



Comparative effectiveness of transverse oscillatory pressure and cervical traction in the management of cervical radiculopathy: A randomized controlled study

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Received 14 September 2016; Accepted 24 October 2017; Published 14 August 2018

Background: Radiating neck pain is one of the major symptoms of cervical radiculopathy (CR).

Objective: This study compared the effects of cervical traction (CT) and transverse oscillatory pressure (TOP) in management of CR.

Methods: Seventy-five participants with unilateral radiating neck pain were randomly allocated into three groups, 25 (14 males, 11 females) for CT, 25 (15 males and 10 females) for TOP and 25 (11 males and 14 females) control (Cnt) group. All participants received massage, cryotherapy and active exercises three times in a week for six weeks. CT was administered to CT group, TOP to TOP group while the third group served as control. Pain intensity (PI) and neck functional disability (NFD) were assessed pretreatment, 3rd and 6th week of intervention. Data were analyzed using descriptive and inferential statistics.

Results: There was a significant reduction in PI and NFD between pretreatment and 6th week in all the groups ($p < 0.05$). The effect size of PI ($F = 7.533, p < 0.001$) and disability index ($F = 37.888, p < 0.001$) in CT group were significantly lower than that of TOP group at 3rd week. PI of TOP was significantly ($p < 0.05$) lower than that of CT and Cnt groups at the 6th week.

Conclusion: TOP reduces the PI and disability of patients with CR faster compared to CT.

Keywords: Cervical traction; transverse oscillatory pressure (TOP); cryotherapy; neck disability index; visual analogue scale.

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Introduction

Radiating neck pain, one of the major symptoms of cervical radiculopathy (CR), though less common than non-radiating neck pain has constituted an important cause of disability; therefore, it is imperative to discover the best way to manage it.¹⁻⁶ In addition to neck pain, other most common complaint of individuals with CR are paresthesia and radicular pain and while sensory manifestation can be dermatomal, the expression of pain may be myotomal.⁷ Patterns of dematomal pain is common at C4 level followed by C6 and then C7 and scapular pain may occur in 51.6%, pain at periscapular region and in the upper limb, as well as neurological signs such as numbness, weakness and loss of reflexes in the affected nerve root distribution.⁸ Painful range of motion and reduced tendon reflex are typically found on the course of examination with more than 10% having upper limb weakness and one-third may present with decreased sensation, and muscular atrophy may be present in less than 2%.⁹ The major causes of CR are discogenic and spondylitis combined, which form 68%, while 22% of cases were from intervertebral disc.⁹

The annual incidence report of CR was 83.2 per 100 000 and an increased prevalence in the fifth decade of life among the general population. Approximately 14–71% of adults experience neck pain at some points in their lifetime and the one-year prevalence rate for neck pain in adults ranges from 16% to 75%.¹⁰ Study has found a prevalence of neck pain of 53.6% among learners in the Gauteng Province, South Africa.¹¹ Also, researchers have documented that neck pain was found to be common among Nigerian university undergraduate and affects females than males.¹² In the south western part of Nigeria, it has been documented that the leading work-related musculoskeletal disorder was low back pain, followed by neck pain among nurses and physiotherapist which is an indication that neck pain is very prominent among musculoskeletal pain in Nigeria.^{13,14}

The etiology of neck pain though multifactorial and poorly understood has been linked to factors like poor posture, depression, anxiety, aging, acute injury and occupational or sporting activities.^{15,16} This leads to altered joint mechanics, muscle structure or function resulting into mechanical neck pain. Researchers also reported that the most common cause of mechanical neck pain is zygo-physeal joint locking and muscle strain.¹⁶

With respect to the management of CR, Costello¹⁷ observed that conservative treatment is more effective than surgical options. Conservative treatment for CR typically includes therapeutic exercise (range of motion, strengthening), manual therapy (muscle energy techniques, non-thrust mobilization, manipulation), modalities (cryotherapy, traction), massage therapy, medication and cervical collar.¹⁸⁻²¹ From the empirical observations of Maitland,²² transverse oscillatory pressure (TOP) which is one of the manipulative techniques was recommended for unilaterally distributed symptoms of cervical origin. TOP, originated by Nwuga,²³ although one of the frequently used manipulative techniques by physiotherapists, has been claimed to be effective in amelioration of pain intensity (PI) especially radiating pain in cervical, thoracic and lumbar regions.^{23,24} It involves mobilization of the spinous process of the vertebrae in the region of the spine that had mechanical pain.²⁴ This technique was reported to be useful when pain has a unilateral distribution, whether localized to the neck or referred to the upper limb.²⁴

