EFFECT OF ENDURANCE TRAINING IN CERVICAL SPONDYLOSIS

A Dissertation

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In Partial Fulfillment of the Requirements

for the Degree of

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In

Neurology

Submitted by

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Under the Supervision of

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May 2022

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I certainly owe my gratitude to my PARENTS, sister's & my Husband, for their never-ending love and support and being there as a strong and unshakable force now and forever this work is dedicated to them.

EKTA SINGH

DEDICATION

This is dedicated to my parents; who encouraged me with education and armed my entire family, with the values necessary to succeed in life. Also, my husband, who supported me in every obstacle.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

INTRODUCTION

Neck Pain was considered to be the second-largest cause of time off from work, after Low Back Pain (LBP).[1,2] However, in recent years, neck pain prevalence has surpassed that of LBP. Some prognostic studies have suggested that chronic neck pain is related to repetitive working conditions.[3]

Interpretation of neck pain applies to the axiom, “if characteristic pain can be reproduced by a position or a movement and the exact nature of that position or movement is understood, the mechanism of pain production is also understood”[4] When observed in the clinical setting, patients with neck pain often assume a forward head posture. These position places increased stress on the soft tissues and joints of the cervical spine.[5]

The pain in and from the neck results from the mechanical factor of ‘encroachment of space’ and ‘impairment of movement’. Encroachment of space resulting in pressure upon these tissues may result in pain or loss of function. Impairment of movement of any part of the cervical spine can be responsible for pain, discomfort and disability.[4]

Steindler states that the two most frequent causes of cervical pain are ‘arthritis’ and ‘trauma’. In the neck, ‘arthritis’ is more often a condition of repair against stress and injury than a condition caused by infection. Spondylosis is most often used to describe degenerative changes of vertebral joints related to and resulting from diskogenic disease.[6]

Cervical spondylosis is the most common condition affecting the neck. Degenerative changes appear early in the life in cervical spine, often during the 3rd decade. The disc space between the 5th and 6th cervical vertebrae is most frequently involved. There is inevitable restriction of movements at the affected level, but this is often impossible to detect clinically as it is marked by persisting mobility in the joint above and below.[7]

Matsumoto in his study of 497 asymptomatic subjects found that disk degeneration was a common observation, present in 17% of men & 12% of women in their 20s. Degenerative disc changes are found in 86% of men & 89% of women over 60yrs of age.[8]

Causes of Cervical Spondylosis.[9]

- Age related degeneration
- Injury
- Bad posture
- Occupational strain
- Body type
- Life style

Phases of Cervical Spondylosis

Cervical Spondylosis was classified into the following stages.[10]

State I	Discogenic phase
State II	Spondylosis
Stage III	Stabilization phase

Investigations for Cervical Spondylosis

Roentgenogram (anterior, posterior, lateral, oblique), Computed tomography, Magnetic resonance imaging, Myelogram, Electromyography.

Management of Cervical Spondylosis[11]

Controlled physical activity, traction, physical modalities (ice massage, hot packs, whirlpool, diathermy, ultrasound, TENS, cervical orthosis, therapeutic exercises (to increase muscular strength, endurance, elasticity, range of motion), ergonomics, NSAIDS, analgesics, injection therapy, patient education, cognitive behavior therapy, alternative therapies (chiropractic manipulation), acupuncture.

Operational Definitions

Neck pain

Pain perceived as arising in a region bounded superiorly by the superior nuchal line, laterally by the lateral margins of the neck and inferiorly by an imaginary transverse line through the T_1 spinous process.[12]

Cervical spondylosis

It is a degenerative disorder that may cause loss of normal spinal structure and function. Although aging is the primary cause, the location and rate of degeneration is individual.

Endurance Exercise

It is the ability to work for prolonged periods of time and ability to resist fatigue.[13]

Muscular Endurance

It refers to the ability of an isolated muscle group to perform repeated contractions over a period of time.[13]

Isometric Exercise

A form of exercise in which tension is developed in the muscle but no mechanical work is performed, no appreciable joint movement occurs and the overall length of the muscle remains the same.[13]

CHAPTER 2

REVIEW OF LITERATURE

Neck Pain

Neck pain is extremely common in the general population. It is costly in terms of treatment, individual suffering and time lost from work. Standard clinical examination procedures cannot for the most part establish a pathoanatomic relationship to the presenting symptoms of most patients experiencing non-specific spinal pain.[14]

Epidemiology

Chronic neck syndrome was identified in 9.5% of the males and 13.5% of the females in Finland. Lifetime prevalence was estimated in only two population studies. Study from Canada estimated lifetime prevalence of 67%, a finding similar to the 71% found in a study from Finland.[15]

Even if well-documented population studies give the adequate estimates of neck pain, studies of specific group of employees are also important because these studies can point out health problems to different professions. In some of the studies of specific group of employees, physical workload is not correlated to the presence of neck pain, however neck pain can be significantly related to poorly experienced psychological work environment.[16,17] A previous period of neck pain also increases the prevalence rate that is there are often recurrent symptoms.[18]

From a large survey in France of 4.4 million employees, Weil et al reported a period prevalence of neck pain 20.6% for all male employees and 36.6% for all female employees.[19] In a Swedish study Kammendo et al estimated the point prevalence of neck pain for medical secretaries 28 to be 33% similar to the 34% for hospital employees reported by Marshall et al from Great Britain. Gam et al found that those who worked in the sitting position for greater than 1% of the working time were at higher risk of developing neck pain than those who seldom work in sitting position.[20] They also found a trend for a positive relation between neck flexion and neck pain suggesting an increased risk of neck pain for those who spent a high percentage of time (>70%) with neck at minimum of 20^0 of flexion.

Etiology

1) Repetitive work: These factors are not easily measured and assessed and are seldom distinguished from other potentially harmful exposures such as static load or monotony, which also implies poor psychosocial conditions. Pain can refer to neck movement themselves or to repeated arm and shoulder motions that generate loads to the neck.[21]

2) Static load in the neck region: Static load in the neck region is common in many work tasks, especially in the assembly line industry. Most of the studies show increased risks and improvement in working conditions lowered the risk estimates.[22]

Visual display unit work is characterized by working in a static position with hands fixed, often in a stressful environment. Studies of visual display unit operators are numerous. A review of musculoskeletal health effects of this type of work found an increased risk for persons heavily exposed to the work tasks.[23]

Skove et al found that odd ratios for neck pain increased with time spent working in a sitting position[24] (an odd ratio of 0.68 for a quarter of the working time in a sitting position, an odd ratio of 1.92 for half of the working time in a sitting position, an odd ratio of 2.18 for three quarters of the working time in a sitting position, and an odd ratio of 2.80 for all the working time in a sitting position), suggesting a clear relationship between sitting posture and neck pain.

3) Force or dynamic load: Forceful movements have been discussed as a risk factor, for many neck and shoulder disorders. The force usually results from work tasks requiring forceful movements of the arm not of the neck. Some studies show a positive association with reports of neck and shoulder pain.[22,25]

4) Psychological factors: - They play a significant role not only in chronic pain, but also in etiology of acute pain, particularly in the transition to chronic problems. Stress, distress, or anxiety as well as mood and emotions, cognitive functioning and pain behavior all were found to be significant factor. Personality factors produced mixed results.[26,27]

5) Psychosocial exposures: - The most common exposures with an association of reports of neck pain is high demand. The increased risks are moderate. Other exposures investigated have included job satisfaction, perceived stress, poor

relations with colleagues and superiors, monotony, poor work content, low control,

Table 2.1 Occupational Risk/Prognostic Factors for Neck/Shoulder Pain, by Type of Factor.

Type of factor	Factor	Reference
Physical	Arm raised above shoulder level	28
	Work with neck in bent position	28
	Work with twisted or bent posture	19
	Work in static posture	24
	Work in seated position	29
	Monotonous work	19
	Work involving repetitive motion	24,29
	Work with strenuous movements	19
	Work involving fast pace	28
	Physical stress	15
	Heavy physical loads	30
	Driving	31
	Ergonomic factors	31
Psychological	Mentally stressful work	15
	Low job satisfaction	32
	Poor Psychological environment	24
	Psychologically demanding work	28
	Lack of social support	33
	Competition	33
	Low control over time	33
	Heavy work load	34
	Medical Secretary	24
	Forestry worker	35
	Construction worker	36
	Driver	31
	Video display terminal Operator	33
	Lamp assembler	37
	Data entry operator	37
	Typist	37
	Scissors maker	37

negative outcome from the neck region, with increased pain and sometimes muscle tension. Work tasks involving these factors often also are associated with a poor physical environment, with repetitive work and static postures.[26]

Neck pain and muscle imbalance

Muscle imbalance describes the situation where some muscles become inhibited and weak while others become tight. Janda[38] noted particular patterns that develop largely due to postural positioning in sedentary environments and repetitive work tasks. He named "proximal/upper crossed syndrome" involving the neck, upper thoracic and shoulder girdle region. In the upper crossed syndrome as described, imbalances between muscles that are overactive and underactive can occur in an agonist-antagonist relationship and between synergistic muscles. Length associated changes may accompany these imbalances with overactive muscles having a tendency to tighten and inhibited muscles having a tendency to lengthen. The muscle imbalance does not remain limited to a certain part of body but gradually involves the entire muscular system.

In the proximal part of the body of following muscles tend to develop tightness. Pectoralis major and minor, upper trapezius, levator scapulae, and sternocleidomastoid. While detailed analysis of the following muscles still remains to be undertaken, it is considered that the masseter, temporalis, digastric, and the small muscles connecting the occiput and cervical spine (the recti and obliques) also tend to become tight. The muscles, which become weak, are the lower stabilizers of the scapula and the deep neck flexors. Topographically, when the weakened and shortened muscles are connected, they form a cross.[38]

This results a typical change in posture and motion due to the muscle imbalance. In standing elevation and protraction of the shoulders are evident as well as rotation and abduction of the scapulae, a variable degree of winging of scapulae and forward head posture.

Consequences of muscles imbalance

Influence on neck pain

Harms Ring dahl et al (1988) observed that patients with neck pain often assume a forward head posture. This position places increased stress on the soft tissues and joints of cervical spine.[39]

Muscle imbalance lead to neck pain by a number of possible mechanisms: -[13]

(1) Stress to the anterior longitudinal ligament in the upper cervical spine and posterior longitudinal ligament in the lower cervical and upper thoracic spine.

(2) Muscle tension or fatigue.

(3) Irritation of facet joints in the upper cervical spine.

(4) Narrowing of the intervertebral foramina in the upper cervical region, which may impinge on the blood vessels and nerve roots, especially if there are degenerative changes.

(5) Impingement on the neurovascular bundle from anterior scalene muscle tightness.

