T.C.
YEDİTEPE UNIVERSITY
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DEPARTMENT OF PHYSIOTHERAPY

COMPARISON OF THE EFFECT OF CORE STABILIZATION TRAINING IN ADDITION TO DEEP CERVICAL FLEXOR TRAINING IN PATIENTS WITH CHRONIC NECK PAIN

MASTER THESIS

BESTE HAZAL GÜMÜŞÇÜ, PT

ISTANBUL, 2021

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ADVISER
Prof. RASMİ MUAMMER

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	Title, Name-Surname (Institution)
Chair of the Jury:	Prof. Dr. Rasmi Muammer (Yeditepe University)
Supervisor:	Prof. Dr. Rasmi Muammer (Yeditepe University)
Member/Examiner:	Dr. Öğr. Üyesi Çiğdem Yazıcı Mutlu (Yeditepe University)
Member/Examiner:	Dr. Öğr. Üyesi Gülşah Kınalı (Sakarya University)

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This thesis has been deemed by the jury in accordance with the relevant articles of Yeditepe University Graduate Education and Examinations Regulation and has been approved by Administrative Board of Institute with decision dated 01/03/2021 and numbered 2021/02-45

Prof. Dr. Bayram YILMAZ

Director of Institute of Health Sciences

DECLARATION

I hereby declare that this thesis is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person nor material which has been accepted for the award of any other degree except where due acknowledgment has been made in the text.

23.02.2021

Beste Hazal GÜMÜŞCÜ

DEDICATION

I would like to dedicate my thesis to my beloved parents Gülsen and Ahmet GÜMÜŞCÜ and I also thank everyone who contributed on me.

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LIST OF SYMBOLS/ABBREVIATIONS

BMI	Body Mass Index
CCFT	Craniocervical Flexor Training Test
Cm	Centimeter
COG	Center of Gravity
DCF	Deep Cervical Flexor Muscles
FHP	Forward Head Posture
Kg	Kilogram
n	Number of Individuals
NDI	Neck Disability Index
p	Statistical Error Margin
SD	Standard Deviation
Sf-36	36-Item Short Form Survey
TENS	Transcutaneous Electrical Nerve Stimulation
VNPS	Verbal Numeric Pain Scale
Δ	Difference Between Groups

ABSTRACT

Gümüşcü, BH (2021). Comparison of The Effect of Core Stabilization Training in Addition to Deep Cervical Training in Patients with Chronic Neck Pain. Yeditepe University, Institute of Health Sciences, Department of Physiotherapy Master Thesis. İstanbul 2021.

Neck pain is a very common problem in the general population and ranks second most frequently to musculoskeletal problems after low back pain. The aim of this thesis is to compare the conventional therapy, cervical stabilization exercise approach and core stabilization exercise in addiction to the cervical stabilization in patients with chronic neck pain.

Our study was conducted on 45 patients with neck pain. Patients were divided into 3 groups by randomization method. Conventional therapy and isometric neck exercises to the first group (n=15), conventional exercise and deep cervical flexor training to the second group (n=15), conventional treatment and stabilization of the neck and core region were studied to the third group (n=15). The exercise programs were applied for four weeks, three days a week for 45 minutes. The demographic data of the cases in all three groups were recorded. Verbal Numeric Pain Scale was measured to assess pain intensity. The posture were evaluated using the Reedco's posture scale. Cervical ROM was evaluated using a goniometer. Neck Disability Index is a self-assessment form which evaluate the ability of patients with neck pain to perform daily activities. Health status assesed the SF-36. All data were analyzed by statistical method.

The results showed a significant difference between groups ($p < 0.05$). According to the findings, a significant improvement was found in pain, posture, ROM, NDI and SF36 values in all groups in the in-group evaluation results ($p < 0.05$). When examined between the groups, pain and posture improved more in Group 3, while a more significant difference was found in ROM and quality of life in Group 2. A significant difference was found within and between all groups after treatment.

In addition to conventional treatment, applying core stabilization exercises to patients with neck pain will be more effective in reducing pain, increasing range of motion and quality of life.

Key Words: Cervical stabilization, Core stability, Neck pain, Posture

ÖZET

Gümüşçü, BH. Kronik Boyun Ağrısı Olan Hastalarda Derin Servikal Fleksör Eğitimine Ek Kor Stabilizasyon Eğitiminin Etkisinin Karşılaştırılması. Yeditepe Üniversitesi Sağlık Bilimleri Enstitüsü Fizyoterapisi Yüksek Lisans Tezi. İstanbul 2021.

Boyun ağrısı, genel popülasyonda çok yaygın bir sorundur ve kas-iskelet sistemi problemlerinde bel ağrısından sonra en sık görülmede ikinci sırada yer alır. Bu tezin amacı, kronik boyun ağrısı olan hastalarda geleneksel tedavi, servikal stabilizasyon egzersiz yaklaşımı ve servikal stabilizasyona ek core stabilizasyon egzersizini karşılaştırmaktır.

Çalışmamız 45 boyun ağrısı olan hasta üzerinde yapılmıştır. Hastalar randomizasyon yöntemi ile 3 gruba ayrıldı. Birinci gruba (n = 15) konvansiyonel terapi ve izometrik boyun egzersizleri, ikinci gruba (n = 15) geleneksel tedavi ve derin servikal fleksör eğitimi, üçüncü gruba geleneksel tedavi ve boyun ve kor bölgenin stabilizasyon egzersizleri verildi (n = 15). Egzersiz programları dört hafta, haftada üç gün 45 dakika uygulandı. Her üç gruptaki vakaların demografik verileri kaydedildi. Ağrı yoğunluğunu değerlendirmek için Numerik Ağrı Derecelendirme Ölçeği ile ölçülmüştür. Duruş, Reedco Duruş Analizi kullanılarak değerlendirildi. Servikal ROM, bir gonyometre kullanılarak değerlendirildi. Boyun Engellilik İndeksi, boyun ağrısı olan hastaların günlük aktivitelerini gerçekleştirme yeteneklerini değerlendiren bir öz değerlendirme formudur. Sağlık durumu SF-36'yı değerlendirdi.

Tüm veriler istatistiksel yöntemle analiz edildi. Sonuçlar gruplar arasında anlamlı bir fark gösterdi ($p < 0.05$). Bu bulgulara göre tüm gruplarda grup içi değerlendirme sonuçlarında ağrı, postür, ROM, NDI ve SF36 değerlerinde anlamlı bir iyileşme bulundu ortaya konmuştur ($p<0,05$). Gruplar arasında incelendiğinde ağrı ve postür daha fazla Grup 3'te düzelirken, Grup 2'de EHA ve yaşam kalitesi daha fazla anlamlı bir fark bulunmuştur. Tedaviden sonra tüm gruplar kendi içinde ve arasında anlamlı bir fark bulunmuştur.

Geleneksel tedaviye ek olarak boyun ağrısı olan hastalara core stabilizasyon egzersizlerinin uygulanması ağrıyı azaltmada, hareket açıklığını ve yaşam kalitesini artırmada daha etkili olacaktır.

Anahtar Kelimeler: Servikal stabilizasyon, Kor stabilizasyonu, Boyun ağrısı, Postür

1. INTRODUCTION AND PURPOSE

Neck pain is frequently observed problem in the world population and is the second musculoskeletal problem after low back pain (1).

Pain that is not diagnosed with a specific pathology is defined as non-specific and is defined as chronic pain when it lasts for more than 3 months. Although neck pain is not serious enough to threaten a person's life, it reduces the quality of life of the person (2).

Symptoms of chronic neck pain occur on palpation of that area and a feeling of hyperalgia against muscles and ligaments during active or passive movement. If there is no specific pathology and the intensity of pain can be increased with provocative stimuli, it can be called mechanical neck pain (3).

Persons with chronic neck pain adversely affected their postural behavior due to jobs requiring long sitting positions such as computer-assisted work. Most of the individuals with neck pain spend the whole day in sitting position. Chronic neck pain occurs a potential to alter the biomechanics of the cervical region by adversely affecting the muscle imbalance and head and neck posture (4).

Proper posture of the person is a balance of musculoskeletal balance with minimal stress and strain on the body. While the correct posture is desirable, many people do not have a good posture. An ideal posture is considered to be aligned with a postural line. In a side view, postural line passes slightly anterior the ankle joint and the middle of the knee joint, posterior of the hip joint and through from the center of the shoulder joint and the external ear. Forward head posture is one of the common types of the head posture problems seen in persons with neck pain. The forward head posture is the condition in which the head comes in the frontal position relative to the lateral postural line (5).

According to previous studies, it has been proven that an average of 60% of patients with neck pain have a forward head posture. Being in a prolonged forward head posture increases the load on all structures in the posterior cervical region, such as bones, muscles, and joints, and this leads to altered scapular kinetics. Forward head posture causes shortening of the posterior neck extensors and tightening of the anterior neck and shoulder muscles (4).

The minimum passive resistance to movement in the neck region is the posture in which the cervical spine is upright and neutral. The cervical vertebrae are supported by the muscular sheath that is occured the longus colli muscle, the semispinalis cervicis and cervical multifidus muscles. Longus colli muscle has an important postural role, which is to support cervical lordosis. Besides, the cervical region is supported by the muscles that connect to the skull and surround the upper cervical vertebrae, such as the longus capitis muscle anteriorly and the suboccipital extensor, semispinalis, and splenius capitis muscles posteriorly.

Superficial muscle activity must be in balance with deep cervical muscle activity to stabilize the cervical region. Previous studies have indicated that patients suffering from neck pain have decreased the endurance of the deep cervical flexor muscles such as longus colli and longus capitis. The deep cervical flexor muscles provide in postural support and the knowledge that activation of these muscles is impaired in people with neck pain. This muscles causes the postural endurance. Moreover, it has been observed that the performance of the clinical craniocervical flexion test reduces the symptoms of the patient with neck pain. Since training the deep cervical flexor muscles increases the activation of the deep cervical flexor muscles, it can improve the ability of the cervical spine to maintain its neutral posture (6).

The deep cervical flexor muscles support the cervical lordosis and are an important stabilizer of the head and neck posture. In individuals with mechanical neck pain, there is a decrease in muscle activation of the deep cervical stabilizer muscles. This causes superficial muscles such as the trapezius muscle to undertake postural functions and increase the load on these muscles. When the performance of these muscles decreases, it means that the balance between the stabilizing muscles in posterior of the neck is disturbed. The deep cervical flexor muscles will deteriorate and cause a loss of proper posture, possibly contributing to cervical impairment. Therefore, deep cervical flexor training is suggested to increase the endurance of these postural muscles, and this results in a reduction in symptoms of neck pain. Research shows that motor control training of deep cervical flexor muscles before strengthening global cervical muscles is more efficient in neck pain rehabilitation (7).

Conservative methods are primarily preferred in the therapy of neck pain. In this treatment, manual therapy applications, electrotherapy and exercise methods are mostly used in patients with neck pain (8).

Patients with chronic or recurrent neck pain may experience deficiencies in maintaining head / neck position and postural stability. Trunk / core exercises that develop neck muscles should be included in order to increase the support of posture (9).

