Comparison between Linear and Non-Linear Traction on Cervical Spondylosis

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ABSTRACT

The purpose of this study was to investigate the effect of linear and non-linear cervical traction on patient with cervical spondylosis. Thirty patients (18 females, 12 males) from out clinic of Faculty of Physical Therapy were participated in this study with age ranged from 40 to 50 years. Patients were assigned randomly into two equal groups. Both groups received conservative treatment in the form of ultrasound and infrared radiation before initiating cervical traction. Group I and II received linear and non-linear cervical traction respectively for three alternative days per week for ten weeks. Plain X ray was administrated for all patients to measure the Cobb angle before treatment and at the end of the treatment at ten weeks and after three months follow up. Also, Neck Disability Index, proprioception and visual analogue scale were conducted at the same previous periods to compare the effect of both types of cervical traction. The results of the study demonstrated the superiority of a non-linear traction over the linear traction as evidenced by the significant scores for all parameters recorded at post measurements and this improvement remain stable at long term follow up (three months) in contrast to linear traction. Further research is recommended to examine the same effect on gender.
Keywords: Cervical spondylosis, linear traction, non-linear traction, cobb angle.

INTRODUCTION

Cervical spondylosis is considered the commonest cause of neck and arm pain[11]. It involves degenerative changes in the cervical spine including spondyloasrthrosis, apophyseal joint osteoarthrities and disc degeneration. It is estimated that 90 percent of male over the age of 50 and 90 percent of female over the age of 60 have radiographic evidence of degeneration of cervical spine[2]. The recent studies found that about 75 percent of cervical spondylotic patients reported symptoms resolution with nonsurgical care[19].

In this regard, cervical spine traction is now a routine for the treatment of spinal disorders. Concerning the treatment of lower cervical spondylosis studies reported in literature and treatment guidelines focus on various mechanical factors influencing the efficacy of traction and ignoring the importance of restoring the normal sagittal alignment of cervical spine[10]. Cervical traction applied in standard manner aim to separate the vertebrae, increase the width of foramina and stretch the posterior neck muscle. All these effects have been documented[26,27] but as beneficial as linear traction has proven to be, there are still adverse side effects. It was postulated that this treatment is not without complication and critics[5,8], where the effectiveness of traction for the treatment of cervical spine syndrome is controversial and the outcome of this treatment has not been established in the literature[16].

Numerous biomechanic studies have tried to determine the mechanisms at work in cervical traction, including vertebral movement, interverteberal foramen separation, optimum angle of pull, optimum force, optimum time period, friction of body

slippage, ligament deformation and disc height increases[10,12,16,17.] Several positions have been suggested for cervical traction including sitting, supine, and prone[3.] Although axial and flexion traction increase the posterior disc space and interverteberal foramina area the adverse mechanical tensions in cervical spinal accompanied with axial or ventro flexion traction may increase the injury to cervical spine following loading[7] and may lead to pathological architectural changes in muscles, ligaments, bone and central nervous system[17].

Regarding the neck position, all cervical traction concepts have accepted the premise that traction in flexion with consequent decrease in lordotic curve is the goal[10] ignoring that the configuration of the sagittal cervical curve has reemerged as an important clinical outcome of health care where it is necessary for proper spinal coupling[18].

The abnormal spinal posture will produce pain due to the abnormal sheer and stresses for prolonged time[17]. Moreover, the proprioception of the neck may be impaired in the patient with lower cervical spondylosis as postulated by Loudon[12].

Proprioception is essential for proper joint function in sports, activities of daily living, and occupational tasks. Any deficiency may contribute to decline in function[12]. So, the measurement of mechanical alignment impact have not to be limited to the ability of the patient to reproduce head position but have to extend to measure the functional abilities of the patients.

The non-linear traction is a new type of traction where the head is extended, retracted and distracted with addition of transverse load, it was suggested in the literature that this new type of traction could restore the normal curve due to increase of anterior disc height and anterior longitudinal ligament length[1,10,27].