(6) Impingement on the cervical plexus from levator scapulae muscle tightness.

(7) Lower cervical disk lesions from the faulty flexed posture

Influence on headache

Muscle imbalance and weaknesses of upper cervical flexor musculature are associated with and coexist in cervical headache patient.[39]

Implications

Watson and Trott (1991) Study show the direct relationship of endurance and forward head posture also confirm the need for specificity in terms of rehabilitation exercise. These should be endurance based because endurance training improves the efficiency of type I fibers and converts type IIb fibers into IIa fibers, the later being more resistant to fatigue.

Patho – Physiology[4]

Neck and head pain can originate in the muscles of neck so called cervical tension state and tension headache occurs in the neck and head as a direct result of sustained muscular contraction.

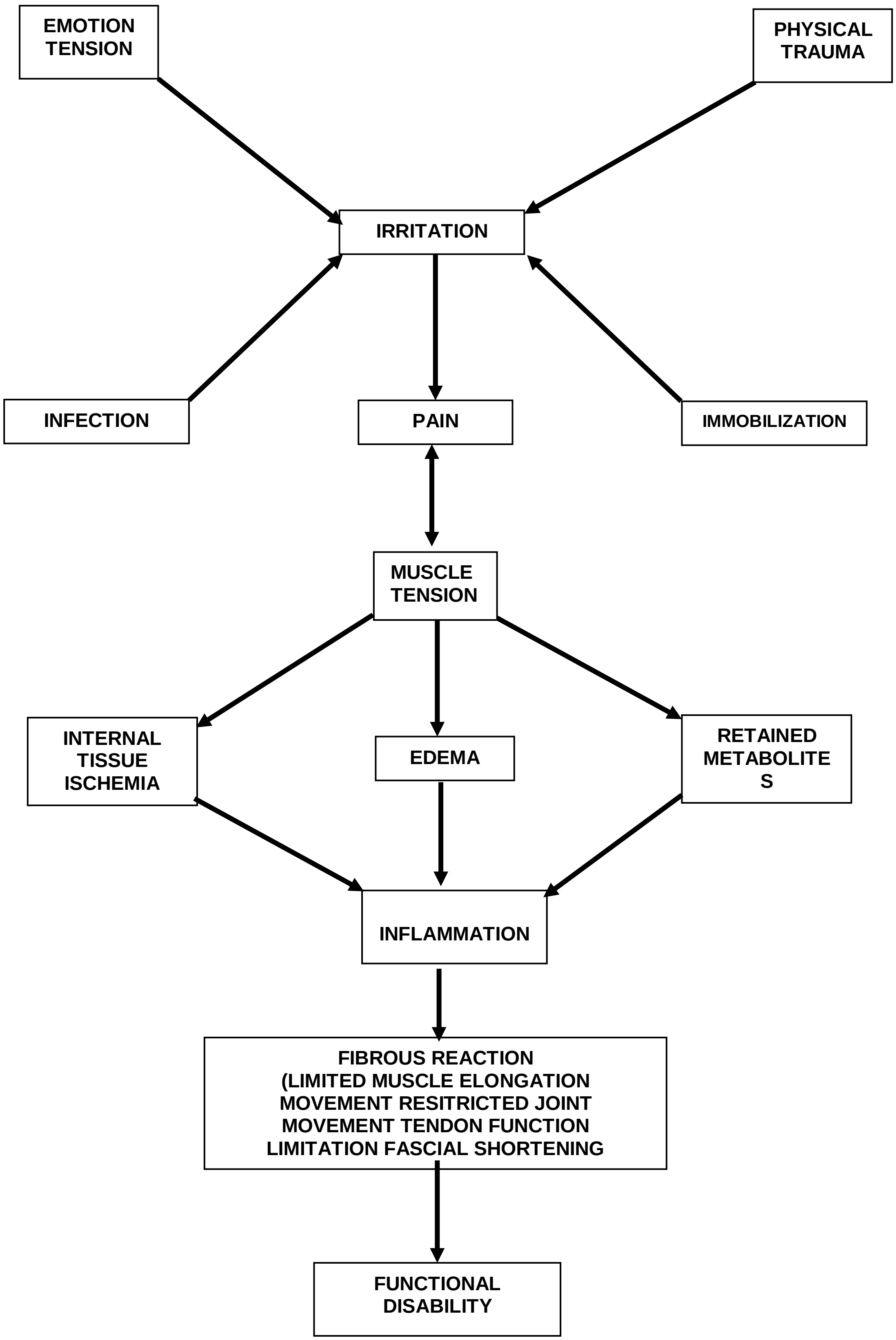
Sustained muscle contraction such as occurs in emotional tension or in maintaining an awkward position for prolonged periods will produce sustained traction at the site of insertion.

Either acute or sustained traction upon these pain sensitive tissues can cause local pain or tenderness. A common site of this local tenderness is at the base of the skull, in the occiput, where the neck extensors attach and cause the common "tension headache at the base of the skull. The muscles attached to the occiput at the site of emergence and passage of the superior occipital nerve, which when irritated will transmit and refer pain across the top and side of the scalp to the frontal area.

Muscular contraction creates intra-muscular pressure. Intra-muscular pressure is significantly greater in isometric contraction than in isotonic contraction. Collapse of small blood vessels and tears of muscle fiber have been demonstrated to result from strong isometric contraction. During contraction the internal pressure of the muscle belly increases, constricting the blood vessels and stopping internal circulation, the contracting muscle is performing work, thus creating metabolites which requires oxygen. It is paradoxical that muscle shuts off its own blood supply when it needs oxygen and blood flow to wash out the metabolites it creates.

Alternating contraction and relaxation permit painless, non-fatiguing muscular activity, muscular activity. The combination of tissue ischaemia and retained metabolites initiates inflammation that leads to ultimately a fibrous reaction within the muscle and their contiguous tissues. Thus, a cycle towards pain and disability results.

Fig. 2.1 **Pathophysiology**



Degenerative Process[4]

The process of normal aging in the cervical spine contributes to and is difficult to differentiate from patho-physiologic changes. From the fourth through the fifth decade, it is clear that the water content of the intervertebral disc, particularly the nucleus pulpous, undergoes progressive desiccation. In patients younger than thirty years, the disc approaches 90% water weight. By the eight decades, this percentage decreases to less than 70% with aging, the large, sterically active GAG proteins diminish in size and number. As this occurs, this imbibing capacity (the ability to retain water) also diminishes. Degenerated disc, with fewer GAG proteins and less water retaining capacity, becomes more compressible and less elastic.

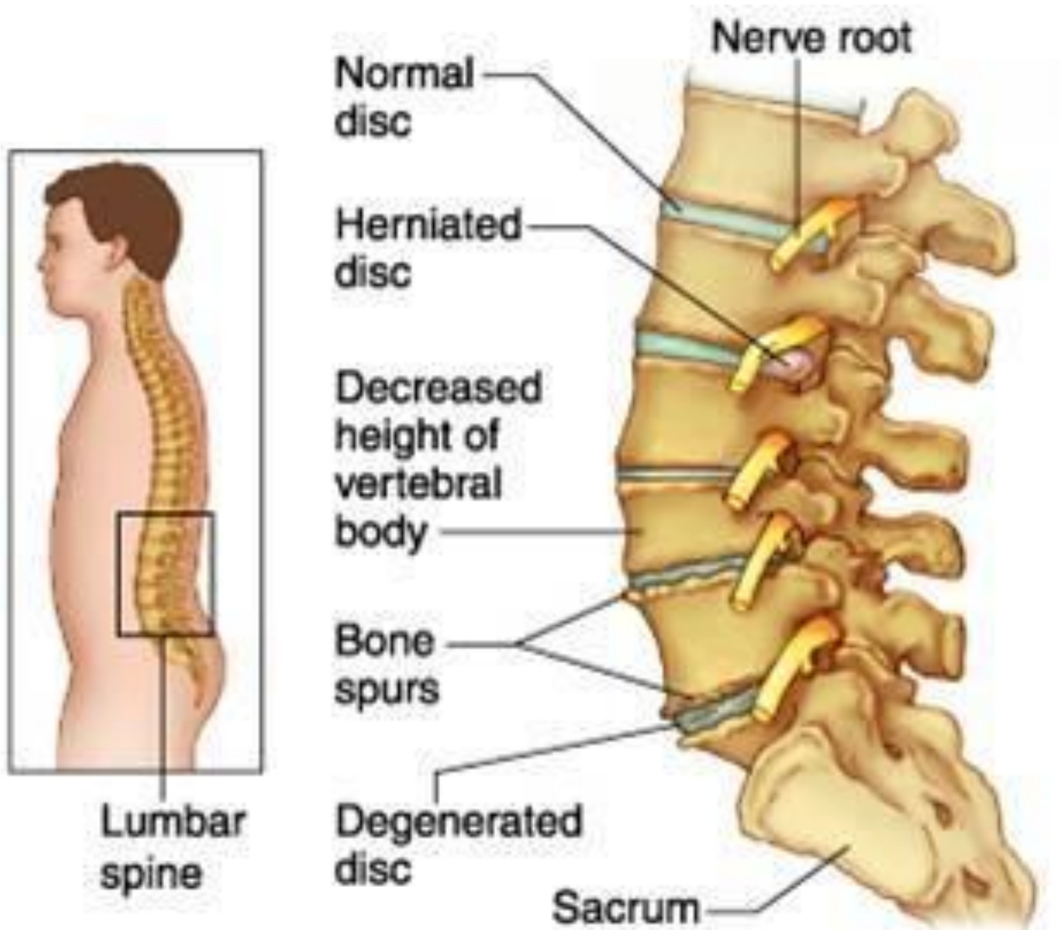
The progression of degenerative change finds increasing nuclear fragmentation with invasion outward through the rents in annulus. This sequence proceeds until the nuclear material is against and held by the longitudinal ligament fig.No. 2.2

As the disc degenerates, the intradiscal pressure decreases, the annulus bulges and the vertebral end plates approximate. This approximation is enhanced by muscle tone and muscle action as well as by gravity so that opposing intradiscal pressure is diminished.

This extruded material may be ‘soft’ disc if accompanied by annulus tissue, it may be ‘hard ‘disc or there may be osteophytic formation of raw periosteal site of ligamentous attachment plus calcification of extruded disc material that forms an osteophyte.

Fig. No. 2.2

Mechanism of Spondylosis



The predominant sites of osteophytes formation in the entire spine are the summits of concavity at the points farthest from the center of gravity. These sites are C_{4}-$_{5}$ and C_{5}-$_{6}$ in cervical spine.

These findings lead to the concept that osteophytes develop as a defense mechanism and thus are a repair process rather than disease state. The osteophytes ultimately are composed of more compact strong bone than as the rest of the vertebral body.

