, should not be on medication, willingness to participate.

The exclusion criteria includes inflammatory, malignant and neurological conditions, metabolic disease neck pain radiating into arms and upper extremity, neck pain associated with headaches or facial pain recent major trauma or fracture of the cervical spine referred pain history of surgery of cervical spine.

Group A (N=11) received conventional treatment for 5 days per week for 2 weeks such as MHP (Moist Heat Pack) for 20 minutes, Static Stretching exercises for upper trapezius, levator scapulae and scalene muscle which is held for 10-30 seconds- repeated 3-5 times, Cervical spine non-thrust mobilization (Grade 3) was given to each segment from C_2-C_7 was

oscillated for 10 repetitions, followed by a 10 seconds rest between segments, Cervical spine active ROM (Range of Motion) exercises with 10 repetitions- 2-3 times a day and Postural exercises were given as home programme. Group B (N=11) received DNF training along with conventional treatment. In this programme, emphasis was placed on first attaining the correct craniocervical flexion action, with minimal activity of the superficial cervical flexor muscles. The craniocervical flexion action involves a specific craniocervical movement (nodding – "yes" movement) of head such that it remains in contact with the supporting surface. Once the correct action had been achieved, participants were instructed in the use of the sphygmomanometer to guide the training of the CCF muscle contraction at the various incremental levels of pressure (22 to 30 mmHg, progressively inner range positions).[12] Group C (N=11) received MET in additional to conventional treatment. MET was applied to Upper trapezius, Levator scapulae and Scalene Following the 7-10 seconds isometric contraction and complete relaxation of all elements, the stretch is maintained for 30 seconds. The effort and the counter-pressure should be modest (20% of available strength) and painless. The process is repeated 3-5 times.

The data for functional disability, pain and range of motion were recorded using NDI, VAS and goniometry respectively. NDI is a self reported ten- item scale. Each item assesses different neck pain complaints. Most of the items are related to restrictions in activities of daily living, and each item is expressed by 6 different assertions in the range 0-5, with 0 indicating no disability and 5 indicating highest disability. The total score ranges from 0 to 50. VAS is used to assess the severity of pain**.** A 10 cm horizontal line was drawn, with 0 means no pain and 10 means the worst possible pain. The patient was asked to mark a point in the scale representing their intensity of pain. Active Range of Motion was assessed using universal standard goniometer for cervical flexion, extension, side flexion (left and right), rotation (left and right). All ranges were assessed in sitting position. The data was collected at baseline, 7^{th} day and 14^{th} day.

The data were analyzed using statistical Package for the Social Sciences (SPSS) version 16. One-way ANOVA was used to compare the mean age, BMI and to find out difference in disability, pain and range of motion for between group comparisons. Chi square test was used to compare the gender differences among the groups. Repeated measure ANOVA was used to determine whether there is difference between the pre score and post score within the Group A, B and C. Post hoc analysis was done in which turkey's test was used for significant interaction between groups and to find which group is better. Between group effect size was calculated by SPSS version 16.

RESULTS

The p value in demographic (continuous and categorical variable and baseline characteristics, shown no significant difference between group A, B and C thus, homogeneity between the three groups were maintained (Table 1). Overall results of the study indicate that the between group difference of NDI score and extension ROM was significantly improved in group B ($p< 0.05$) after 2 weeks of treatment as compared with group A and C (Table 2 and 5). VAS score showed significant improvement in both the groups B and C ($p< 0.05$) after 2 weeks of treatment as compared to group A (Table 3). In group C there was a significant improvement in improving flexion ROM ($p< 0.05$) after 2 weeks treatment protocol, when compared to other group A and B (Table 4). On the other aspect, both groups B and C showed significant improvement in improving side flexion and rotation ROM ($p< 0.05$) after 2 weeks treatment protocol when compared to group A (Table 6-9).

Table 1. Demographic and Baseline Characteristics of Participants

Variables		Group A	Group B	Group C	P-value
Age (years) Mean ± S.D		33.727±4.496	32.454±4.762	32.181±5.250	0.730
Gender n (%)	Male	6 (54.54)	7 (63.63)	5 (45.45)	0.69
	Female	5 (45.45)	4 (36.36)	6 (54.54)	
BMI (kg/m^2) Mean ± S.D		24.297±2.722	22.996±3.282	23.324±2.433	0.455
NDI score [a]		37.879±3.365	37.143±4.107	36.942±3.750	0.828
VAS score [a]		6.473±0.703	6.636±0.765	6.464±0.827	0.839
Flexion ROM [a]		28.364±1.433	28.546±2.067	28.909±1.578	0.751
Extension ROM [a]		36.364±2.580	35.091±3.700	37.364±1.912	0.185
Side flexion ROM	(left) [a]	31.000±1.732	31.818±2.786	31.000±1.732	0.447
	(right) [a]	33.182±2.562	31.455±2.018	33.182±2.562	0.211
Rotation ROM	(left) [a]	60.455±2.162	62.091±2.587	60.455±2.162	0.154
	(right) [a]	60.455±3.236	61.273±2.760	60.455±3.236	0.156

p≤ 0.05 considered as significant, BMI: Body Mass Index, S.D: Standard Deviation; [a] Data are F value; [b] Data are Chi square value, NDI: Neck Disability Index; VAS: Visual Analogue Scale; ROM: Range of Motion; [a] Data are Mean± standard deviation

