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TRACTION WITH DIFFERENT HEAD POSITIONS AND ITS EFFECT ON NEUROPHYSIOLOGICAL FUNCTION IN PATIENTS WITH DISCOGENIC CERVICAL RADICULOPATHY

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ABSTRACT

Traction angle is an essential factor influencing the outcomes of traction. The optimal angle has been determined via numerous trials; however, the effective traction angle has not been fully clarified. **Objective :**To examine how could various traction angles affect nerve root function in patients with cervical radiculopathy (CR). Forty-five patients with chronic discogenic CR of both sexes participated in this study. Patients were assigned into three equal groups. All 3 groups received static cervical traction but at different angles, Group (A) received it at angle 24º flexion, Group (B) at angle 15 º extensions while Group (C) at angle 0º (neutral position). Each group had a 20-minute traction period. Dermatomal somatosensory evoked potentials (DSSEPs) were assessed both before and after the traction to determine their peak to peak amplitude and latency.

There was a statistically significant difference in the peak-to-peak amplitude of DSSEPs in the extension traction group (B) compared to the other two groups. In group B, the percentage of change increased by 68.9% (f-value=26.144, p-value >0.005), while in group A (flexion), the percentage of change decreased by -29%, and in group C (neutral), it decreased by -13.9%. Additionally, no statistically significant variation in latency was seen for any of the groups in this study. Extension traction angle is an effective traction angle in patients with chronic discogenic cervical radiculopathy as it improves the nerve root function.

Key Words: Discogenic Cervical Radiculopathy, Traction angle, Dermatomal somatosensory evoked potentials (DSSEPs).

INTRODUCTION

Cervical radiculopathy (CR) is a medical condition characterized by a compression of cervical nerve roots. Cervical radiculopathy affected 107.3 out of 100,000 males and 63.5 out of 100,000 women annually **(Kuijper, *et al.*, 2009)**. The peak incidence of CR is most frequently reported in the fourth or fifth decade of life, **(Salemi, *et al.*, 1996 & Wainner, and Gill, 2000)**. It is generally agree that the involvement of the C6 and C7 nerve roots secondary to lesion of C5-6 and C6-7 motion segments are the most common, **(Ellenberg *et al.*, 1994 ; Radhakrishnan *et al.*, 1994 ; Ahlgren, and Garfin, 1997 ; Constantoyannis, *et al.*, 2002 and Brebach, *et al.*, 2004)**.

Cervical radiculopathy is associated with a number of risk factors that include white race, cigarette smoking, lifting heavy objects, driving equipment that vibrates, and playing golf, **(Kim, and Iyer, 2016)**.

Cervical radiculopathy can present with a variety of clinical manifestations that may include pain, sensory deficits, motor deficits, diminished reflexes, or any combination of them**, (Kim, and Iyer, 2016)**. Damage to either the dorsal and/or ventral nerve root can result in cervical radiculopathy, so this lesion may affect sensory and/or motor fibers. As a result, patients may have paresthesia, radicular pain, or motor symptoms such muscular weakness in the myotomal or dermatomal distribution of a damaged nerve root, **(Schliesser, *et al.*, 2003 and Joghataei *et al.*, 2004)**.

Cervical traction is considered one of the physical therapy treatment options in patients with cervical radiculopathy, **(Cleland *et al.*, 2005 ; Cleland *et al.*, 2005 ; Fritz & Brennan, 2007 & Fater, 2008)**. Traction has been used as a therapeutic intervention to alleviate symptoms related to nerve root compression, cervical muscle contraction, and zygoapophyseal joint osteoarthritis, **(Saunders and Ryan, 2004)**. Relieving pain, regaining neural integrity, and enhancing functional capacities are the primary goals of spinal traction, **(Braddom, 2000)**.

The beneficial effects of cervical traction may be due to reduction of disc derangement, **(Constantoyannis, *et al.*, 2002)**, muscle relaxation, **(Delacerda, 1996)**, and widens the intervertebral foramina, which lessens compression on the nerve roots, **(Cleland *et al.*, 2005 ; Cleland *et al.*, 2005 ; Fritz & Brennan, 2007 & Dennis and Fater, 2008)**.

One of the factors thought to influence the result of traction is the traction angle, **(Grieve, 1991)**. The greater the angle of flexion, the larger the intervertebral separation in the lower cervical spine, according to several prior studied conducted on patients with chronic cervical radiculopathy, **(Saunders and Ryan, 2004)**.