Role of Cervical Muscles-Movements and Stability

The cervical spine is generally separated into 2 distinct functional parts: the upper cervical spine (C0-C2) and the lower cervical spine (C3-C7) The directions are expressed as flexion, extension, lateral flexion and rotation, Translations are referred to as anterior, posterior and left and right translations.

Movements

The primary action of the muscles of the cervical spine is the maintenance of the upright posture. They do this with a series of co-contractions that occur continuously as we move about in the upright position.

Flexion

Flexion of the cervical spine can be carried out in two ways - with the upper cervical spine in flexion and with the upper cervical spine in extension. Flexion of

Table No. 2.2 Origin and Insertion of cervical muscles[40]

Muscles	Origin	Insertion
Longus coli	Superior oblique portion: Anterior tubercles of transverse processes of third, fourth, and fifth cervical vertebrae. Interior oblique portion: Anterior surface of bodies of first two or three thoracic vertebrae. Vertical portion: Anterior surface of bodies of first three thoracic and last three cervical vertebrae.	Tubercle on anterior arch of atlas. Anterior tubercles of transverse processes of fifth and sixth cervical vertebrae. Anterior surface of bodies of second, third, and fourth cervical vertebrae.
Longus capitis	Anterior tubercles of transverse processes of third through sixth cervical vertebrae.	Inferior surface of basilar part of occipital bone.
Rectus capitis anterior	Root of transverse process, and anterior surface of atlas.	Inferior surface of basilar part of occipital bone.
Rectus capitis lateralis	Superior surface of transverse process of atlas.	Inferior surface of jugular process of occipital bone.
Scalenus anterior	Anterior tubercles of transverse processes third through sixth cervical vertebrae.	Scalene tubercle and cranial crest of first rib.
Scalenus Medius	Posterior tubercles of transverse processes of second through seventh cervical vertebrae.	Cranial surface of first rib between tubercle and sub clavian groove.
Scalenus posterior	By two or three tendons from posterior tubercles of transverse processes of last two or three cervical vertebrae.	Outer surface of second rib.
Platysma	Fascia covering superior parts of Pectoralis major and Deltoid.	Inferior margin of mandible, and skin of lower part of face and corner of mouth.

Sternocleidomastoid	Medial or sternal head: Cranial part of manubrium sterni. Lateral or clavicular head: Medial one third of clavicle.	Lateral surface of mastoid process, lateral one half of superior nuchal line of occipital bone.
Rectus capitis posterior major	Spinous process of axis.	Lateral part of inferior nuchal line of occipital bone.
Rectus capitis posterior minor	Tubercle on posterior arch of atlas.	Medial part of inferior nuchal line of occipital bone.
Obliquus capitis inferior	Apex of spinous process of axis.	Inferior and posterior part of transverse process of atlas.
Obliquus capitis superior	Superior surface of transverse process of atlas.	Between superior and inferior nuchal lines of occipital bone.
Trapezius	Origin of Upper Fibers: External occipital protuberance, medial one third of superior nuchal line, ligamentum nuchae, and spinous process of seventh cervical vertebra.	Insertion of Upper Fibers: Lateral one third of clavicle and acromion process of scapula.
Iliocostalis cervicis	Angles of third, fourth, fifth and sixth ribs.	Posterior tubercles of transverse process of fourth, fifth and sixth cervical vertebrae.
Longissimus Cervicis	By tendons from transverse processes of upper four or five thoracic vertebrae.	By tendons into posterior tubercles of transverse processes of second through sixth cervical vertebrae.
Longissimus capitis	By tendons from transverse processes of upper four to five thoracic vertebrae and articular processes of lower three or four cervical vertebrae.	Posterior margin of mastoid process.
Spinalis cervicis	Ligamentum nuchae, lower part; spinous process of seventh cervical vertebrae.	Spinous process of axis and, occasionally, into spinous processes of C3

		and C4.
Spinalis capitis	Inseparably connected with Semispinalis capitis.	
Semispinalis cervicis	Transverse processes of upper five or six thoracic vertebrae.	Cervical spinous processes, second through fifth.
Semispinalis capitis	Transverse processes of upper six or seven thoracic and seventh cervical vertebrae, and articular processes of cervical fourth, fifth, and sixth.	Between superior and inferior nuchal lines of occipital bone.
Semispinalis multifidi	Sacral region: Posterior surface of sacrum, medial surface of posterior superior iliac spine, and posterior Sacroiliac ligaments. Lumbar region: Thoracic region: } Transverse processes Cervical region: of L5 through C4	Spanning two to four vertebrae, inserted into spinous process of a vertebra above.
Rotators	Transverse processes of vertebrae.	Lamina of the vertebra above.
Interspinalis	Placed in pairs between spinous processes of contiguous vertebrae. Cervical: six pairs Thoracic: two or three pairs; between first and second, (second and third), and 11^{th} and 12^{th} Lumbar: four pairs.	
Intertransversarii	Small muscles placed between transverse processes of contiguous vertebrae in cervical region.	
Splenius cervicis	Spinous processes of third through sixth thoracic vertebrae.	Posterior tubercles of transverse processes of first two or three cervical vertebrae.
Splenius capitis	Caudal one half of ligamentum nuchae: spinous process of seventh cervical vertebra; spinous processes of first three or four thoracic vertebrae	Mastoid process of temporal bone, and on occipital bone inferior to lateral one third of superior nuchal line.

the cervical spine as a whole with the upper cervical spine in flexion is generally considered more efficient, more stable and produces less strain on the upper cervical joints.[38]

The muscles that are primarily involved in creating movement in each of these two areas will be different. Flexion of the upper cervical spine is created by the longus capitis, the rectus capitis anterior and the supra and infra hyoids. Flexion of the lower cervical spine is carried out by the sternocleidomastoid and scalene. The longus colli assists in the flexion of the cervical spine as a whole. The sternocleidomastoid, if the flexors are not active, creates flexion of the lower cervical spine and the extension of the upper cervical spine.[41]

Extension

Extension of the upper cervical spine is primarily carried out by the semispinalis capitis, splenius capitis, suboccipital group (except oblique capitis posterior) and sternocleidomastoid. In addition to these muscles the upper trapezius contributes to the extension of the upper cervical spine.[42]

The most important extensors of the lower cervical spine are the semispinalis cervicis, multifidus, and longissimus cervicis.[42] The extensors of the cervical spine are, in general, more bulky and powerful than the flexors. The semispinalis muscles, in particular are powerful extensors[43] and along with the multifidus, are important stabilizers of the lower cervical spine and, in the case of the semispinalis cervicis, of the upper thoracic spine. When multilevel surgical procedures, such as multilevel laminectomies, are performed that damage these muscles, swan neck deformities commonly develop. Even in the absence of destruction such as that from surgery, normal activity of these muscles, particularly in the lower cervical spine, is essential to the maintenance of normal head posture and prevention of forward head posture.[41]

Rotation

Rotation of the cervical spine involves activity from a wide variety of muscles. This is because of the importance of fine motor control of this movement during functional movements including rotation, such as smooth pursuit movements of gaze and normal rotational head movements while talking especially to a group. The movement of the head and neck into rotation is primarily carried out by the ipsilateral splenius capitis. Contralateral sternocleidomastoid and ipsilateral semispilnalis capitis.[42] In the upper cervical; spine the obliques capitis inferior and rectus capitis posterior major also play an important role.[43] In the lower cervical spine splenius cervicis contributes. In addition to these muscles.[43] The contralateral upper trapezius, ipsilateral levator scapulae, and ipsilateral longissimus capitis and cervicis are important rotators.[42] One the inter segmental level, the multifidus and rotators are prime movers.

Lateral flexion

The sternocleidomastoid shows the greatest activity with this movement with substantial contribution from levator scapulae, longissimus cervicis and capitis and scalene. The iliocostalis cervicis and the upper trapezius also make significant contributions.[43]

On an intersegmental level, the obliques capitis superior and inferior in the upper cervical spine and the intertransversarii and multifidus in the lower cervical spine are the prime movers.[41]

Involvement of Cervical Muscles in Upper Extremity Movements

The muscles that attach to the cervical spine and scapula play an important role in controlling and stabilizing the shoulder and neck in the activity of prehension of an object and bringing it to the mouth a basic survival function. Clinically, the most important movements are flexion and abduction.[41]

Involvement of Cervical Muscles in Other Activities

The sternocleidomastoid, scalenes, upper trapezius and pectoralis minor contract with deep breathing.[44] During coughing, there is slight activity in the deep neck flexors to stabilize the head and neck.[44] The deep neck flexors are also active in talking and swallowing for the purpose of preventing excessive anterior movement of the head and neck.[45]

Cervical Stability

The stability of the cervical spine is determined by a number of factors. More recently, there has been greater appreciation for the role of muscles, and, more important, the nervous system in the maintenance of stability of the spine. There are three subsystems that interact in a delicate and intricate manner to maintain stability of the spine.[46] These are:

1. The passive subsystems (ligaments, joint capsules, bones, facet joints, discs, passive mechanical properties of muscles), which functions to limit excessive movement of the intervertebral joints primarily at end ranges.

2. The active subsystem (muscles), which functions to dampen sudden movements of the intervertebral joints that result from perturbations.

3. The control subsystem (mechanoreceptors in the locomotor system that detect force, direction, and velocity of motion; neural control centers), which functions to read and interpret incoming signals from all the tissues of the locomotor system and to order the appropriate responses required to provide stability and protection to the spine.

Dynamic Stability

It must be realized that the spinal ligamentous system only functions to stabilize the spine at end ranges. And recent evidence suggests that the system may not even have the strength to serve this function to a great degree.[46] Regardless, most microtrauma and even some macrotrauma to the spine do not occur at end ranges but somewhere around the neutral zone.[47] The purpose of stabilizing system of the spine is to, as Panjabi puts it, “provide sufficient stability to the spine to match the instantaneously varying stability demands due to changes in spinal posture and static and dynamic loads”.[46] That is to say, the stabilizing system of the spine must be constantly active and easily adaptable to meet the ever changing demands placed on it by the external and internal forces that are continually acting on the locomotor system.

To do this, there must be delicate, harmonious interaction between the three subsystems, particularly the active subsystem and the neural control subsystem. The central nervous system (CNS) constantly monitors the signals from the receptors in the locomotor system, including those coming from the vestibular and visual systems, to assess the status of the body. From this, the CNS determines the level of activity in the active subsystem that is required to maintain stability. This leads to a set of efferent signals that are sent to the specific muscles necessary to produced the force and direction of contraction required to create the appropriate postural reactions to meet the stability needs that have been established. These very muscles are not only tissues capable of generating fore but, through afferentation from the Golgi Tendon Organs (GTOs), are also capable of monitoring the degree of force being produced. They report this to the CNS, which then makes the determination as to whether the force generated matches that previously determined to be required. If it does not, an adjustment is made.