It was hypothesized in the current study that non-linear traction of the cervical spine would improve proprioception and functional ability, decrease neck pain, in addition to restore lordosis or increase the cervical curvature in patients with lower cervical spondylosis more than linear traction.

MATERIALS AND METHODS

Subjects

Thirty patients (18 females, 12 males) were selected with lower cervical spondylosis participated in this study from out clinic patients of Faculty of Physical Therapy. Their age ranged from 40 to 50 years with Cobb angles at C1-C7 was less than 54º and suffering from pain longer than three months following the protocol of Harrison et al.,[10]. Subjects were excluded if examination revealed a suspected disc herriation or if they had canal stenosis as measured on the radiographs. The patients were assigned randomly into two equal groups either for the linear cervical traction group (I) or for non-linear cervical traction group (II), in addition both groups received conservative treatments in the form of ultrasound (US) and infrared radiation (I.R) prior to the traction.

Instrumentation

a) Instrument for evaluation:

The cervical range of motion device (CROM) was used to assess joint angles. The CROM is a plastic device that is affixed to the head of the patient and aligned according to the three cardinal planes of movement. Sagittal and frontal plane movement is measured using a gravity goniometer. The transverse plane measurement involves a compass goniometer and a shoulder mounted magnetic yoke. Several studies have

discussed the reliability of the instrument and found the CROM to be reliable in measuring cervical range of motion[20,29].

- Plain cervical spine radiograph.
- Visual analogue scale (VAS) was used on which patients related their perceived pain intensity from zero° (no pain) to 10° (excruciating pain).
- Neck disability index (NDI): is a 10 items self report questionnaire that consists of seven activities of daily living questions. Two pain related items and one question addressing concentration[25] the patients choose the statement that best describes their situation in each of ten sections that concern impairments like headaches, abilities like personal care, lifting, reading, driving and recreation. Total scores ranged from zero (highest level of function) to 50 (Lowest level of function).

b) Instrument for treatment:

- Static Traction device with the availability to apply transverse load were used for linear and non-linear traction.
- Ultrasound therapy (U.S.) sonopluse 590 Enraf to deliver U.S. therapy.
- Infrared device (I.R): quartz I.R. lamp.
- The instruments were caliberated before starting the study.

Procedures

Proprioception measurement:

Subjects were seated erect in a chair with back support. Initial head position was recorded. The subject was then asked to perform full cervical active range of motion within a pain free range, and these measurement were recorded. The subject's head was positioned at 30^o of right rotation and then returned to 0^o with eye closed. Each subject was asked to reproduce the angle three times with eye closed within a 60 second period. The three angles were recorded and the mean was calculated. The subject performed three trials at 6 more test positions (30^o rotation right and left, 50^o rotation right and left, 20^o side bending right and left). These target position were used for all subjects according to the protocol of Loudon[12].

Measurement of the Cobb angles:

Standing lateral cervical radiographs were obtained with subjects, right shoulder against cabinet with a standard tube distance of 182.9 cm. Before exposure subjects were asked to nod their heads twice and assume a comfortable resting position. This neutral resting posture is height repeatable[9]. After that the lateral cervical radiographs were analyzed using the position tangent methods in which the two-lines of Cobb angles are constructed by extending the tangents to vertebral body endplate lines of C_1-C_7 until these lines intersect[10]. These angles were measured by the protractor.

All test measurements including proprioception VAS, NDI and Cobb angles were performed before initiating the treatment and at the end of ten weeks of treatment and after three months follow up.

Treatment Procedures

Conservative treatment:

Before cervical traction, both groups were received U.S. and I.R. as conservative treatment. Each patient in the two groups received continuous U.S. therapy at an intensity 1.0 W/cm². Diameter of the U.S. head is 2.5 cm. It was applied on the para spinal muscles of the neck and on trapezies muscles the coupling media was applied between the treatment head and the skin surface. The treatment head was moved continuously over the surface while even pressure was maintained in order to iron out the

irregularities in the sonic field. The duration of application was five minutes per session[13]. Then I.R. radiation was administrated for 15 minutes for the same area[23].