Cervical traction (CT) consists of administering a distracting force to the neck in order to separate the cervical segments and relieve compression of nerve roots by intervertebral disks. Various techniques (supine versus sitting; intermittent versus sustained; motorized or hydraulic versus an over-the-door pulley with weights) and durations (minutes versus up to an hour) have been recommended for the management of CR.²⁵ According to Shirai,²⁶ CT increases blood flow to neck muscles 2 min after it is applied. A systematic review by Graham *et al.*²⁷ also reported that there was moderate evidence to support the use of mechanical intermittent CT in the management of cervical disorder. Ojoawo *et al.*²⁸ in their study reported that CT is effective in the management of CR. CT in addition to other exercises is the major treatment technique in many facilities in Nigeria physiotherapy clinic to manage CR but there are paucity of data on its efficacy in Nigerian environment. More so, TOP though effective was not a common practice in Nigerian physiotherapy clinic because of the skill required. The question is, that does TOP and CT have the same result in the management of CR? CT requires kit which in some facilities may not be readily available and TOP demands special skills which were not known by all physiotherapists. If TOP cannot be applied, will CT give the desired result? The purpose of the

study was to compare the effects of TOP and CT in the management of CR.

Methods

The participants for this study were 75 (40 males, 35 females) individuals referred for physiotherapy treatment at the Obafemi Awolowo University Teaching Hospital Complex, Ile-Ife, Nigeria, with CR in either right or left upper limb. They were recently diagnosed patients from the Orthopaedic Clinic of the same hospital. All patients' reported neck pain that radiated distally down the right or left arm to the elbow.

Sample Size Determination

Sample size equation $22S^2/d^2 + 1$ for calculation of study with comparison of three groups according to Dallal²⁹ is adopted for the study.

S = within group standard deviation, d = expected difference between means within the group. With respect to the study of Ojoawo *et al.*,³⁰ $S = 2.98$ in one of the groups and d was 2.01. The equation sample size is $22(2.98)^2/(2.01)^2 + 1 = 39$ for each group. The total number for the three groups should be 116. The study lasted for a period of two years and three months, the total number of patients with CR fulfilled the requirement for that period was 87 and all of them were considered for the study. However, only 75 (86.2%) patients were able to participate in the study.

Fifty patients had pain radiating to right while 25 patients reported radiation toward the left upper limb. Their pain started 6–8 weeks before the commencement of the study. None of the patients could remember any pathology that precipitated his/her complaint. There were various descriptions of pains with a greater percentage which described the pain as a deep ache in the neck and a peppery sensation into either of the arms