The position of maximum stability in the cervical spine is that of combined flexion of the upper cervical spine and extension of the lower cervical spine.[41] Conversely, upper cervical extension combined with lower cervical flexion (forward head posture) is the least stable position. When a stabilization response is required for the cervical spine, some degree of upper cervical flexion and lower cervical extension is adopted. This requires a postural set that provides the cervical stabilization system with the greatest ability to elicit this type of response.

In the cervical spine, the most important muscles are the multifidi, suboccipital, including the rectus capitis anterior, and the deep cervical flexors. The enhanced ability of the small muscles to provide intersegmental stability is owing to the fact that they are positioned closer to the center of rotation and provide less deformation to the neural arch.[48] The reason these factors are essential is that because of them, these small muscles have a shorter reaction time than do the larger spinal muscles. The stabilizing effect of the intrinsic muscles is especially important in the upper cervical spine where, as Winters and Peles[49] have shown through computer modeling, when only the large muscles are used, focal areas of instability develop during normal movements.

Passive Stability

As Panjabi et al state,[50] the functions of a ligaments are to provide stability to the joint, to act as a joint position transducer during physiologic motions, and to absorb energy during trauma. In terms of providing stability in the presence of macrotrauma, where the integrity of end-range stability is threatened.

The zygapophyseal joint capsules play a role in stability in lateral bending and rotation but little role in flexion and extension. But, as we stated earlier, the principal role that ligaments play in the spine is mechanoreception.[41]

Management of Cervical Spondylosis

Exercises in Cervical Spondylosis

Treatment commonly used for cervical Spondylosis are active and passive physiotherapy.[51] Passive physiotherapy implies to massage, heat and stretching etc. Active physiotherapy for neck and shoulder symptoms is becoming more common. Active therapeutic management consists of proprioceptive neck stabilization exercises, neck and should muscle training and relaxation maneuver. Active therapeutic exercise is supposed to relax muscle spasm and tension, increase muscle strength, improve muscular endurance, increase stress tolerance and raise the threshold beyond which symptoms occur.[52]

It has been found that multimodal treatment exercises are beneficial for postural neck pain and that activated home exercises are better than just a recommendation for exercises and neck lecturer.[53]

Young women clerks showed increased strength and reduced neck pain after unspecific training using light dump bells and emphasizing shoulder and neck muscle group. Reports also suggest that symptom free individuals and patients with degenerated discs can tolerate neck strength training that leads to marked increase in strength.[54]

An isometric measurement protocol was performed at the beginning and at the end of a 3-week rehabilitation program that included physiotherapy (Combination of massage, cold packs, hot packs, ultrasound, electrotherapy, acupuncture, manipulation and traction depending on the patient's condition), stretching, aerobic exercises and circuit training (thrice weekly) to improve arm, should and neck muscle strength. There was a significant increase in the ability to push forward and backward (increase in strength), which correlated with lessening of neck pain and disability found at the end of the program[55] ($p<0.05$).

In another research for neck pain, therapeutic exercises were the only intervention with clinically important benefit relative to a control. There was good agreement with the recommendation from practitioners[3] (93%).

Isometrics

Isometrics were introduced in the early 1950s with the work of Hettinger and Muller, and the definitive text on isometrics was written in 1961 by Hettinger.[56] As the muscle is contracting, no resultant visible joint motion will occur. External force applied to the muscle is greater than the internal force that the muscle can generate.

Watson and Trott (1991) Poor isometric performance of the cervical short flexor muscle has been observed in females with chronic cervical origin headache and forward resting head posture. They developed a computerized device to measure isometric performance of cervical short flexor muscle group.[39]

Barton PM, Hayes KC (1996) compared the neck flexor muscle strength, efficiency and relaxation times in normal subjects and subjects with unilateral neck pain and headache. He found all force values were significantly lower in neck pain population compared with the controls.[57]

Endurance in cervical muscles

Trott (1988) studied that cervical short flexor muscle group is believed to play an important role in stabilizing the position of head on neck. In the exercise protocol described by Trott (1988), subjects lay supine on a plinth, retracted their chin and lifted their head a short distance from a pillow placed under the head. This is a gravity resisted exercise where the chin is ‘tucked (upper cervical flexion) while just taking the weight of head off the pillow”. It is proposed that the length of time during which a subject maintains Trott’s (1988) antigravity head position measures cervical short flexor muscle endurance.[58]

Anthony Barber (1994) worked on “upper cervical spine flexor muscle: age related performance in asymptomatic women. He assessed strength (kilo pounds) and endurance (see) and found there was no significant relationship between strength and age or endurance and age.[59]

Karen Grimmer (1994) measured the endurance capacity of the cervical short flexor muscle group. He adapted and refined Trott's (1998) protocol which is a time efficient and inexpensive tool and that was shown to provide reproducible measurements one month apart.[60]

Grimmer K, Trott P (1998) did the study on a randomly selected sample of 427 never injured subjects to examine the relationship between poor posture and deep cervical short flexors muscle endurance and found that for both men and women, poor deep cervical short flexor muscle endurance was associated only with extremely large excursion angles traced by upper cervical spine, that is head posture associated with excessive cervical lordosis rather than a forward translated head position.[61]

Alan Jordan (1998) did study comparing intensive training, physiotherapy, and manipulation for patients with chronic neck pain. He found that the patients who underwent intensive training demonstrated significantly greater endurance levels than isometric strength at the completion.[62]

Another device, the stabilizer (Chattaudoga Group Inc, Chattandoga, Tern), has an are filled pressure sensor that monitors the slight flattening of the cervical lordosis associated with contraction of the lonyus colli muscle. It, too, is useful in retraining the upper cervical flexor/ lower cervical segmental extensor muscles.[63]

Cervical muscle endurance was measured by a modified Bering Soreness test. Neck muscle endurance were found to be significantly lower for subjects with neck pain.[64]

For neck endurance testing, subjects were asked to lie prone on a therapy table with their head and cervical spine supported over the end of the plinth. Arms were positioned alongside the trunk with hands at the nips. To counter support the upper thoracic spine, strap was used across T2. For objective determination of endurance failure, the following equipment configuration was used. A Velcro strap was positioned around the skull with the lower edge of the strap made level with the top of the ears. Next, a Myron goniometer was placed on the Velcro strap immediately above the superior most tip of the helix of the left ear and was used as gravity inclinometer in the sagittal plane. An extendable tape measure was attached to the Velcro strap at the subject's glabella, with the tape measure cases hanging just short of the floor, in pendulum fashions. Endurance was measured by removing the support, then requiring the subject to hold their head steady in a position with the chin retracted and the cervical spine horizontal. The test was discontinued if the subject could not hold their head horizontal any longer due to fatigue or pain, if the subject cost more than 5^0 of upper cervical retraction for more than 5 seconds as measured with the Myrin goniometer, or if the subject could not maintain the extended position the tape measure case touching the floor for longer than 5 seconds or on more than 5 occasions.[64]

In a study neck muscle endurance was significantly lower for the groups reporting monthly and weekly pain compared with the never / infrequent groups.[65]

To improve the endurance of the upper cervical flexors, which is often poor in patients with chronic headaches, the patients is asked to maintain a chin-tuck position over the end of the table for 10 to 30 seconds.[66]

Physiological Adaptations to Endurance Training

There is overwhelming evidence that muscle fibers and therefore motor units can convert from one form to another.[67,68,69] This plasticity in contractile and metabolic properties in response to stimuli (e.g. training and rehabilitation) allows for adaptation to different functional demands.[67]

Fiber conversions between type II B and type II A are the most common, but type I to type II conversions are possible in cases of severe deconditioning or Spinal Cord Injury. Less evidence exists for the conversion of type 11 to type 1 fibers with training or rehabilitation.[71]

Numerous studies on animals and humans with SCI have demonstrated a shift from slow to fast fibers.[67,70] In humans, detraining (i.e., a decrease in muscle use from a previously high activity level) have been shown to lead to the same slow to fast conversion, with shifts from MHC IIa to MHC IIx/d and possibly MHC1 to MHC IIa[2]. There is also a concomitant decrease in the enzymes associated with aerobic – oxidative metabolism.[67]

Recent evidence in aged muscle suggests that fiber type conversion may occur, because there is a much larger co-expression of myosin heavy chain in older adults as compared with young individuals.[72] Older muscles was found to have a greater percentage of fibers that coexpress MHC II & MHC IIa (28.5%) compared with younger muscle (5% - 10%).[72]

It has been known for some time that training that places a high metabolic demand on the muscle (endurance training) will increase the oxidative capacity of all muscle fiber types, mainly through increases in the amount of mitochondria, aerobic/ oxidative enzymes and capillarization of the trained muscle.[73,74] Using the metabolic enzyme-based classification system, this would lead to a transition from FG to FOG muscle fibers without necessarily, a conversion of myosin heavy chain isoform.

The myosin heavy chain composition of a muscle fiber can change when subjected to endurance training.[69] Within type II fibers there is a transformation from II B to II A, with more MHC IIa being expressed, at the expense of MHC IIx/d. [67,69] Consequently, the percentage of pure type II B fibers decreases and the percentages of type IIAB and pure type II A fibers increase. Evidence is lacking to demonstrate that type II fibers convert to type I with endurance training,[69] although there does appear to be an increase in the mixed type I and IIA fiber populations. Researchers have found that type I fibers becomes faster with endurance exercise and slower with deconditioning in humans.[75,76]

This change in contractile speed is not because of a conversion of fiber types, but rather because of changes in the myosin light chain isoforms from slow to fast isoforms and from fast to slow isoforms, respectively.[75,76] Because this change in muscle contractile speed does not occur by altering the myosin ATPase, it would not be detectable by his to chemical fiber typing.[67] This shift from slow to fast myosin light chain isoforms allows the slow fibers to contract at a rate fast enough for the given exercise yet retain efficient properties of energy use.[74] In summary, muscle fiber adaptations to endurance exercise depend on fiber type, although the oxidative capacity of all fibers is increased. Type I fibers become faster through myosin light chain conversion, whereas type II fibers convert into slower, more oxidative types.