The aim of our research is to compare the conventional therapy, cervical stabilization exercise approach and core stabilization exercise in addition o the cervical stabilization in patients suffering from chronic neck pain.

Hypothesis 0: Conventional therapy, deep neck flexor muscle training and core stabilization training are not superior to each other in patients with neck pain.

Hypothesis 1-1: Deep neck flexor muscle training is more effective than conservative treatment in patients with chronic neck pain.

Hypothesis 1-2: Core stabilization exercises and deep neck flexor training that will correct the posture of the patient are more effective than conservative treatment in patients with chronic neck pain.

2. THEORATICAL FRAMEWORK AND LITERATURE REVIEW

2.1. Anatomy of Neck Region

2.1.1. Structure of Vertebra

The spine or vertebral column is a bony structure which contains and protects the spinal cord and connects the head to the pelvis. The most important function of the spine is to contain and protect the spinal cord, which provides the nerve supply of the whole body coming out of the brain. Apart from this main function, it supports body mass, resists external forces and distributes energy throughout the body and allows motions and flexibility while maintaining against impact. The vertebral column is attached from the muscles and ligaments to the trunk, which helps support postural control and stability (10).

The spine is consists of 33 vertebrae: 24 vertebrae occurance of 7 cervical, 12 thoracic, and 5 lumbar vertebra. The sacrum and coccyx have various variations. The sacrum is consisted of 5 vertebra which are fused. The coccyx consists 4 vertebra which are variably fused (11).

Each ‘‘standard’’ vertebra is consisted of a body, two pedicles, two lamina, four facet joints, and the spinous process. There are two openings between each vertebra, a spinal nerve and the foramina through which blood vessels pass. Each foramen is framed superiorly and inferiorly by pedicles, posteriorly from the facet joint and anteriorly by the intervertebral disc and adjacent vertebral body surfaces (12).

The vertebral foramen is the hole inside each vertebra. Therefore a typical vertebra has the vertebral body, the pedicles, the laminae, and the spinous process occur the edges of the vertebral foramen. The size and shape of the vertebral foramina varies from one area of the spine to another. The combination of all vertebral foraminas occurs the vertebral canal. This vertebral canal includes the spinal cord, nerve roots, meninges, and many vessels (13).

The spinal canal has laminas and ligamentum flavum posterolaterally, while the anterolateral part consists of pedicles and the other anterior aspect of the vertebral bodies and the posterior surface of the intervertebral discs.

The facet (zygapophyseal) joint is formed as a synovial joint. Although it has limited support for the spinal column, the main task of the facet joint is to provide spinal column stability. Maintaining stability is a function that is adhere to the plane of the facet joint surface and changes along the spine by guiding the direction of the spine movement (14).

The intervertebral discs are positioned between vertebral bodies and connect them together. They help transmit loads from body weight and muscle activity through the spine. They provide flexibility and allow flexion and rotation (15). Each disc is consisted of an elastic collagen tissue, the annulus fibrosus, which surrounds the gelatinous nucleus pulposus. Intervertebral disc transforms into avascular tissue with aging, and disc nutrition is given to the disc by diffusion. The nucleus pulposus has no nerve supply in the normal adult disc (14).

2.1.2. Cervical Vertebra

The cervical spine includes vertebra (C1–C7) and intervertebral discs between them, and is starting from the bottom of the skull and continuing to the thoracic vertebrae. The cervical spine’s major missions contain to support and to act cushioning loads to the head/neck while performing movements, and to protect the spinal cord (16). Of these cervical vertebrae, the atlas (C1) and axis (C2) are among those that play the most role in the movements and rotation of the head (17).

The 1st, 2nd and the 7th cervical vertebra are dissimilar than the others. The another four vertebra are likely to each other. Although the 3rd, 4th and 5th cervical vertebrae are the same, there are some minor differences in the 6th vertebra (18).

The occiput and first 2 vertebrae are called the upper cervical spine and craniocervical region (14). Atlas (C1), unlike other cervical vertebrae, has no vertebral body, but rather a more annular structure to form the atlanto-occipital joint to embrace the skull in the occipital bone. Motion in the sagittal plane of the atlantooccipital joint, that allows for 40% of cervical flexion extension and 5° to 10° of lateral flexion and this is the major function. The axis (C2) occurs a large bony protrusion (the odontoid process) and forms the atlanto-axial joint. This combination let to rotate the head and atlas from side to side as a block, providing an average of 50% of the rotation of the neck and transmitting the weight of the head to other parts of the cervical spine. The axis forms the junction for the superior and inferior connections of the posterior deep muscles of the craniocervical and lower cervical regions. In this way, the deep muscles of the lower cervical region can further stabilize the atlas by creating a stable base for craniocervical muscle function. The lower region of the cervical spine (C3-C7) has less mobility, and its main task is to carry the weight of the head and support the loads applied to this area. The Atlantoaxial complex allows 60% of the rotation of the entire neck area (17).

The C3 to C7 vertebrae are called the lower cervical spine. This common structure allows flexion, extension, and strong ipsilateral axial rotation and lateral flexion motions. The spinous processes are in two parts for ligamentum nuchae connection. The annulus of an adult intervertebral disc is crescent shaped and relatively absent posteriorly (fibrocartilage replaced by structure). The 2 adjacent vertebra and supportive soft tissues of each movement segment may be divided into an anterior and a posterior column. The stability of a cervical segment is provided directly from the anterior spinal region. The paraspinal muscules and ligaments provide to support oppose forces. The facet articulations restrict anterior vertebra. The primary limitation to distraction of the spine are ligamentous structures. Tensile forces are directly resisted by the annulus fibrosus and longitudinal ligaments. Then, these are assisted by the additional resistance countered by the ligamentum flavum, facet capsules, supraspinous and interspinous ligaments (14)(figure 2.1).

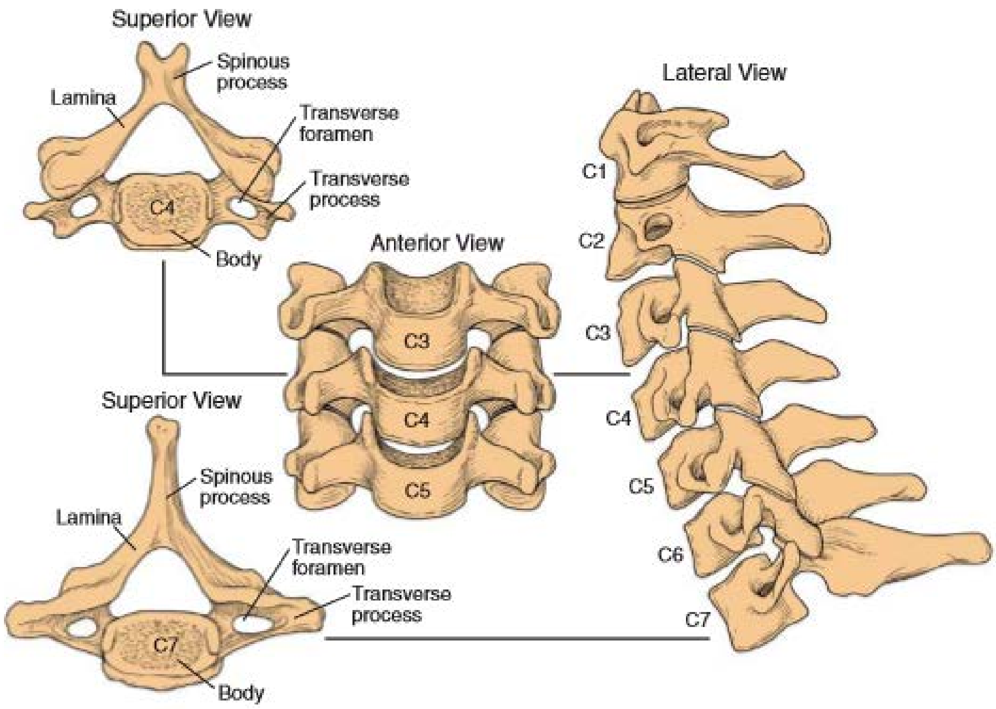


Figure 2. 1: Cervical spine vertebra (11)

2.1.3. Ligaments of Cervical Spine

Ligaments are fibrous bands that carry a tensile load in the direction of fiber orientation. When an external force is exerted on the spine, ligaments provide tensile resistance to balance the forces. Ligaments consist of collagen, water, elastin and proteoglycans (19).

The ligaments have four major functions, two for motion and stability and two functions for protection. The first function is to allow proper movement of the vertebrae using minimal amounts of energy from the surrounding muscles. Secondly, along with the muscles, the ligaments provide stability for the spine. Third, the ligaments must preserve the spinal cord by limited movement and preventing the disc from protruding into the intervertebral foramen. Lastly, ligaments protect the spinal cord during traumatic injury. When large loads are performed to the area, the ties must restrict maximum movement and absorb the large amount of strain applied to the area (20).

The five primary ligaments in the cervical region are the anterior longitudinal ligament, posterior longitudinal ligament, ligamentum flavum, interspinous ligament, and capsular ligaments (19)(figure2.2).

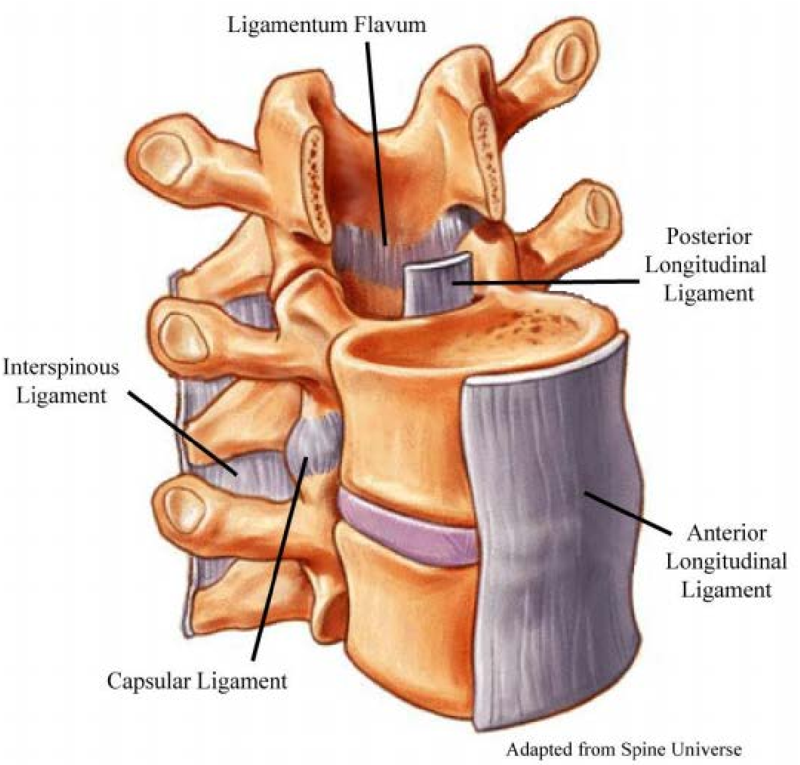


Figure 2. 2: Neck Ligaments (19)

The anterior longitudinal ligament (ALL) is a long and broad band of longitudinal fibers that runs from the atlas and occipital bone of the skull to the sacrum. It is continuous with the craniovertebral ligament, the anterior atlantoaxial ligament which runs from the atlas to the base of the skull. The mission of the ALL is to maintain stability for the intervertebral joints and prevent hyperextension of the spine.