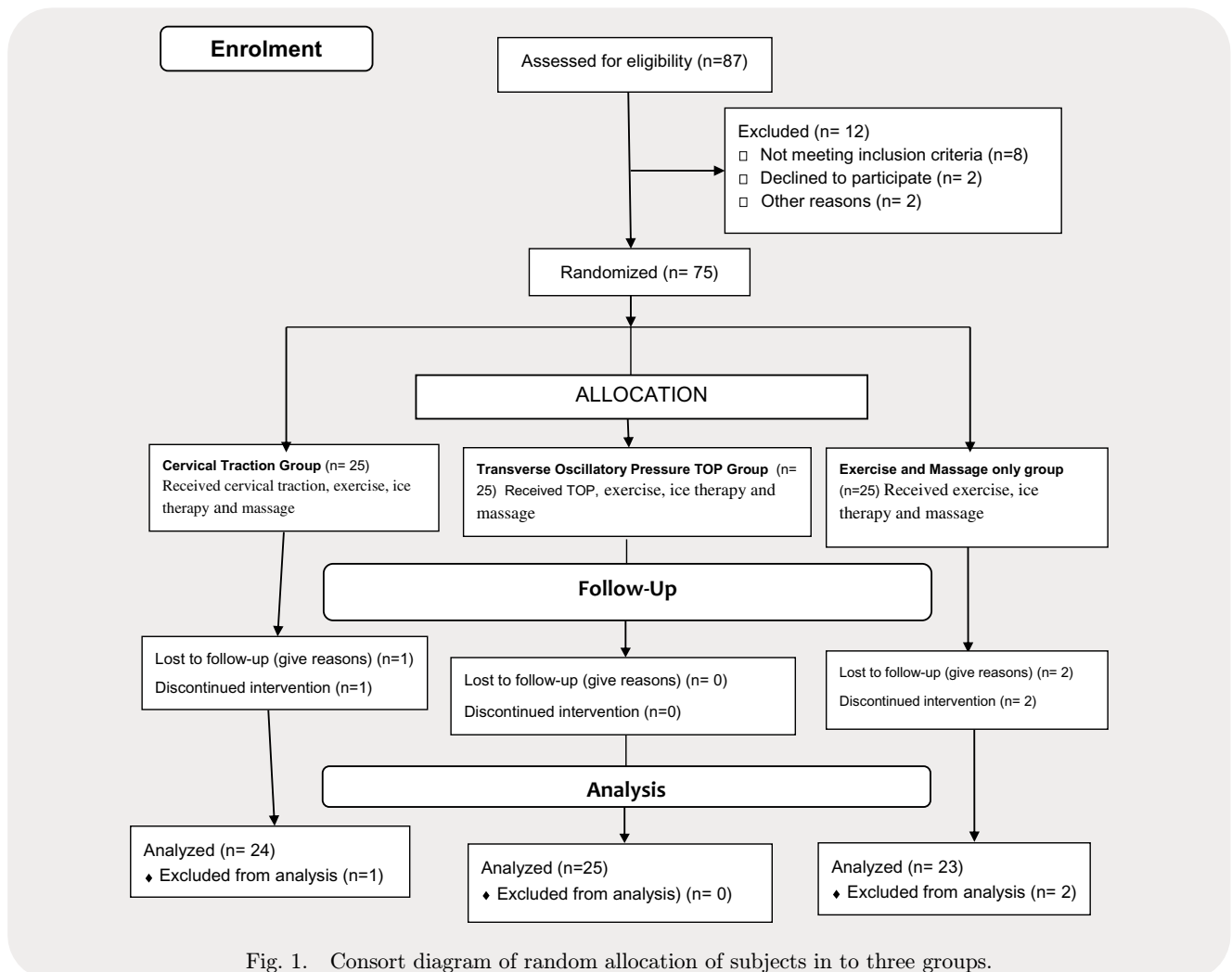


Fig. 1. Consort diagram of random allocation of subjects in to three groups.

that was aggravated by activities at work or even at rest. Fifteen patients reported numbness of some fingers in addition to the radiating pain. Patients with unilateral radiating neck pain that was not of mechanical origin and patients with recent major trauma or fracture of the cervical spine. Patients whose primary complaint was that of headaches or facial pain associated with unilateral radiating neck pain, and any patient who had received manual therapy of the cervical region in the past three months were excluded from the study. Each participant's blood pressure (mmHg), height (m) and weight (kg) were measured. Active range of motion of the neck-elicited pain, especially lateral flexion toward the side of radiculopathy. Skin rolling test according to Bansevicius and Pareja³¹ and posterior–anterior pressure according to Egwu³² to the cervical region provoked pain between the fourth cervical and seventh cervical vertebrae in all patients. Spurling's distraction and Valsalva tests were carried out according to Konin *et al.*³³ and were found positive. Individuals found suitable for the study were randomly allocated into three groups. Seventy five pieces of paper with inscription of CT, TOP and control group (Cnt) on 25 each were put in an opaque envelope. Each participant was asked to pick one and such patient was allocated as inscribed into the paper. Each participant was randomly allocated into CT, TOP and Cnt group. CT group had 24 participants (13 males 11 females) TOP group with 25 participants (15 males and 10 females) while Cnt group had 23 (11male and 12 females) as shown in Fig. 1.

Each participant in the three Groups was treated two times per week. The maximum experimental treatment period for a participant was six weeks, after which the treatment time was estimated from the patient's record.

This amounted to 12 treatment sessions for each participant in the groups. Present PI and neck functional disability (NFD) were measured using visual analogue scale (VAS) and neck disability index (NDI), respectively.

Outcome Measures

Patients were introduced to a 10-point VAS with instructions not to over or underestimate the pain. VAS is a continuous scale comprised of a horizontal or vertical line, usually 10 cm (100 mm) in length, anchored by two verbal descriptors, one for each symptom extreme. The scale is most

commonly anchored by “no pain” (score of 0) and “pain as bad as it could be” or “worst imaginable pain” (score of 10; 100-mm scale).³⁴ Each participant was asked to point to the number corresponding to the PI, which was recorded.