Cervical traction:

Group I received non-linear traction and group II received linear traction three alterative days per week for ten weeks.

In the linear cervical traction, the position of the patient was sitting position. The cervical harness was adjusted in relation to patient's head parameters and gently placed into the patient's head with occipit positioned in the center. The angle of pull with traction was adjusted so the cervical spine had an ventroflexion of approximately 15˚. The force of traction was (6 kg) and increased over consecutive visits to tolerance of the patients or maximum of (15 kg) for duration of twenty minutes per session following the protocol of Coldwell and Krusense[3]. Both linear and non-linear traction were conducted three alternatives days per week for ten weeks of treatment.

In non linear traction, the position of the patient was sitting position, the head halter was fixed posteriorly to cause slight distraction, retraction and extension to fifteen degrees. At the same time, the front anterior strap provides a transverse load at mid neck which had weight applied over a pulley that started at (6.8 kg) and increased over consecutive visits to tolerance or a maximum of (15.9 kg). The duration of each session started at approximately three minutes and increased one minute per session until reaching goal of 20 minutes per session, following the protocol of Harrison et al.,[10].

Data Analysis

Descriptive statistics (mean ± SD), paired and unpaired t-test was used to analyze and compare the effect of linear and nonlinear cervical traction on all tested parameters. The level of significance for all tests was set at 0.05.

RESULTS

Effect of linear and non-linear traction on Cobb angle, VAS and NDI:

As presented in table (1) and figure (1) linear traction failed to produce significant changes in Cobb angle either when comparing pre and post test (t= 1.52, P= 0.1) or between post and follow up measurement, (t=0.36, P=0.7).

Table (1): Effect of linear and non-linear traction on Cobb angle VAS and NDI.

Tested parameters	Linear traction			Nonlinear traction		
	Pre	Post	Follow up	Pre	Post	Follow up
Cobb Angle Mean ± SD	40.8±2.4	41.3±2.8	41.2±2.6	41±2.2	54.1±3.7	53.4±3.5
t&P	t = 1.52 & P = 0.1			t =14.6&P<0.0001*		
		t = 0.36 & P = 0.7			t = 1.46 & P= 0.1	
VAS Mean ± SD	5.8± 1.2	4.6± 1.2	6.6 ± 0.9	5.9 ± 1.1	1.2 ± 0.8	0.9±0.9
t&P	t = 2.73 & P =0.01*			t =15.76&P<0.0001*		
		t =4.74& P=0.0003*			t = 1.46 & P =0.1	
NDI Mean ± SD	16.6±1.9	13.2±2.2	16.9±2.3	17.7±1.8	8.5±3.09	8.4 ± 3.2
t & P	t = 5.26 & P=0.001*			t = 8.9 & P<0.0001*		
		t = 4.34 & P=0.005*			t = 0.52 & P= 0.6	

