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Impact of Nursing Physical Training Program on Clinical Outcomes for Patients Undergoing Cervical Spine Surgery

Samah R.Shaheen[1], Sanaa Alaa Eldeen[2], Maha Adel Salem[3], Osama Abdelaziz [4]
[1]*(Medical - Surgical Nursing / Faculty of nursing, Alexandria University, Egypt,)*
[2]*(Medical - Surgical Nursing / Faculty of nursing, Alexandria University, Egypt)*
[3]*(Medical - Surgical Nursing / Faculty of nursing, Alexandria University, Egypt)*
[4]*(Neurosurgery department / Faculty of medicine, Alexandria University, Egypt)*
Corresponding author: Samah Ramadan

Abstract: ***Background:*** *Cervical spine disorders (CSD) including degenerative disc disease ("DDD") are common causes of neck pain. CSD are characterized by degenerative changes in the intervertebral discs. It can be noticeable anywhere along the spine. Population-based surveys have indicated lifetime prevalence rates for neck pain somewhere in the range of 67 to 71%, whereas 13- 22% of the population in industrialized society encounter neck pain at any time point. CSD also account for an essential number of physical therapy outpatient visits yearly.* ***Objectives****: Determine the influence of nursing physical training program on the clinical outcome of patients undergoing cervical spine surgery.* ***Setting****: The study was done at the neurosurgery department at Alexandria Main University Hospital and the affiliated Outpatient Clinic.* ***Subjects****: Subjects of this study were a convenient sample of 40 adult patients with cervical spondylosis, canal stenosis and cervical disc prolapse undergoing cervical spine surgery. They were sequentially divided into 2 equal groups; the first was the control group which comprised 20 patients and exposed to routine care only, the second was the study group and comprised 20 patients and they received the nursing physical training program.* ***Tools****: Two tools were used Tool I: Cervical Spine Surgery Patients' Assessment and Tool II: Neck Disability Index.* ***Results****: There were highly statistical significant differences between study and control regarding pain intensity 1 month after the surgery. It was found that among the study group, the mean score of all assessed muscles strength was increased from preoperative day to two weeks postoperatively and one month after surgery. This increase within the study group was statistically significant .The mean scores of all reflexes among study group were 2.0± 0.00 one month postoperative which denotes the improvement to normal response. A statistically significant improvement in the disability level was noticed among the study group.* ***Conclusion****: Applying nursing physical training program significantly enhanced the studied patients' pain intensity, gait, muscle strength, reflexes, and neck disability index postoperatively than their controls.*

Keywords - *Cervical Spine Disorders, Degenerative Disc Disease, Nursing Physical Training Program, Neck Disability Index*

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I. Introduction

Cervical DDD is a typical reason for pain and disability, affecting around two-thirds of adults in the U.S. Most symptomatic cases present between 40 and 60 years old, although numerous people never develop symptoms MRI studies have recorded DDD in 60% of asymptomatic persons greater than 40 years and 80% of patients over 80 years [(1, 2)].

Around 15% United Kingdom's clinic-based physiotherapy and 30% Canada's Chiropractic referrals are for neck pain. Neck pain provides up to 2% of general specialist consultations in the Netherlands [(3)]. Approximately 50–85% of individuals with neck pain do not experience full resolution of symptoms and some may experiences chronic pain [(4)].

DDD of the cervical spine is a natural consequence of aging that results in gradual deterioration of cervical intervertebral discs as the capacity of these discs to absorb the stress and shock of vertebral movement decreases, they become inelastic and cause a settling of the spinal column structure and abnormal spinal movement patterns. This process in turn causes the development of anomalous bony growths and/or spurs (spondylosis), osteoarthritis, and/or herniation of at least one cervical disc [(5)]. These conditions may in turn cause radiculopathy, or peripheral nerve root impingement. Cervical radiculopathy symptoms encompass arm and neck pain, and weakness, tingling, or numbness in the upper limbs. Less commonly, cervical DDD progression and its sequelae may directly compress the spinal cord parts (myelopathy), influencing gait and balance in addition to causing arm and/or leg weakness and numbness [(6)].

Degenerative cervical spine disorders must be recognized early and managed either medically or surgically. Delayed management may make recovery less likely. If the condition progresses rapidly and causes loss of function, early treatment should be considered. Treatment may vary enormously depending on correlation of diagnostic findings with the clinical findings. Referral for surgery relies upon the level of the patient's neurologic dysfunction (7). In mildly to moderately symptomatic patients, medical management usually starts with medications and physical therapy. Muscle relaxants and nonsteroidal anti-inflammatory drugs (NSAIDs) or other analgesics are commonly used for symptomatic treatment of associated radiculopathic manifestation. Antidepressant and anticonvulsants medications may be given to treat neuropathic pain associated with nerve-root compression (8, 9).

While most patients with degenerative cervical disorders might be successfully treated conservatively, some do not react to conservative treatment or have symptoms that necessitate surgery. After 4 to 6 weeks of conservative therapy, if the symptoms worsen or did not improve surgery might be recommended. The objective of surgery is to inhibit symptom progression and restore lost function, if possible. Contingent upon the imaging findings that correlate with the patient's symptoms and signs, one of several approaches may be used (10). For a patient with neurologic deficits associated with cervical spondylosis, decompression is the objective of surgery. Decompression may take place using a ventral approach to the cervical spine (anterior cervical micro discectomy with or without corpectomy), or a dorsal approach (laminectomy). In most cases, a procedure called "fusion" is required to restabilize and correct the deformity (11, 12).

Nurses in neurosurgery practice settings encounter patients with pain because of CSDs and they struggle to manage it. Nurses play an essential role in assessing and implementing interventions that advance viable help with pain relief. Neurosurgical nurse serves as an integral member of the multidisciplinary pain team as she/he is, in a unparalleled position to provide patients with effective management strategy to relieve their persistent suffering and pain (13).

The nurse plays a key role in dispensing accurate information about the proper use of body mechanics how to properly lift heavy objects, how to maintain good posture while working and during other activities, and how to perform certain exercises to treat and prevent recurrence of symptoms (14). Nursing is a pivotal factor in the recovery and progress of patient's condition through teaching and education of physical training program, which includes exercises, body mechanics, straining factors prevention, education about early symptoms and signs of post-operative complications (15).

Exercise provides a plenty of health benefits for CSDs. Physically; it restores the optimal spinal muscle strength, which protects the intervertebral disc from chronic, repetitive dynamic overload. Exercise is effective in reducing neck pain by detracting tension on the posterior annular fibers, decreasing tension on the nerve root, changing intradiscal pressure, improving blood flow to nerve roots and improves metabolic exchange in cervical disc thus aiding disc repair. Exercise can also allow "endorphins" to be released into the blood. These endorphins act as natural pain relievers (16).

Psychologically, it has been announced that depression improves after long period of exercise program. The increase in mood was found to be related to the release of endogenous opiates (beta –endorphins) and increase in concentrations of circulating hormones (e.g., catecholamine) .These biological changes, together with a relief of somatic symptoms, may improve the quality of life and the physical functioning. These in turn, reduce anxiety, enhances the capability to resist stress, and enhance psychological well being (17, 18).

Therefore, this study will be conducted to determine the effect of nursing physical training program on the clinical outcomes of patients undergoing cervical spine surgery.

II. Material And Methods

Research design:
A quasi-experimental design was used in this study.

Setting:
The study was carried out at the Neurosurgery Department, Alexandria Main University Hospital, and the affiliated Outpatient Clinic.

Subjects:
This study comprised a convenient sample of 40 adult patients admitted to the above mentioned setting and diagnosed with canal stenosis and cervical disc prolapse undergoing cervical spine surgery. The study subjects were divided randomly into two equal groups; a study group, consisting of 20 adult patients who received the nursing physical training program and a control consisting of 20 adult patients who received the routine hospital care only. The patients, who participated in this study, were chosen based on the next criteria:

- Aged from 25-60 years of both sexes.
- Patients, who can communicate verbally, alert and follow instruction.
- Patients diagnosed as cervical spondylosis, cervical canal stenosis or cervical disc prolapse and are undergoing cervical spine surgery.