The NDI utilized in the study was in English Language. NDI is a commonly utilized outcome measure to capture perceived disability in patients with neck pain.³⁵ The NDI contains 10 items: seven related to activities of daily living, two related to pain and one related to concentration.³⁶ Each item is scored from 0 to 5, and the total score is expressed as a percentage, with higher scores corresponding to greater disability.³⁶ The NDI has demonstrated moderate test–retest reliability and has been shown to be a valid health outcome measure in a patient population with CR. Westaway *et al.*³⁷ identified the minimum detectable change as 5 (10% points) in a group of 31 patients with neck pain. Stratford and colleagues³⁸ identified the minimal detectable change also to be 5 (10% points) in a group of 48 patients with neck pain and arm pain.

Interventions

Exercise therapy

During each appointment, participants in the three groups underwent exercises. All participants performed cervical spine retraction, rotation in each direction especially away from the direction of pain, extension and side-bending stretching exercises on the side that is not painful. Stretching exercises were applied with the aim of releasing any contracture that might set in by virtue of unilateral flexion or side rotation away from the pain. The goal of exercises was to improve endurance of the cervical deep neck muscles to cause the muscles to stop exhibiting painful response and to improve strength according to Ylinen *et al.*³⁹ Although Ylinen *et al.*³⁹ examined the general musculature of the neck, deep neck muscles are part of the general neck muscles. Any cervical range of motion that aggravated pain was avoided during the exercise. In a case of high PI, cryotherapy was applied first to relieve the pain which was followed by exercise. The exercises also included passive stretching and isometric exercises to the posterior neck muscles. Isometric exercise was administered according to Kisner and Colby⁴⁰ to the posterior neck muscles for 10 s in 10 rounds, in which the contraction was

against resistance of the physiotherapist's hand. Ice chips were packed in a towel and applied to the cervical region for 7 min. This was done to suppress muscle spasm caused by the pain. The isometric exercise, cryotherapy and stretching served as baseline intervention for all the groups.

Cervical traction

The CT group was given CT using the "over the door" CT for 15 min in addition to exercise, ice therapy and massage. A strap was affixed under the chin of the patient. This chinstrap was then connected to a water bag that was held aloft over a doorway via pulleys that were utilized. The water bag was loaded in kilogramme to 10% of the patient's total body weight according to Akinbo *et al.*⁴¹ The 10% weight administered was the minimum weight; this was increased gradually according to the tolerance of each patient to the extent to which there was a desired pull at the cervical region. Treatment was administered twice per week for 6 weeks making 12 treatment sessions. Each session was followed with isometric exercise, cryotherapy and stretching as baseline treatment to improve the strength release contracture and suppress muscle spasm. Patient response was assessed after each second treatment session using VAS and NDI.

Transverse oscillatory pressure

TOP was administered with the patient lying prone on a couch with the forehead placed on the backs of her fingers. Standing on the side of the patient, the therapist placed the pad of the thumbs against the left side (or the right side depending on the location of the pain) of the spinous process of the vertebrae to be moved. The fingers are spread out on the neck and the upper thoracic region. Pressure is directed horizontally through the thumbs to the side of the spinous process. TOP is executed by a pressure-relaxed sequence on the spinous process. Movement is initiated from the trunk and transmitted down the arm to the thumbs.²⁴ Treatment is affected by a push-relax sequence on the spinous process using the thumbs to produce an oscillatory movement. Transverse pressure was directed toward the side of pain on the cervical vertebrae. The rationale of performing transverse pressure toward painful side is in order to rotate the body of vertebrae away from the side

of pain when pressure is applied on the spinous process toward the side of pain. This will restore the joint play and mobilize the articular surfaces on the painful side.²⁴ The oscillation is done rhythmically with low amplitudes for a period of 20 s. This was repeated three times with a rest period of 2 min for a session per day.²⁴

Treatment was administered twice per week for 6 weeks and cumulated to 12 treatment sessions. Each session was followed with isometric exercise in order to improve the strength of the muscles; cryotherapy was applied to suppress the muscle spasm and stretching of the neck muscles with the aim of preventing and releasing any muscular contracture that may be setting in. Patient response was assessed after each second treatment session using VAS and NDI. Patients were advised not to involve in any other intervention without consulting the corresponding author of this paper.

Data Analysis

SPSS version 17.0 (SPSS Inc., Chicago, IL, USA) was used to analyze the data. Descriptive and inferential statistics were used to summarize the result. Analysis of variance (ANOVA) was used to compare each of the physical characteristics of the participants in the three groups. Repeated measures ANOVA was used to compare the pretreatment, 3rd week and 6th week values of PI and NDI of participants in CT, TOP and Cnt within the groups. Repeated measures ANOVA was also used to compare pre-treatment, 3rd week and 6th week values of the outcome measures among the groups. *Post hoc* analysis using Tukey's highest significant difference was carried out to examine which variables were significantly different from each other. An alpha level of 0.05 was set as level of significant. With respect to the subjects that could not complete the six weeks, the principle of intention to treat was applied and the last observation carried forward (LOCF) method was used for the analysis.