A study was done on myoelectric manifestations of sternocleidomastoid and anterior scalene muscle fatigue in chronic neck pain patients which suggested predominance of type II fibers in neck pain patients and or greater fatigability of the superficial cervical flexors in neck pain patients. These results were in agreement with previous muscle biopsy studies in subjects with neck pain which identified transformation of slow twitch type I fibers to fast twitch type II B fibers, as well as the clinical observation of reduced endurance in the cervical flexors in neck pain patients was found.[77]

Other Treatments

During the past decades, there has been an increasing interest in summarizing and analyzing the available evidence on conservative management of neck pain. As for low back pain, the effectiveness of conservative management of cervical syndrome is a complex issue.[78] Many treatments are available to patients and accepted as standard forms of practice including such common conservative strategies as medication, Physical medicine methods, manual treatments and education of patients.[78,79] Many review articles have no basic descriptive information or rationale for classifying disorders interventions and outcomes.[80] The insufficiency of information hinders to a large extent the application of the results of review articles, making it more difficult to extrapolate the findings presented in the review articles to clinical practice.

Manual Treatments

Reviews reporting on manipulation and mobilization in combination with other conservative therapies were not in agreement.[80] The trails studied the use of manual treatment alone (that is, not in combination with any other form of treatment) compared with other treatments. Cassidy et al showed no significant difference between treatments while Vernon et al reported a significant improvement in the manipulation group.[78]

The Philadelphia panel[3] found insufficient data for mechanical traction similar to Quebec task force on spinal disorders, which found no scientific evidence.

Philadelphia panel[3] further advised to investigate other confounding variables such as neck position, traction force, duration of traction, angle of pull and position of patient. Three randomized controlled trials investigated the use of traction.[78] In a moderate quality study, Goldie et al compared traction with a control treatment of analgesics, muscle relaxants and postural advice. They reported the difference between groups to be small and not significant, but no statistical analysis was reported. Pennie and Aganbar, in a study of weak quality, compared traction, exercise and patient education with collar and exercise. No significant difference between groups was reported, and no statistical analysis was reported. A methodologically weak study by Loy compared traction and short-wave diathermy with electroacupuncture. Electroacupunture was reported to improve symptoms significantly better than traction and diathermy but no details of analysis were reported.

Ultrasound Therapy

Studies [3,81] conclude that the use of ultrasound in treatment of musculoskeletal disorders is based on empirical experience, but is lacking firm evidence from well designed controlled studies. Philadelphia panel[3] also found no evidence of clinically important benefit of therapeutic ultrasound for chronic cervical syndrome.

Transcutaneous electrical nerve stimulation (TENS)

The one randomized controlled trial[78] of moderate quality that compared TENS with a combination of collar, rest, education and analgesics reported no difference between these treatments. Quebec task force[82] do not recommend TENS for cervical pain. However, the Quebec task force guidelines do not differentiate between electroanalgesia and TENS.

Laser

In a controlled, cross-over study[83] the effect of low-level laser therapy was evaluated. Results of this controlled study together with those from other similar studies[78] indicate that it is not possible to achieve myofascial pain reduction in neck and shoulder girdle with low-level laser therapy under strictly blinded conditions. There was no reduction in consumption of analgesics associated with either laser or placebo treatment.

EMG biofeedback, Therapeutic massage, Thermo therapy, Electrical stimulation and Combined rehabilitation interventions:

There are many studies in the scientific literature showing the positive physiological effects of these interventions. Despite the physiological effects, either there are no clinical data or there is insufficient clinical information on the effectiveness of EMG biofeedback, Therapeutic massage, Thermotherapy, Electrical stimulation and Combined rehabilitation interventions for acute and chronic neck pain.[3]

Drug Treatments

Four randomized controlled trials that used drug treatments were analyzed.[78] Two placebo-controlled trials, one of moderate methodological quality and the other strong, investigated muscle relaxants with algometry or muscle spasm symptom scores as outcomes. Direct pain score data could not be abstracted from either study. Both reported significant improvement in patients with both neck or low back disorders. One methodologically weak randomized controlled trial compared a topical anti-inflammatory applied with TENS alone and reported significant pain reduction with the combined treatment. The magnitude of this effect, was not able to be calculated. One strong randomized controlled trial tested a combination of anti-inflammatories, analgesics, and patient education compared with a placebo of detuned electrotherapy and showed no significant difference between treatments, but the small sample size used in this subgroup analysis probably does not have sufficient power to state conclusively that no difference exists.

Patient education

Three randomized controlled trials[78] that used patient education (including ergonomic advice, neck school, postural advice, and strategies for the management of pain) were analyzed. In one study traditional neck school combined with ergonomic advice were each compared with no treatment control in a moderate quality study. According to effect size there was no significant difference between groups. Two randomized controlled trial investigated forms of patient advice. In a methodologically strong study, compared a combination of anti-inflammatories, analgesics, and patient education with a placebo and found no significant difference between groups. One study compared two forms of education (advice) in a methodologically weak study. At four weeks of treatment, education combined with posture, relaxation training, and exercise gave significant pain relief compared with advice and rest. At eight weeks of treatment, this effect disappeared.

Visual Analogue Scale (VAS)

Among the numerous psychophysical procedures for assessing human pain, direct scaling procedures such as VAS have gained popularity because of their simplicity, versatility, relative insensitivity to bias effects, and the assumption that the procedures yield numerical values that are valid and on a ratio scale.[84,85] Because of the ease and simplicity of its administration, this is by now the most widely used method of measuring pain. The patient is presented with a strip of paper on which there is a fine 10cm long scale. At one end are written zero pain and the other maximum pain. The patient is then asked to mark his current pain intensity on that line. The distance of that mark from the '0' or no pain end is measured and that gives the VAS score. VAS have been demonstrated to be reliable, generalizable, internally consistent with measures of clinical and experimental pain sensation intensity, separate measures of pain sensation intensity and pain unpleasentness,[86] and relatively sensitive measures of effect of analgesic treatments. An important related advantage of VAS is that, unlike whole numbers and words, they provide and unlimited number of possible responses along a single continuum[85] (Scot and Huskisson 1976).

Neck Disability Index

The neck disability index (NDI) is a region-specific functional status questionnaire designed for patients with neck problem was developed by Vernon and Mior,[87] at the Canadian Memorial Chiropractic College, based on Oswestry Low Back Disability Questionnaire. It has ten categories of disabilities that are graded in terms of severity between 0 to 5 (Appendix E). Adding the points from each of the ten categories completes the scoring. The final score is then categorized into a chart to grade the level of disability. NDI appears to measure both physical and mental health related factors[88]. Reliability and validity have been established for the NDI.[89,87] A reduction in the score indicates an improvement in the function. The maximum score possible indicates complete disability is 50 and the minimum possible score indicating no disability is 0.

Rationale of the Study

Endurance in muscles in necessary to maintain postural control. Sustained postures require continual small adaptation in the stabilizing muscles to support the neck against fluctuating forces. With the sustained load, creep and distention occurs in the inert tissues, causing mechanical stress to pain sensitive structures. Relieving the stress to the pain sensitive structure relieves the pain stimulus and the person no longer experience pain.

Generally conventional treatment of Cervical Spondylosis includes isometric exercises but no endurance training (elevating fatigue threshold and improving performance, thus reducing disability) is given.

So this motivated to conduct a study on Effect of Endurance Training of Neck muscles the course of treatment of Cervical Spondylosis.

Aims and Objectives of the Study

1) To formulate a treatment protocol for endurance training.

2) To examine the efficacy of endurance training in the management of cervical spondylosis.

Hypothesis

Experimental Hypothesis

There will be a significant difference between endurance training and conventional isometric exercises in reducing neck pain and functional status in subjects with cervical spondylosis.

Null Hypothesis

There will be no significant difference between endurance training and conventional isometric exercises in reducing neck pain and functional status in subjects with cervical spondylosis.

CHAPTER 3

METHODOLOGY

Sample Design

The study has an experimental design. There are two groups

Group A - Conventional treatment group

Group B - Experimental treatment group

Space and location

Integral university, Lucknow.

The Physiotherapy department at Paras hospital, Patna and

The Physiotherapy department at Model health care clinic, Patna.

Sample Size

Thirty subjects (n=30) were recruited and divided into two groups each having 15 subjects.

Methods of selecting subjects

The population was screened for the eligible subject and then they were chosen randomly for the two groups A and B.

Study duration

Duration of the Study is of 6 week.

Criterion

Inclusion Criterion

- Subjects diagnosed as cervical spondylosis with neck pain not less than two months.
- Age between 40 to 50 years
- Females
- Sedentary job holders for 6-8 hours
- Mode of transport: personal car

Exclusion Criterion

- Receiving concurrent occupational therapy treatment or any other treatment for cervical spondylosis.
- History of trauma
- Post-surgical conditions in the neck and shoulder areas

- Disabling upper quarter pain present at the time of study i.e. acute cases of neck pain.
- Herniated disc, Myelopathy, Radiculopathy
- Malignancy
- Shoulder diseases (tendonitis, bursitis, capsulitis)
- Contraindicated to exercise therapy (for examples uncontrolled hypertension, previous Myocardial infarction and CVA.
- Pulmonary conditions
- Psychiatric illness
- Inflammatory rheumatic diseases
- Pregnancy at the time of intervention
- Any other systemic disorders
- Receiving medications other than analgesics and NSAIDS

Instrumentation

1) Equipment

- Therapy Table
- A pillow
- A Therapy Ball

2) Space and facilities location for the data collection

Outcome Measures

1) Functional status was measured using the Neck Disability Index Questionnaire. For some patients who understood the Hindi language better double-blinded translation of the scale was done and the best one was chosen.

The questionnaire includes 10 sections assessing limitations of daily living in the following areas:

1. Pain intensity
2. Personal care

3. Lifting

4. Reading

5. Headache

6. Concentration

7. Work

8. Drinking

9. Sleeping

10. Recreation

Each section is scored from 0 to 5 and total score of 50, where 0 represents minimal disability and 5 represents maximal disability. They were instructed to tick the choice closest to the one which indicated the true subjective assessment of the subject's functional disability for that particular item. The scores for each item was added and final score thus calculated (Appendix- C)

2. Pain was assessed using the Visual Analogue scale when patients were at rest. Consisting of a 10 cm line, the patients were asked to mark their pain anywhere on a 10 cm line with 10 markings at a distance of 1 cm each, with left side indicating zero pain and the right side the maximum pain. The

point where the patients cut the line was measured from point 0 using a ruler and this represented the VAS reading (Appendix -D)

Variable

Independent variable

Endurance training

Isometric Strength training

Dependent variable

Pain (measured by Visual Analogue Scale)

Functional status (measured by Neck Disability Index)

Protocol

10 seconds hold with 7 repetitions for first 3 weeks.

10 seconds hold with 10 repetitions for the next 3 weeks.

Flexion

Position of the patient: - Standing facing the wall holding ball against wall with head, keeping chin tucked in.

Extension

Position of the patient: - Standing, facing opposite to the wall holding ball against wall with head, keeping chin tucked in.