Tools for data collection:

Tool I: Cervical Spine Surgery Patients' Assessment:

This tool was developed by the researcher after reviewing relevant literature and it was utilized to assess patients with CDD disease before and after implementation of nursing physical training program. It comprised of four parts:

Part I: Patient's Sociodemographic Characteristics: This part included data such as; sex, age, marital status, educational level, occupation.

Part II: Patients' Clinical Data: This part included data such as; medical history, surgical history, operation name, duration of disease, names of prescribed medications, level of cervical disc affected, patients complaints and previous neck –or back surgery.

Part III: Cervical Spine Surgery Patients' Pain Assessment, this part included two sections.

Section one: to evaluate pain characteristics that include: site, radiation, and quality, duration, aggravating factors, and reliving factors. Section two: to evaluate pain intensity.

Part IV: Physical Assessment:

This part encompassed five sections to assess patients' motor and sensory status

- Section one; assessment of gait.
- Section two; assessment of posture.
- Section three; assessment of muscle strength.
- Section four; assessment of sensory function.
- Section five; assessment of reflexes.

Tool II: Neck Disability Index (NDI):-

This tool was produced by Vernon to assess patients' level of disability. It is an instrument for estimating self-rated disability of neck pain due to CSDs. The NDI comprises of 10 items: individual care, pain intensity, reading, lifting, headaches, concentration, driving, sleeping, work and recreation. Each item was evaluated on a rating gradation ranging from 0 to 5, for a total score of 50. The lower the score, the less self-rated disability. The following guide is for interpretation of a patient's score: 0 – 4 means no disability, 5 – 14 means mild disability, 15 – 24 means moderate disability, 25 – 34 means severe disability, and 35 or over means complete disability.

III. Method

- An official letter was attained from the administrative office of the Faculty of Nursing
- A written approval was attained from the hospital administrator and head of neurosurgery department, after explanation of the study aim.
- Tool I cervical spine surgery patients' assessment was developed by the researcher after reviewing related literature.
- Tools and booklet were tested for content validity, completeness and clarity of items by five faculty staff of Medical –Surgical Nursing and five Neurosurgeons in Alexandria University.
- The reliability of the tools was measured by Cronbach's alpha test tool I=0.95 and tool II=0.80, indicating reliable tools.
- A pilot study was done on four patients for testing, clarity, feasibility and applicability of the developed tool.
- Forty adults patients were recruited according to the previously mentioned inclusion criteria and assigned into two sequential equal groups as follows:

  Group (1): subjects maintained on the routine hospital treatment regimen
  Group (2): subjects received the proposed nursing physical training program

- Initial assessment of all patients (study and control group) was done preoperatively using tool (I and II) to collect a baseline data.
- Physical assessment was done for every patient individually after carefully listening and documenting his or her history, and assessment ranged from 40-60 minutes on individual sessions depending on the degree of tolerance and response of the patients.
- The program was developed after reviewing related literature, the content of this program included exercises, body mechanics training and patient health education about straining factors prevention as chronic cough chronic constipation ,early signs symptoms of postoperative complications, and patients follow up schedules.

- The developed program was implemented to patients of the study group individually in the inpatient department.
- It included 3 sessions of patient's teaching during preoperative, 3 days post-operative and pre-discharge periods.
- After program application, every patient in the study and control group was evaluated two times after two weeks, and one month post discharge using tool I and II at the affiliated out- patients' clinic.

IV. Statistical ANALYSIS

The raw data were coded and entered into SPSS system files (SPSS package version 23). Analysis and interpretation of data were conducted.

The following statistical measures were used:

- Descriptive statistics including frequency, distribution, mean, and standard deviation were used to describe different characteristics
- Kolmogorov – Smirnov test was used to examine the normality of data distribution.
- Univariate analyses including: Chi-Square test, Monte Carlo test and Fisher's Exact test were used to test the significance of results of qualitative variables.

Univariate analysis including: independent t test was used to test the significance of results of quantitative variables.

The significance of the results was at the 5% level of significance

Data was analyzed using pc with statistical package for social sciences

- $P < 0.05$ level was used as the cut off value for statistical significance and the following statistical measures were used.

A- Descriptive statistics.

1- Frequency and percentage, used for describing and summarizing qualitative data

2- Arithmetic mean (x) standard deviations (SD) are used as measure of central tendency and dispersion respectively for normally distributed quantitative data.

B -Analytical statistics:-

They were used for comparing each group in the study independently between preoperative days, two weeks and one month postoperatively, the following tests were used:

- Quantitative data:
  - Parametric: One way repeated measures ANOVA and paired t test.
  - Non-parametric: Freidman test and Wilcoxon Signed Rank test.
- Qualitative data:
  - Dichotomous: McNemar test and Cochran test
  - Multichotomus: Kendall's W test

V. Figures and Tables

Table (1): present the distribution of the study and control group according to their socio-demographic characteristics. Two thirds of studied and control groups their age extended from 40 to less than 50 years. Males were more predominant in the studied sample and most of the studied patients in both groups were married. Half of each group was illiterate. More than two thirds of the control group and one fifth of the study group were manual workers and one third of study and control groups were housewife.

Table (2): present the distribution of the study and control groups as per their clinical data. More than 50% of the study group was diagnosed with cervical disc prolapse compared to three fifths of the control group .The remainder of study group (45.0%) and control group (40.0%) were diagnosed with cervical stenosis. Less than one third of study group affected from C3- C7 compared to 45.0% of the control group. All patients in both groups were suffering of neck stiffness and numbness. More than two thirds of study group complained from muscle weakness compared to more than four fifths of control group also, two fifths of study group had bladder dysfunction. Half of the study group undergone laminectomy and the other half did discectomy. While in control group, 45.0% did laminectomy and the remaining 55.0% undergone discectomy.

Table (3): presents the distribution of the study and control groups of cervical spine surgery patients according to prescribed medications, medical history and surgical history: all patients of study and control groups were receiving muscle relaxants and analgesics. Also, most of patients in study group were receiving NSAIDs compared to more than half the control group without statistical significant difference. 10.0% were on neurotone compared to 15.0% of control group and this variance was not statistically significant (P= 1.00). Most of patients in both groups 80.0% and 75%, respectively had symptoms for less than six months. A little more than one third of the study group (35.0%) had comorbid disease as compared to 55.0% of the control group without statistically significant difference, (P= 0.204). Among those who had comorbid diseases, 42.9% and 72.7% from study and control groups respectively suffered from hypertension, while 57.1% from study group and 18.2% from control group had diabetes mellitus. The majority of both study and control groups (90.0% each) did not perform previous back surgery and only 10.0% at each group previously had undergone lumbar laminectomy (P= 1.00). Moreover, none from the studied patients in both group previously performed any neck surgery.

Figure (1): illustrate the distribution of the study and control groups of cervical spine surgery patients according to pain intensity preoperatively. The majority of study and control group, 80.0% and 85.0%, respectively experienced severe pain while the remainders in both groups suffered from pain as bad as it could be (worst level of pain) but these differences were not statistically significant (P= 1.00).

Figure (2): illustrate the distribution of the study and control groups of cervical spine surgery patients' according to pain intensity 14 days postoperatively, the pain intensity of more than four -fifths of patients in each group (85.0%) was moderate and 10.0% of the study group compared to none from control group experienced mild pain. Moreover, the intensity of pain in only 5.0% of study group and 15.0% of control group was severe with no statistically significant difference between both groups, (P= 0.347) as shown in figure (2).

Figure (3): illustrate the distribution of the study and control groups of cervical spine surgery patients according to pain intensity 30 days postoperatively the figure reveals that two -fifths of patients in study group improved and no more experienced any pain compared to no one from the control group. Also, more than half of the study group experienced a mild degree of pain compared to only 15.0% of control group. On the other hand, the majority of patients in control group still suffered from moderate pain and 10.0% of them experienced severe pain. These differences were highly statistically significant (P= <0.001).

Table (4): show the distribution of the study and control groups of cervical spine surgery patients according to their gait. More than half of patients at each group had normal gait before operation. The remainders in study group were either unable to walk (40.0%) or had stiffness (5.0%), while in control group all the remainders (45.0%) were unable to walk. Regarding the degree of improvement observed in each group separately, it was statistically significant among the study group (P= 0.002) while in the control group, these changes were not statistically significant (P= 0.115).