Table 2. Within and Between Group Comparison of NDI Score among the Groups

Treatment Groups	Baseline (T1)	7th day (T2)	14th day (T3)	CH_1 (T1-T2) Mean ± SEM	F (P-value)	CH_2 (T2-T3) Mean ± SEM	F (P-value)	CH_3 (T1-T3) Mean ± SEM	F (P-value)
Group A [a, b]	na=37.879 ±3.365 [35.618-40.139]	nb=26.784 ±3.481 [24.444-29.122]	nc=16.126 ±3.280 [13.923-18.329]	ND (na-nb)= 11.095±0.205[c]	8.719 (0.001)	NE (nb-nc)= 10.658±0.418[c]	1.938 (0.162)	NF (na-nc)=21.753 ±0.344[c]	4.029 (0.028)
Group B [a, b]	n'a'=37.143±4.107 [34.385-39.901]	n'b'=22.517±2.884 [20.579-24.454]	n'c'=12.726 ±2.172 [11.267-14.185]	N'D' (n'a'-n'b')= 14.626±1.081[c]		N'E'(n'b'-n'c')= 9.791±0.831[c]		N'F'(n'a'-n'c')= 24.417 ±0.848[c]	
Group C [a, b]	n"a"=36.942 ±3.750 [34.422-39.460]	n"b"=21.470±4.381 [18.526-24.413]	n"c"=12.677 ±2.620 [10.917-14.437]	N"D"(n"a"-n"b")= 15.472±0.881[c]		N"E"(n"b"-n"c")= 8.793±0.694[c]		N"F"(n"a"-n"c")= 24.265 ±0.91[c]	
Group A- Group B (CH'_1) [b] Mean ± SEM				ND-N"D"= -3.531 ±1.112 [(-6.270)-(-0.789)]	(0.009)	NE-N"E"= 1.865 ±0.948 [(-0.472)-(-4.210)]	(0.636)	NF-N"F"=-2.512 ±1.054 [(-5.110)-(-0.086)]	(0.044)
Group A- Group C (CH'_2) [b] Mean ± SEM				N'D'-N"D"=-4.377 ±1.112 [(-7.117)-(-1.635)]	(0.001)	N'E'-N"E"= 0.867 ±0.948 [(-1.470)-(-3.203)]	(0.138)	N'F'-N"F"=-2.664 ±1.054 [(-5.262)-(0.065)]	(0.060)
Group B- Group C (CH'_3) [b] Mean ± SEM				ND-N'D'=-0.846 ±1.112 [(-3.587)-(-1.894)]	(0.729)	NE-N'E'=0.998± 0.948 [(-1.338)-(-3.334)]	(0.550)	NF-N'F'= 0.152 ±1.054 [(-2.446)-(-2.750)]	(0.989)

p≤ 0.05 considered as significant; ROM: Range of Motion; SEM: Standard error of mean; NDI: Neck Disability Index; CH_1, CH_2, CH_3: change score within the group; CH'_1, CH'_2, CH'_3: change score between the group; [a] Data are Mean± standard deviation; [b] Data are 95% Confidence Interval; [c] P value <0.0001