Conversely, there are many other studies reporting a non-significant effect of traction from ventroflexion position especially for patients with chronic CR, **(Brian, *et al.*, 2005 ; Waldrop, 2006 and Young *et al.*, 2009)**. The rules for cervical traction in all previous studies are mainly dependent on mechanical principles that include the changes in the cervical neural foramen, **(Cleland *et al.*, 2005)**, intervertebral separation, **(Alice, *et al.*, 1992 and Wong, *et al.*, 1992)**, and range of motion, **(Moffett, *et al.*, 1990)**,while ignoring the role of adverse mechanical tension developed during the ventroflexion traction.

Other studies implicates that the ideal posture for preventing nerve root compression is dorsal extension and retraction because it places the spinal cord and nerve root in a relaxed position, **(Harrison *et al.*, 2002)**.

Dermatomal somatosensory evoked potential (DSSEPs) provide a reliable information about segmental nerve root function that correlates to clinical symptoms more than the other electrophysiological examinations, as they reduce the problems associated with mixed nerve stimulation (F wave or mixed nerve SSEPS).

The contradiction found in all of the previous studies represents a major problem in determining the most effective traction angle. Consequently, the purpose of the current investigation was to ascertain how various traction angles affected the function of the nerve roots in individuals suffering from chronic discogenic cervical radiculopathy.

METHODS

Study design: A prospective single-blinded (assessor) randomized control study has been conducted in compliance with the Helsinki Declaration (1964) and the Consolidated Standards of Reporting Trials guidelines from august 2023 to December 2023 at Cairo university hospital. The protocol was prospectively accepted by the Faculty of Physical Therapy's Research Ethics Committee (NO:P.T.REC/012/005106)

Subjects

Forty-five Egyptian patients with chronic lower discogenic cervical radiculopathy of both genders participated in this cross-sectional study. They were recruited from the outpatient clinic of the Faculty of Physical Therapy, Cairo University through the period from August 2023 to March 2024. Prior to data collection, patients signed an informed consent form in order to participate in the current study. Recruitment began after approval was obtained from the Ethics Committee of the Faculty of

Physical Therapy, Cairo University and the study adheres with the Declaration of Helsinki, **(World Medical Association2013)**.

The inclusion criteria were: Patients with chronic lower discogenic cervical radiculopathy of lower cervical spine (C5-C6 and/ or C6-C7) as determined by MRI; their ages ranged from 40 to 50 years old ; had symptoms that had been present for more than three months; side to side amplitude differences of 50% or more in DSSEPs measurement, **(Naguszewski *et al.*, 2001)**.

Participants were excluded according to the following criteria: individuals suffering from osteoporosis, rheumatoid arthritis, vestibular insufficiency, posterior cervical osteophytes, and spinal canal stenosis any myelopathy symptoms or indicators; Any abnormalities of deep sensation; referred pain from the costotransverse joint, rotator cuff tendonitis, cervical rib syndrome, and entrapment neuropathy; incapacity to tolerate cervical extension/flexion position, **(Donald, M. 2000)**.

The patients were randomly allocated into three equal groups (n=15) as shown in Figure (1).The randomization was conducted via random generator and by using permuted blocks of different sizes. In **Group A**, static mechanical cervical traction was applied at an angle of 24º flexion; in **Group B**, it was applied at an angle of 15º extensions; and in **Group C**, it was applied at an angle of 0º (neutral position).