The posterior longitudinal ligament (PLL) is like ALL as it stretches along the spine. The PLL begins at C2 and extends into the sacrum along the posterior of the vertebral bodies inside the vertebral canal. At C2, the PLL is continuous with the craniovertebral ligament, the tectorial membrane. The PLL is much narrower than the ALL; however it is widest across the intervertebral discs where it is most firmly attached. The posterior longitudinal ligament helps to prevent hyperflexion of the vertebral column. Since it covers the disc, and lies between the disc and the spinal cord, the PLL also serves to prevent herniation; where a large compression or bending force is applied to the spine and the intervertebral disc bulges posteriorly due to the increased pressure in the nucleus pulposes, and risks making contact with and injuring the spinal cord.

The ligamentum flavum (LF) are very elastic ligaments that join laminae of adjacent vertebral arches, and are located within the spinal cord, posterior of the spinal cord. The LF has the highest elastincollagen ratio of the spinal ligaments. The ligamentum flavum prevent separation of the laminae which stops sudden flexion of the spinal column, preventing hyperflexion and injury to the intervertebral discs. The high elastic content preserves the normal curvature in the spine as well as helps to return the vertebrae to normal position after movement (19).

The capsular ligaments (CL), surround the facet joints, as mentioned previously, and are attached to the articular processes of adjacent vertebrae. The capsular ligaments completely surround the joint in order to keep the synovial fluid contained, but are thin and lax (especially in the cervical spine where they are also longer than in other spinal regions) in order to allow the joint to move (20).

The interspinous ligament (ISL) connects adjacent spinous processes, where the ligament runs from the root to the tip of each process. It is very thin and membranous, and generally weak, especially in the cervical spine region. The anterior edge of the ISL is in contact with the LF, and the posterior edge adjacent to the supraspinous ligament or the nuchal ligament.

The supraspinous ligament (SL) is attaches to the tips of spinous processes, and is a strong cord that runs along the posterior of the spine, continuous with the ISL between processes. This ligament is underdeveloped in the cervical spine but is present from C7 to the sacrum.

The nuchal ligament (NL) is continuous with the SL into the cervical region connecting with the external occipital protuberance of the skull. This ligament is made of thick fibroelastic tissue and mainly functions to divide the left and right soft tissues of the neck, and does not contribute to kinematic response. Since C3 to C5 have such short spinous processes, the NL must connect to muscle instead of bone. Therefore it is not simple to test the mechanical features as there are no adjacent vertebral bony attachment points (20).

The intertransverse ligaments (ITL) are ligaments that connect adjacent transverse processes throughout the spine. They are insignificant in the cervical spine as they are very small, and indistinguishable from surrounding tissue as they only consist of a few irregular, scattered fibers (19).

Craniovertebral lig.

The craniovertebral junction is one of the most complicated set of articulations in the person skeleton. Therefore the ligaments due to the movement functions of the neck. Not only must the head be able to rotate, flex and extend with a relatively large degree of motion, but it must also protect the spinal cord. This leads to an increased number of ligaments to limit motion and protect the spinal cord. The craniovertebral ligaments are divided into two groups, ligaments connecting the occipital of the skull to the atlas; the atlanto-occipital joints, and the ligaments connecting the atlas and axis; the atlantoaxial joints. The most significant of these ligaments are the cruciate, alars, anterior and posterior atlanto-occipital and atlantoaxial membranes, tectorial membrane, apical and accessory ligaments (21).

There are three cruciate ligaments: the atlantal transverse, and the superior and inferior longitudinal bands (known as crus or crux). The superior and inferior 33 longitudinal bands cross to the posterior of the transverse ligament, running vertically, forming a cross. The superior band runs from the transverse ligament to the occipital bone, while the inferior band runs down to the vertebral body of C2, the axis. The transverse ligament connects to the medial tubercles of the atlas and run posterior to the odontoid process, but anterior of the tectorial membrane. The transverse ligament fits into a slight groove on the odontoid process and holds it in place opposite the anterior surface of the atlas, and restricts motion of the atlas; limiting motion to rotation about the axis, and prevents translation in the transverse plane. The remaining space in the vertebral foramen is for the spinal cord.

The alar ligaments are cord-like ligaments that attach to the medial edges of the occipital bone and connect to the lateral sides of the odontoid process. There are also alar ligaments that attach the odontoid process to the anterior surface of the atlas. They are fibers that connect the dens to the skull and the dens to the atlas. The ligaments are short, and round; about 5 mm in diameter. The mission of the alar ligaments is to prevent over rotation of the head, and are commonly referred to as ‘check ligaments’.

The apical ligament connects from the superior tip of the odontoid process to the anterior margin of the foramen magnum between the alar ligaments. It is closely intertwined with the deep layers of the anterior atlantooccipital membrane and superior longitudinal cruciate ligament (21).

The anterior atlantooccipital and atlantoaxial membranes (AAOM and AAAM respectively) are formed end of the anterior longitudinal ligament. They are both strong and wide membranes comprised of dense fibers with a rounded cord along the midline to add strength. The anterior atlanto-occipital membrane runs from the anterior inferior surface of the occipital bone to the anterior superior surface of the anterior arch of the atlas, while the atlantoaxial membrane runs from the inferior anterior arch of C1 to the superior body of the axis. Like the capsular ligaments, they are very thin and loose, so the joint can flex and extend easily (19).

The posterior atlanto-occipital and atlantoaxial membranes (PAOM and PAAM respectively) are also both wide membranes but are relatively weak compared to the anterior counterparts. The posterior atlanto-occipital membrane runs from the posterior inferior surface of the occipital bone to the posterior superior surface of the posterior arch of the atlas, while the atlantoaxial membrane runs from the inferior posterior arch of C1 to the superior lamina of the axis. The function of these ligaments is to restrict excessive general motion of the craniovertebral joints.

The tectorial membrane (TM) is formed end of the posterior longitudinal ligament. It runs from the body of C2 through the foramen magnum and attaches to the central base of the cranial cavity. The tectorial membrane covers the cruciate and alar ligaments. The function of the TM is to limit extreme flexion (21).

2.1.4. Muscles of Cervical Region

The muscles of the cervical region have two primary tasks: holding the head in an upright position against gravity and positioning the head properly. It also stabilizes the head and neck and allows movement of the scapula (22). In a standing upright position, the center of gravity passes in front of the neck, creating a flexion moment in the head and neck. Posterior muscles and ligaments in the cervical region resist the flexion moment to keep the head in an upright position. Cervical region muscles have a very complex structure. They provides sufficient stability to maintain the spinal cord and allows movement of the upper limb (23)(tablo 2.1).

ANTERO-LATERAL MUSCLES	**POSTERIOR MUSCLES**		
Platysma Hyoid Muscles Sternocleidomastoid Scalene Muscles -anterior scalene -medius scalene -posterior scalene	**Superficial group**	**Middle group**	**Deep group**
	Trapezius Levator scapula	Splenius capitis Splenius cervisis	Erektor spina -iliocostalis cervisis -longissimus capitis -longussimus cervisis -spinalis cervisis Transversospinalis -semispinalis cervisis -semispinalis capitis -multifidus -rotator muscles
Prevertabral Muscles	**Suboccipital Muscles**		
Longus colli Longus capitis Rectus capitis anterior Rektus capitis lateralis	Rectus capitis posterior major Rectus capitis posterior minor Oblicus capitis inferior Oblicus capitis superior		

Table 2. 1: Classification of Neck Muscles (23)

The neck muscles support to static and dynamic controling of the head posture and neck posture and surround cervical spine. However, there are differences in their mechanical effects on the spine due to the morphological differences between the muscular layers surrounding the spine. The deep flexor muscles are associated with the cervical vertebra and articular elements, but the sternocleidomastoid has no connection with the cervical vertebra (24) (figure 2.3).

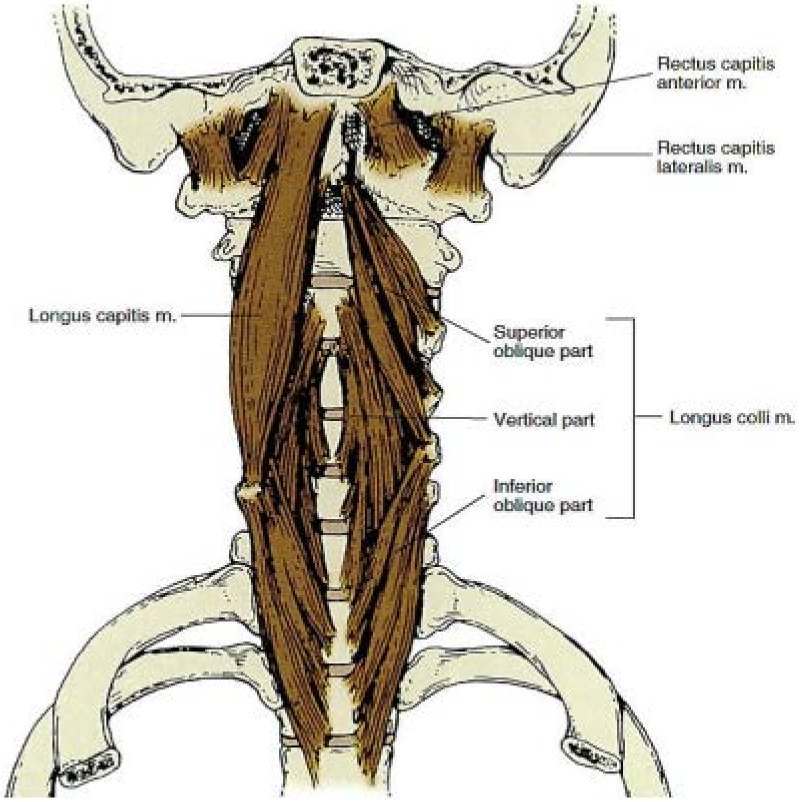


Figure 2. 3: Cervical anterior deep muscle group (13)

Antero-Lateral Muscles

The platisma muscle is between the skin and the fascia cervicalis superfisialis. Mouth corner and from the mandible to the clavicle. Stretches the skin of the neck. It is innervated by pleksus cervicalis and n.fasiali.

The sternocleidomastoid muscle (SCM) extends from the manubrium and proximal clavicle to the mastoid process. In the lateral contraction of the atlantooksipital joint to the head extension, neck flexion. When unilateral contraction, lateral flexion in the same side and rotation in the opposite side. Essentially n. axessorius is inervated in the ventral branch (figure 2.4).