Table 3. Within and Between Group Comparison of VAS Score among the Groups

Treatment Groups	Baseline (T1)	7th day (T2)	14th day (T3)	CH_1 (T1-T2) Mean ± SEM	F (P-value)	CH_2 (T2-T3) Mean ± SEM	F (P-value)	CH_3 (T1-T3) Mean ± SEM	F (P-value)
Group A [a, b]	va=6.473 ±0.703 (5.907-7.019)	vb=4.291 ±0.541 (2.739-3.424)	vc=2.482 ±0.751 (1.119-1.517)	VD (va-vb)= 2.182±0.0952 [c]	28.374 (0.000)	VE (vb-vc)= 1.809±0.111 [c]	0.087 (0.917)	VF (va-vc)= 3.991±0.122 [c]	16.917 (0.000)
Group B [a, b]	v'a'= 6.636 ±0.765 (6.122-7.150)	v'b'=3.118 ±0.534 (2.759-3.477)	v'c'=1.382 ±0.319 (1.167-1.596)	V'D' (v'a'-v'b')= 3.518±0.143 [c]		V'E'(v'b'-v'c')= 1.736±0.125 [c]		V'F'(v'a'-v'c')= 5.254±0.165 [c]	
Group C [a, b]	v"a"=6.464 ±0.827 (5.907-7.019)	v"b"=3.082 ±0.510 (2.739-3.424)	v"c"=1.318 ±0.296 (1.119-1.517)	V"D"(v"a"-v"b")= 3.382±0.166 [c]		V"E"(v"b"-v"c")= 1.764±0.138 [c]		V"F"(v"a"-v"c")= 5.146±0.211 [c]	
Group A- Group B (CH'_1) [b] Mean ± SEM				VD-V"D"= -1.336 ± 0.195 [(-1.817)-(-0.855)]	(0.000)	VE-V"E"= 0.073 ±0.177 [(-0.362)-(0.507)]	(0.987)	VF-V"F"= -1.3 ±0.241 [(-1.857)-(-0.670)]	(0.000)
Group A- Group C (CH'_2) [b] Mean ± SEM				V'D'-V"D"=-1.200 ± 0.195 ([-1.681)-(-0.718)]	(0.000)	V'E'-V"E"=0.045 ± 0.177 [(-0.389)-(0.480)]	(0.964)	V'F'-V"F"= -1.155 ± 0.241 [(-1.748)-(-0.561]	(0.000)
Group B- Group C (CH'_3) [b] Mean ± SEM				VD-V'D'= 0.136 ±0.195 [(-0.344)-(-0.617)]	(0.766)	VE-V'E'=-0.027 ±0.177 [(-0.462)-(0.407)]	(0.911)	VF-V'F'= 0.109 ±0.241 [(-0.484)-(0.702)]	(0.893)

p≤ 0.05 considered as significant; ROM: Range of Motion; SEM: Standard error of mean; VAS: Visual Analogue Scale; CH_1, CH_2, CH_3: change score within the group; CH'_1, CH'_2, CH'_3: change score between the group; [a] Data are Mean± standard deviation; [b] Data are 95% Confidence Interval; [c] P value <0.0001;

Table 4. Within and Between Group Comparison of Flexion ROM among the Groups

Treatment Groups	Baseline (T1)	7th day (T2)	14th day (T3)	CH_1 (T1-T2) Mean ± SEM	F (P-value)	CH_2 (T2-T3) Mean ± SEM	F (P-value)	CH_2 (T1-T3) Mean ± SEM	F (P-value)
Group A [a, b]	fa=28.364 ±1.433 (27.400-29.326)	fb=32.455 ±1.368 (31.535-33.373)	fc=35.546 ±1.864 (34.293-36.797)	FD(fa-fb)=-4.091±0.251 [c]	2.692 (0.084)	FE(fb-fc)= -3.091±0.211 [c]	4.559 (0.019)	FF(fa-fc)= -7.182±0.266 [c]	5.000 (0.013)
Group B [a, b]	f'a'=28.546 ±2.067 (27.156-29.934)	f'b'=34.091 ±1.300 (33.217-34.964)	f'c'=37.364 ±1.120 (36.611-38.116)	F'D'(f'a'-f'b')= -5.545±0.638 [c]		F'E'(f'b'-f'c')= -3.273±0.304 [c]		F'F'(f'a'-f'c')= -8.818±0.615 [c]	
Group C [a, b]	f"a"=28.909 ±1.578 (27.848-29.969)	f"b"=33.546 ±1.368 (32.626-34.464)	f"c"=37.727 ±1.348 (36.821-38.633)	F"D"(f"a"-f"b")= -4.637±0.364 [c]		F"E"(f"b"-f"c")= -4.181±0.325 [c]		F"F"(f"a"-f"c")= -8.818±0.325 [c]	
Group A- Group C (CH'_1) [b] Mean ± SEM				FD-F"D"= -1.454 ±0.633 [(-3.0150)-(0.106)]	(0.072)	FE-F"E"= -0.182 ±0.387 [(-1.136)-(0.772)]	(0.064)	FF-F"F"= -1.636 ±0.598 [(-3.109)-(-0.163)]	(1.000)
Group B- Group C (CH'_2) [b] Mean ± SEM				F'D'-F"D"= -0.546 ±0.633 [(-2.106)-(1.015)]	(0.668)	F'E'-F"E"=-1.09 ±0.387 [(-2.045)- (-0.136)]	(0.022)	F'F'-F"F"=-1.636 ±0.598 [(-3.109)-(-0.163)]	(0.027)
Group A- Group B (CH'_3) [b] Mean ± SEM				FD-F'D'= 0.908 ±0.633 [(-0.652)-(2.470)]	(0.336)	FE-F'E'= -0.908 ±0.387 [(-1.863)-(0.045)]	(0.886)	FF-F'F'= 0 ±0.598 [(-1.473)-(1.473)]	(0.027)

p≤ 0.05 considered as significant, ROM: Range of Motion, SEM: Standard error of mean, CH_2, CH_3: change score within the group; CH'_1, CH'_2, CH'_3: change score between the group; [a] Data are Mean± standard deviation; [b] Data are 95% Confidence Interval; [c] P value <0.000