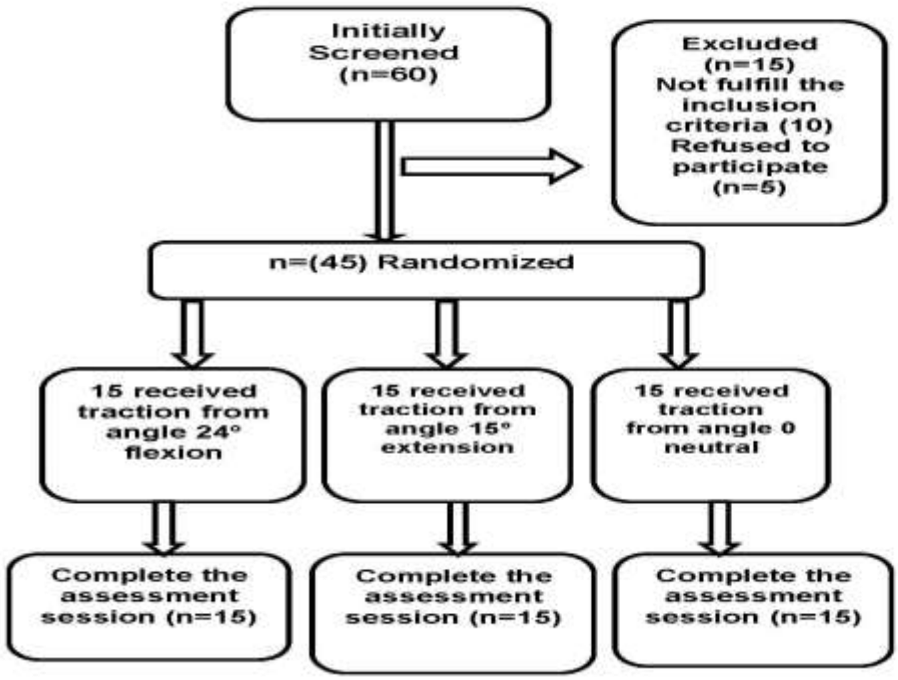

Figure (1): Diagram of flow of study participants.

Procedures:

Measurement of Dermatomal somatosensory evoked potential (DSSEPs) by Computerized electromyography (EMG) device (Tonneis Neuroscreen plus version 1.59, Germany): This was performed according to **Liguori *et al.*, (1991),** protocol. Cortical recording was made for all patients before and at the end of application of cervical traction.

Position of the patient: The patient was positioned as a supine on a softly padded table with cushions beneath his head and legs. Skin overlying the dermatome, was gently cleaned with methylated alcohol and then patted dry with clean, dry cotton wool. Additionally, great care was taken prior to the recording electrodes being affixed to the scalp. The hair was separated, and the skin in between was thoroughly cleaned by methylated alcohol and sand paper was used to gently abrade the skin sites by removing multiple superficial layers of skin and skin oils.

Stimulation:

About 7 centimetres above the radius's styloid process was the stimulation site for C6, and between the second and third metacarpal bones was the site for C7. A bipolar electrode was used for stimulation with 2.5 cm inter-electrode space, while the stimulation cathode was positioned proximally. Stimulation was delivered with a constant current square wave pulse of 0.2 ms duration, conducted at 3.1 Hz. The sensory threshold for electrical stimulation was established by raising the electrical current intensity until the patient reported feeling it, and the tolerable painless stimulus intensity was typically set at 2.5 times over above this level.

Recording:

The international EEG 10-20 system was used to mark the locations of the recording electrodes. Affixed with cream to the abraded skin, 9 mm diameter tin/lead electrodes were used for recording. The reference electrode was positioned at Fz, the ground electrode at Fpz, and the recording electrodes were set at c3γ and c4C (between c3 and p3 and c4 and p4 of the international EEG 10-20 system), **(Ernst 2004).**

Outcome measures:

Positive peak and negative near field potential were identified to determine the peak-to-peak amplitude after the stimulation was carried out and the traces were superimposed to guarantee consistency. The distal latency was defined as the interval between the stimulation of a compound muscle or selective dermatome and the observed response, while the amplitude was measured as the distance between positive and negative peak.

Measuring angles of cervical spine by Cervical Range of Motion (CROM) device:

A velcro strap was used to fasten the CROM device to the patient's head after it had been placed over their ears and nose bridge. Each patient was then directed to move the head in the direction required (flexion or extension) or to hold it in the neutral position according to the group involved.

Traction procedures:

It was done by a mechanical traction device. The position of traction was supine lying position with pillow under both knees, static mode of traction was used, the force of traction was 15% of total body weight of each patient and the duration of traction was 20 minutes. The therapist stand beside the affected side and the measurement of nerve root function (peak to peak amplitude and latency) of C6 and/or C7 of DSSEP was taken by EMG device and the outcome of the measurement was recorded in EMG sheet. Then the cervical angle was measured for the three groups by CROM as the following: **For group A**: The angle reached 24º flexion and was kept by a pillow under the patient head. **For group B**: The angle reached 15 º extension and was kept by a pillow under the patient thorax. **For group C:** The angle reached 0º (neutral position) and was kept by a pillow under the patient head. The last step was to remeasure nerve root function of C6 and /or C7of DSSEP at the end of traction and the outcome of measurement was recorded in EMG sheet.

Statistical Analysis:

Statistical analysis of the obtained data was conducted using the arithmetic mean and their standard deviation. The differences in each group's physical characteristics were determined using a one-way ANOVA, the differences between the groups were determined using a one-way ANOVA, and the differences within each group were determined using a Paired T-test.