*Significant VAS: visual analogue scale NDI: Neck Disability Index

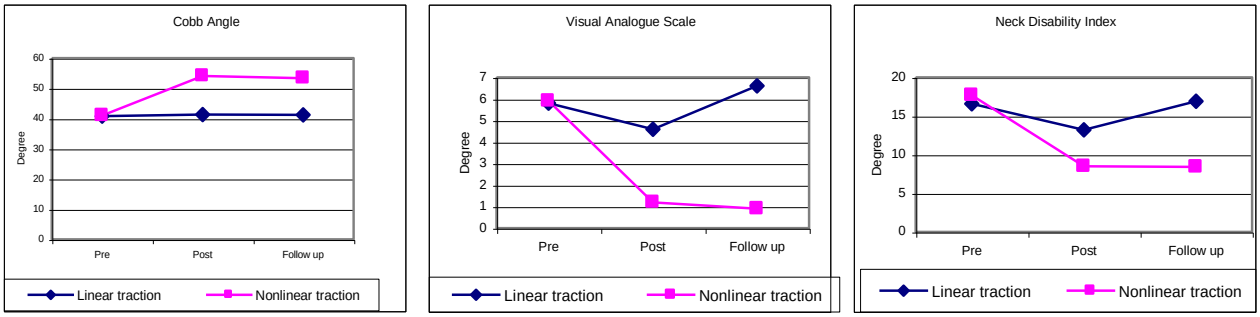

Fig. (1): Effect of linear and non-linear traction in the measured parameters.

In the other hand non-linear traction produced significant increase in Cobb angle at post treatment as (t=14.6, P<0.0001) and these improvement maintained throughout the three months follow up as evidenced in the non-significant differences between post and follow up measurements (t = 1.46 and P=0.1).

Regarding VAS, both linear and nonlinear traction induce significant decrease in pain in the post treatment comparison where (t= 2.73, P= 0.01) for linear traction and (t= 15.76, P<0.0001) for non linear traction. In the follow up, the pain became worse in the linear traction as there was significant increase (t=4.74, P=0.0003) while in non linear traction, there was a tendency towards pain decrease although this decrease was not significant (t= 1.46, P= 0.1).

t-test revealed that both linear and non linear traction induced significant decrease in NDI scores as (t = 5.26, P= 0.001) for linear traction and (t = 8.9, P < 0.0001) for non-linear traction. However the patient in linear traction failed to sustain this decrease at follow up measurement. As there was a significant increase in NDI scores (t= 4.34, P=0.005) in contrast to the non linear traction's patient (t= 0.52, P=0.6).

The effect of linear and non linear traction on proprioception:

All proprioception measurement in linear traction group demonstrated significant improvement temporarily in post test. Unfortunately, there was deterioration in proprioception in follow up measurement as presented in table (2) and figure (2).

Table (2): Effect of linear and nonlinear traction on proprioception.

Tested parameters		Linear traction			Nonlinear traction		
		Pre	Post	Follow up	Pre	Post	Follow up
20 side Bending lt	Mean±SD	33.2±1.3	32.4±1.3	33.6±1.6	33.1± 1.5	30.6±0.6	30.8±0.9
	t & P	t = 2.3 & P = 0.03*			t = 6.3 & P< 0.0001*		
			t = 2.8 & P = 0.01*			t = 0.48 & P = 0.6	
20 side BendingRt	Mean±SD	32.9±1.5	32.1±1.3	33.5±1.1	33.1±1.6	30.7±0.7	30.6±0.7
	t & P	t = 2.16 & P= 0.04*			t = 6.24& P<0.0001*		
			t = 3.29 &P=0.005*			t = 0.29 & P= 0.7	
50 Rot Lt	Mean±SD	53.5±1.5	52±1.4	53.8±1.8	52.7±2.1	50.5±0.7	50.8±0.7
	t & P	t = 2.92 & P = 0.01*			t = 4.78& P=0.0003*		
			t = 3.91 & P=0.004*			t = 1.14 & P= 0.2	
50 Rot Rt	Mean±SD	53.1±1.9	51.9±1.5	54±1.3	52.9±2.1	51.1±1.1	50.8±1.2
	t & P	t = 2.9 & P = 0.01*			t = 3.19 & P=0.006*		
			t = 4.04 & P=0.001*			t = 1.29 & P= 0.2	
30 Rot Lt	Mean±SD	23.4±1.7	22.3±1.3	24.2±1.4	23.8±1.7	21.2±1.1	21±1.1
	t & P	t = 1.86 & P= 0.08*			t = 6.14 &P<0.0001*		
			t =4.88 &P=0.0002*			t = 0.74 & P= 0.6	
30 Rot Rt	Mean±SD	23.6±1.5	22.4±1.9	24.5±1.1	23.4±1.5	21.2±1.4	21.1±1.4
	t & P	t = 1.81 & P = 0.09*			t = 4.6 & P= 0.004*		
			t = 2.28 & P=0.005*			t = 0.32 & P= 0.7	

*Significant Rot Rt: Rotation Right Rot Lt: Rotation Lift

In the other hand, the non-linear traction group showed a highly significant improvement in all proprioception measurement post test and this improvement was maintain throughout the follow up measurement.