Table 5. Within and Between Group Comparison of Extension ROM among the Groups

Treatment Groups	Baseline (T1)	7th day (T2)	14th day (T3)	CH_1 (T1-T2) Mean ± SEM	F (P-value)	CH_2 (T2-T3) Mean ± SEM	F (P-value)	CH_2 (T1-T3) Mean ± SEM	F (P-value)
Group A [a, b]	ea=36.364±2.580 (34.630-38.096)	eb=40.636± 2.580 (38.903-42.369)	ec=43.273± 2.867 (41.346-45.198)	ED(ea-eb)= -4.272±0.237[c]	1.515 (0.236)	EE(eb-ec)= -2.637±0.244[c]	9.474 (0.001)	EF(ea-ec)= -6.909±0.315[c]	6.384 (0.005)
Group B [a, b]	e'a'=35.091±3.700 (32.605-37.516)	e'b'=39.273±3.133 (37.167-41.377)	e'c'=45.364±1.690 (44.228-46.498)	E'D'(e'b'-e'c')= -6.091±0.909[d]		E'E'(f'b'-f'c')= -3.273±0.304[c]		E'F'(e'a'-e'c')= -10.273±1.037[c]	
Group C [a, b]	e"a"= 37.364± 1.912 (36.079-38.647)	e"b"=42.364±2.292 (40.823-43.903)	e"c"=46.364±1.859 (45.115-47.612)	E"D"(e"a"-e"b")= -5±0.486[c]		E"E"(e"b"-e"c")= -4±0.27[c]		E"F"(e"a"-e"c")= -9±0.426[c]	
Group A- Group B (CH'_1) [b] Mean ± SEM				ED-E"D"= 0.09 ±0.515 [(-1.179)-(1.361)]	(0.983)	EE-E"E"= -3.454 ± 0.799 [(-5.425)-(-1.483)]	(0.000)	EF-E"F"= -3.364 ±0.951 [(-5.707)-(-1.020)]	(0.004)
Group A- Group C (CH'_2) [b] Mean ± SEM				E'D'-E"D"= -0.728 ±0.515 [(-1.997)-(0.5430]	(0.348)	E'E'-E"E"= -1.363 ±0.799 [(-3.334)-(0.607)]	(0.220)	E'F'-E"E"= -2.091 ±0.951 [(-4.434)-(0.252)]	(0.088)
Group B- Group C (CH'_3) [b] Mean ± SEM				ED-E'D'= -0.818 ±0.515 [(-2.088)-(0.452)]	(0.266)	EE-E'E'= 2.091 ±0.799 [(0.120)-(4.061)]	(0.036)	EF-E'F'= 1.273 ±0.951[(-1.070)-(3.616)]	(0.385)

p≤ 0.05 considered as significant; ROM: Range of Motion; SEM: Standard error of mean; CH_2, CH_3: change score within the group; CH'_1, CH'_2, CH'_3: change score between the group;; [a] Data are Mean± standard deviation; [b] Data are 95% Confidence Interval; [a] P value <0.0001, [d] P value =0.0002

Table 6. Within and Between Group Comparison of Side Flexion ROM (Left) among the Groups