Table (5): demonstrates the distribution of the study and control groups of cervical spine surgery patients' according to muscle strength assessment. It was found that among the study group, the mean score of all assessed muscles strength was increased from preoperative day to two weeks postoperatively and one month after surgery. This increase within the study group was statistically significant as shown in table (5) with different values of P. Concerning the control group; the score did not change when comparing assessment before surgery, with 14 days post-surgery in the following muscles: left side elbow flexors, right side elbow extensors and finger abductors at both sides. Then one month postoperative assessment revealed a statistically significant increase in the muscle strength score in the majority of muscles assessed.

Table (6): demonstrates the distribution of the study and control groups of cervical spine surgery patients according to deep tendon reflexes assessment .The mean scores of all deep tendon reflexes assessed increased significantly from the preoperative assessment to two weeks after surgery to one month postoperatively. Also, the mean scores of all reflexes among study group were 2.0± 0.00 one month postoperatively which denotes improvement to normal response. Also among the control group, in the majority of tendon reflexes assessed there were also a significant increase in the mean scores all over the periods of assessment although the mean score did not reach to 2.0± 0.00 but it was around 1.8± 0.41 in all deep tendon reflexes except for brachioradialis reflex on right and left sides, 1.8± 0.37 and 1.9± 0.37, respectively.

Table (7): demonstrates the distribution of the study and control groups of cervical spine surgery patients according to neck disability index. All the studied patients in both study and control groups were suffering from complete disability before operation. Two weeks after surgery, 80.0% of the study group turned to severe disability compared to only less than one third of the control group (30.0%) while the remainders at both groups (20.0% of study and 70.0% of control groups) remained with complete disability. These differences were statistically significant (P= 0.004). One month postoperatively, the degree of disability of 60.0% of study group improved to moderate disability compared to only 10.0% among the control group. Moreover, half of the patients in control group were remained suffering from complete disability compared to no one from the study group. Also, 10.0% of study group experienced more improvement and reached mild disability degree compared to none from control group. These differences were highly statistically significant, (P= <0.001).

Figure (4): illustrate the distribution of the study group of cervical spine surgery patients according to neck disability index percent score, the median percent score of study group showed high statistically significant decrease from 77.6% preoperatively to 61.1% two weeks postoperatively to 42.3% one month postoperatively, (P= <0.001 for each) as illustrated in figure (4).

Figure (5): illustrate the distribution of the control group of cervical spine surgery patients according to composite neck disability index percent score ,the median percent score changed from 82.5% before surgery to 72.9% two weeks after surgery to 68.8% one month postoperatively with high statistically significant difference among different periods (P= <0.001).

VI. Discussion

Cervical spine diseases have a great significance and impact on neuroscience patients. They are usually accompanied by a considerable impact on daily life that results in broad usage of healthcare resources to enhance patients' functional status and the quality of life [(19)]. It is estimated that degenerative cervical spine disorders affect approximately 2/3 of the population throughout their lifetime. Usually, it is difficult to differentiate pathological changes from the typical maturing process. While frequently episodic and favorable in nature, cervical disorders might become disabling, causing severe pain and possibly neurologic sequelae [(20)].

Numerous patients with cervical disc disease need to leave from work, because of dependable, complex indications, comprising chronic pain and lessened levels of physical and psychological function [(21)]. On a few segmental levels, surgery may be expected to retreat disc-specific pain and to decrease neurological deficits, but not the non-specific neck pain and the frequent illness. Most studies in the field did not focus on function, or rehabilitation, instead they focused on surgical techniques [(22)].

Going with this context, the present study was carried out to evaluate the impact of nursing physical training program on the clinical outcomes of patients undergoing cervical spine surgery.

In relation to age group, the present study findings revealed that the majority of studied and control groups were aged from 40 to less than 50 years. This is in agreement with Samartzis et al (2012) [(23)] who confirmed that age was a significant factor associated with the presence of degenerative disc disease in all spine regions. Additionally, Teraguchi et al (2014) [(24)] studied the distribution and prevalence of intervertebral disc degeneration over the whole spine and expressed that the prevalence of DDD in the cervical and thoracic regions and over the whole spine increased with getting older in both men and women. The possible explanation of these findings is that patients in this age group appear to be more vulnerable since the elasticity and water content of the nucleus pulposus decreases with age. The discs become narrower and less flexible. The cervical spine becomes structurally unsteady and unable to afford stress [(25)].

Concerning sex, the current study findings revealed that less than two-thirds of study and control groups were males. The possible explanation of these findings is that male patients were engaged in hard work that requires prolonged awkward positions, as well as extremely repetitive movements of the neck and carrying heavy loads on the head, that will induce early degenerative changes in the cervical spine

This finding was supported by Diener et al. (2007) [(26)] who reported that, 40% of their studied cases were women and 60% were men. While coming into contradiction with Raghavendra and Holtman (2016) [(27)], in their study about gender differences in the prevalence of CDD disease, they reported that most of their sample patients were females.

Regarding the educational level, results of this study revealed that illiteracy was predominant among half of patients in the study subjects. This result could be attributed to the reality that the illiterates are late in looking for medical help than educated persons. A similar finding was reported by Laaksonen et al (2008) [(28)] and Patrick et al (2011) [(29)] who reported that lower levels of education have been associated with many diseases, other health-compromising behaviors, and lower levels of treatment adherence.

In relation to occupation, it can be noticed that the highest percent of study and control group patients were manual workers and housewives. This may be related to the long times of standing and lifting heavy objects, which lead to stress on the cervical spine. Also they are seeking for surgical help to be able to continue their effective role in their families. This result also may be related to the fact that illiteracy was prevailing among half of patients in the study subject and patients had no formal work. This result is supported by Hiratzka et al. (2011) [(30)] and Degefe et al. (2007) [(31)] who reported that manual labour exposes the intervertebral discs to mechanical stress leading to altered biomechanics and therefore a higher risk of undergoing early degenerative changes. Likewise, Jäger et al. (1997) [(32)] presumed that axial strain of carrying load on the head triggers degenerative changes in the cervical spine.

Regarding level of cervical disc affected, the single most common affected intervertebral disc was C5-C6 followed by C6 - C7. This finding corresponds with the study conducted by Murthy et al. (2016) [(33)] who found DDD at C5-C6, C6-C7, C4-C5, and C3-C4 levels is 48.93%,36.17%,17.02% and4.25% respectively.

Also, this outcome is upheld by Kipngetich (2014) [34] in his study about patterns and clinical results of surgically treated cervical spine DDD, who found that the single most basic influenced disc was C5/C6. These results might be ascribed to the generation of the most compressive symptoms in the C5 to C7 region because the spinal canal is narrow at this region, and the spinal cord, which is around 10 mm in its anteroposterior diameter (ranges between 8.5 and 11.5 millimeters), takes up 3/4 of the spinal canal in the typical cervical spine at the C6 level. In contrast, the spinal cord just occupies1/2 of the spinal canal in the upper cervical region [35]. Besides, C5/C6 and C6/C7 sections of the cervical spine control most flexion and extension movements in the neck with most compressive symptoms in the C5 to C7 region, hence its sensibility to trauma as precursor to chronic DDD [36].

Concerning patients' preoperative complains, the present study illustrated that all patients in both groups were complaining of neck stiffness and numbness. More than 2/3 of study group complained from muscle weakness compared to more than four fifths of control group. This finding was upheld by Anneli et al (2014) [22] who stated that patients with CDD (herniation and/or spondylosis changes) regularly display complex symptomatology. The symptoms incorporate disc-specific and non-specific neck pain, distinct, intense arm pain, motor loss, sensory loss, and reflex aberrations. Furthermore, the symptoms are often followed by physical and psychological disability, illness, long periods of sick-leaves, and difficulty returning to work.

In relation to circumstances of conservative management, the findings of the current study revealed that all patients of both groups had received preoperative analgesics and muscle relaxants. Also, a high percentage of patients in study group had received non-steroidal anti-inflammatory drugs compared to more than 50% of the control group. These finding are emphasized by Wolff and Levine (2002) [37] who reported that there are several influential strategies for symptom management, including muscle relaxants to reduce muscle spasm, nonsteroidal anti-inflammatory drugs (NSAIDs) to reduce inflammation of the nerve root, and opioids for short-term acute pain repose; short-term repose from pain symptoms enables patients to take part in an exercise program. This result also is in line with Chou and Huffman (2007) [38] who found that the most commonly prescribed medications for disc prolapse are nonsteroidal anti-inflammatory drugs (NSAIDs), skeletal muscle relaxants, and opioid analgesics. Similar findings were reported by Luo et al (2004) and Bernstein et al (2004) [39, 40].