Results

Figure 1 is the consort flowchart of the participants. Eighty-seven were recruited for the study but twelve participants did not meet the inclusion criterial. Seventy-five were randomly allocated to three groups but a candidate dropped out from CT group and two participants were not able to complete the study in the Cnt group. Based on the

premise that those who did not complete the study had report of their PI and disability, and were able to complete three weeks of treatment, they were also included in the study. Indicating that 75 participants were analyzed for the study.

Physical characteristics of all the participants were shown in Table 1. There were no significant difference ($p > 0.05$) among the physical characteristics of participants in all the groups. Inferring that the three groups' physical parameters were comparable and that the results obtained from the study were as a result of the intervention not based on variation in the groups' physical characteristics.

In Table 2, the repeated measures ANOVA comparing the effect of TOP, CT and exercise only on the PI and neck disability of participants at pretreatment, 3rd week and 6th week of treatment is presented. There was a significant difference ($p < 0.05$) among the pretreatment, 3rd week and 6th week of PI and neck disability of participants in all the groups.

The mean difference among the outcome measures in the three groups and the observed power is

shown in Table 3. The mean difference between the pretreatment and 3rd week PI for CT group was 1.04 and between the 3rd and sixth week was 3.33 ($F = 7.355, p < 0.001$). The difference in disability between the pretreatment and 3rd week was 12.63, and between the 3rd week and 6th week was 9.50. The difference of TOP on PI and disability was greater than that of CT at the 3rd week and 6th week except the PI at 6th week which was less ($F = 23.156, p < 0.001$). The observed power using *post hoc* power analysis was 1 indicating that though the response rate of the subjects was 86.2%, the sample size was enough to give a reliable effect size.

In Table 4, the repeated measures ANOVA with *Post Hoc* Turkey Highest Significance Difference comparing the mean values of PI among the three groups' pretreatment, 3rd week and 6th week is shown. There was no significant difference ($p > 0.05$) among the mean values of pretreatment pain intensity in the three groups. It can be inferred from this that the pretreatment PI among the three groups was comparable, therefore, any result obtained from the study is due to the

Table 1. Physical characteristics of participants ($N = 75$).

Variables	CT group $n = 25$	TOP group $n = 25$	Crt group $n = 25$	F	P
	Mean \pm SD	Mean \pm SD	Mean \pm SD		
Age (yrs)	51.38 \pm 6.545	55.67 \pm 5.35	59.50 \pm 2.646	3.01	0.08
Weight (kg)	73.13 \pm 13.010	73.00 \pm 5.36	71.25 \pm 5.377	0.05	0.95
Height (m)	1.63 \pm 0.12	1.66 \pm 0.10	1.65 \pm 0.026	0.09	0.92
BMI (Kg/m ²)	27.99 \pm 7.96	26.83 \pm 4.437	26.02 \pm 2.041	0.15	0.86
Sex: M	14	15	11		
F	11	10	14		

Note: BMI = Body Mass Index.

Table 2. Repeated measures ANOVA comparing the mean values of PI and neck disability of the three groups ($N = 75$).

Variables		Pretreatment	WK3	WK6	F	P
		Mean \pm SD	Mean \pm SD	Mean \pm SD		
CT Grp	PI	6.87 \pm 0.99	5.83 \pm 1.64	2.50 \pm 0.53	7.533	0.001**
	ND	42.13 \pm 16.86	29.50 \pm 17.88	20.00 \pm 17.82	37.881	0.001**
TOP Grp	PI	7.63 \pm 2.98	4.83 \pm 0.75	2.66 \pm 0.81	23.156	0.001**
	ND	58.66 \pm 8.91	39.00 \pm 17.46	16.33 \pm 9.75	40.352	0.001**
Cntr Grp	PI	7.00 \pm 0.81	6.25 \pm 0.95	3.75 \pm 0.53	24.540	0.001**
	ND	55.32 \pm 11.30	33.82 \pm 1.67	21.50 \pm 5.00	34.40	0.001**

Note: **significant at $P < 0.001$, WK = week, Grp = Group, Cntr = Control.

Table 3. Observed power and test between subjects' effects within the three groups ($N = 75$).