Treatment Groups	Baseline (T1)	7th day (T2)	14th day (T3)	CH_1 (T1-T2) Mean ± SEM	F (P-value)	CH_2 (T2-T3) Mean ± SEM	F (P-value)	CH_2 (T1-T3) Mean ± SEM	F (P-value)
Group A [a, b]	sIa=31.000±1.732 (29.836-32.163)	sIb=35.364±1.690 (34.228-36.498)	sIc=38.273±1.618 (37.185-39.359)	SLD(sIa-sIb)= -4.364±0.279[c]	1.285 (0.291)	SLE(sIb-sIc)= -2.909±0.368[c]	5.686 (0.008)	SLF(sIa-sIc)= -7.273±0.237[c]	11.284 (0.000)
Group B [a, b]	sl'a'=31.818±2.786 (29.946-33.690)	sl'b'=36.091±3.562 (33.697-38.484)	sl'c'=41.818±1.60 (40.742-42.893)	SL'D'(sl'a'-sl'b')= -4.273±0.506[c]		SL'E'(sl'b'-sl'c')= -5.727±0.821[b]		SL'F'(sl'a'-sl'c')= -10±0.603[c]	
Group C [a, b]	sl"a"=32.091±1.446 (31.119-33.062)	sl"b"=37.273±1.679 (36.144-38.400)	sl"c"=41.546±1.635 (40.447-42.6438)	SL"D"(sl"a"-sl"b")= -5.182±0.501[c]		SL"E"(sl"b"-sl"c")= -4.273±0.488[c]		SL"F"(sl"a"-sl"c")= -9.455±0.366[c]	
Group A- Group B (CH'_1) [Φ,≡] Mean ± SEM				SLD-SL"D"=0.091 ±0.625 [(-1.448)-(1.630)]	(0.988)	SLE-SL"E"=-2.818 ±0.836 [(-4.878)-(-0.757)]	(0.006)	SLF-SL"F"=-2.727 ±0.608 [(-4.225)-(-1.229)]	(0.000)
Group A- Group C (CH'_2) [Φ,≡] Mean ± SEM				SL'D'-SL"D"=-0.818 ±0.625 [(-2.357)-(0.721)]	(0.401)	SL'E'-SL"E"= -1.364 ±0.836 [(-3.424)-(0.696)]	(0.248)	SL'F'-SL"F"= -2.182 ±0.608 [(-3.679)-(-0.684)]	(0.003)
Group B- Group C (CH'_3) [Φ,≡] Mean ± SEM				SLD-SL'D'= -0.909 ±0.625 ([-2.448)-(0.630)]	(0.326)	SLE-SL'E'= 1.454 ±0.836 [(-0.606)-(3.515)]	(0.207)	SLF-SL'F'= 0.545 ±0.608[(-0.952)-(2.043)]	(0.646)

p≤ 0.05 considered as significant, ROM: Range of Motion, SEM: Standard error of mean, C.I: Confidence Interval; CH_2, CH_3: change score within the group; CH'_1, CH'_2, CH'_3: change score between the group; * P value <0.0001, ‡ P value =0.0001; [Φ]Data are Mean± standard deviation; [≡]Data are 95% Confidence Interval

Table 7. Within and Between Group Comparison of Side Flexion ROM (Right) among the Groups

Treatment Groups	Baseline (T_1)	7th day (T_2)	14th day (T_3)	CH_1 (T1-T2) Mean ± SEM	F (P-value)	CH_2 (T2-T3) Mean ± SEM	F (P-value)	CH_2 (T1-T3) Mean ± SEM	F (P-value)
Group A [a, b]	sra=33.182±2.562 (31.460-34.903)	srb=36.364±2.063 (34.977-37.749)	src=39.091±2.253 (37.575-40.606)	SRD(sra-srb)= -3.182±0.784 [d]	2.215 (0.127)	SRE(srb-src)= -2.727±0.273 [e]	13.220 (0.000)	SRF(sra-src)= -5.909±0.889 [c]	14.213 (0.000)
Group B [a, b]	sr'a'=31.455±2.018 (30.098-32.810)	sr'b'=36.000±2.324 (34.438-37.561)	sr'c'=42.000±1.000 (41.328-42.671)	SR'D'(sl'a'-sl'b')= -4.545±0.413 [c]		SR'E'(sr'b'-sr'c')= -6±0.467 [c]		SR'F'(sr'a'-sr'c')= -10.545±0.39 [c]	
Group C [a, b]	sr"a"= 32.636±2.248 (31.126-34.146)	sr"b"=37.273±2.195 (35.798-38.747)	sr"c"=41.727±1.104 (40.985-42.468)	SR"D"(sr"a"-sr"b")= -4.636±0.338 [c]		SR"E"(sr"b"-sr"c")= -4.454±0.495 [c]		SR"F"(sr"a"-sr"c")= -9.091±0.562 [c]	
Group A- Group B (CH'_1) [b] Mean ± SEM				SRD-SR"D"= -1.363±0.744 [(-3.272)-(0.545)]	(0.200)	SRE-SR"E"= -3.273±0.637 [(-4.842)-(-1.702)]	(0.000)	SRF-SR"F"= -4.636 ±0.889 [(-6.829)-(-2.443)]	(0.000)
Group A- Group C (CH'_2) [b] Mean ± SEM				SR'D'-SR"D"= -1.454±0.774 [(-3.272)-(0.454)]	(0.162)	SR'E'-SR"E"= -1.727±0.637 [(-3.297)-(-0.157)]	(0.029)	SR'F'-SR"F"= -3.182 ±0.889 [(-5.374)-(-0.989)]	(0.003)
Group B- Group C (CH'_3) [b] Mean ± SEM				SRD-SR'D'= -0.090±0.744 [(-1.996)-(1.817)]	(0.992)	SRE-SR'E'= 1.546 ±0.637 [(-0.024)-(3.115)]	(0.054)	SRF-SR'F'= 1.455±0.889 [(-0.738)-(3.647)]	(0.247)

p≤ 0.05 considered as significant; ROM: Range of Motion; SEM: Standard error of mean; CH_2, CH_3: change score within the group; CH'_1, CH'_2, CH'_3: change score between the group; [a] Data are Mean± standard deviation; [b] Data are 95% Confidence Interval; [c] P value <0.0001; [d] p value =0.0069; [e] P value =0.0002,