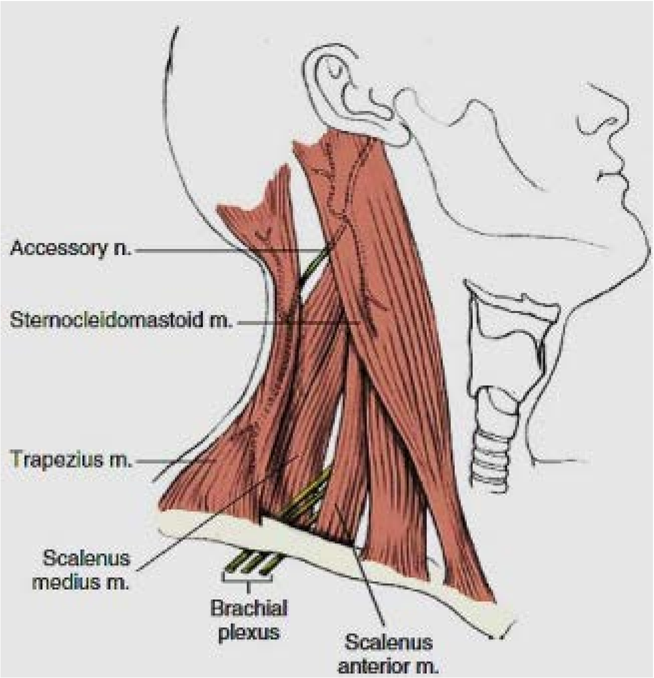


Figure 2. 4: Side view of the cervical region muscles (13)

Digastric, stylohyoid, mylohyoid and geniohyoid muscles are called suprahyoid muscles. The infrahyoid muscles include omohyoid, sternohyoid, sternotroid and thyrohyoid muscles. Suprahyoid and infrahyoid muscles work as a group. Hyoid bone and larynx and trachea connected to this bone, speech, swallowing, breathing during the task in the best way to do. In addition, these muscles help the head and neck flexion.

Scalene muscles, scalenus anterior, scalenus medius and scalenus The M. scalaren anterior attachs from the anterior tubercles of the transverse processes of the vertebrae to the inner edge of the first rib. Helps inspiration by lifting the first costa. Makes lateral flexion of the neck. The subclavian vein positioned from the front of the anterior scalar muscle, behind the subclavian artery and also the brachial plexus. It is innervated by the anterior branches of the C4-C6 spinal nerves. The M. scalenus medius extends from the transverse protrusions of the C1-C6 vertebrae to the front of the first rib. Helps inspiration by lifting the first costa. It also helps lateral flexion and rotation of the neck. It is innervated by the anterior branches of C3-C8 the spinal nerves. The M. scalenus posterior extends from the transverse protrusions of the C4-C7 vertebrae to the outer rib of the second rib. Makes lateral flexion of the neck. It also helps the inspiration by pulling up the second rib. It is innervated by the front branches of C6-C8 the spinal nerves.

Prevertebral neck muscles consists of m. longus colli, m. longus capitis, m. rectus capitis anterior, m. the rectus capitis the lateralis. The longus colli and the longus capitis muscles are deep group muscles in the anterior cervical region. Longus capitis begins from the anterior tubercle of the processus transversus of the cervical vertebrae and attaches to the occiput. The longus colli starts from the corpus of the trocal vertebra and adheres to the anterior tubercle of the processus transversus of the cervical vertebra. The longus colli is the main muscle that supports and controls the cervical curve opposite caused by contraction of strong extensor muscles and head weight. These muscles are involved in the segmental stabilization of the cervical vertebra. The degree of cervical lordosis decreases when contracted. It has been shown that the Longus collium muscle is activated bilaterally by swallowing, coughing, and stabilizing the head by bilateral activation. In various types of cervical vertebra dysfunction, the anterior deep segmental muscles were weakened and lost their endurance capacity. (25)

The rectus capitis anterior and rectus capitis lateralis muscles extend between the transverse process of atlas and the inferior face of the occipital bone. M. rectus capitis allows anterior head flexion, m. rectus capitis lateralis also makes lateral flexion to the head. Longus colli is innervated from the anterior branches of C2-C7 the spinal nerves, while the other prevertebral neck muscles are innervated by the anterior branches of the C1-C2 spinal nerves. (25)

Posterior Muscles

The trapezius muscle, which is the most superficial of the posterior group muscles, consists of 3 parts: the upper, middle and lower parts. The upper part extends out of the processus spinozus of the linea nukae and all the cervical vertebrae 1/3 of the clavicle. While the head and neck are fixed, it pulls up the scapula. If the scapula is fixed with other muscles, the head and neck extension is done. Middle part adheres from the spinus of the thoracic vertebra to the acromion. It brings the scapula up to the vertebral. The lower part adheres from the spinus of the thoracic vertebra to the spina scapula. It pulls the scapula down and inwards. It is innervated by N. Aksessorius.

Levator scapula muscle, from the processus transverse of the 1-4 cervical vertebrae, extend to the angulus superior scapula and margo extend to the upper part of the medialis. Pulls the scapula up and inwards. If the scapula is fixed with other muscles, the head and neck are lateral flexion when the muscle is twisted unilaterally, and the head and neck is extended when bilateral contractions. It is inerveted by N. dorsalis the scapula.

Splenius Servisis, 3-6. the process of the thoracic vertebrae is associated with the spinus of the 3rd cervical vertebrae between the processus transversus. The Splenius Capitis muscles are between the processus spinozus of the 7th cervical and the first 4 thoracic vertebrae, and the 1/3 lateral of the linea nukae superior and the porcelain mastoideus. When the splenius muscles work unilaterally, lateral flexion to the head and neck and rotation to the same side make extension to the head and neck when they work bilaterally. It is inerveted by the ramus dorsalis.

Erector spina muscle, cervical, thoracic and lumbar parts of the sacrospinal muscle group. The muscle fibers extend parallel to the vertebral column. These muscles in the cervical area from the lateral to medial m. iliokostalis servisis, m. longissimus servisis, m. longissimus kapitis, m. spinalis servisis and m. spinalis. These muscles in the cervical region are lateral extension of the neck when they contract, and lateral flexion when they are unilateral. It is inerveted by the ramus dorsalis (25)(figure 2.5).

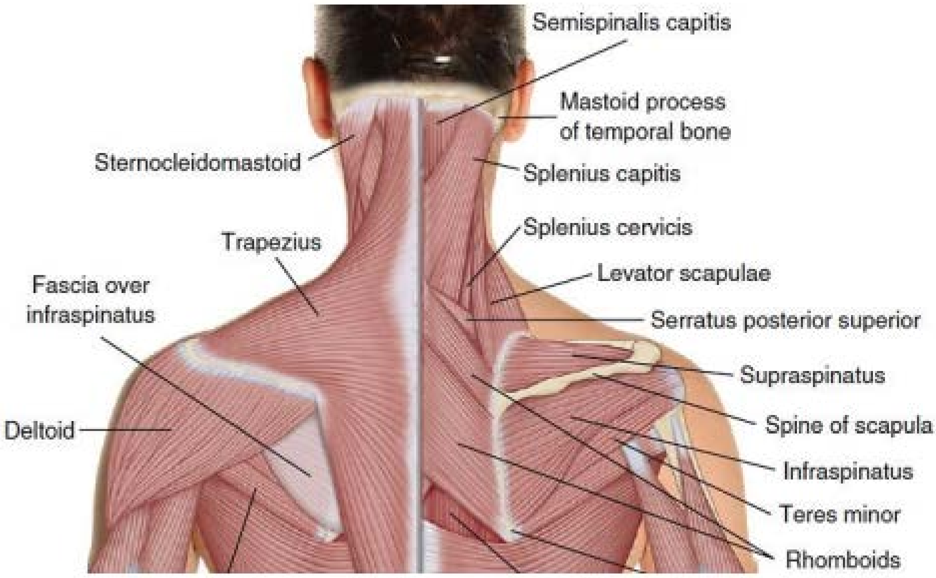


Figure 2. 5: Cervical region posterior superficial and middle group muscles (13)

2.1.5. Cervical Nerves

The neck regions are innervated by C1-C4 nerves.When the cervical spinal nerves leave the spinal canal through the neural foramina, they are divided into two branches called ventral and dorsal ramies after giving the meningeal branch that induces regional vertebral structures. The ventral ramus forms the cervical nerve while the dorsal ramus retains the facet joints and muscle structures in the back of the neck. The ventral rami of C1-C4 forms the brachial plexus between the cervical plexus and the C5 T1. The cervical plexus is occured by the anterior ramus nerves of the spinal cord, the motor and sensory fibers. The sensory branches of the plexus cervicalis that take the anterior, lateral and scalpular sensation, N. Occipitalis minor (C1), N. Transversus cervicalis (C2-C3), N. Auricularis magnus (C2-C3) and N. Supraclaviculares (C3-C4). This common point of all nerves is called the Erb point (17).

2.2. Biomechanic of Cervical Region

The cervical region is the segment of the spinal vertebra that allows the most movement. The average range of motion of the cervical spine is normal for an individual with 80° to 90° flexion, 70° extension, 20° to 45° lateral flexion, and 90° rotation to both sides. The height difference of the vertebra from the body to the disc is 1/3 and the anatomically special combination of C1 and C2 increase this mobility (17).

The cervical spine consists of two parts as the upper (occiput-C1-C2) and the lower (C3-C7) cervical vertebra. While the upper cervical region moves with its unique feature, the lower cervical region movements are similar. The first cervical vertebra that is called the atlas allows the skull to support the head by articulating the occiput. The atlas occurs the joints with the occipital condyles and allows flexion and extension movement. The atlanto-occipital joint has normal flexion to hyperextension ranges from average 15° to 20°. Due to the atlantal sockets with occipital condyles, rotation and lateral flexion movements are not performed in the area between the occiput and the atlas.

The Atlanto-axial (C1-2) joint is the most mobile segment of the vertebral column and carrys the head weight. After weight bearing, the other task of the this joint is to provide a wide range of axial rotation. In the neutral position the apex of the atlantial convexity is located on the convexity of the axial facet (16). The meaning of the convexity of the atlanto-axial joint is that all cervical joints must improve a movement in the flexion and extension of the Atlas. When the cervical vertebrae are flexed, Atlas extension makes, Atlas flexion when the cervical vertebrae extends. The balance of the Atlas can be adjusted in the concussion of the Axis (17).

The body of the axis occurs as a root within C3, it separates the upper cervical spine from the remaining cervical column. The articular surfaces of the lower and upper intervertebral joints resemble a saddle joint and protect concavities in all directions. This junction of the cervical trunks of the middle-lower cervical column have rotation and flexion movements, but it limits lateral flexion. While lateral flexion occurs in the cervical region, a combined movement occurs in the cervical vertebra, and this is due to the rotational movement in the entire segment due to that side.

Since flexion and extension movements occur mostly at C5-C6 levels, degeneration is also common at these levels. In addition, the facet joints in the cervical area have more mechanoreceptors than the thoracic and lumbar regions. This shows that the cervical region has a great importance in proprioceptive function. Also, the neutral and resting position of the cervical spine is light extension, maximum stability, and the closed pack position is full extension (17).

2.3. Neck Stabilization

Deep muscles play an important mission in posture control and stability of the cervical vertebra. Cervical spine stabilization is a phrase applied to a variety of different techniques used in the cervical spine (the neck) to reduce or eliminate instability. Instability can be caused by degenerative disc diseases, trauma, injury, herniated discs and more (26).