RESULTS:

- There was no statistically significant difference ($P > 0.05$) in the baseline variables of age, weight, and height between the three groups, as shown in Table1.
- When comparing the peak amplitude of dermatomal somatosensory evoked potentials (DSSEPs), a statistically significant difference was observed between pre-traction and post-traction in all groups, with post traction mean values were 0.920 ± 0.376, 1.666 ±0.730, 1.480 ±0.528 respectively as shown in Table 2.
- Group A (flexion group) and group C (neutral group) showed a significant decrease in peak to peak amplitude of DSSEPs as the percentage of change decreased by -29% (*p*-value= 0.001) and -13.9% (*p*-value= 0.028) , while group B (extension group) showed a remarkable increase in peak to peak amplitude of DSSEPs as the percentage of change increased by 68.9% ($P <$ 0.005) as shown in Table 2.
- Using one way ANOVA, between group analysis of the amplitude of DSSEPs revealed a statistically significant difference between the three groups (f-value=26.144) ($P > 0.005$) as shown in Table 3.

- A pairwise comparison of the DSSEPS amplitude showed that group B (the extension group) had a statistically significant increase in the amplitude when compared to group A (the flexion group) and group C (the neutral group), with mean differences of 0.977 (p-value<0.005) and 0.726 (p-value<0.005), respectively. However, group C and group A did not show any statistically significant differences, with a mean difference of 0.251 (p-value = 0.239) at 95% confidence interval as shown in Table 4.
- In all groups, a non-statistically significant difference was found in the latency of dermatomal somatosensory evoked potentials (DSSEPs) between pre-traction and post-traction. Post traction mean values were 21.413 ±2.049, 20.566 ±2.134, and 21.406 ±1.27 9 respectively as shown in Table 5.

Table (1): One way ANOVA of baseline characteristics of patients in the three groups:

Variable	Group A (n=15)	Group B (n=15)	Group C) (n=15	Comparison	
	Mean ± S.D	Mean ± S.D	Mean ± S.D	f-value	p-value
Age (Years)	44.53±3.26	45±2.69	43.83±2.86	0.593	0.557
Weight (Kg.)	74.06±6.25	70.8±7.02	71.66±6.98	0.939	0.399
Height (Cm)	61.86±7.9	162.66±7.9	161.93±8.0	0.054	0.947

S.D: Standard deviation F: ANOVA test P: Probability value

Table (2): Paired t-test of peak amplitude (µv) of DSSEPs for group A (flexion), group B (extension) and group C (neutral).

Group	Amplitude of DSSPs Mean ± SD		Difference	Percentage of change	t- value	P-value
	Pre-traction	Post-traction				
Group A	1.300±0.585	0.920 ± 0.376	-0.378	- 2 9%	4.432	0.001 *
Group B	0.986±0.540	1.666 ±0.730	0.68	68.9%	-5.743	< 0.005 *
Group C	1.720±0.633	1.480 ±0.528	-0.24	-13.9%	2.449	0.028

S.D: Standard deviation P: Probability value T: t test *: significant

Table (3): One way ANOVA of amplitude(µv) of DSSEPs for the three groups:

Group	Amplitude of DSSPs Mean ± SD		F- value	*p*-value
	Pre-traction	Post-traction		
Group A	1.300±0.585	0.920 ± 0.376	26.144	>0.005*
Group B	0.986±0.540	1.666 ±0.730		
Group C	1.720±0.633	1.480 ±0.528		

Table (4): Pairwise comparison of amplitude of DSSEPS between groups.

Tested groups	Mean difference	significance	95%Confidence Interval Difference	
			Lower	Upper
(Extension 15 ,Flexion 24)	0.977	<.005	0.635	1.319
(Extension 15 ,Neutral 0)	0.726	<.005	0.349	1.104
(Neutral 0, Flexion 24)	0.251	0.239	-0.98	0.599

Table (5): Paired t-test of latency of DSSEPs of group A (flexion), group B (extension) and group C (neutral).