Concerning medical history, slightly more than one third of the study group had comorbid diseases compared to more than half of the control group. Among those who had comorbid diseases, slightly more than two-fifths and about two-thirds from study and control groups respectively suffered from hypertension. In this regard, Peng et al (2015) [42] reported that stimulation of sympathetic nerve fibers in pathologically degenerated disc could produce sympathetic excitation and initiate a sympathetic reflex to cause cervical dizziness and hypertension. Also, chronic neck pain could contribute to hypertension development by sympathetic arousal and failure of typical homeostatic pain regulatory mechanisms. In addition, more than half of the study group and slightly less than one -fifth of the control group had diabetes mellitus (DM). In this context, Ralph et al (2001) [43] found that DM has no relation to the development of disc herniation, but there were high rates of postoperative infection and prolonged hospitalization.

Regarding pain intensity preoperatively, the majority of study and control group, experienced severe neck pain. This finding was supported by Carette and Fehlings (2005) [43] who stated that most patients with symptomatic cervical disc herniations and radiculopathy report severe arm and neck pain. In addition, Yeung et al. (2012) [44] reported that cervical disc herniation regularly results in arm and neck pain because of direct impingement of nerve roots and associated inflammatory processes.

Regarding pain intensity one month after surgery, there were high statistically significant differences between study and control group, where two-fifths of patients in study group improved compared to none from the control group. Also, the majority of the study group experienced a mild degree of pain compared to only less than one-fifth of the control group. Otherwise, most of patients in control group still suffered from moderate pain. These findings may be attributed to the application of the nursing program, which included regular exercise that altered the level of pain. The body typically releases natural opiates, for example, endorphins and other substances that can somewhat inhibit the discomfort and alter the body's reaction to pain on the long term. These also improve the blood flow to nerve roots and improve metabolic exchange in cervical disc thus aiding disc repair, which increases pain threshold and accordingly, decreases pain [45].

In this respect, Kay et al (2005) [46] reported that there is a moderate evidence that neck strengthening exercises reduce pain, improve function and global perceived effect for chronic neck disorder in the short and long term. Moreover, this result is supported by Bronfort et al (2012) [47] who compared three groups of neck pain patients who were treated with 1) spinal manipulation, 2) an exercise program, or 3) medications, including acetaminophen, NSAIDs, or (in non-reacting patients) narcotic medications and/or muscle relaxants. It was found that the patients who were remedied with either spinal manipulation or the exercise program had more prominent repose of pain in the short and long term (up to one year after treatment ended).

Proper body mechanics comprises the way the skeleton, muscles, and the nervous system coordinate to assure that the proper balance, posture, and body alignment is maintained. Poor and improper body mechanics cause the spine to be subjected to stresses that with time result in its tear and wear which affect patient motor functions and gait [(48)]. Assessment of patients' gait in the present study showed a statistically significant improvement between preoperative, 14 days postoperatively and 30 days postoperatively in the study group. While in the control group, these changes were statistically insignificant. These findings are attributed to adherence of the study group patients to the instructions provided for them by the researcher to perform body mechanics. This result was contradicted with Moorthy et al (2005) [(50)] who performed quantitative gait analysis before and after surgery for 6 patients with Cervical Spondylotic Myelopathy (CSM) who was subjected to anterior corpectomy. It was found that all patients had significant postoperative progress in ambulation parameters such as walking speed, stride length, and percentage of single-limb stance time.

Concerning muscle strength assessment, it was found that among the study group, the mean score of all assessed muscle strength was increased from preoperative day to two weeks postoperatively to one month after surgery and this increase within the study group was statistically significant. This result may be due to the continuous application of exercises by patients of study group as instructed by the researcher and as demonstrated by the colored booklet which was distributed to each patient of the study group. Continuous exercises improve circulation, increase flexibility, prevent joint stiffness, and improve overall physical conditioning.

This result is supported by Carrie and Lori. (2004) [(50)], who reported that isometric exercises are used generally to improve the muscle performance. Isometric exercise is counted as functional since it gives a strength base to dynamic exercise and since numerous postural muscles work basically in an isometric fashion. Isometric exercise is used as an exceptional method in proprioceptive neuromuscular assistance to enhance the perseverance and strengthens the muscles in a weak portion of the range.

Moreover, this finding is in accordance with Ylinen et al. (2006) [(51)] who studied the impacts of neck muscle exercise in women with chronic neck pain and they reported that neck and shoulder muscle exercise is an effective treatment for chronic neck pain, bringing about early progress in both the strength tests and subjective measures. Also, Thomas et al. (2004) [(52)] reported that after 6 weeks, patients with chronic neck pain can profit from the neck practice program with great progress in pain, disability, and isometric neck muscle power in several directions.

In relation to sensory assessment, the present study's findings showed that there was a statistically significant improvement in sensory function in the postoperative period in both study and control group. This result corresponds with Buchowski et al. (2009) [(53)] in their report about improvement of neurologic deficits following anterior cervical spine surgery. The author concluded that in most of patients, sensory and motor improvement occurred during the first 6 weeks following surgery.

Moreover, this finding was in agreement with Cheung et al. (2008) [(54)] who reported that surgical decompression for cervical spondylotic myelopathy generated neurological improvement in 71% of patients. The neurological improvement, in terms of Japanese Orthopedic Association (JOA) score, enhanced after surgical decompression, reached statistical significance at 3 months, and reached a plateau at 6 months. The neurological improvement evidently was best in the upper limb function, followed by lower limb function, and was worst in the sphincter function.

In relation to reflexes, the current study revealed that the mean scores of all deep tendon reflexes, assessed among the study group, increased significantly from the preoperative assessment, to two weeks after surgery and to one month postoperative. Also among the control group, in the majority of tendon reflexes assessed there was a significant increase in the average scores all over the periods of assessment. The differences in assessment score between study and control groups were statistically significant, mainly at one month postoperatively.

These findings are further supported by Löfgren et al. (2003) [(55)], in their study about reduced pain after surgery for cervical disc protrusion/stenosis. The authors stated that long-lasting pain lessening was noted both in the arm and neck for the operated patients, and also enhanced sensory function and decrease of reflex disturbances.

Concerning the degree of neck disability index, the results of the current study revealed that there was high statistically significant difference between study and control groups at two weeks and one month postoperatively. These findings are attributed to adherence of the study group patients to the instructions provided for them by the researcher to perform self-care activities or due to incorporating home exercises regularly into their everyday living. This may improve patient's functional abilities as regular exercises may increase the autonomy for everyday and routine activities, thus averting functional incapacity and dependency conditions.

This result is supported by, Thomas et al. (2004) [(52)], in their study to assess the efficacy of neck exercise program in patients with chronic neck pain. He reported that, following 6 weeks, patients with chronic neck pain can profit by the neck exercise program with expressive improvement in pain, disability, and isometric neck muscle power in several directions. Similarly Ian et al (2009) [56] found that there was significant improvements in pain, function, disability, and symptom distribution from baseline to the 4-week follow-up.

Finally, this study emphasizes the role of integrating education in the management of patients with cervical DDD. Patient education is the single most important action toward independence, confidence and rehabilitation for patient. Rehabilitation of cervical spine included cervical exercises and body mechanics education. Exercise provides a myriad of health benefits for cervical spine disorders. Physically it restores the optimal spinal muscle strength, which protects the intervertabral disc from chronic, repetitive dynamic overload. Exercise is influential in reducing neck pain by lowering tension on the posterior annular fibers, decreasing tension on the nerve root, changing intradiscal pressure, improving blood flow to nerve roots and improving metabolic exchange in cervical disc thus aiding disc repair [57]. The objective of body mechanics is to figure out how to move the body to avert further damage to the spine. Awareness of common mistakes and proper principles can help to achieve this goal and prevent occurrence of any complication like failed neck surgery syndrome [58].