Cervical stability is very important. The strength of the muscles around the neck plays a major role in stabilizing the cervical region. Deep neck flexors are a large muscle needed to stabilize the neck, support the head against gravity and support the head posture (27).

Recently, the roles of longus colli and longus capitis, the deep muscles, play a role in maintaining cervical stability. Strengthening the deep muscles can improve posture and improve the ability of the neck to maintain a neutral position (28).

2.4. Neck pain

Neck pain (NP) is becoming increasingly prevalent in the population. Predictions show that 67% of individuals will experience neck pain at some stage in their life. NP is an important illness not just for adults but also for adolescents. The onset and course of NP is influenced by many factors with physical, psychosocial and personal factors interacting in the occurance of these disorders (7).

Neck pain is a prevalent musculoskeletal problem. Occasionally neck pain may be due to a various pathology such as nerve entrapment, a prolapsed intervertebral disc and a vertebral fracture. Also, there is usually no specific and identifiable cause of neck pain and it is considered non-specific neck pain. If neck pain persists for more than 3 months, it is considered chronic (29).

People with chronic pain experience a decrease in the quality of daily life and related physical disability. According to epidemiological studies, even when looking at the incidence of the sexes according to the frequency and severity of pain, women feel pain and take painkillers significantly more than men. The incidence of neck pain increases due to aging (30).

Acute pain; Pain or disability, pain in the left eye for 0-6 weeks, subacute neck pain; Pain or disability persists for 6-12 weeks and chronic neck pain is defined as pain or disability that has persisted for more than 12 weeks (31).

2.4.1. Causes of Neck Pain

Neck pain is categorized by mechanical, neuropathic, or secondary (pain from heart or vascular problems) mechanisms. Mechanical pain is considered for pain caused by the spine or its surrounding structures (ligaments and muscles). Mechanical pain are caused by facet joints (eg Arthritis), discogenic pain, and types of myofascial pain. Neuropathic pain is often caused by mechanical or chemical damage to nerve roots. Radicular symptoms and spinal stenosis from a herniated disc are the most common examples of peripheral neuropathic pain. Pain caused by myelopathy or spinal cord pathology falls under the category of neuropathic pain. Mixed neuropathic-nociceptive problems contain postlaminectomy (bad surgery) syndrome and common degenerated discs (32).

Studies show that the presence of muscle imbalance, impaired muscle strength and endurance, impaired cervical mobility, impaired head posture, and impaired cervical proprioception in patients suffering from neck pain, show that abnormal psychological conditions, namely anxiety, depression and disaster, will also affect it. Neck mobility, head posture, and changes in local and global muscular system dysfunction cause to alters in force-length curves, imbalances of muscles, and segmental imbalance. It causes abnormal stress and strain on joints. This strain creates repetitive microtraumas in the neck area. These microtraumas cause the neck structures to fail to perform their missions and consequently cause segmental instability. Anormal segmental instabilite leads to decrease servical range of motion (33).

Trauma and many sports injuries result neck pain. Chronic neck pain is more common in women and its incidence increases with aging. Psychosocial factors, occupational factors, cultural factors and physiological factors are among the factors affecting neck pain. In previous studies, many jobs such as office workers, workers using computer, manual workers, and healthcare workers found higher incidence of neck pain (34).

Mechanical Neck Pain

Mechanical neck pain (MNP) is described as a general neck pain with symptoms affected by neck movements, head position, and palpation of the cervical muscles. It has become an increasing problem causing functional problems in wide populations. The underlying causes of chronic MNP are not known exactly. Previous studies have supported that biomechanical factors such as excessive computer use and poor posture and repetitive motions are related to the occurance of neck pain. Apart from physical factors, neck pain may be related to people under psychosocial stress.

Trapezius muscle activation was observed in the absence of physical activity and during mentally stressful work, and the combination of physical and mental stress was shown to further increase trapezius muscle activity. Therefore, chronic exposure to biomechanical and psychosocial stressors can potentially cause pain and muscle spasm. The prolonged duration of the pain reduces functional conditions, activities in daily life and work performance, and this improves psychological problems such as anxiety and depression in the person (34).

Cervical Degenerative Disc Disease

Degenerative disc problem and degenerative joint problems, osteoarthritis and spondylosis have the same meaning. These diseases occur as a result of wear and tear in all joints. Progression of the disease leads to the possibility of wear due to gravity, the pressure of the damage and overuse of the joints. It is not actually like an arthritis, it is just alters in our joints and discs in the spine. Increasing risk factors can increase the rate of joint degeneration (35).

Cervical Strain and Sprain

Sprains and acute strains, which are neck injuries most commonly seen in athletes, occur in neck muscles and soft tissue contusion. Trauma such as whiplash causes muscle damage that happens when muscle is overstretched. Whiplash from a fall can result of trauma, or, more often, a collision of the vehicle. This trauma may damage bone skeleton, the facet joints, muscles, blood vessels, ligaments, nerves and the intervertebral disc. Most cervical spine problems leads some degree of muscle damage. This is a serious damage stabilization neck muscles of the motion of the spine (35).

Cervical Disc Herniation

Herniated disc refers to a problem in the disc between the vertebrae. Disk is positioned between two vertebra. When a herniated disc or disc herniation occurs, part of the disc protrudes further. Disc herniation can put pressure on the nerve that passes near the disc and it leads to occur numbness and muscle weakness in arms and legs. However, many people with herniated disc do not have symptoms (35).

Bulging: It is a change in the form of anulus fibrosis by making a herniation (swelling) out of the normal border of the nucleus pulposus (figure2.6.a).

Protrusion: There is rupture of the fibers of the inner layer of annulus fibrosis. Nucleus pulposus annulus is surrounded by fibers and support ligaments of the outer layer of fibrosis. There is no problem in the posterior longitudinal ligament (figure2.6.b).

Extrusion: The annulus fibrosis ruptures completely and the nucleus pulposus into the canal, the posterior longitudinal ligament is torn (figure2.6.c).

Sequestration: The herniated nucleus is the release of the pulposus in the epidural space. The free fragment is called and the posterior longitidunal ligament is torn (figure2.6.d).

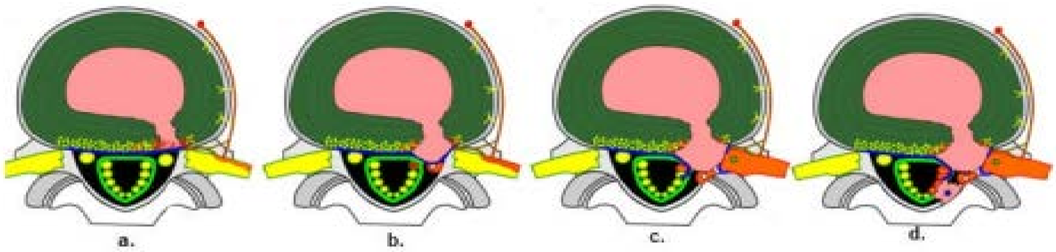


Figure 2. 6: Classification of herniated disc (a. Bulging, b. Protrusion, c. Extrusion, d. Sequestration) (35)

Cervical Spondylosis

Cervical spondylosis occurs when intervertebral discs break down, lose their water density and collapse with aging. Disc degeneration leads to increased mechanical stress at the cartilage at the vertebral body. This leads to subperiosteal bone creation or osteophytic formations that extend along the anterior apperance of the spinal cord and nerve tissue. Discs between the third and seventh cervical vertebrae are more frequently affected than the upper neck region (36).

Whiplash Injury

Whiplash injury, which is a widespread lead to chronic neck pain, is often experienced in motor vehicle collisions and is called neck injury caused by acceleration-deceleration forces. Symptoms of the disease are neck pain, headache, jaw pain, dizziness, a singing in the ears, memory and concentration difficulties (37)

Cervical Radiculopathy

Cervical radiculopathy is a nerve root-related pathological disease caused by disc herniation, spondylosis, tumor or nerve root avulsion. Cervical radiculopathy can also occur when a definitive cause cannot be determined. The nerve root is compressible in the intervertebral foramen such as the facet joint, invertebrate joints and disc. Patients with cervical radiculopathy have pain, tingling and weakness, or all of these symptoms may be seen. Assessment for radiculopathy should contain a history to describe the precipitating cause, pain, paresthesia, weakness, arise with the presence of activity and night pain (38).

Facet Syndrome

Individuals with facet syndrome causes back pain. Facet joints are found in each segment on both sides of the vertebra. They maintain about 20 percent stability for rotation. Facet joints which provide the rotation motion, facet joints are positioned at each level of the spine. This syndrome consists of degenerative changes in facet joints. The cartilage inside the facet joint can break down and the nerve networks in this area can increase pain (35).

Muscle Spasms

Muscle spasm progresses with pain, stiffness and tenderness in the neck and trapezius muscles. Accompanying it, trigger point formation is also observed. These symptoms are not only observed in the neck area, but can also cause pain that spreads from the shoulders to the arms and hands. Keeping the neck in flexion for a long time is the most important reason for muscle spasm. Weakness of the muscles stabilizing the neck and the imbalance between the muscles increases this pain even more (35).

Myofascial Pain Syndrome

They are pain caused by the trigger point of the muscle or muscle group in the fascia. Symptoms of this syndrome are muscle stiffness, tenderness, limited range of motion and fatigue. Causes of trigger points are injuries of the musculoskeletal system, overuse, stress, fatigue, cold and genetic factors. It also causes poor posture, physical inactivity, infections, vitamin B complex deficiency, metabolic and endocrine disorders.

The cause of osteoarthritis is mostly unknown and it can be seen as a result of aging in humans. It occurs due to wear on the joint. Cartilage is found in joints and has a firm elastic tissue feature to cushion bones. If the cartilage is destroyed, the bone rubs against each other. This problem causes pain, swelling and stiffness. Osteophytes or additional bone, can be occured around the joint. In this area, weak ligaments and muscles around the joint may become stiff (35).

2.4.2. Evaluation of the Patients with Neck Pain

Laboratory evaluation

Blood tests can be applied to evaluate inflammatory disorders such as rheumatoid factor. Imaging tests such as radiography, ultrasound, and MRI should be performed to detect morphological changes in the diagnosis of neck pain. Regions such as degeneration in the spine, neck, and ribs should be interpreted with caution in radiographic findings. Intervertebral disc distances, changes in cervical lordosis, osteophytes, pedicles, foramen stenosis, listesis uncovertebral and facet joints are seen on direct radiographs, but it is not possible to obtain information about neural tissues. computed tomography shows cross-sectional bone and soft tissue anatomy of the cervical region. We can observe the difference between soft tissue and bone by MRI. Thus, it gives detailed information about the nerve root, spinal cord, disc, tecal sac, bone and bone marrow.

Physical evaluation

The first information to be taken in the patient's history is the onset, course and symptoms of the disease. This determines whether the condition is acute or chronic and whether the onset is due to trauma. Then the patient should be physically evaluated. After the person is evaluated as a physical examination, range of motion test, pain and muscle strength test, palpation of muscle tendons and joints, neurological evaluation and specific tests are applied. The physician needs to have a diagnostic strategy to evaluate various diseases (39).