Group	Latency of DSSPs Mean ± SD		Difference	Percentage of change	t- value	P- value
	Pre-traction	Post-traction				
Group A	21.580 ±2.177	21.413 ±2.049	-0.173	-0.8%	0.882	0.393
Group B	20.220 ±2.503	20.566 ±2.134	0.346	1.7%	-.873	0.398
Group C	20.946 ±1.0868	21.406 ±1.27 9	0.46	2.1%	-1.178	0.258

S.D: Standard deviation P: Probability value t: t test

DISCUSSION:

The findings of this study revealed a statistically significant difference in peak to peak amplitude of DSSEPs in group B (extension group) where the percentage of change was increased by 68.9% in comparison with the other two groups (f value=26.144) (P < 0.005), while percentage of change decreased by -29% in group A (flexion group) and- 13.9% in group C (neutral group) .The current study also revealed no statistically significant difference in latency for all groups.

The current study offers objective proof that, while performing cervical traction on patients with chronic discogenic cervical radiculopathy, neurophysiological principles—particularly with regard to nerve root function—must be taken into account, rather than only mechanical ones.

These findings concur with those of **Harrison *et al.*, (1996)**, who highlighted the significance of cervical traction extension for patients suffering from cervical radiculopathy. Additionally, **(Harrison *et al.*, 2003),** also supported the current study, who claimed that the Chiropractic Biophysics (CBP) technique's extension-compression 2-way cervical traction is effective in reducing chronic neck pain.

Such improvement of nerve root function (peak to peak amplitude) in group B (extension traction) in the current study could be attributed to the nervous system's biomechanics. This explanation is consistent with **Yuan *et al.*, (1998),** who examined the cervical spine cord deformation and displacement in flexion and found that the spinal cord increased 10% and 6% of its initial length along the posterior and anterior surfaces, respectively, between neutral posture and full flexion, causing abnormal stresses on the neural tissue. .

Additionally, **Schnebel *et al.*, (1998),** examined how spinal flexion and extension affected nerve compression in disc herniation and demonstrated that flexion of the spine increased the amount of compressive force and tension in the nerve root whereas extension of the spine lowered it.

The second explanation that could have contributed to the extension position's positive outcomes was the biomechanics of vascular system. Changes in posture are thought to cause the blood vessels in the dorsal and ventral roots to distort. The radicular and medullary arteries and veins will be under tension and thus narrowed with an increase in spinal canal length, and relaxed in the pons-cord's extended posture , **(Rossitti, 1993 ; Abdulwahab, 1999 ; Sabbahi and Abdulwahab 1999).**

The amplitude of SSEPs was found to decrease in cases of impaired blood supply of nerves or nerve roots, these findings are consistent with those of **Licht *et al.*, (1999),** who discovered that following cervical manipulation, the vertebral artery volume of blood flow increased significantly for 40 seconds before returning to baseline values in less than 3 minutes while there were no significant changes in the volume of blood flow during pre-manipulative testing of the vertebral arteries (DeKleyn's test).

The third possible explanation could be based on interruption of the pain spasm cycle, since the extension posture is thought to be the favored position by the neurological system, which leads to relaxed decreased strain and compression on CNS structures, **(Harrison *et al.*, 1999)**.

Clinical studies had shown that a significant number of patients with spinal pain also have spasms in their muscles. Patients with persistent back pain exhibit reduced muscle activity during movement and increased muscular activity in static postures, according to EMG investigations. Experimental evidence proved that both muscular activity and discomfort can result from muscle spasms. Analgesics can diminish muscle spasm, and different muscle relaxant techniques can lessen pain, which is another evidence for the presence of a pain-spasm-pain cycle, **(Djupsjöbacka *et al.*, 1995)**.

In contrast to the current study's findings, other studies have called into question the usefulness of the extension position in the treatment of cervical radiculopathy. These studies have hypothesized that a significant decrease in sagittal diameters and intervertebral mobility were the possible explanation for their findings. **Farmer and Wisneski (1994),** reported that cervical spine extension significantly decreases the foraminal size and consequently increases nerve root pressure and radicular symptoms.

According to research by **Chen *et al.*, (1997),** cervical flexion between 20 and 30 degrees is ideal since it separates the posterior zygoapophyseal joints. There is an enlargement of the transverse and intervertebral foraminae and a relief of compression on the lateral nerve roots.

A nonsurgical treatment of cervical disc herniation with flexion distraction was proposed via (**Wainner, and Gill, 2000),**] and reported that flexion distraction applied to cervical spine might be an effective therapy in treatment of cervical disc herniation and improving the neural function as indicated by pain reduction.

This discrepancy may be attributed to the guiding rules for cervical traction in the previous studies which were primarily based on mechanical principles—such as modifications to the cervical neural foramen and intervertebral separation—rather than neurophysiological principles, particularly with regard to nerve root function. Also, it may be due to the particular multimodal treatment approach used in most of the previous studies that made it challenging to determine the efficacy of any one treatment variable.