Interval: 5 seconds rest between each exercise and 30 seconds rest time during changeover of flexion to extension.

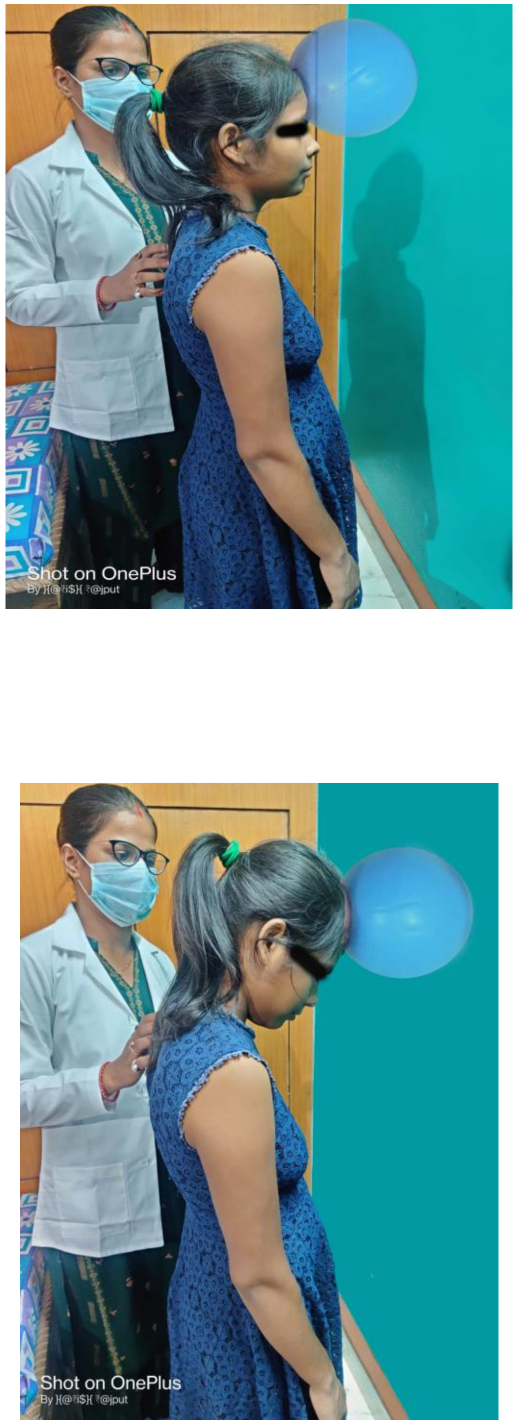


Fig no. 3.1 conventional isometric exercise in flexion

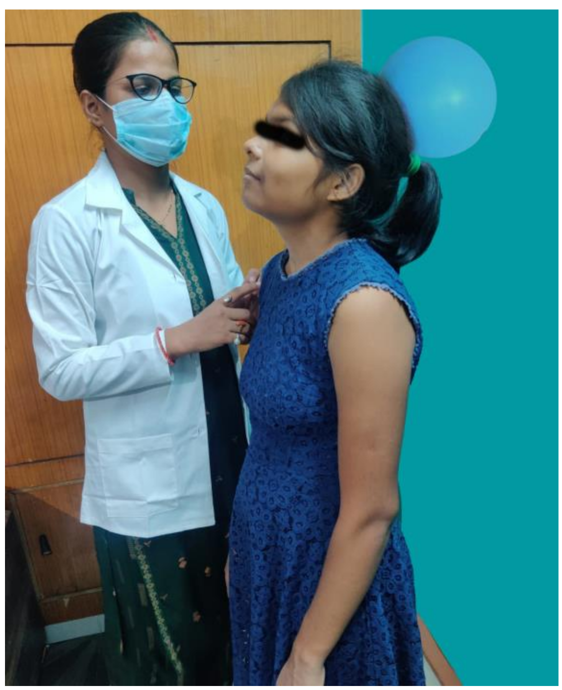


Fig no. 3.2 conventional isometric exercise in extension

Home Exercise Programme

Subjects were asked to perform same exercises at home for 2 times a day on day of treatment and 3 times a day on day off treatment.

GROUP B- Endurance training.

Protocol given on next page

Interval: 5 seconds rest between each exercise and 30 seconds rest time during changeover of flexion to extension.

Home Exercise Programme

Subjects were asked to perform same exercises at home for 2 times a day on day of treatment and 3 times a day on day off treatment.

For both the experimental and control group, the reassessment was taken at 3^{rd} & 6^{th} week. During the reassessment sessions, subjects completed the visual analogue scale, Neck Disability Index questionnaire.

Table No. 3.1 Endurance Training Protocol

Exercise Position	Exercise		**Weeks**					
			1st	2nd	3rd	4th	5th	6th
			Using pillow under head		No pillow under head		Head off the plinth	
Supine	Lift head keeping chin tucked in	Repetition	5	5	10	10	15	15
		Holding time (secs)	5	10	10	15	15	20
Prone	Lift head backward		Keeping arms at sides		Arms abducted		Head off the plinth	
		Repetition	5	5	10	10	15	15
		Holding time (secs)	5	10	10	15	15	20

Fig no. 3.5 endurance training protocol in supine

Fig no, 3.6 endurance training protocol in prone

Procedure

Thirty subjects (n=30) were recruited from the Orthopedic out-patient Department, Paras hospital, Patna, and were referred to the Physiotherapy department at Paras Hospital, Patna and the Physiotherapy department at Model health care clinic, Patna.

Description of the study, including its tittle, purpose & subject inclusion and exclusion criteria was submitted to the department.

The subjects were chosen randomly. Then the subjects were screened and those fitting the inclusion criterion were presented the proposal of the study. Written informed consent (Appendix--) was taken from the volunteers and the procedure explained in detail. The subjects were assigned to the two groups randomly.

Measurement of the pain at rest and functional status at the ‘0” day was done.

Treatment Protocol was formulated after review of various books, research articles and discussion with senior physiotherapist in the field of rehabilitation, specifying the duration and number of repetitions of exercise.

Treatment for both the groups was given five times a week for 6 weeks in the physiotherapy Department.

GROUP A- Conventional Isometric exercises.

CHAPTER 4

DATA ANALYSIS

Data Analysis

An experimental design was used for the study. The values collected were that for the 2 dependant variables — Visual Analogue scale (VAS), neck disability index (NDI). The two variables were recorded on day 0 (week 0), week 3 and week 6. The data was analyzed using the software SPSS 11.0.

Unpaired ‘t’ test was used to compare the baseline values of all the variables and other demographic and clinical data collected. It was applies thrice for observations at week 0, week 3 and week 6.

Paired ‘t’ test was used to compare a variable within the groups. It was applied thrice after pairing the data into day 0 – week 3, day 0 – week 6 and week 3 – week6.

The ‘p’ value was noted for all the variables and it was taken to be statistically significant if $p < 0.05$.

CHAPTER 5

RESULTS

Results

Demographic Data and Clinical Data

30 female patients were evaluated at day 0 of the study for age and daily hours in the sedentary position. Table No. 5.1 gives the details of the mean and standard deviation of these scores. These variables had no significant differences between the groups ($p > 0.05$).

Results of Statistical Analysis of Visual Analogue Scale (VAS) and Neck Disability Index (NDI)

Visual Analogue Scale

The visual analogue scale was measured at day 0, week 3 (VAS) and week 6 (VAS). The means and standard errors for the VAS day 0, VAS week 3, VAS week 6 are shown in Table 5.2. The variable was compared using paired 't' test for pairs VAS day 0 — VAS week 3, VAS day 0 — VAS week 6, VAS week 3 — VAS week 6 and mean improvement and standard error with the 'p' values noted which are shown in Table No. 5.2. The variable was compared using unpaired 't' test for group A cross B for day 0, week 3 and week 6. The main difference and standard error for these are shown in Table No 5.2.

VAS had no significant difference in the baseline (day 0) value for two groups ($p > 0.05$). In group A which was the conventional group the VAS was reduced significantly ($p < 0.05$) from the baseline values to the first observation at week 3, the mean reduction in score was 1.95 ± 0.32. The change from week 3 to week 6 was also significant ($p < 0.01$). Mean reduction being 1.7 ± 0.29. The total decrease in pain as measured as the difference between was VAS day 0 and VAS week 6 was also highly significant ($p < 0.05$) with the mean difference being 3.6 ± 0.39.

In group B which was the experimental group, the VAS score changed significantly from day 0 to week 3 ($p < 0.05$), Mean decrease was 2.0 ± 0.24. Similarly the change between week 3 and week 6 values were also significant ($p < 0.05$) with mean difference being 1.4 ± 0.30. Total decrease in pain from day 0 to week 6 was 3.4 ± 0.4 which was also significant.

In between group analysis the difference in improvement was not satistically significant any point of time ($p > 0.05$). At week 3 the mean difference was 0.3 ± 0.39 and at week 6 it was 0.03 ± 0.53.

Neck Disability Index

The neck disability index was taken at day 0, week 3 and week 6. The means and standard errors for day 0, week 3 and week 6 are shown in Table No. 5.3. The variable was compared using paired ‘t’ test for pairs NDI day 0 – NDI week 3, NDI week 3 – NDI week 6, NDI day 0 – NDI week 6. The mean improvement and standard errors with the ‘p’ values noted which are shown in table No. 5.3. The variable was compared using unpaired ‘t’ test for group A and B for week day 0, week 3 and week 6. The mean difference and standard errors for these groups with the p values are shown in Table No. 5.3.

NDI has no significant difference in the baseline values (week 0) for the two groups ($p > 0.05$).

In group A, which the conventional treatment group the NDI was reduced significantly ($p < 0.05$) from the baseline values two the first observation at week 3. The mean reduction in score was 3.37 ± 0.87. The change from week 3 (NDI) to week (NDI) was also significant ($p < 0.05$), mean reduction being 3.65 ± 0.94. The total decrease in NDI score, which means improvement in function, measured as the difference between NDI day 0 and NDI week 6 was also highly significant ($p < 0.05$). The mean difference was 3.50 ± 0.90.

In group B, which was the experimental group, NDI score changed significantly from week 0 to week 3 ($p < 0.05$). Mean decrease was 2.93 ± 0.75 similarly the change between week 3 and week 6 values were also significant ($p < 0.05$) with mean difference being 3.33 ± 0.86. Total decrease in pain from week 0 to week 6 was 3.65 ± 0.94 which was also significant ($p < 0.05$).

In between group analysis, the difference in improvement was not statistically significant ($p > 0.05$) at any point of time. The mean difference at week 3 was 1.6 ± 1.03 and at week 6 it 1.4 ± 1.19.