Groups	PnDif Wk1-3	PnDif Wk3-6	F	P	DisDif Wk1-3	DisDif Wk3-6	F	P	ObP
CT	1.04	3.33	7.533	0.001	12.63	9.50	37.881	0.001	1.000
TOP	2.80	2.17	23.156	0.001	19.66	22.67	40.352	0.001	1.000
Cntr	0.78	2.50	24.540	0.001	21.50	12.32	34.400	0.001	1.000

Note: PnDifWk = Pain difference between weeks 1 and 3, Dis = Disability, ObP = Observed Power.

Table 4. Repeated measures ANOVA with *post hoc* comparing the mean values of PI of the three groups ($N = 75$).

	CT Grp Mean \pm SD	TOP Grp Mean \pm SD	Cntr Grp Mean \pm SD	F	P
Pretreatment	6.87 \pm 0.99 ^a	7.63 \pm 2.98 ^a	7.00 \pm 0.81 ^a	0.688	0.518
WK3	5.83 \pm 1.64 ^a	4.83 \pm 0.75 ^b	6.25 \pm 0.95 ^a	7.800	0.005*
WK6	2.50 \pm 0.53 ^c	1.66 \pm 0.81 ^d	3.75 \pm 0.53 ^e	10.121	0.002*

Notes: Superscript letters a-e in the table mean that a mean mode of the same superscript letters indicates no significant difference but mean mode with different superscript letters indicates significant difference.

intervention, and not of variation from the pretreatment PI. In the CT and Cnt groups, there was no significant difference between pretreatment PI and 3rd week ($p > 0.05$) but there exists a significant difference ($F = 7.80, p < 0.05$) in the pretreatment and 3rd week in TOP group inferring that PI may be ameliorated after 2nd week of intervention of TOP. Considering the time effect, TOP proves to be faster in relieving PI. Nonetheless, there was a significant difference ($p < 0.05$) in the 6th week PI among the three groups with TOP group having the minimum values, interpreting that TOP can relieve PI quicker and more than either CT or exercise only.

Table 5 revealed the magnitude of the effect size in the three groups using partial Eta square. The highest magnitude is between the Cnt group and

TOP at the 6th week ($\eta_p^2 = 1.6$) followed by that of CT and Cnt at 6th week ($\eta_p^2 = 1.2$). The magnitude of effect size between TOP and CT group at the third and 6th week was 0.6 and 0.4, respectively. An indication is that TOP reduces PI faster than CT.

Table 6 shows the repeated measures ANOVA and *post hoc* comparison of the disability index among the three groups and Table 7 shows the magnitude of the effect size. There was a significant difference among ($F = 4.08, p < 0.05$) the three groups at third week, there was a significant difference between CT and TOP, and Cnt and TOP but not between CT and Cnt in the 6th week. The effect size of TOP and Cnt at the 6th week was the highest among the others ($\eta_p^2 = 0.4$).

Table 5. Magnitude of effect size using partial Eta square for PI among the three groups for 3rd and 6th weeks.

Variables	$M1$	$M2$	$M1 - M2$	SD1	SD2	SD1 + SD2	PETA (η_p^2)
CT and TOP 3rd WK	5.83	4.83	1.00	1.64	0.75	2.39	0.40
CT and Cnt 3rd WK	5.83	6.25	0.42	1.64	0.95	2.59	0.20
TOP and Cnt 3rd WK	4.83	6.25	1.42	0.75	0.95	1.70	0.80
CT and TOP 6th WK	2.50	1.66	0.84	0.53	0.81	1.34	0.60
CT and Cnt 6th WK	2.50	3.75	1.25	0.53	0.53	1.06	1.20
TOP and Cnt 6th WK	3.75	1.66	2.09	0.81	0.53	1.34	1.60

Table 6. Repeated measures ANOVA with *post hoc* comparing the mean values of neck disability index of the three groups ($N = 75$).

	CT Grp Mean \pm SD	TOP Grp Mean \pm SD	Cntr Grp Mean \pm SD	F	P
Pretreatment	42.13 \pm 16.86 ^a	58.66 \pm 8.91 ^a	55.32 \pm 11.30 ^a	0.125	0.115
WK3	29.50 \pm 17.88 ^b	39.00 \pm 17.46 ^d	33.82 \pm 1.67 ^f	4.870	0.009
WK6	20.00 \pm 17.82 ^c	16.33 \pm 9.75 ^e	21.50 \pm 5.00 ^c	0.118	0.889

Note: Superscript letters a–f in the table mean that a mean mode of the same superscript letters indicates no significant difference but mean mode with different superscript letters indicates significant difference.