Inspection

The patient’s diagnosis, basic complaints, symptoms, his background, the medications he used, and the risk factors of neck pain (sex, age, body mass index, occupation, smoking, alcohol, sports habits)

Posture Analysis

Assessment of posture includes assessment of the position of the pelvis, shape of the postural curves, neck and head position, and scapular position from the anterior posterior and lateral. For patients with posture neck pain, sitting and standing can be examined. Preserving the neutral spine posture has a positive effect on cervical muscle functions. When the sitting posture is specifically facilitated by the restoration of the lumbar lordosis, greater activation of the deep cervical flexor and lumbar multifidus muscles has been demonstrated (40).

Testing the range of movements

Normal joint movements in the cervical region are important for many activities in daily life. Range of motion should be tested in patients suffering from neck pain, as there may usually be limitation of motion. Neck flexion and extension, right and left lateral flexion, right and left rotation should be tested. Measurement methods in the assessment of normal range of motion are clinical goniometer, gravity goniometer, CROM (cervical range of motion) device, radiological methods, digital inclinometer and three-dimensional analysis systems (39).

Determination of contraction pain and muscle strength in the neck

Since there is muscle imbalance in people with neck pain, measurement of muscle strength is important. Two methods such as isometric or dynamic techniques are used to measure the strength of the cervical region muscles. The isometric method is the most used method in testing, and the types of this method are manual evaluation, hand dynamometry, fixed frame dynamometry device and isokinetic dynamometry.

Manual muscle testing is performed with the patient in different positions, such as prone position (for extension) and supine position (for flexion and rotation). When strength is evaluated according to the manuel muscle testing scale, muscles can resist gravity are measured as grade 3. Considering the movements of the cervical muscles, maintaining the grade 3 may be enough for most functional activities. Because the force produced by the muscles during this test is already above the level of strength required for normal activities. Otherwise, manual muscle testing is less valid, considering that the strength in the cervical region should be a grade 4 or 5. This testing is not a method for evaluating neck muscles above grade 3.

Handheld dynamometry is called the quantitative application of manuel muscle testing. The force-sensitive measuring device is manufactured as a device that can be easily held by the practitioner's hand. The device has a small display that shows the static strength in units of kgf, lb or N. This device is performed by the practitioner's hand; measures the static force created by the measured muscles, while the tester must adjust the resistance force and provide stabilization.

In a fixed frame dynamometer, the person's hand does not act as a support base. It is attached to a fixed support (mounted anywhere eg wall) and this device can be adjusted to fit people of different heights above the floor. Individuals are commonly tested in the sitting position.

Isokinetic dynamometry is commonly used as the standard principle for dynamic muscle testing. The evaluation method of the isokinetic dynamometer depends on resistance. This means that regardless of the magnitude of the force exerted by the muscles while being tested, it is restricted by the lever arm to move at a largely constant predetermined speed. When evaluating the cervical muscles, it is the head that moves angularly along the sagittal or frontal plane relative to the fixed body (41).

Palpation

Palpation is performed while the person is standing or sitting and is applied to bony structures, tendons and muscles. Abnormal palpation pain can be easily detected by comparing the right or left sides. With palpation, we can get an idea about muscle spasm, taut bands, trigger points, tenderness and joint dysfunction (40).

Diagnostic Tests

Various special provocative tests are used in neck physical examination.

Spurling’s Neck Compression Test: While the diagnostic test is applied to the person, the neck is done extension motion and the head is done rotation motion, and then downward pressure is applied to the head. The test is positive if the pain radiates to the arm on the side where the head is rotated. Radicular symptoms are defined as pain that occurs in the distribution of the cervical spinal nerve root away from the neck.

Shoulder Abduction Test: While the person is in a sitting position, the arm on the symptomatic side is asked to abduct above the head. If the ipsilateral cervical radicular symptoms get lighter or diminish, it indicates a positive test. A positive test indicates the presence of radiculopathy; If the pain increases during the test, the problem is mostly of mechanical origin.

Neck distraction test: The diagnostic test is also defined as the Axial Manual Traction Test. While the individual is in a sitting position, the patient's head is taken into traction by grasping the occiput and chin. The test is positive sign if there is a reduce in radicular symptoms. If the test is positive, it is thought to indicate cervical radiculopathy. If the patient's complaints are increasing, it indicates that there are muscle or ligament related problems.

L`hermitte’s sign: The test is positive if the head and one of the hips of the patient in the long sitting position are brought into flexion at the same time while the knee is straight. A positive test is indicated when there is an electrical-like sensation that occurs in the extremities. This test indicates that there may be diseases in spinal cord pathology such as Multiple Sclerosis, spinal cord tumors, cervical spondylosis, and radiation myelitis.

Hoffmann’s Sign: The patient's hand is gently grabbed at the metacarpal joints and the fingers and the patient's middle finger are pushed immediately over the nails. The test is positive sign if there is adduction and flexion in the index and thumbs of the patient; specific for cervical myelopathy.

Adson’s Test: The test evaluates symptoms of circulatory symptoms caused by the presence of a cervical rib. The test called “The Vascular Test” in studies. During the test, the patient takes a long breath, raises her chin and turns it towards the affected side. This test is performed while the patient is sitting upright, with her arms relaxed and resting on her knees. An alteration radial pulse or change in blood pressure indicates the presence of the scalenus anticus syndrome (42).

2.4.3. Treatments of the Patients with Neck Pain

Medications

The World Health Organization (WHO) organized the appropriate medications for patients suffering from neck pain in stages. The first stage contains the use of nonopioid and adjuvant medications. Nonopioid medications contain acetaminophen and NSAIDs. Antidepressants, antiepileptics, and muscle relaxants are adjuvant medications. The second stage includes hydrocodone or oxycodone 1 acetaminophen. If these do not reduce a patient’s pain, WHO recommendations for third stage are the administration of strong opioids to the patient. Medications included strong opioids are morphine, oxycodone (43).

Orthoses

Orthosis is used to provide cervical immobilization in the treatment of cervical spine problems and is important in patients suffering from pain and with unstable spine injuries. Although neck collars are widely recommended for patients with nonspecific neck pain (especially people with recent injuries), the use of orthoses has never been shown to have an impact on such problems (44).

Orthosis treatment helps to correct a deformity based on the three-point pressure method and prevent its progression (two aligned forces opposing a single force placed on the deformity or angulation area). It also stabilizes and immobilizes the weak spinal cord, reducing the load on the spine and controlling movement. Another effect of orthosis therapy is that it warms soft tissues and protects them from cold, and also has a placebo effect. An orthosis limits movements in the affected area of the patient and should be stimulating for posture (45).

Thermal Modalities

Heat and cold applications have been used since ancient times. Modalities of heat and cold are frequently used compatible with alternative therapeutic approaches. In most cases, it uses some thermal methods before or after treatment. Attitudes regarding longitudinal thermal application have been adopted by expanding traditional therapy on a body area where ice or heat is often applied.

Cold application includes ice, ice massage application and cold packs. Cold decrease edema, to cause vasoconstriction, to reduce inflammatory progression, to reduce local muscle tone, and to improve pain physiology.

There are many heat application methods. Heat causes vasodilation in tissue and thus helps reduce muscle tone. Heat application methods are hotpack, infrared, ultrasound and diathermy treatments. Theoretically, these different modalities are capable of heating different tissues and they can all focus on different penetration depths or focus on different deep structures (44).

Ultrasound

Therapeutic ultrasound is a device used in physical therapy and rehabilitation, and it emits a sound wave (acoustic energy), causing warming in the deep tissue. It is used to stimulate soft tissue repair and inflammation management, thus relieving pain and also for bone healing. Ultrasound can transmit the temperature of the tissue much deeper than the surface heat, as the sound vibration creates mechanical effects, it is considered a deep heating method. It should be kept in mind that ultrasound can be applied without causing a significant increase in tissue temperature. Ultrasound increases blood flow and metabolism in the area where it is performed, resulting in a decrease in pain and an increase in recovery rate (46).

Tens

Transcutaneous electrical nerve stimulation (TENS) is not a pharmacological device applied for the improvement of acute and chronic pain problems in rehabilitation. This device transmits alternating current to the area with cutaneous electrodes placed near or over the painful area. In addition, the pulse frequency and intensity parameters of the device are adjustable and depend on the type of therapy.

It provides pain inhibition by increasing and decreasing muscle spasm. Tens activates the neuronal junction to reduce pain or hyperalgesia. This clinically used device stimulates large diameter afferent fibers at frequencies and densities. This afferent input is transmitted to the central nervous system to reduce hyperalgesia (47).

Mechanical Traction

Mechanical traction is a pulling force used to the neck by a mechanical system that can be adjusted as intermittent or continuous pull according to the patient in rehabilitation. The physiological effects of mechanical traction, which is frequently used in neck rehabilitation, include separation of vertebral vertebrae, motion of facet joints, widening of intervertebral foramen, and stretching of soft tissue (47).

Manual Therapy

Manual therapy is a therapeutic category for mechanical pain management, which includes various procedures for musculoskeletal structures. There are two main methods. The first method is manipulation, mobilization and manual traction. The second method includes both general soft tissue therapies such as various types of massage, and specific area soft tissue therapies such as trigger point therapy.

The theoretical basis of the aim of manual therapy is that the forces and movements stimulated in somatic tissues lead to a reduction in pain, to reduce spasm in muscles and to improve alignment and movement in joints.

Manual therapy can be characterized by a force from lowest to highest. These forces are ordered deep from the surface into subcutanous, muscular, the ligamentous tissues and the joints and are realized through layers of somatic tissue. A specific procedure of manuel therapy;

1. Effleurage massage applied to the skin by lowest forces
2. Deep effleurage applied to the skin by higher forces
3. Deep massage, trigger point therapy by increasing forces on the skin, muscles and fascia
4. Mobilization applied to the muscles and ligaments by increased forces
5. Manipulation applied to the ligaments and deep muscles by highest forces (high velocity/low amplitude) (48)

Massage Therapy

Massage, one of the oldest treatment methods, is applied to reduce muscle tension, provide better posture and use muscle activation more efficiently. Tissues such as sternocleidomastoids, scalenes, upper trapezius, levator scapulae, splenius capitis, pectoralis and intercostals and fascia are most affected in the patient with neck disease. Bilateral or unilateral excessive tension in these tissues, muscle spasm may disrupt the normal mobility of the neck, create pathological cervical vertebral alignment and cause headache. Massage techniques are categoried effleurage, petrissage, tapping and friction. Also, the massage techniiques include static pressure, myofascial release, and vibration. All of these techniques provide relaxation and relaxation in the soft tissue by providing mechanical compression and stimulation (49).

Massage therapy has many benefits, including improved circulation, increased oxytocin, decrease in basal activity, feeling of relaxation and reduction in being of anxiety, depression, and pain. Serotonin levels increase by massage. Application massage helps to reduce the use of analgesics.

Massage of the cervical, shoulder and upper back muscles can reduce tension, increase range of motion in the cervical area, reduce headache severity and affect neck pain (50).