Comparison between linear and non-linear traction:

Independent t-test was performed to compare between linear and non-linear traction effects at each set of measurements (Cobb angle, VAS, NDI and proprioception). At pre test measurement, there were non-significant differences in all the tested parameters between both groups (table 3).

The non linear traction showed a superior effect over the linear traction as evidenced by the significant scores for all parameters recorded at post measurements and this improvement remained stable long term follow up (3 months), In contrast to linear traction.

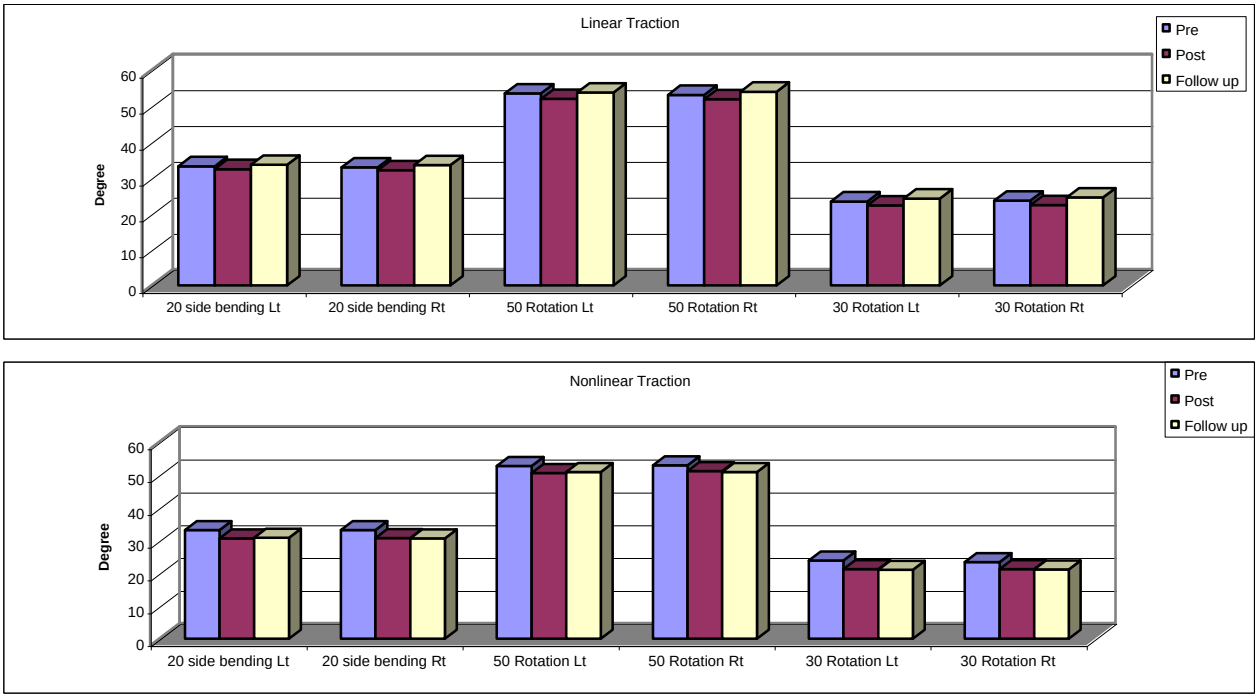

Fig. (2): Effect of linear and non-linear traction on proprioception.

Table (3): Comparison between linear and nonlinear traction at each set of measurement.