Table 5.1 Details of subjects

Group	No.	Age Mean ± S.D.	Hours daily in sitting work mean ± S.D.
A	15	44.7 (3.32)	7.1 (0.74)
B	15	44.4 (2.97)	7.1 (0.74)

Keywords

S.D. – Standard deviation

Group A – Conventional treatment group

Group B – Experimental treatment group.

Table 5.2 Means and standard errors for dependant variable VAS and its p values

VAS	Group	VAS 0 day	VAS 3 week	VAS 6 week	'p' value	Mean diff(se)
	A	6.54 (0.24)	4.58 (0.31)	2.88 (0.35)	0.000x 0.000y 0.000z	-1.95(0.32) x -1.70 (0.29)y -3.66(0.37)z
	B	6.32 (0.23)	4.28(0.32)	2.88(0.39)	0.000x 0.000x 0.000x	-2.03 (0.24)x -1.4(0.30) y -3.44(0.40)z
Mean Diff (se)		0.22 (0.33)	0.30 (0.39)	0.00 (0.53)		
'p' value		0.519	0.452	1.0		

'x' denotes the p value and the mean difference between the values at week 0 and week 3.

'y' denotes the p value and the mean difference between the values at week 3 and week 6.

'z' denotes the p value and the mean difference between the values at week 0 and week 6.

Table 5.3 Means and standard errors for dependant variable NDI and its p values

NDI	Groups	NDI 0 day	NDI 3 week	NDI 6 week	'p' value	Mean diff (se)
	A	26.4(0.68)	15.73 (0.81)	10.4 (0.95)	0.000x 0.000y 0.000z	10.66(0.87)x 5.33 (0.94)y 16.0(0.90)z
	B	27.06(0.75)	14.1(0.64)	9.0(0.71)	0.000x 0.000y 0.000z	12.99(0.75)x 5.13(0.86)y 18.06(0.94)z
Mean diff (se)		-0.66(1.02)	1.6(1.03)	-1.4(1.19)		
'p' value		0.519	0.135	0.249		

'x' denotes the p value and the mean difference between the values at week 0 and week 3.

'y' denotes the p value and the mean difference between the values at week 3 and week 6.

'z' denotes the p value and the mean difference between the values at week 0 and week 6.

Fig. No. 5.1 Comparison of Mean of values of visual Analogue Scale with Standard Error.

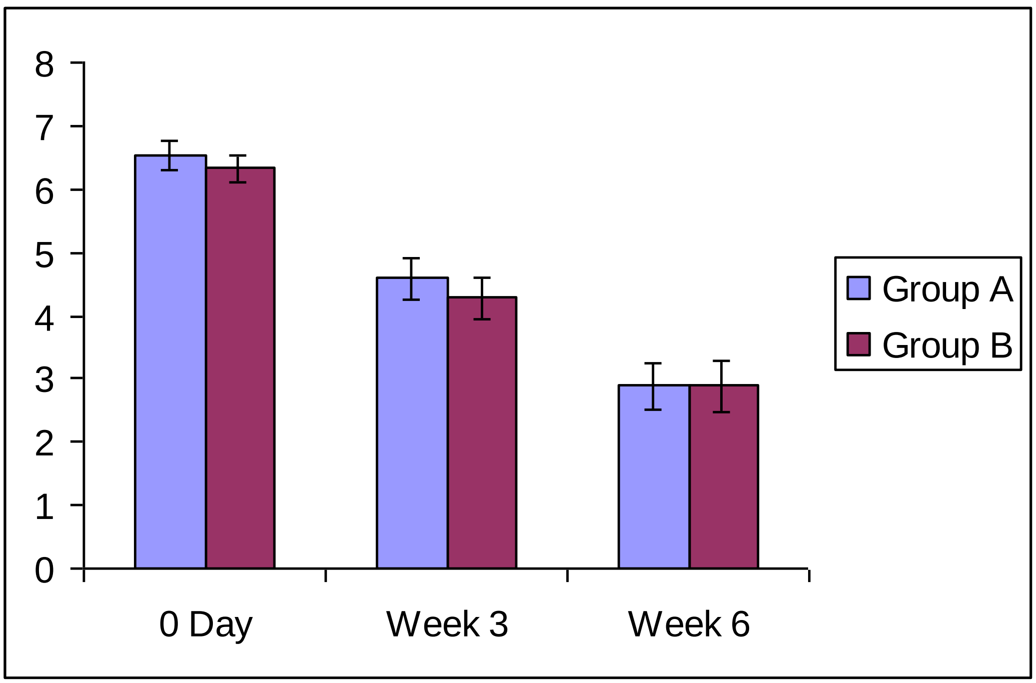


Fig . No. 5.2 Comparison of Mean Values of neck Disability Index with Standard Error

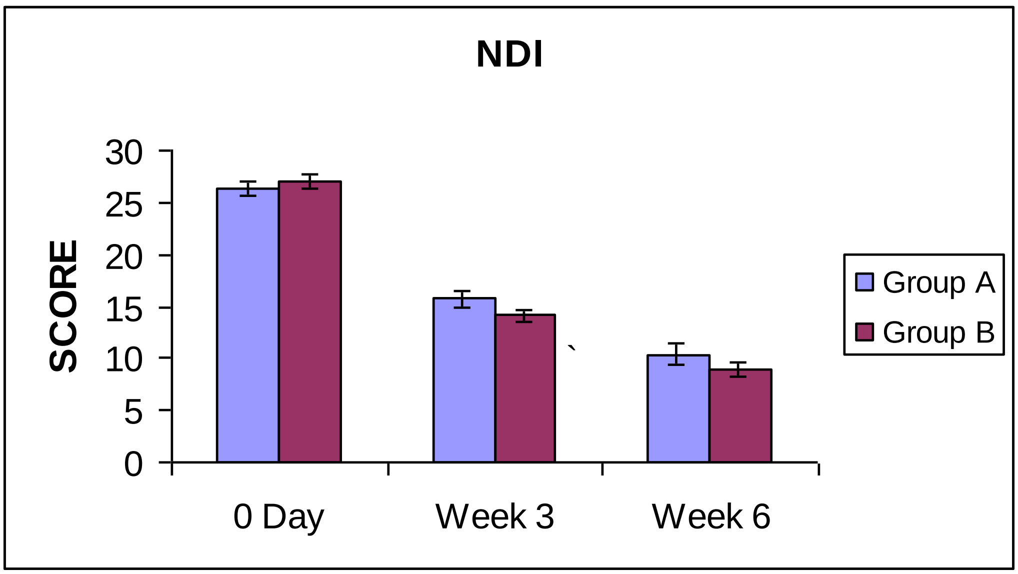


Fig. No. 5.3 Comparison of Mean Values of Visual Analogue Scale

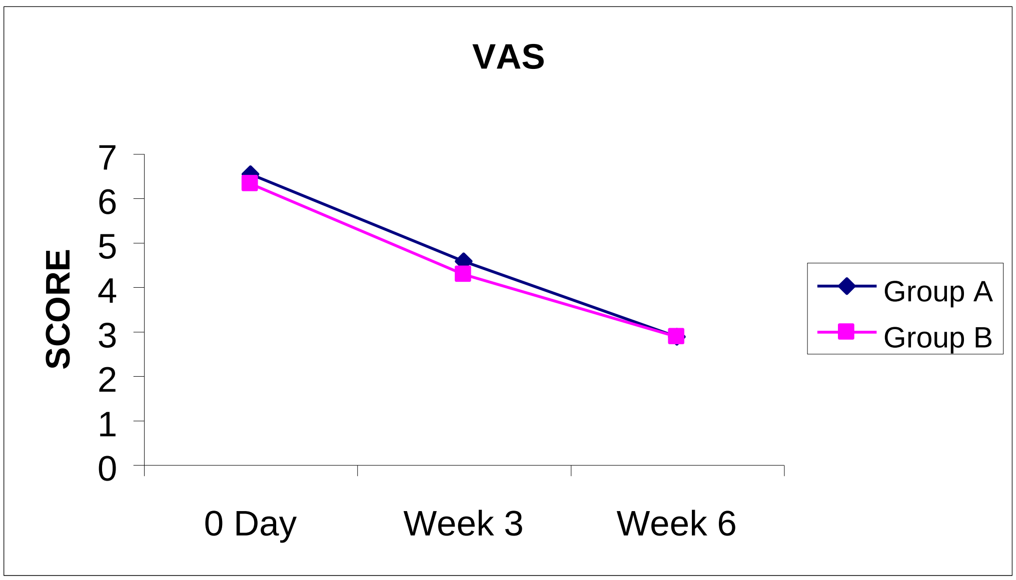
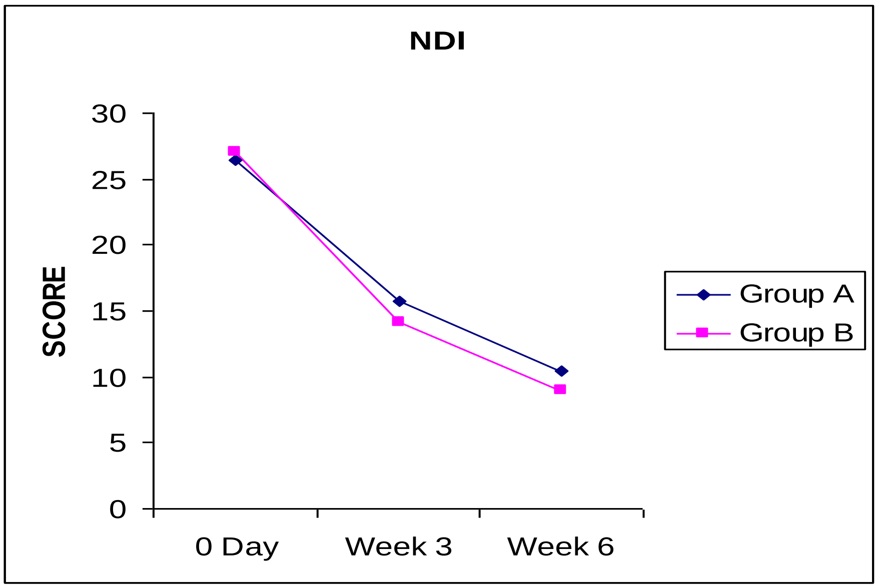


Fig. No. 5.4 Comparison of Mean Values of Neck Disability Index



CHAPTER 6

DISCUSSION

DISCUSSION

Cervical Spondylosis is very common among sedentary workers who sit for long hours as found by this study. The average number of hours spent in the sitting position in sedentary work were comparable for the two groups. This could be the reason why the amount of neck pain and the amount of disability present also were not significantly different. Even then, no direct correlation could be established between the number of hours and the amount of pain and disability. This indicates that besides the time for which the loading occurs there are probably other crucial factors which determine the amount of pain and associated disability. Some of these could be the nature of work, the psychosocial environment, the psychological state, the personality and the body type. Since the subjects were from different work settings, all requiring different levels of concentration and cognitive processing and having different work station arrangements, a uniform level of stress cannot be expected. Hence, the pain experienced and disability measured could have been affected.