Therapeutic Exercise

Therapeutic exercise is applied in almost all cases as part of the conservative treatment of neck pain. With some studies, the basis of treatment should first be started with postural evaluation. Patients may have abnormal cervical curvature and anterior head posture according to neck and head positional changes. Cervical curvature can also be assessed visually or on cervical spine X-rays. When the tragus of the ear is in front of the tip of the acromion, the forward head posture can be detected. These postural habits cause the occurrence of cervical muscle imbalance and consequently mechanical neck pain problems. Postural control and corrective exercises based on strengthening the surrounding muscles, various stretching and increasing range of motion are beneficial. Also, improving ergonomic conditions and modification of workplace contribute to prevention of postural problems and neck pain. (46)

There are many therapeutic neck exercises such as range of motion exercises, isometric and stretching exercises, dynamic exercise and postural control exercise training for patients with neck pain (43).

Cervical Stabilization Education

Cervical stabilization exercises are a treatment used to control neck joint movements and improve body balance and function. The most important function in the stability of the cervical vertebra is the balance of the muscles. The cervical stabilization exercises increase the muscle strength and endurance of the muscles connected to the cervical vertebra and the muscles that support the posture of the head. The muscles surrounding the cervical vertebra facilitate head and neck movement. The most important cervical stabilization muscles are the longus colli and the longus capitis. The longus capitis and longus colli provide to control and maintain the neck movement. Sternocleidomastoid and middle scalenus muscle are connected directly to the cervical vertebra and their position is in-depth. The neck muscles have certain number of muscle spindles per unit, therefore muscles can be considered to have a high level of proprioception function. Recently, the longus colli has a higher spindle distribution ratio than the multifidus, emphasizing the greater role of longus colli in neck for postural stability (51).

Cranio-cervical flexor training test (CCFT) is applied when the patient lies in supine position. After the pressure-biofeedback unit is placed just below the occiput between the back of the neck, it is inflated to a baseline of 20 mmHg. With this device, the patient is informed about the necessary information about the cranio-cervical flexion test and the desired movement. One examiner observes and corrects any wrong movements to provide performance of a successful test. The patient is warned to relax the neck muscles and concentrate on allowing a gentle nodding motion. The patient should try to keep the neck craniocervical flexion movement taught to the patient at 5 different pressure levels (22, 24, 26, 28 and 30 mmHg) for 10 s at each level and rest for 30 s between each pressure difference. If patient can not hold a certain pressure level for 10 seconds or the maximum level of 30 mmHg is reached, the testing procedure is finished. The value it holds for 10 seconds is recorded as the maximum activation point.

In craniocervical flexion training, the person is in the supine position while the test is performed. The pressure stabilizer device is placed behind the neck only to fill the space between the back of the neck and the bed, without revealing lordosis in the neck. The pressure sensor is held just behind the occiput and inflated to an initial pressure of 20 mm Hg. This provides visual feedback and guidance to the patient while the patient is exercising (52).

Deep cervical flexor muscles are the most important stabilizers in stabilizing the head and neck posture. It has been proven that when these muscle performance deteriorates, the balance between stabilizers and the deep cervical flexor muscles will be impaired, resulting in a loss of proper alignment, possibly contributing to cervical pain. Therefore this training is recommended for increasing the endurance of these stabilizer muscles, leading to improvement in patients with neck pain. Training emphasizes the correct use of deep cervical flexor muscles before strengthening the global cervical spine muscles is more effective in rehabilitating neck pain than non-specific strengthening of the neck muscles. The craniocervical flexion test is distinguished as an appropriate strategy to specifically activate deep cervical flexor muscles and decrease the increased activity of the sternocleidomastoid muscle. In previous studies, the increased capacity of DCF has been found to affect a reduction in neck pain and cervicogenic headache. Therefore, DCF muscle training should be performed in the management of neck pain in clinical practice. Pressure stabilizer device is a device used for stabilization exercises (7)(figure 2.7).

Figure 2. 7: The pressure stabilizer device (7)

2.5. Lumbar Vertebrae

The lumbar spine have five vertebrae (L1 to L5) of the spinal column between the thorax and the sacrum. In this region, there are vertebrae, articular facet joints, intervertebral discs, ligaments and muscles surrounding them. The lumbar spine is the part with the greatest loads, forces and moments as well as the greatest mobility relative to the neck and thorasic spine (53).

The mobility of the spine can vary according to several factors. It adheres to primarily on the state of the intervertebral discs: their form, hardness, fluid content, degeneration, and aging. Lumbar region vertebrae compared to thoracic vertebrae, vertebra diameter is small and height is larger. This leads to greater mobility in the lumbar region (54).

The angle of flexion / extension movement is the greatest among the movements of the lumbar spine. (L1–L5: flexion and extension 57°). The degree of lateral bending (L1–L5: 26°) and axial rotation (L1–L5: 8°) is more limited (55).

2.5.1. Muscles of the Lumbar Spine

The muscles of the lumbar spine are categorized according their location around the spine: postvertebral and prevertebral muscles. The postvertebral muscles are divided into deep, middle and superficial. The prevertebral muscles are defined as abdominal muscles. Postvertebral deep muscles are composed of adjacent spiny and transverse processes and short muscles connecting the laminae. The intermediate muscles are more diffuse, originating from the transverse processes of each vertebra and connecting to the spiny process of the above vertebra. The postvertebral muscles are the erector spinae, multifidus, quadratus lumborum. There are four abdominal muscles such as the external obliques, the internal obliques, the transversus abdominis and the rectus abdominis (55)(tablo 2.2).

Local Core Muscles		Global Core Muscles
	Primary	**Secondary**
Transversus Abdominis	Internal oblique	Rectus Abdominis
Multifidi	External oblique medial fibers	External oblique-lateral fibers
	Quadratus lumborum	Psoas major
	Pelvic floor muscles	Erector spinae
	Iliocostalis and longissimus-lumbar portion	Iliocostalis-thoracic portion
	Diaphragm	

Table 2. 2: Classification of core muscles (18)

2.6. Core Stabilization

Core stabilization is muscle capacity of the body area surrounded by the abdominal wall, pelvis, waist and diaphragm to provide motor control. It is the ability to stabilize the body during movement. The normal function of the stabilization system is to maintain stability to the spine to meet the changes in stability demands instantaneously due to alters in spinal stance and static and dynamic loads (56).

Core stabilization provides stabilization of the lumbar region by activation of the multifididus, transversus abdominus and pelvic floor muscles. These muscles are the main stabilizers of the lumbar spine and pelvis and have an important effect on maintaining body position. According to Panjabi’s stability model, active spinal stabilizers (muscles and tendons), passive stabilizers (spinal column, the vertebrae, discs, and ligaments) and neural control mechanism (nerves) for core stabilization manage daily life performance by controlling the movement of intervertebral joints. Injury to the spine or weakness of the muscles can cause spine instability or back problems. Active stability of the trunk is provided by the core muscles and is called a core stability. The core, which is a group of trunk muscles surrounding the spine and abdominal internal organs, the abdominal, gluteal, hip belt, paraspinal and other muscles work together to provide spinal stability (57).

General core muscles act as the transferring force from the rib cage and pelvis to the extremities. These muscles are responsible for providing trunk movements. These muscles that provide movement are rectus abdominis, external oblique, psoas major and erector spina. Trunk muscles are divided into the global or local muscles. The global muscles (the rectus abdominis and external obliques) work together in contraction to spine movement, generate torque and these muscles transfer the load immediately between the thoracic cage and the pelvis. The muscles (Transverse abdominis and multifidus) that have direct or indirect connections to the lumbar vertebrae are the local muscles. These muscles are responsible for the segmental stability of the lumbar region during all movements of the body and postural alignment. Therefore, local muscles of trunk improve segmental stability. Trunk stability has been described as the combined activation of spherical and local muscles. Therefore, special training that supports the function of these muscles is necessary to increase coactivation (58)

2.7. Posture

The classification of Kendall categorized 4 types of posture. Ideal alignment occurs when all curves of the spine are normal and body segments (such as head, pelvis, hip joints) are in neutral position. Postural deformity with hyperkyphosis in the thoracic spine and hyperlordosis in the lumbar spine is called kyphotic-lordotic posture. Therefore, individuals with this posture have hyperextension in the cervical spine, a forward shift of the head, posterior tilt of the pelvis, and hip flexion. Postural deformity that have flattening of the lower thoracic and lumbar spine with anterior shift of the head, pelvis posterior tilt, and hip extension is called flat back posture. Postural deformity, which is the displacement of the upper body towards the back and the flattening of the lumbar spine, which is the forward displacement of the pelvis, is called the sway back posture (59)(figüre 2.8)

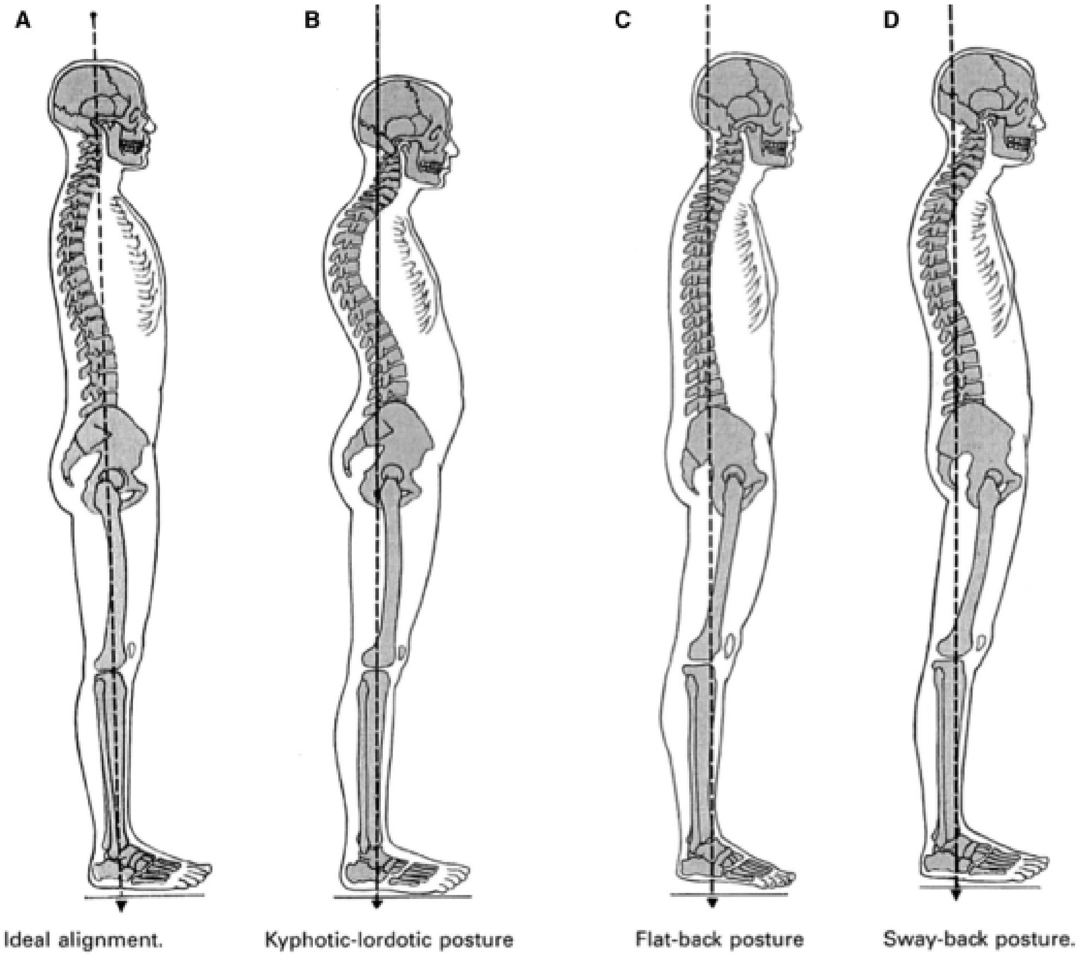


Figure 2. 8: The 4 postural types described in Kendall's classification. (59)