Tested parameters	Significance	Pre	Post	Follow
Cobb Angle	t	0.23	10.45	10.78
	P	0.81	<0.0001*	<0.0001*
VAS	t	0.15	8.64	16.57
	P	0.8	<0.0001*	<0.0001*
NDI	t	1.55	4.8	8.32
	P	0.1	<0.0001*	<0.0001*
Proprioception				
20 side Bending lt	t	0.23	2.001	6.03
	P	0.81	0.055*	<0.0001*
20 side Bending Rt	t	0.51	2.37	7.06
	P	0.6	0.02*	<0.0001*
50 Rot Lt	t	0.17	1.74	6.95
	P	0.8	0.09*	<0.0001*
50 Rot Rt	t	1.2	3.46	6.03
	P	0.2	0.001*	<0.0001*
30 Rot Lt	t	0.23	3.22	7.98
	P	0.8	0.003*	<0.0001*
30 Rot Lt	t	0.25	4.51	5.62
	P	0.8	0.0001*	<0.0001*

*Significant VAS: visual analogue scale NDI: Neck Disability Index Rot Rt: Rotation Right Rot Lt: Rotation Lift

DISCUSSION

We hypothesized that the non-linear cervical traction procedure would increase anterior disc height and anterior longitudinal ligament length there-by producing an increase in cervical lordosis more than the linear traction. In the present study the significant increase in the Cobb's angle at C1-C7 support the hypothesis of this study. In addition the increased lordosis resulting from non-linear traction was not transient. As comparison of radiographic measurements of Cobb's angle after 3 months indicated that cervical lordotic improvements were long lasting. On the other hand, the linear traction failed to restore normal sagittal curve of cervical spine after 10 weeks of treatments or after 3 months follow up measurements.

These interpretation are consistent with Harisson et al.,[10] who attributed the significant improvement of sagittal cervical curve after application of 3-point bending traction (non-linear) to stretch of the viscous and plastic elements of the soft tissue which deformed by shortening in the anterior and lengthening in the posterior aspect.

Regarding the measuring of pain level and function level, both groups demonstrated significant decrease in pain and NDI. The recent literature provide some evidence that conservative treatment represent in the (U.S &IR) in addition to linear traction is an effective treatment for the relief of cervical spine pain syndrome[16,23] but the results of this study support that this improvement would be transient in contrast, the correction of sagittal cervical curve with non-linear traction was important factor associated with long term improvement in chronic pain with subsequent improvement of functional level. This transient effect of linear traction may be attributed to inflammatory process set into motion by disturbed spinal curvature in addition to abnormal stresses result from abnormal mechanical alignment.

Regarding the abnormal stresses Oktenoglu et al.,[17] has shown that postural deviations which cause abnormal stresses on the spinal column and soft tissue, create histopathological changes in the structures surrounding the nerve root leading to disturbance of the neural function. The same results were supported by clinical and in vitro studies which demonstrated that neural function can be disrupted by mechanical deformation and resulting abnormal stresses without structural damage to the neural elements[7].

In continuation to demonstrate the adverse effect of abnormal mechanical alignment. It was reported that loss of all or part of the cervical lordosis causes a loss of all or part of the normal cervical and thoracic coupling motion so, the involved discs receive inadequate nutrition and oxygenation. It also results in their being burdened with toxic metabolic products because the waste removal process has been slowed down which is pain producing[6,12].

This interpretation supported by Abrams[1] who reported that one of the deteriorative processes set into motion by a disturbed spinal curvature is an inflammatory reaction occurring on and around the spinal disc, facets, joints and nerves. As postulated by Abrams this inflammatory process excused toxins, which producing pain and hyper sensitizing to both motor and sensory nerves which cause over reaction of the proprioceptors of the neck.