Table 7. Magnitude of effect size using partial Eta square for disability among the three groups for 3rd and 6th Weeks.

Variables	M_1	M_2	$M_1 - M_2$	SD1	SD2	SD1 + SD2	PETA (η_p^2)
CT and TOP 3rd WK	39.00	29.50	9.50	17.88	17.46	35.34	0.30
CT and Cnt 3rd WK	33.82	29.50	4.32	17.88	1.67	19.55	0.20
TOP and Cnt 3rd WK	39.00	33.82	5.18	17.46	1.67	19.13	0.30
CT and TOP 6th WK	20.00	16.33	3.67	17.82	9.75	27.57	0.10
CT and Cnt 6th WK	20.00	21.50	1.50	17.82	5.00	22.82	0.10
TOP and Cnt 6th WK	21.50	16.33	5.17	9.75	5.00	14.75	0.40

Notes: M = mean value of disability index; WK = Week; SD = standard deviation; PETA = partial eta.

Discussion

This study compared the therapeutic effect of CT and TOP in the management of CR. The study revealed that the pretreatment PI, neck disability assessment and other physical characteristics of participants in the CT group, TOP and Cnt group did not show any significant difference. This is an indication that the baseline parameters of the participants in all the groups were comparable and any result obtained from the study was due to the intervention. Considering the comparative effect of CT and TOP, it was observed that there was a significant reduction in PI at 3rd week in TOP group than that of CT group. Meanwhile, the mean difference between the 3rd week and 6th week of CT group PI was more than that of TOP. This may be inferred that TOP may relieve PI faster but CT may relieve the PI for longer period of time. It has to be emphasized that the technique of TOP is the application of oscillatory pressure directly to the specific region where there is pain.²⁴ This may alter segmental biomechanics by releasing trapped meniscoids, releasing adhesions or by diminishing distortion in the intervertebral disc^{42,43} and restored joint play which immediately increases the

mobility of the region.²⁴ Also, individual motion segments are thought to be capable of buckling, thereby producing relatively large vertebral motions that achieve a new position of stable equilibrium.⁴⁴ The manipulative impulse provides sufficient energy to restore a buckled segment to a lower energy level, thus reducing mechanical stress or strain on soft and hard spinal tissues.⁴⁵ Giles⁴³ proposed that spinal manipulation activates all known mechanosensitive, somatosensory receptors because they all possess mechanical thresholds lower than the peak force delivered during a manipulation and the receptor types are responsive to dynamic and/or static components of a mechanical stimulus. These may be reasons while TOP relieves the PI of patient faster.

Elnaggar *et al.*⁴⁶ in their study reported that CT methods had a significant effect on neck and arm pain reduction, a significant improvement in nerve function and a significant increase in neck mobility. Our finding was also in consistence with the work of Voltonen *et al.*⁴⁷ who concluded that traction relieves muscle spasm and significantly decreases electrical activity in the muscles and produces relaxation, which leads to systematic relief of pain.⁴⁷

Krause *et al.*⁴⁸ found that traction has been shown to separate the vertebrae, stretch the cervical joint capsules, stretch neck muscles and open the foramina. These may be the reasons while CT relieves PI of patients with CR longer.

It was observed that there was a significant improvement between the pretreatment PI and the six-week PI and disability index in CT group. This inferred that CT was effective in the management of CR. Our findings were in line with the study of Borman *et al.*⁴⁹ and Cleland *et al.*²⁰ Borman *et al.*⁴⁹ and Cleland *et al.*²⁰ in their independent studies using intermittent CT documented that the application of CT produced a desired result in the management of CR. In addition, Rhee *et al.*⁵⁰ and Swezey *et al.*²⁵ reported that the application of CT at home was found to decrease radicular symptoms. Levine *et al.*⁵¹ documented further that CT is most beneficial when acute muscular pain has subsided and should not be used in patients who have signs of myelopathy. CT was known in theory to distract the neural foramen and decompresses the affected nerve root.⁵² Evidence also revealed that continuous CT decreases the pressure within the vertebral disks and stretches muscles and ligaments of the cervical region thereby unloads the structure of the spine.⁵³ It is probable that traction has an important role in breaking the “circle of pain” in CR caused by a herniated disk. This cycle begins when nerve roots are compressed by a herniated disk, causing entrapment within the intervertebral foramina. The irritated nerve produces a reflex response to the patient’s cervical muscles, causing those muscles to contract. That contraction further narrows the foramina and the neck pain is increased. Traction helps to relieve the inflammatory reaction of nerve roots by improving the circulation and reducing the tissues swelling. Gentle alteration of stretching and relaxation of the neck soft tissue structures prevents the formation of adhesions of the dural sleeve.⁵⁴ These are additional factors why CT can reduce the PI of cervical radicular patients longer than TOP.