Failed neck surgery is a subcategory of a status recognized as failed back surgery syndrome (FBSS). This term encompasses a broad range of complications, including recurrence of the symptoms that originally led to the decision to undergo surgery. Failed back and neck surgery syndromes may likewise happen if there were issues in the rehabilitation that brought about inappropriate healing. The treatment process plays a very important role in each spinal procedure. If the spine does not heal correctly, it can make existing problems worse or create new structural changes in the spine [59].

So, evaluating the impact of nursing physical training program on the clinical outcomes of patients undergoing cervical spine surgery will enhance the patients' awareness and take proper precautions to prevent the recurrence of disease and to reduce the morbidity and mortality rate .Therefore, from the result of the present study it can be said that implementation of nursing physical training program for cervical degenerative disc patients, proved to be influential in improving patients' clinical outcomes.

VII. Conclusion

From the findings of the present study, it can be concluded that: applying nursing physical training program significantly improved the studied patients’ pain intensity, gait, muscle strength, sensory function, reflexes, and neck disability index postoperatively than their controls.

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Table (1): Distribution of the study and control groups of cervical spine surgery patients according to socio demographic characteristics (N = 40)

Socio-demographics	Study group (n=20)		Control group (n=20)		*Test of significance* (P-value)
• **Age (years)**	**No.**	**%**	**No.**	**%**	**Monte Carlo test**
20-<30	0	0.0	0	0.0	X^2mc= 0.128 P = 1.00
30-<40	1	5.0	1	5.0	
40-<50	13	65.0	14	70.0	
50- 60	6	30.0	5	25.0	
• **Gender**	**No.**	**%**	**No.**	**%**	**Chi Square test**
Male	13	65.0	12	60.0	X^2 = 0.107 P = 0.744
Female	7	35.0	8	40.0	
• **Marital status**	**No.**	**%**	**No.**	**%**	**Monte Carlo test**
Married	16	80.0	17	85.0	X^2mc= 2.230 P = 0.515
Divorced	2	10.0	0	0.0	
Widowed	2	10.0	3	15.0	
Single	0	0.0	0	0.0	
• **Education**	**No.**	**%**	**No.**	**%**	**Monte Carlo test**
Illiterate	10	50.0	10	50.0	X^2mc= 1.667 P = 0.907
Read and write	0	0.0	1	5.0	
Primary education	1	5.0	2	10.0	
Secondary education	7	35.0	5	25.0	
University	2	10.0	2	10.0	
• **Occupation**	**No.**	**%**	**No.**	**%**	**Monte Carlo test**
Clerical	6	30.0	3	15.0	X^2mc= 2.038 P = 0.606
Farmer	4	20.0	3	15.0	
Housewife	6	30.0	7	35.0	
Retirement	0	0.0	0	0.0	
Manual worker	4	20.0	7	35.0	

*Significant at P ≤0.05

Table (2): Distribution of the study and control groups of cervical spine surgery patients' according to clinical data (N = 40)

Clinical data	Study group (n=20)		Control group (n=20)		*Test of significance* (P-value)
• **Diagnosis**	**No.**	**%**	**No.**	**%**	**Monte Carlo test**
Cervical disc prolapse	11	55.0	12	60.0	X^2mc = 0.102 P = 0.749
Cervical stenosis	9	45.0	8	40.0	
Spondylosis	0	0.0	0	0.0	
• **Level of cervical disc affected**	**No.**	**%**	**No.**	**%**	**Monte Carlo test**
C2-C7	2	10.0	1	5.0	X^2mc= 2.711 P = 0.937
C3-C5	1	5.0	0	0.0	
C3-C7	6	30.0	9	45.0	
C4-C7	1	5.0	2	10.0	
C5-C6	5	25.0	4	20.0	
C5-C7	2	10.0	1	5.0	
C6-C7	3	15.0	3	15.0	
• **Chief complaints**	**No.**	**%**	**No.**	**%**	**Fisher's Exact test**
Neck stiffness	20	100.0	20	100.0	-NA-
Muscle weakness	14	70.0	17	85.0	^{FE}P= 0.256
Numbness	20	100.0	20	100.0	-NA-
Inability to walk	4	20.0	3	15.0	^{FE}P= 1.00
Bowel dysfunction	0	0.0	1	5.0	^{FE}P= 1.00
Bladder dysfunction	8	40.0	6	30.0	**Chi Square test** X^2 = 0.440 P = 0.507
• **Operation name**	**No.**	**%**	**No.**	**%**	**Chi Square test**

Laminectomy	10	50.0	9	45.0	X^2 = 0.100 P = 0.752
Discectomy	10	50.0	11	55.0	
Spinal fusion	0	0.0	0	0.0	

*Significant at P ≤0.05
-NA-: Not applicable

Table (3): Distribution of the study and control groups of cervical spine surgery patients according to prescribed medications, medical history and surgical history

Medications, Medical and surgical history	Study group		Control group		*Test of significance* (P-value)
• **Prescribed medications**	**No.**	**%**	**No.**	**%**	**Fisher's Exact test**
Corticosteroids	1	5.0	0	0.0	FEP= 1.00
NSAIDs	14	70.0	11	55.0	**Chi Square test** X^2 = 0.960 P = 0.327
Muscle relaxants	20	100.0	20	100.0	-NA-
Analgesics	20	100.0	20	100.0	-NA-
Neurotone	2	10.0	3	15.0	FEP= 1.00
Narcotics	0	0.0	0	0.0	-NA-
• **Duration of symptoms before medication intake**	**No.**	**%**	**No.**	**%**	**Monte Carlo test**
<6 months	16	80.0	15	75.0	X^2mc= 1.532 P = 0.692
6-<12 months	3	15.0	5	25.0	
≥12 months	1	5.0	0	0.0	
• **Medical history**	**No.**	**%**	**No.**	**%**	**Chi Square test**
Yes	7	35.0	11	55.0	X^2 = 1.616 P = 0.204
No	13	65.0	9	45.0	
• **If yes,**	**No.=7**	**%**	**No.=11**	**%**	**Fisher's Exact test**
Hypertension	3	42.9	8	72.7	FEP = 0.332
Diabetes	4	57.1	2	18.2	FEP = 0.141
Bronchial asthma	0	0.0	1	9.1	FEP = 0.389
• **Previous back surgery (Lumbar laminectomy)**	**No.**	**%**	**No.**	**%**	**Fisher's Exact test**
Yes	2	10.0	2	10.0	FEP = 1.00
No	18	90.0	18	90.0	
• **Previous neck surgery**	**No.**	**%**	**No.**	**%**	
Yes	0	0.0	0	0.0	-NA-
No	20	100.0	20	100.0	

*Significant at P ≤0.05
-NA-: Not applicable

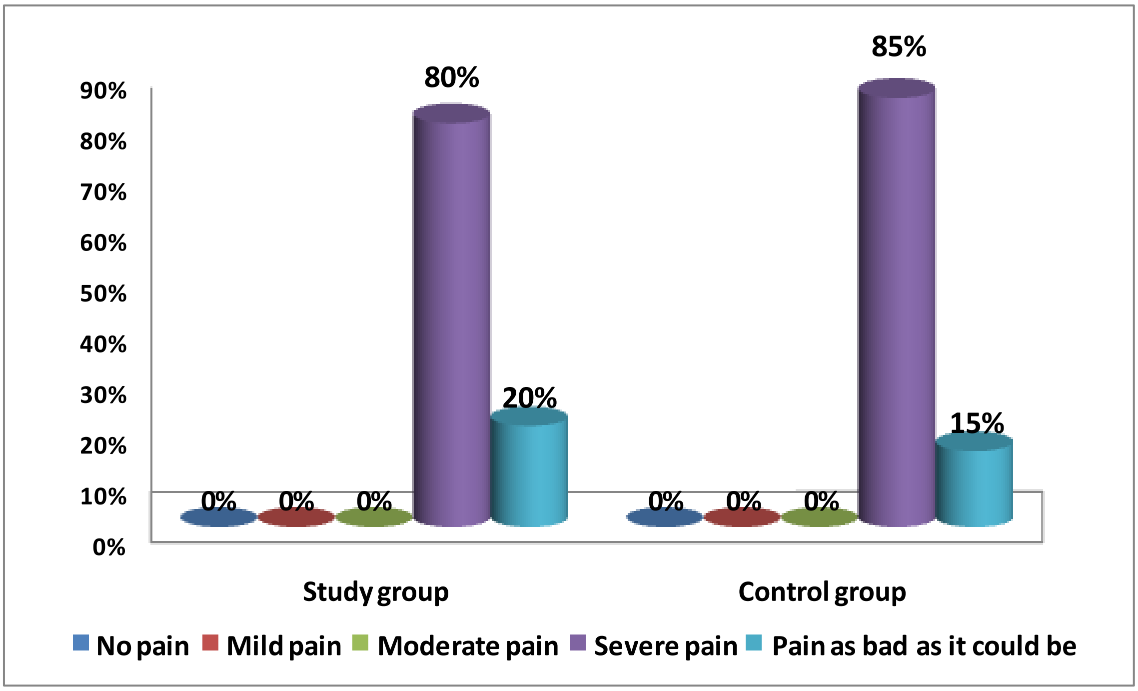


Figure (1): Distribution of the study and control groups of cervical spine surgery patients according to pain intensity preoperatively