Table 8. Within and Between Group Comparison of Rotation ROM (Left) among the Groups

Treatment Groups	Baseline (T1)	7th day (T2)	14th day (T3)	CH_1 (T1-T2) Mean ± SEM	F (P-value)	CH_2 (T2-T3) Mean ± SEM	F (P-value)	CH_2 (T2-T3) Mean ± SEM	F (P-value)
Group A [a, b]	rIa=60.455±2.162 (59.002-61.906)	rIb=63.818±2.562 (62.097-65.539)	rIc=67.182±2.401 (65.569-68.794)	RLD(rIa-rIb)= -3.363±0.388[c]	8.701 (0.001)	RLE(rIb-rIc)= -3.364±0.279[c]	9.956 (0.000)	RLF(rIa-rIc)= -6.727±0.333[c]	21.949 (0.000)
Group B [a, b]	rI'a'=62.091±2.587 (60.353-63.828)	rI'b'=67.909±2.548 (66.197-69.620)	rI'c'=74.000±2.490 (72.327-75.672)	RL'D'(rI'a'-rI'b')= -5.818±0.377[c]		RL'E'(rI'b'-rI'c')= -6.091±0.563[c]		RL'F'(rI'a'-rI'c')= -11.909±0.803[c]	
Group C [a, b]	rI"a"=62.273±2.284 (60.738-63.807)	rI"b"=68.182±2.562 (66.460-69.903)	rI"c"=72.909±1.178 (71.848-73.969)	RL"D"(rI"a"-rI"b")= -5.909±0.653[c]		RL"E"(rI"b"-rI"c")= -4.727±0.407[c]		RL"F"(rI"a"-rI"c")= -10.636±0.491[c]	
Group A- Group B [b] Mean ± SEM				RLD-RL"D"=-2.455±0.692 [(-4.161)-(-0.747)]	0.004	RLE-RL"E"= -2.727 ±0.611 [(-4.234)-(-1.220)]	0.000	RLF-RL"F"= 5.182 ±0.815 [(-7.191)-(-3.172)]	0.000
Group A- Group C [b] Mean ± SEM				RL'D'-RL"D"= -2.546 ± 0.692 [(-4.250)-(0.838)]	0.003	RL'E'-RL"E"= -1.364±0.611 [(-2.870)-(0.143)]	0.082	RL'F'-RL"F"= 3.909 ±0.815 [(-5.918)-(1.899)]	0.000
Group B- Group C [b] Mean ± SEM				RLD-RL'D'= -0.091±0.692 [(-1.797)-(-1.615)]	0.991	RLE-RL'E'= 1.364±0.611 [(-0.143)-(2.870)]	0.082	RLF-RL'F'= -1.273±0.815 [(-0.736)-(3.282)]	0.278

p≤ 0.05 considered as significant; ROM: Range of Motion; SEM: Standard error of mean; CH_2, CH_3: change score within the group; CH'_1, CH'_2, CH'_3: change score between the group; [a] Data are Mean± standard deviation; [b] Data are 95% Confidence Interval; [c] P value <0.0001

Table 9. Within and Between Group Comparison of Rotation ROM (Right) among the Groups