The study observed in addition that TOP group reported significant decrease in the outcome measures when the pretreatment mean values were compared with the posttreatment values. This is an indication that TOP has a significant therapeutic value in the management of CR. Researchers reported that manipulation may provide short-term benefit in the treatment of neck pain, cervicogenic headaches⁵¹ and radicular symptoms.⁵⁵

Researchers have reported that TOP to the spinal region has both neurological and mechanical effects.^{56,57}

Paris⁵⁷ mentioned further that mobilization technique stretches tissues by taking them into the area of plastic deformation of stress–strain curve. TOP has been found as one of the techniques that stretches cervical connective tissues and joint capsules to a reasonable point on the stress–strain curve to produce a salvo of beneficial neuro inhibitory and mechanical effects.^{56,57}

Considering the participants in the cnt group of the study, it was revealed that exercise with massage and cryotherapy also reduced the PI and disability of participants. This is an indication that pain of CR and NDI can be ameliorated when treated with a combination of exercise, massage and cryotherapy. The improvement of outcome measures in cnt group is in line with the observation of Radhakrishnan *et al.*⁹ Studies have examined the effect of isometric exercise on the contracting body part as well as on the contralateral and a distant body part to the contracting one and affirmed that the hypoalgesic effect of isometric exercise was multisegmental and not isolated to the contracting muscle.^{58,59} Moreover, the pain-reducing effects of isometric exercise on the contralateral and distant body parts were similar in magnitude to the local body part. These results suggest that a central widespread inhibitory mechanism is activated by static muscle contractions. As discussed by Kosek and Lundberg,⁶⁰ these central mechanisms may include increased secretion of *b*-endorphins, attention mechanisms, activation of diffuse noxious inhibitory controls or an interaction of the cardiovascular and pain regulatory systems.

The effect of kneading massage in this study is explained by a researcher who documented that massage has traditionally been used to relieve pain in producing short-lived analgesia by activating the “pain gate” mechanism.⁶¹ Cutaneous mechanoreceptors are stimulated by touch and transmit information within large nerve fibers to the spinal cord.⁶² These impulses block the passage of painful stimuli entering the same spinal segment along small, slowly conducting neurons.⁶³ Massage is a potent mechanical stimulus and a particularly effective trigger for the pain gate process which can reinforce a naturally occurring discomfort, cause much greater release of opiates and achieve more profound pain suppression.⁶⁴ The contribution of

cryotherapy in the relief of pain has been reported in studies noting that cryotherapy may be most effective when combined with exercise.⁶⁵ Adequate cooling can reduce pain, spasm and neural inhibition, thereby allowing for earlier and more aggressive exercises. Cryotherapy can increase pain tolerance and pain threshold and decrease nerve conduction velocity.⁶⁶

Limitations

There are some limitations of this study, one of them is that the physiotherapist who treated the patients was not blinded to the group allocation and the assessors were not totally independent of the intervention. The reason is that the hospital administration where the study was carried out did not permit blinding. The study also did not assess the range of motion and strength of the cervical muscles. The researchers in the proposal did not consider the variables as part of the objectives of the study, though it may be an omission which has been noted for subsequent study, but the opinion is that ones the pain and disability have been addressed, other variables will fall in line. Researchers were aware of the results of intermittent traction using traction machine in the management of CR, but lack of funds was a major constrain why this could not be used. More so, facilities in Nigeria with CT machine are very limited; it is then imperative that a research is carried out on what is commonly available in the environment of practice. The less favorable results of CT could be due to continuous traction adopted in the present study. The results may be different if intermittent CT was given to the patients. Graham *et al.*²¹ in the systematic review concluded that intermittent traction is better than continuous traction for mechanical neck disorders. The short- or long-time follow-up could not be concluded because of some logistic problems.

Conclusion

It can be concluded from the study that combination of exercise, massage and cryotherapy reduces PI and disability of patient with CR in the 6th week of intervention but addition of TOP proved better and may be better than inclusion of CT.

Conflict of Interest

Authors did not have any conflict of interest on the study.

Funding/Support

The study did not enjoy funding from any organization or government.

Authors Contributions

Ojoawo A.O conceived the idea of the study, analyzed the data, interpreted and did the final write-up including the proof reading to make it suitable for publication. Olabode A.D collected the data, supplied the literature and did the skeletal write-up.

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