The level of pain decreased in both the groups significantly, the mean decrease in pain for group A, which was the conventional treatment group was 3.6± 0.39 and for the group B which was the experimental treatment group, it was 3.4± 0.4.

The research on mechanism of pain, reduction by exercise is also very conclusive. The increase in endorphins that occurs after training and better neuromuscular control may decrease activity related pain. Strong muscle contractions activate muscle ergo receptors (stretch receptors). The afferent from these receptors cause endogenous options to be released and also cause the release of beta-endorphins from the pituitary gland. These secretions may cause both peripheral and central pain to be blocked.[90]

A decrease in pain leads to an improvement in function as can be seen by the improvement in the score of the neck disability index for both the groups. The mean improvement for both the groups was similar because there was an associated parallel decrease in pain**.**

Thoren, P. Floras, JS. in a study reported that reinforced training (for 6 to 8 weeks) group increased in strength and endurance of the appropriate muscle group. It can be hypothesized that increase in strength, endurance reduces pain. Reduction in pain leads to an improvement in function which can be seen by the improvement in the score of the neck disability index.

Although the improvement in pain and function was significant for both the groups, on between group analysis, there was no significant difference between the improvement obtained in the two groups. Hence, the results of this study indicate that Endurance training in cervical spondylosis is as effective as the conventionally given isometric strength training. It leads to no extra improvement.

Adams GR, Hather BM, Baldwin KM. In a study report that even though changes in muscle protein, such as the myosin heavy chains, do begin after a few work outs, but visible hypertrophy of muscle fibers is not evident until training is conducted over a longer period of time (more than 8 weeks).

Jari Ylinen et al in a study reported that after 12 month follow up neck pain and disability decreased in both training groups compared with the control group ($P < .001$). Maximal isometric neck strength had improved flexion by 110%, rotation by 76% and extension by 69% in the strength training group. The respective improvements in the endurance training group were 28%, 29% and 16% and in the control group were 10%, 10% and 7%. Range of motion had also improved statistically significantly in both training groups compared with the control group in rotation, but only the strength training group had statistically significant improvements in lateral flexion and flexion and extension.

A critically appraised paper reports that at the 12 month follow up, neck pain was reduced by 61% and 69% in the endurance and strength training groups respectively, compared with 27% in the control group ($p < .001$) neck disability was reduced by 36% and 43% in the endurance and strength training groups respectively, compared with 13% in the control group and more so for the strength training group than the endurance training group.

Limitations of the study

A study of longer duration with more number of subjects preferably from the same working environment leading to a better comparison between the treatment groups. Use of MRI changes in cervical spine would have strengthened the inclusion criterion. No strength, range of Motion was used to quantify the improvement. Intermediate outcome measures for mood assessment could have provided added support to the efficacy of the treatment under study. The inclusion of control group would have provided some added support to the efficacy of the treatment under study.

Future Recommendation

Findings from this study appear to suggest that a newly deviced treatment protocol for endurance training can be used along with the conventional isometric strength treatment in the management of cervical spondylosis.

Conclusion

The result of this study show that endurance training program is as effective as isometric strength training in the management of Cervical Spondylosis when both were compared using pain as measured by Visual Analogue Scale and function as measured by the Neck Disability index.

The dependent variables of interest was VAS and NDI, which improved equally in both the groups. The study therefore concludes by rejecting the Experimental Hypothesis “Endurance training given in cervical spondylosis leads to significant improvement than conventional isometric exercise in reducing neck pain and improving functional status”. And thus accepting the Null Hypothesis “Endurance training given in cervical spondylosis is as effective as conventional isometric exercises in reducing neck pain and improving functional status.”

CHAPTER 7

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APPENDIX A

CONSENT FORM

CONSENT FORM

TITLE:

Effect of endurance training in cervical spondylosis.

INVITATION TO PARTICIPATE:

You are invited to participate in this research study which is being done as a part of fulfillment of master's programme in Physiotherapy in Integral University.

INTRODUCTION TO THE STUDY

Cervical spondylosis, is a worldwide problem which turns an employee absent from work and hamper their activities of daily life.

ABOUT THE PROCEDURE:

Subject fitting the inclusion criterion would undergo an evaluation procedure. Subjects diagnosed as cervical spondylosis with neck pain not less than 2 months would be enrolled. The total duration of study is 6 weeks. You will be exercised by the researcher in the workplace for 5 days a week. Exercises would be explained to you in detail and would at no time cross your individual capability. Each exercise session shall last approximately 15 minutes. The data should be collected at the beginning of the study and after 3rd & 6th week.

BENEFITS OF PARTICIPATION IN THE STUDY:

You learn about the ways and means to check your neck pain. Weakness of the muscles which leads to the neck pain will be controlled by the exercises which you will be able to do after the completion of treatment session.

RISK OF PARTICIPATION IN THE STUDY:

The risks involved are minimal of all present. The possibility of the discomfort being aggravated cannot be ruled out but it is very unlikely since you will be under the supervision of a qualified occupational therapist.

RIGHT TO WITHDRAW:

You have right to withdraw from the research at any point of time.

CONFIDENTIALITY:

All the information about you will be kept strictly confidential and limited to the research guides Prof. (Dr.) Abdur Raheem Khan and me and will not be shared with any other person not a part of the study.

DECLARATION:

I…………………………………..voluntarily consent to participate in this study. All my questions have been satisfactorily answered and the risks involved have been explained to me. I reserve my right to withdraw at any point of time and I have the contact address of Ekta Singh, if I require any further information.

____

SIGNATURE

Contact Address:

Ekta Singh

Email:

Contact no.______________

APPENDIX B

EVALUATION PERFORMA

EVALUATION PERFORMA

Name

Age / Sex

Height

Weight

Occupation

Address

Diagnosis

D.O. Registration

D.O. Examination

Current Medications if any:

History

Observation (standing or sitting)

Examination, sitting

- Active movements
- Flexion
- Extension
- Side flexion (right and left)
- Rotation (right and left)
- Peripheral joint scan
- Temporomandibular joints (open mouth and closed mouth)
- Shoulder girdle elevation through abduction.
- Elevation through forward flexion,
- Elevation through plane of scapula
- Medial rotation at90^0 abduction
- Lateral rotation at90^0 abduction
- Elbow (flexion, extension, supination, pronation)
- Wrist (flexion, extension, radial and ulnar deviation)
- Fingers and thumb (flexor, extension, abduction, adduction, circumduction)

Myotomes

Neck flexion (C1-C2)

Neck side flexion (C3)

Shoulder elevation (C4)

Shoulder abduction (C5)

Elbow flexion (C6) and /or extension (C7)

Wrist flexion (C7) and / or extension (C6)

Thumb extension (C8) and /or ulnar deviation (C8)

Hand intrinsics (abduction or adduction (T1)

Special tests

Forminal compression (Spurliag's) test

Distraction test

Shoulder abduction test

Vertebral artery tests

Reflexes and coetaneous distribution

Biceps (C5-C6)

Triceps (C-7-C8)

Hoffmann's sign

Sensory scan

Examination, supine

Passive movements

Flexion

Extension

Side flexion

Rotation

Special tests

Upper limb tension test

Vertebral artery test

Functional evaluation:

A.D.L. evaluation:

Work evaluation:

Radiological:

X-ray:

C.T. Scan:

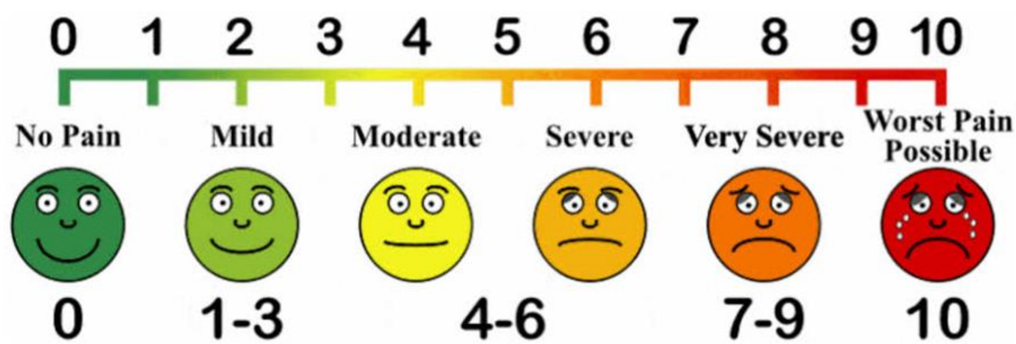
M.R.I.:

Treatment Plan:

APPENDIX – C

VISUAL ANALOGUE SCALE

VISUAL ANALOGUE SCALE



Zero pain Maximum pain

APPENDIX – D

MASTER CHART

GR	Age	Hrs	VAS			NDI		
			VAS 0day	VAS Week 3	VAS Week 6	NDI 0 day	NDI Week 3	NDI Week 6
A	42	7	6.3	5	3.4	24	12	8
A	42	8	5.8	5	2.4	25	11	9
A	44	8	6.8	4.2	2.4	26	14	9
A	40	6	7.2	4	1.1	22	16	7
A	50	7	8	6	4	31	18	9
A	45	8	7	5.5	3.4	27	22	12
A	48	6	6.8	4.7	3.1	28	18	10
A	49	8	5.8	4.1	1.5	30	14	9
A	41	8	6.1	6	2	23	14	8
A	47	7	7	5	6	28	18	19
A	43	6	6	1.4	1	26	12	8
A	41	7	4	4	3	23	18	10
A	48	7	7.5	4.8	3.1	29	17	19
A	43	7	7	6	5	26	13	9
A	48	7	6.8	3.1	1.8	28	19	10
B	45	6	6.5	5	2	28	17	9
B	41	7	6	4	3	24	15	6
B	48	8	8.1	4.1	1.8	30	12	7
B	40	8	7	4	4	22	12	7
B	50	6	7.1	5.5	3.2	32	16	10
B	42	8	6	6	5	25	10	7
B	45	7	7.1	4.8	6.2	28	15	18
B	41	8	5	4	4	23	16	10
B	44	6	5.8	3	1.5	27	12	8
B	44	7	6.1	4.2	1.3	27	12	9
B	47	7	5.1	3.5	2	29	17	9
B	48	7	7	5	4	31	16	8
B	46	7	7	5	3	29	18	8
B	43	8	5	3.2	1	26	12	10
B	42	7	6	3	1.2	25	12	9