In this regard, the non-linear traction in the present study demonstrated a highly significant improvement in all proprioception measurement post test and this improvement remain stable throughout the follow up

measurement. In contrast to linear traction where the significant improvement was temporary and failed to maintain the improvement in follow up measurement. This improvement could be attributed to the mechanical alignment of cervical spine.

This interpretation are consistent with Darnell[4] who reported that distortion of the bony cervical curve prevents the proper coupling movement of the cervical vertebrae which is essential for balanced integrated signaling to the brain. So the brain receives garbled messages because many proprioceptors are signaling weakly and others sending more signals than balance situation.

Looking into the matter further, the receptors for proprioception in the neck include the muscle spindles and Golgi tendon organs that are present in density in the intervertebral muscles and dorsal muscles[21]. Afferent information from the muscle spindles provides information about muscle length and rate of change of length. When the muscle shortening, the gamma-motor invervation maintains length of the spindle relative to the length of the muscle. By this mechanism, the central nervous system remains apprised of the length of the muscle even when it is contracting. However, there is evidence that in the presence of pain and muscle inflammation there is inhibition of gamma-motoneuron discharge[14.] Under these conditions, the information conveyed by the spindle is inaccurate, resulting in alteration of proprioceptive sensibility. Joint capsule receptors (Pacinian corpuscles, Ruffini endings) and Golgi tendon organs at musculotendinous junctions may also contribute to proprioceptive sensation. The adverse effect will extend to the Golgi tendon organs which have a very low threshold. As it is postulated that the prolonged muscle fiber contraction for any reason including static and prolonged stresses resulting from cervical abnormal posture will lead to decreased of proprioceptive response at same time[12].

Perception of the orientation of the head on the trunk is essential to perform of many every day task[15,22,28]. The recent studies found that proprioception sensation from the neck contributes more to positioning of the head in relation to the target than does vestibular system[24.] This is supported the finding of this study where the results revealed a significant and long lasting improvement in the neck disability scale for the non linear traction group which has a long lasting improvement in the proprioception.

Conclusion

The results of the study demonstrated the superiority of a non-linear traction over the linear traction as evidenced by the significant scores for all parameters recorded at post measurements and this improvement remained stable at long term follow up (three months) in contrast to linear traction. Further research is recommended to examine the same effect on gender.

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الملخص العربي

مقارنة بين الشد الطولي وغير الطولي على خشونة الفقرات العنقية

يهدف هذا البحث إلى دراسة تأثير كلاً من الشد الطولي وغير الطولي على خشونة الفقرات العنقية السفلية من خلال استعادة الانحناء الطبيعي للفقرات العنقية وتحسين الإدراك الحركي والألم . وقد أجريت هذه الدراسة على ثلاثين مريضاً من الجنسين تتراوح أعمارهم ما بين 40-50 عاماً وقد تم تقسيمهم عشوائياً إلى مجموعتين متساويتين في العدد . تم علاج المجموعتين بالعلاج التقليدي بالموجات فوق الصوتية والأشعة تحت الحمراء قبل بداية الشد العنقي . المجموعة الأولى تم علاجها بالشد الطولي والمجموعة الثانية بالشد غير الطولي ثلاث مرات في الأسبوع لمدة عشرة أسابيع . تم عمل آشعة عادية لجميع الحالات على منطقة الفقرات العنقية ، وتم قياس زاوية Cobb قبل العلاج وبعد عشرة أسابيع وبعد ثلاثة أشهر للمتابعة لتحديد التأثير البعيد للعلاج ، وكذلك تم قياس معيار الألم والاختلال الوظائفي للرقبة في نفس الفترات . وقد أسفرت النتائج عن تفوق الشد غير الطولي على الشد الطولي بوجود زيادة ذات دلالة إحصائية في جميع القياسات بعد العلاج مباشرة وأن هذا التحسن استمر مدة ثلاثة أشهر بعد العلاج وهي فترة المتابعة بعكس الشد الطولي . ويوصى بإجراء دراسة أخرى في هذا المجال للمقارنة بين الجنسين .