CONCLUSION

The study's results indicated that, for patients with discogenic cervical radiculopathy, extension traction at angle 15, was the most beneficial traction angle in patients with discogenic cervical radiculopathy based on improvement of nerve root function. Also, this study highlighted that while selecting traction angles in patients with discogenic cervical radiculopathy, neurophysiological considerations should be taken into account rather than biomechanical ones.

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الشد مع أوضاع الرأس المختلفة وتأثيره على الوظيفة الفسيولوجية العصبية في المرضى الذين يعانون من اعتلال الجذور العنقية الغضروفي

شيماء طه ابو القاسم [1،2]، رانيا محمد توفيق[3]، ابراهيم مصطفي مصطفي[2] ، سحر محمد عادل الحق [1،2]، عبير فرغلي[4،5] و انجي بدرالدين صالح[3].

[-1] قسم العلوم الاساسيه ، كليه العلاج الطبيعي ، جامعه الجلاله ، السويس ، مصر
[-2] قسم العلوم الاساسيه ، كليه العلاج الطبيعي ، جامعه القاهر ، القاهره ، مصر
[-3] قسم العلاج الطبيعي للاعصاب و جراحه الاعصاب ، جامعه القاهره . القاهره ، مصر
[-4] قسم العلاج الطبيعي لاضطرابات القلب والأوعية الدموية / الجهاز التنفسي وطب الشيخوخة ، كليه العلاج الطبيعي ، جامعه القاهره ، القاهره ، مصر
[-5] كليه العلاج الطبيعي ، جامعه الابتكار ، الشرقيه، مصر

زاوية الشد هي عامل أساسي يؤثر على نتائج الشد تم تحديد الزاوية المثلى من خلال العديد من التجارب. ومع ذلك ، لم يتم توضيح زاوية الجر الفعالة بشكل كامل.

الهدف من دراسة كيف يمكن أن تؤثر زوايا الجر المختلفة على وظيفة جذر العصب لدى المرضى الذين يعانون من اعتلال الجذور العنقية (CR).

شارك في هذه الدراسة خمسة وأربعون مريضا يعانون في حالات اعتلال الجذر العصبي الناتج من غضروف الفقرات العنقية السفلية. وقد تم تقسيمهم عشوائيا الى ثلاث مجموعات متساويات أ، ب، ج

<u>مجموعة أ :</u> تم تطبيق شد ميكانيكى مستمرللفقرات العنقيه السفلي عند زاويه انحناء 24 ° لكل المشاركين فى هذه المجموعه البالغ عددهم 15 مريضا وتم ا قياس مدى استثارة المخ الحسية لاعصاب الفقرات العنقية السفلية وقياس فترة الخفاء القصوى لموجة الاستثارة الحسية قبل وفى نهايه فتره الشد البالغه عشرون دقيقه.

<u>المجموعة ب:–</u> تم تطبيق شد ميكانيكى مستمر للفقرات العنقيه السفلي عند زاويه أمتداد 15° لكل المشاركين فى هذه المجموعه البالغ عددهم 15 مريضا وتم ا قياس مدى استثارة المخ الحسية لاعصاب الفقرات العنقية السفلية وقياس فترة الخفاء القصوى لموجة الاستثارة الحسية قبل وفى نهايه فتره الشد البالغه عشرون دقيقه

<u>المجموعة ج :–</u> تم تطبيق شد ميكانيكى مستمر للفقرات العنقيه السفلى عند زاويه صفر° لكل المشاركين فى هذه المجموعه البالغ عددهم 15 مريضا وتم ا قياس مدى استثارة المخ الحسية لاعصاب الفقرات العنقية السفلية وقياس فترة الخفاء القصوى لموجة الاستثارة الحسية قبل وفى نهايه فتره الشد البالغه عشرون دقيقه.

وقد اسفرت النتائج:

عن وجود زيادة ذ ات دلالة احصائية في مدى استثارة المخ الحسية بعد شد الفقرات العنقيه عند زاويه امتداد 15 فى المجموعه ب بالمقارنه بالمجموعتين الاخرتين عدم وجود دلالة احصائية عن قيمه فترة الخفاء القصوى لموجة الاستثارة الحسية بعد تطبيق الشد من الزوايا المختلفه فى المجموعات الثلاث .وهذه النتائج تفيد بأن شد الرقبه من زاويه أمتداد 15 ° تحسن وظيفه الجذر العصبى.