Treatment Groups	Baseline (T1)	7th day (T2)	14th day (T3)	CH_1 (T1-T2) Mean ± SEM	F (P-value)	CH_2 (T2-T3) Mean ± SEM	F (P-value)	CH_2 (T2-T3) Mean ± SEM	F (P-value)
Group A [a, b]	rra=60.455±3.236 (58.280-62.628)	rrb=63.727±3.552 (61.340-66.113)	rrc=67.182±3.573 (64.781-69.581)	RRD(rra-rrb)= -3.272±0.141 [c]	54.528 (0.000)	RRE(rrb-rrc)= -3.455±0.312 [c]	(0.001)	RRF(rra-rrc)= -6.727±0.333 [c]	31.984 (0.000)
Group B [Φ,≡]	rr'a'=61.273±2.760 (59.418-63.127)	rr'b'=67.636±2.541 (65.929-69.343)	rr'c'=74.091±2.737 (72.252-75.929)	RR'D'(rr'a'-rr'b')= -6.364±0.244 [c]		RR'E'(rr'b'-rr'c')= -6.455±0.638 [c]		RR'F'(rr'a'-rr'c')= -12.818±0.784 [c]	
Group C [Φ,≡]	rr"a"= 62.727±2.005 (61.380-64.0730	rr"b"= 69.091±2.119 (67.667-70.514)	rr"c"=73.546±1.753 (72.367-74.723)	RR"D"(rr"a"-rr"b")= -6.364±0.31 [c]		RR"E"(rr"b"-rr"c")= -4.455±0.455 [c]		RR"F"(rr"a"-rr"c")= -10.818±0.423 [c]	
Group A- Group B (CH'_1) [b] Mean ± SEM				RRD-RR"D"= -3.091 ±0.342 [(-3.933)-(-2.248)]	(0.000)	RRE-RR"E"= -3 ±0.688 [(-4.697)-(-1.303)]	(0.000)	RRF-RR"F"= -6.091 ±0.776 [(-8.004)-(4.176)]	(0.000)
Group A- Group C (CH'_1) [b] Mean ± SEM				RR'D'-RR"D"= -3.092 ±0.342 [(-3.933)-(-2.248)]	(0.000)	RR'E'-RR"E"= -1 ± 0.688 [(-2.697)-(0.697)]	(0.000)	RR'F'-RR"F"= -4.091 ±0.776 [(-6.004)-(-2.176)]	(0.328)
Group B- Group C (CH'_1) [b] Mean ± SEM				RRD-RR'D'= 0.000 ±0.342 [(-0.842)-(0.842)]	(1.000)	RRE-RR''= 2 ±0.688 [(0.303)-(3.697)]	(0.039)	RRF-RR'F'= 2 ±0.776 [(0.086)-([(3.914)]	(0.018)

p≤ 0.05 considered as significant; ROM: Range of Motion; SEM: Standard error of mean; CH_2, CH_3: change score within the group; CH'_1, CH'_2, CH'_3: change score between the group; [a] Data are Mean± standard deviation; [b] Data are 95% Confidence Interval; [c] P value <0.0001

DISCUSSION

The results suggest that there was a significant improvement in mean change scores of NDI, VAS and ROM after treatment of 2 weeks in all the three groups i.e. group A, B, C (Table 3-10), but significant improvement was found in group B and C. However, on comparing group B and C, during1st week group C had more improvement in NDI score and side flexion (left)

ROM, but during 2nd week of treatment group B had shown more improvement. Additionally, the overall improvement for 2 weeks was more in group B than group C.

There was more improvement in group B for VAS score, flexion ROM, and extension ROM in the 1st week of the treatment, but during the 2nd week group C had more improvement, whereas the overall improvement was more in group B (Table 4 and 5). However, for side flexion (right) ROM, rotation (left and right) ROM there was almost equal improvement in both the groups (group B and group C) in 1st week. But during 2nd week and also the overall improvement was greater in group B (Table 8-10).

In the present study, the average within group change scores of NDI for participants in all the three groups exceeded value of both minimal detectable change (MDC) and minimal clinically important difference (MCID) which was 10% and 14% respectively, but it was more in group B and C which was DNF training and MET group respectively (Table 3). For VAS, the mean within change score for participants in all the three groups exceeded value of both MDC (1.3) and MCID (2.1), but it was more in group B and C (Table 4). Additionally, for all six cervical ROM, the average within group scores in all the three groups exceeded value of MDC which ranged from 3.6^0 to 6.5^0, but it was more in group B and C (Table 5-10). The point estimate of the between group difference in change scores of VAS for group A and B was 1.3, which is equal to the MCID suggesting clinically significant impact of adding DNF training to conventional treatment (Table 4). For Side flexion ROM (left), the average mean change scores for group A and B exceeded the value of MDC, indicating beneficial effects of DNF training in addition to conventional treatment (Table 7).[9]

Whereas the average mean change scores for rotation ROM (left) and rotation ROM (right) for group A and B exceeded MDC value more than group A and group C, suggesting more beneficial effects of DNF training than MET in addition to conventional treatment (Table 9-10).[9] The three groups had equal numbers of subjects and also there was no significant difference with respect to their age, which could have altered the results of the study. Between group effect size was medium (f> 0.25) for primary outcome measure NDI.[13]

Results in the study, which shows reduction in functional disability in MET group initially can be explained by the reduction in symptoms, which were produced by shortening of postural muscles that is upper trapezius, levator scapulae and scalene. The initial improvement in extension and side flexion ROM (left and right) can be due to stretching of superficial muscles that is upper trapezius and levator scapulae (Table 6-8). Flexion and rotation ROM (left and right) are improved later due to deep orientation of scalene muscles (Table 5, 9 and 10). Whereas, reduction in pain and improvement in ROM in the DNF training group initially can be due to reduction in cervical impairment, due to craniocervical flexion which is the principal action of DNF.