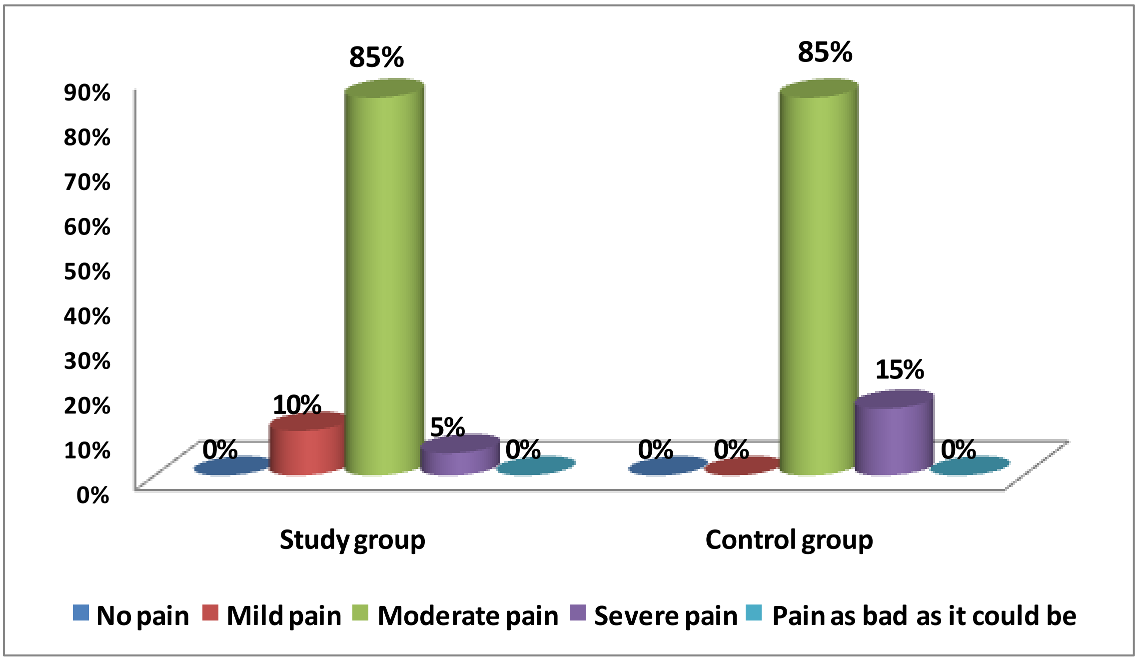


Figure (2): Distribution of the study and control groups of cervical spine surgery patients' according to pain intensity 14 days postoperatively

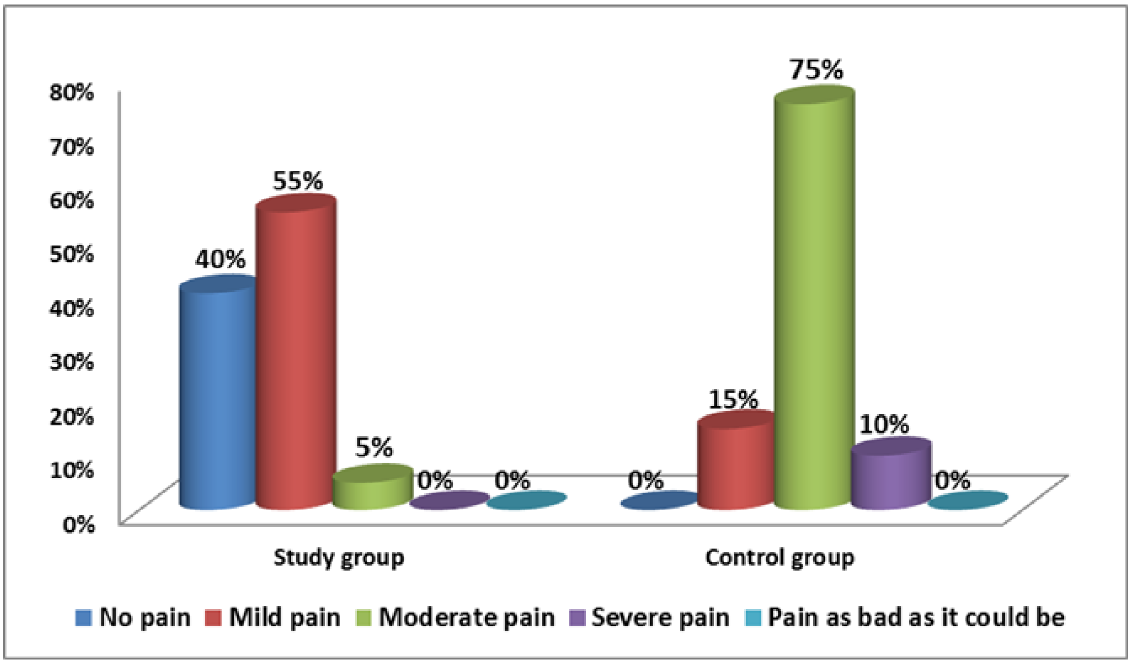


Figure (3): Distribution of the study and control groups of cervical spine surgery patients according to pain intensity 30 days postoperatively

Table (4): Distribution of the study and control groups of cervical spine surgery patients according to their gait

Patients' gait	**Study group (n=20)**		**Control group (n=20)**		***Test of significance* (P-value)**
• **Preoperative**	**No.**	**%**	**No.**	**%**	**Monte Carlo test**
Normal	11	55.0	11	55.0	X^2mc= 1.059 P = 1.00
Unable to walk	8	40.0	9	45.0	
Stiffness	1	5.0	0	0.0	
Loss of balance	0	0.0	0	0.0	
• **14 days postoperatively**	**No.**	**%**	**No.**	**%**	**Monte Carlo test**
Normal	15	75.0	12	60.0	X^2mc= 1.026 P = 0.501
Unable to walk	5	25.0	8	40.0	
Stiffness	0	0.0	0	0.0	
Loss of balance	0	0.0	0	0.0	
• **30days postoperatively**	**No.**	**%**	**No.**	**%**	**Monte Carlo test**
Normal	19	95.0	16	80.0	X^2mc= 2.257 P = 0.334
Unable to walk	1	5.0	3	15.0	
Stiffness	0	0.0	1	5.0	
Loss of balance	0	0.0	0	0.0	
Significance between periods**	$^{KW}X^2$= 12.0, P= 0.002*		$^{KW}X^2$= 4.33, P= 0.115		

*Significant at P ≤0.05
**Kendall's W Test to detect significance between patients' gait preoperative, 14 days postoperatively and 30 days postoperatively.