Although MET is commonly advocated treatment of somatic dysfunction and pain,[14] there remain little research into effects of MET on pain and tenderness. The results obtained for pain in MET group were in consensus with the previous study in which pain intensity was reduced following the MET over the neck area[15] and over other parts[14] of the body. On the other aspect, impairment in craniocervical flexors muscle performance appears to be a feature in some chronic neck disorders. Jull et al[16] reports that there was significant reduction in pain associated with neck movement and joint palpation both with manipulative therapy and DNF training in patients with cervicogenic headache and the effects were maintained.

A fixed head and neck posture for long duration causes shortening of posterior cervical muscles and lengthening of anterior neck muscles.[3] MET can be used to lengthen shortened musculature and improve joint function and range of motion. The two physiological principle on which MET is based on are Post isometric relaxation (PIR) and reciprocal inhibition (RI). PIR refers to the assumed effect of reduced tone experienced by a muscle, or group of muscles, after brief periods following an isometric contraction. Another variation involves the physiological response of the antagonists of a muscle which has been isometrically contracted- reciprocal inhibition (RI).[7]

The possible mechanism for pain reduction in MET group can be explained by inhibitory Golgi Tendon reflex, activated during isometric contraction that leads to reflex relaxation of muscle. Activation of muscle and joint mechanoreceptors leads to sympathoexcitation evoked by somatic efferents and localized activation of periaqueductal gray matter that plays a role in descending modulation of pain.[15] Whereas the effects of MET component for increase in ROM post treatment can be explained on the basis of physiological mechanisms behind the changes in muscle extensibility – reflex relaxation, viscoelastic change, and changes to stretch tolerance.[7,15]

Deep neck flexor muscles are increasingly active during craniocervical flexion and form a sleeve that stabilizes the cervical spine in all position So, whenever a muscle performance is impaired, the balance between the stabilizers on the posterior aspect of neck is disrupted which results in loss of proper alignment and posture and ultimately contributes to cervical impairment.[17] Therefore, low load craniocervical flexion exercise can train deep neck flexors effectively even in early stages of rehabilitation when pain or pathology might preclude high load exercises and thus gradually reduces the symptoms.[18]

The effect of Conventional treatment can be explained as moist heat therapy is known to have effects on pain and spasm and thus can attribute to pain relief and improved tissue extensibility in all three groups. Reduction in the pain following static stretching can be explained on the basis of inhibitory effects of GTO and Pacinian corpuscle modification. These reflexes will allow relaxation in musculotendinous unit tension and decreased pain perception.[15] Cervical spine non-thrust mobilization includes the passive movement which aims to alter the position so that ROM of joint becomes full and pain free that further contributes to increase the strength, endurance and speed with which the muscles can contract to control the movement.[19] Advice on the correction of postural abnormalities is important in preventing recurrence of pain.[20]

The present study found significant improvement in all the three groups, but more improvement was found in group B. Therefore, it can be predicted from the following results that patient pain, cervical flexion and extension ROM can be improved following DNF training as an adjunct to conventional treatment. Additionally, for improvement in functional disability and cervical side flexion and rotation treatment should be continued for 2 weeks. This can be explained as all the postural muscles i.e. upper trapezius and levator scapulae and scalene muscles contributes to the movement in side flexion of cervical spine and thereby more need time for tissue extensibility. Therefore, novelty of the study is that the result suggests that the addition of DNF training to conventional treatment may provide additional short term benefits to patients with MNP.

CLINICAL IMPLICATION

Most patients who present with neck pain have mechanical neck pain and it is more prevalent in among lower socioeconomic status groups, those performing repetitive, static work or physically demanding work which influence the soft-tissue relationship in cervical region. All the three treatments can be used for treatment of mechanical neck pain as statistically significant improvement was seen. For greater improvements in short duration, stretching the shortened muscles and training the deep neck flexor muscles which have impaired activation during neck pain had shown clinically effective results in reducing neck symptoms.

LIMITATIONS OF THE STUDY

Control group was not included in the study to interpret the adjunct effect of DNF training and MET to conventional treatment by evaluating any differences between them. No follow up was taken to see the long term effect of the treatment due to non availability of the patients and also it was uncertain that the observed differences might remain beyond that time.

FUTURE SUGGESTIONS

1. More experimental trials need to be explored on the combined effect MET and DNF training in patients with mechanical neck pain.
2. Follow up can be taken to see the long term effects of MET and DNF training in mechanical neck pain individuals.

Conflict of Interest: None.

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