Table (5): Distribution of the study and control groups of cervical spine surgery patients' according to muscle strength assessment

Muscle group			Study group (n=20)	Control group (n=20)	*p-value*
Elbow flexor right side	**Preoperative**	Mean ±SD	3.9 ± 0.64	3.8± 0.52	0.592
	14 days postoperatively	Mean ±SD	4.1± 0.36	3.9± 0.49	0.034*
	30 days postoperatively	Mean ±SD	4.7± 0.44	4.2± 0.62	0.002*
	Significance between periods		P_1:0.021*, P_2<0.001*, P_3<0.001*	P_1:0.330, P_2:0.005*, P_3:0.002*	
Elbow flexors left side	**Preoperative**	Mean ±SD	3.9± 0.78	4.1± 0.69	0.525
	14 days postoperatively	Mean ±SD	4.2± 0.69	4.1± 0.69	0.497
	30 days postoperatively	Mean ±SD	4.7± 0.49	4.2± 0.62	0.015*
	Significance between periods		P_1:0.01*, P_2:0.001*, P_3:<0.001*	P_1:NA**, P_2:0.083, P_3:0.083	
Wrist extensors right side	**Preoperative**	Mean ±SD	3.2± 0.62	3.3± 0.57	0.597
	14 days postoperatively	Mean ±SD	3.7± 0.57	3.4± 0.51	0.153
	30 days postoperatively	Mean ±SD	4.7± 0.59	3.9± 0.37	<0.001*
	Significance between periods		p_1<0.001*,p_2:<0.001*,p_3:< 0.001*	p_1:0.083,p_2:0.002*,p_3:<0.001*	
Wrist extensors left side	**Preoperative**	Mean ±SD	3.5± 0.60	3.4± 0.68	0.050*
	14 days postoperatively	Mean ±SD	3.7± 0.47	3.5± 0.60	0.387
	30 days postoperatively	Mean ±SD	4.7± 0.49	3.9± 0.44	<0.001*
	Significance between periods		P_1=0.021*, P_2<0.001*, P_3<0.001*	P_1=0.083, P_2:0.005*, P_3:0.002*	
Elbow extensors right side	**Preoperative**	Mean ±SD	3.8± 0.44	3.8± 0.44	1.000
	14 days postoperatively	Mean ±SD	4.0± 0.56	3.8± 0.41	0.206
	30 days postoperatively	Mean ±SD	4.6± 0.50	3.9± 0.39	<0.001*
	Significance between periods		P_1=0.021*, P_2<0.001*, P_3<0.001*	P_1=0.330, P_2=0.083, P_3=0.042*	
Elbow extensors left side	**Preoperative**	Mean ±SD	3.9± 0.37	3.8± 0.52	0.728
	14 days postoperatively	Mean ±SD	4.1± 0.45	3.9± 0.49	0.1000
	30 days postoperatively	Mean ±SD	4.5± 0.51	4.1± 0.64	0.036*
	Significance between periods		P_1:0.021*, P_2:0.002*, P_3:<0.001*	P_1:0.330, P_2:0.021*, P_3:0.010*	
Finger flexors right side	**Preoperative**	Mean ±SD	3.9± 0.72	3.9± 0.69	0.823
	14 days postoperatively	Mean ±SD	4.2± 0.59	4.1± 0.60	0.599
	30 days postoperatively	Mean ±SD	4.8± 0.41	4.3± 0.65	0.006*
	Significance between periods		P_1:0.021*, P_2<0.001*, P_3<0.001*	P_1:0.163, P_2:0.021*, P_3:0.005*	
Finger flexors left side	**Preoperative**	Mean ±SD	3.9± 0.72	3.9± 0.76	0.832
	14 days postoperatively	Mean ±SD	4.1± 0.55	4.0± 0.73	0.627
	30 days postoperatively	Mean ±SD	4.7± 0.44	4.3± 0.66	0.015*
	Significance between periods		P_1:0.042*, P_2:<0.001*,P_3:<0.001*	P_1:0.330, P_2:0.010*, P_3:0.005*	
Finger abductors right side	**Preoperative**	Mean ±SD	4.3± 0.72	4.3± 0.73	0.828
	14 days postoperatively	Mean ±SD	4.6± 0.68	4.3± 0.67	0.249
	30 days postoperatively	Mean ±SD	4.8± 0.41	4.5± 0.69	0.050*
	Significance between periods		P_1:0.005*, P_2:0.042*, P_3:<0.001*	P_1:0.330, P_2:0.083, P_3:0.069	
Finger abductors left side	**Preoperative**	Mean ±SD	4.3± 0.72	4.4± 0.75	0.668
	14 days postoperatively	Mean ±SD	4.6± 0.68	4.4± 0.75	0.275
	30 days postoperatively	Mean ±SD	4.8± 0.51	4.5± 0.69	0.050*
	Significance between periods		P_1:0.005*, P_2:0.042*, P_3:<0.001*	P_1:NA**, P_2:0.163, P_3:0.163	

*Significant at P ≤0.05
** NA: not applicable because the values of preoperative and 14 day postoperative are exactly the same
p1: p value for Paired t test for comparing between preoperative and 14 days postoperatively
p2: p value for Paired t test for comparing between 14 days postoperatively and 30 days postoperatively
p3: p value for Paired t test for comparing between preoperative and 30 days postoperatively

Table (6): Distribution of the study and control groups of cervical spine surgery patients according to deep tendon reflexes assessment

Deep tendon reflex			Study group (n=20)	Control group (n=20)	*t-test*
Biceps Right side	**Preoperative**	Mean± SD	1.3± 0.47	1.3± 0.44	t= 0.346 P=0.731
	14 days postoperatively	Mean± SD	1.7± 0.47	1.5± 0.51	t= 1.611 P= 0.115
	30 days postoperatively	Mean± SD	2.0± 0.00	1.8± 0.41	t=2.179 P=0.036*
	One way repeated measures ANOVA	**F, p value**	21.30, <0.001*	13.913, <0.001*	
	Significance between periods		P_1:0.021*, P_2:0.010*, P_3:<0.001*	P_1:0.042*, P_2:0.005*, P_3:<0.001*	
Biceps Left side	**Preoperative**	Mean± SD	1.4± 0.50	1.4± 0.50	t= <0.001 P=1.00
	14 days postoperatively	Mean± SD	1.7± 0.47	1.5± 0.51	t= 0.967 P= 0.340
	30 days postoperatively	Mean± SD	2.0± 0.00	1.8± 0.41	t=2.179 P=0.036*
	One way repeated measures ANOVA	**F, p value**	15.55, <0.001*	8.39, 0.002*	
	Significance between periods		P_1:0.010*, P_2:0.010*, P_3:<0.001*	P_1:0.083, P_2:0.021*, P_3:0.002*	
Triceps Right side	**Preoperative**	Mean± SD	1.4± 0.50	1.3± 0.44	t= 1.00 P= 0.324
	14 days postoperatively	Mean± SD	1.9± 0.37	1.5± 0.51	t= 2.135 P= 0.039*
	30 days postoperatively	Mean± SD	2.0± 0.00	1.8± 0.41	t=2.179 P=0.036*
	One way repeated measures ANOVA	**F, p value**	18.07, <0.001*	13.40, <0.001*	
	Significance between periods		P_1:0.001*, P_2:0.083, P_3:<0.001*	P_1:0.010*, P_2:0.021*, P_3:<0.001*	
Triceps Left side	**Preoperative**	Mean± SD	1.5± 0.51	1.3± 0.47	t= 0.967 P= 0.340
	14 days postoperatively	Mean± SD	1.9± 0.37	1.6± 0.50	t= 1.798 P= 0.080
	30 days postoperatively	Mean± SD	2.0± 0.00	1.8± 0.41	t=2.179 P=0.036*
	One way repeated measures ANOVA	**F, p value**	14.98, <0.001*	11.65, <0.001*	
	Significance between periods		P_1:0.002*, P_2:0.083, P_3:<0.001*	P_1:0.010*, P_2:0.042*, P_3:<0.001*	
Brachioradialis Right side	**Preoperative**	Mean± SD	1.7± 0.47	1.5± 0.51	t= 1.285 P= 0.206
	14 days postoperatively	Mean± SD	1.8 ± 0.41	1.7± 0.49	t= 1.050 P= 0.300
	30 days postoperatively	Mean± SD	2.0± 0.00	1.8± 0.37	t= 1.831 P= 0.075
	One way repeated measures ANOVA	**F, p value**	5.78, 0.010*	6.83, 0.004*	
	Significance between periods		P_1:0.163, P_2:0.042*, P_3:0.010*	P_1:0.083, P_2:0.042*, P_3:0.005*	
	Preoperative	Mean± SD	1.7± 0.47	1.5± 0.51	t= 1.611 P= 0.115
Brachioradialis Left side	**14 days postoperatively**	Mean± SD	1.8 ± 0.41	1.7± 0.49	t= 1.050 P= 0.300
	30 days postoperatively	Mean± SD	2.0± 0.00	1.9± 0.37	t= 1.831 P= 0.075
	One way repeated measures ANOVA	**F, p value**	5.78, 0.010*	6.83, 0.004*	
	Significance between periods		P_1:0.163, P_2:0.042*, P_3:0.010*	P_1:0.042*, P_2:0.042*, P_3:0.002*	

*Significant at $P \le 0.05$

p1: p value for Paired t test for comparing between preoperative and 14 days postoperatively

p2: p value for Paired t test for comparing between 14 days postoperatively and 30 days postoperatively

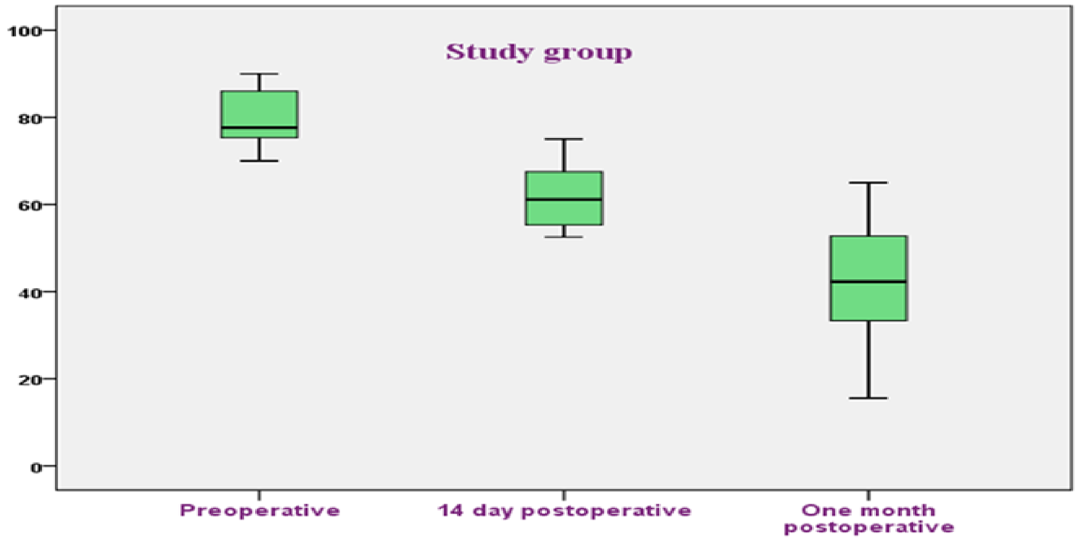
p3: p value for Paired t test for comparing between preoperative and 30 days postoperatively.

Table (7): Distribution of the study and control groups of cervical spine surgery patients according to neck disability index

Neck disability index score**	Study group (n=20)		Control group (n=20)		*Test of significance* (P-value)
• **Preoperative**	**No.**	**%**	**No.**	**%**	
No disability	0	0.0	0	0.0	-NA-
Mild disability	0	0.0	0	0.0	
Moderate disability	0	0.0	0	0.0	
Severe disability	0	0.0	0	0.0	
Complete disability	20	100.0	20	100.0	
Minimum-Maximum	70.0%- 90.0%		71.1%- 92.5%		Z= 1.18 P = 0.242
Median % score	77.6%		82.5%		
Interquartile range (IQR)***	11.6		12.9		
• **14 days postoperatively**	**No.**	**%**	**No.**	**%**	**Chi Square test**
No disability	0	0.0	0	0.0	X^2= 10.10 P = 0.004*
Mild disability	0	0.0	0	0.0	
Moderate disability	0	0.0	0	0.0	
Severe disability	16	80.0	6	30.0	
Complete disability	4	20.0	14	70.0	
Minimum-Maximum	52.5%- 75.0%		57.8%- 85.0%		Z= 3.670 P = <0.001*
Median % score	61.1%		72.9%		
Interquartile range (IQR)***	12.36		16.1		
• **30 days postoperatively**	**No.**	**%**	**No.**	**%**	**Chi Square test**
No disability	0	0.0	0	0.0	X^2= 19.43 P = <0.001*
Mild disability	2	10.0	0	0.0	
Moderate disability	12	60.0	2	10.0	
Severe disability	6	30.0	8	40.0	
Complete disability	0	0.0	10	50.0	
Minimum-Maximum	15.6%- 65.0%		31.1%- 82.5%		Z= 4.087 P = <0.001*
Median % score	42.3%		68.8%		
Interquartile range (IQR)***	20.83		19.6		
Friedman test	$^{Fr}X^2$= 40.0, P= <0.001*		$^{Fr}X^2$= 36.7, P= <0.001*		
Significance between periods	P_1:<0.001*, P_2:<0.001*, P_3:<0.001*		P_1:<0.001*, P_2:0.001*, P_3:<0.001*		

*Significant at P ≤0.05 -NA-: Not applicable Z: value of Mann Whitney test
** No disability: 0-8%, Mild: 10-28%, Moderate: 30-48%, Severe: 50-68%, Complete: 70-100%
*** (IQR): Range between 25th percentile and 75thpercentile.
p1: p value for Wilcoxon signed ranks test for comparing between preoperative and 14 days postoperatively
p2: p value for Wilcoxon signed ranks test for comparing between 14 days and 30 days postoperatively
p3: p value for Wilcoxon signed ranks test for comparing between preoperative and 30 days postoperatively

Figure (4): Distribution of the study group of cervical spine surgery patients according to neck disability index percent score



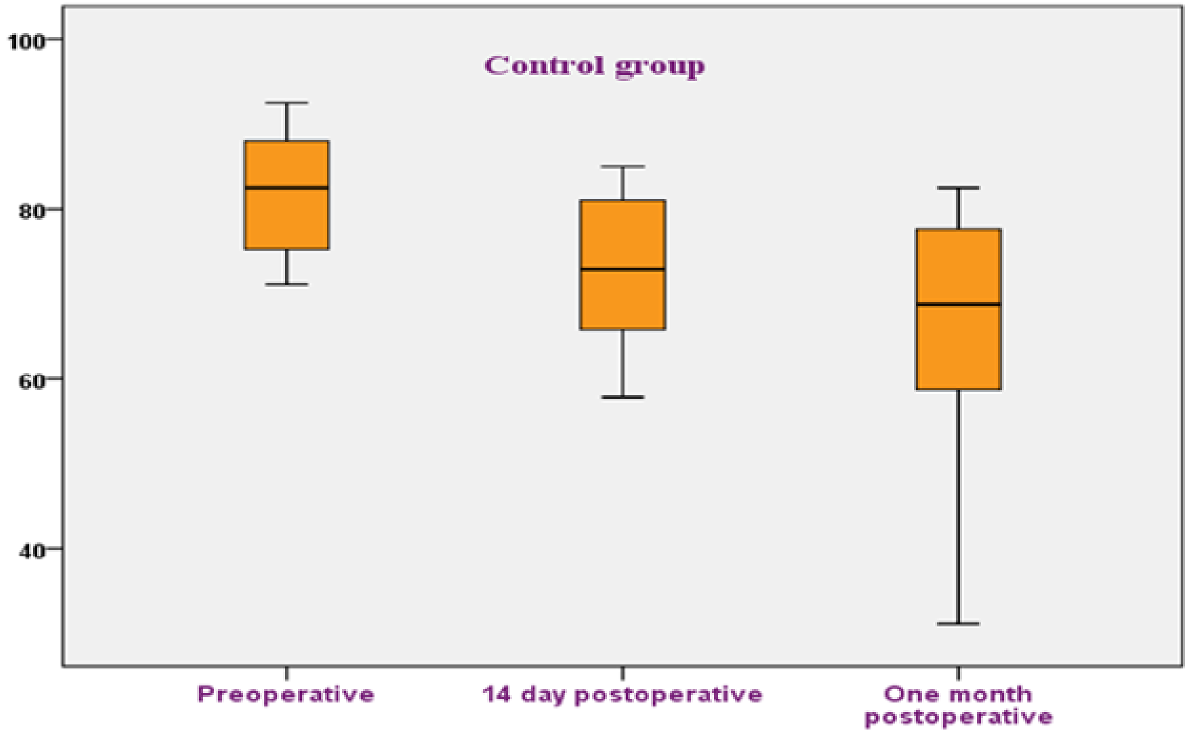


Figure (5): Distribution of control group of cervical spine surgery patients according to composite neck disability index percent score

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