In the forward head posture (FHP), the head is observed in front of the sagittal line and is specified one of the most common postural deformities. This posture change increases the extension of the atlanto-occipital joint and upper cervical vertebra while increasing the flexion of the lower cervical and upper thoracic vertebra. It causes muscle imbalance and abnormal contractions in the suboccipital, neck and shoulder muscles due to the disruption of the normal head position in people with this posture. In FHP, the center of gravity (COG) of the anterior head shifts, increasing the load on the neck, causing dysfunction in the musculoskeletal systems. Additionally, the muscles in the head and shoulders area such as the trapezius, sternocleidomastoid, suboccipital, and temporal, are affected by this posture and it causes postural deformity to worsen. These changes cause permanent and abnormal pressure on the neck and shoulder muscles, fascia, and nerves, resulting in a high contraction on the neck muscles (60).

3. MATERIALS AND METHODS

This study was carried out to compare the effect of core stabilization training given in addiction to deep cervical flexor muscle training, convenional treatment and deep cervical flexor muscle training in patient suffering from chronic neck pain. Between September 2019 – April 2020, it was performed in Özel Pendik Bölge Hospital with cases with chronic neck pain.

In order to conduct our study, approval was received from Yeditepe University Clinical Research Ethics Committee on 11.07.2019 and decision number is 1071. The pre-study application and evaluation methods were explained in detail to all individuals participating in the study, and a written consent form was obtained from the individuals that they voluntarily participated in the study (appendix 8.4).

3.1. Study Design

Patients who were diagnosed with chronic mechanical neck pain by a physical therapy and rehabilitation specialist were included in the study. Our study was conducted on 45 patients with neck pain. Patients included in the study planned to examine the effects of three different applications were divided into 3 groups by randomization method. Conventional therapy and isometric neck exercises to the first group (n=15), conventional exercise and deep cervical flexor training to the second group (n=15), conventional treatment and stabilization of the neck and core region were studied to the third group (n=15). The exercise programs of the patients were applied under the supervision of a physiotherapist for four weeks, three days a week for 45 minutes.

At the beginning of the study, participants were signed with a consent form indicating that the subjects were voluntarily involved in the study and were informed about the evaluation, the applications to be made and the possible benefits of these applications.

3.1.1. Inclusion criteria

- Chronic neck pain more than 3 months
- Medically stable
- Ages between 25-60

3.1.2. Exclusion Criteria

- Patients with benign or tumors in the cervical region
- Patients with active, localized osseous and discal infection in the spine (spondylodiscitis)
- Patients with history of spinal fractures
- Patients with congenital anomaly
- Patients with neck surgery and spinal instability

3.2. Evaluation

3.2.1. Demografic Characteristic of Participants

Gender, age, height, body weight of the participants were recorded. Body mass index (BMI) values were calculated by dividing body weights by the square of the height and expressed in kg/m^2. The demographic data of the cases in all three groups were recorded, and then all the following physiotherapy and rehabilitation evaluations were done twice in four week intervals.

3.2.2. Evaluation Tests

3.2.2.1. Pain Intensity Assessment

Verbal Numeric Pain Scale was measured to assess pain intensity. Pain intensity was measured by using the 11-point VNPS (0 –10; 0, no pain; 10, worst pain). VNPS is a reliable and valid measure for subjective pain measurement. Participants were asked to report the pain severity at that moment on a scale from 0 to 10 (61).

3.2.2.2. Posture Evaluation

Reedco’s posture score (REEDCO, 1974) is a standard tool and it is administered by visual inspection of 10 postural traits viewed laterally (sagittal view including neck, upper back, trunk, abdomen, and lower back) or from behind (coronal view including head, shoulders, spine, hips, and ankles). The scores are marked as follows: a value of 0 equals poor posture or severe deviation, a value of 5 equals fair posture or minimal to moderate deviation, and a value of 10 equals good posture or normal alignment. The maximum score of 100 indicates good posture and a score of 59% or less is recorded as postural dysfunction (62)(appendix 8.5).

3.2.2.3. Evaluation of Cervical Range of Motion

Cervical ROM was evaluated using a goniometer while the patient was sitting on the chair with both feet on the ground. After the goniometer was brought to the neutral position, the patient was asked to perform the desired movement with the head: flexion, extension, right and left lateral flexion, right and left rotation. Three measurements were repeated for each neck movement, recorded and used in the mean analysis (63).

While measuring the cervical flexion and extension angle, the acromion was taken as the pivot point. While the fixed arm is kept parallel to the ground; The ear midline line was followed with the moving arm. Movements were shown to the participant before measurement.

In lateral flexion measurement, the movable arm followed the cervical vertebra while the fixed arm was placed in the C7 and the fixed arm was kept parallel to the ground. The patient was asked to complete the movement by bringing his ear towards his shoulder as much as he could.

In rotation measurement, the goniometer was placed with reference to the midpoint of the head. While the fixed arm was kept parallel to the ground, the movable arm followed the patient's nose line. The patient was asked to complete the movement by turning his chin towards his shoulder as best he could.

Figure 3. 1: Evaluation cervical ROM

3.2.2.4. Disability Evaluation

Neck Disability Index was applied to evaluate daily activities and ability. The form contains of 10 questions related to pain intensity, lifting, concentration, reading, headache, self-management, driving, working, sleeping, and daily activities. The score of each question is 0-5 according to the options and the total score is recorded by adding the scores of all answers. The lower the total score of the test, the less the effect of pain on performance in daily activities. The higher the score, the greater the performance of daily activities is affected (64)(appendix 8.6).

3.2.2.5. Quality of Life Assessment

The SF-36 is a test that includes a 36 item self-administered comprehensive health status questionnaire. This test includes questions evaluating physical function, social function, limitations due to physical health, limitation due to mental health, vitality, body pain, and general health. In this test, two scores are generally calculated, the combined physical and mental summary score (65)(appendix 8.7).

3.2.3. Treatment Program

Two treatment groups and one control group on three groups in total work has been completed. Deep cervical flexor exercises were applied to the patients in the first treatment group, deep cervical flexor exercises and core stabilization exercises in the other treatment group and conventional therapy (hotpack, tens, isometric exercises) in the control group. The patients were treated under the supervision of a physiotherapist three times a week for 4 weeks. Participants were evaluated twice, before and after 4 weeks of treatment. The exercise occupied a period of 30 minutes per day. The exercises were applied in a way that did not increase neck pain.

3.2.3.1. Conventional Therapy

Physical therapy agents and isometric exercises training were applied to the patients. These were administered a combination of transcutaneous electrical nerve stimulation (TENS), ultrasound, and hotpack 3 times a week for 4 weeks by the physical therapist for conventional groups during the study. TENS was applied for 20 minutes with an intensity of 10–30 mA and a frequency of 80 Hz. A surface electrode was placed over the painful area in the neck area with a TENS device (Sonopuls 492, Enraf-Nonius). The intensity of the TENS was adjusted according to the sensory threshold of the patient so that it would not be disturbed by the tingling sensation. Continuous ultrasound was applied in the neck area to produce thermal effects at a density of 1.5 W / cm2 for 5 minutes. (Sonopuls 492, Enraf-Nonius). Hotpack applied the neck area for 10 min.

The conventional therapy group received an intervention based on electrotherapy and exercises. These included stretching exercise and isometric exercise. The treating therapists were asked to aim for an isometric hold of up to 5 seconds, and up to 10 repetitions.

Isometric neck flexion - Patients were taught to place their hands straight on their forehead. Then they were told to push and hold the head towards the hand.

Isometric neck extension – Patients were taught to place their hands straight on their the back of the head. Then they were told to push and hold the head towards the hand.

Isometric neck side flexion – They were taught to place their hands straight on the right or left side of the head. Then they were told to push and hold the head towards the hand.

Neck side flexors stretch- Neck was bent slightly on the right or left side, trying to touch the ear to the shoulder.

Neck lateral rotation stretch- Neck was turned to the right or left side, looking over the shoulder (figure 3.2).

Figure 3. 2: Cervical isometric and stretching exercises

3.2.3.2. Deep Cervical Flexor Muscle Training

Training of the craniocervical flexor muscles focuses on the deep flexor muscles such as longus capitis and longus colli muscles, making neck flexion, not head. Also, this exercise is a low-load to train the deep cervical flexors more specifically, rather than all the neck flexors involved in the head-lifting exercise. Exercising was performed with an air-filled pressure stabilizer placed in the sub-occipital to monitor the flattening of the cervical lordosis caused by the contraction of the longus colli muscle (6).

In addition to the conventional treatment, deep cervical flexor muscle training was given to the second group. Cervical stabilization exercises were started by teaching the patient to contract the deep cervical flexors. After activation of these muscles, the patient was asked to continue this movement in each exercise and in every activity to achieve automatic stabilization. For this purpose, the training of the craniocervical flexor muscles was done with an air-inflated pressure sensor StabilizerTM (Chattanooga Stabilizer Group Inc., Hixson, TN). The patients were hospitalized in the supine hook position (without pillow) to ensure the neutral position of the neck. In some patients, a thin towel placed under the head to ensure the neutral position of the neck. For craniocervical flexion and mild axial extension, each patient was individually treated with a slow, controlled, flexion of the head and upper cervical region by bringing the light chin closer to the chest ("yes" movement). StabilizerTM was placed under the occiput and inflated to 20 mmHg. Gradual training was given to increase the pressure value between 20 and 30 mmHg by 2 mmHg. It was kept for 10 seconds at each pressure value (22, 24, 26, 28 mmHg) and operated 10 times. Then, while providing motor control with the pressurized stabilizer device, the arm is asked to flex 90 degrees (figure 3.3).

Figure 3. 3: Training of the craniocervical flexor muscles with a stabilizer

After training with visual feedback, the patient is asked to slowly move his chin closer to his chest. (chin-tuck) In this exercise, the neck is asked to make a posterior tilt without head flexion.

After the motor control of the cervical stabilization, training was continued progressively in prone, crawling, limb movements in crawling, and overhead ball lifting movements and scapular correction exercises (scapular mobilization and shoulder rolls). These exercises were performed for 10 repetitions with 10 seconds of contraction and 5 seconds of relaxation (figure 3.4).

Figure 3. 4: Cervical stabilization training in crawling position, limb movements in crawling

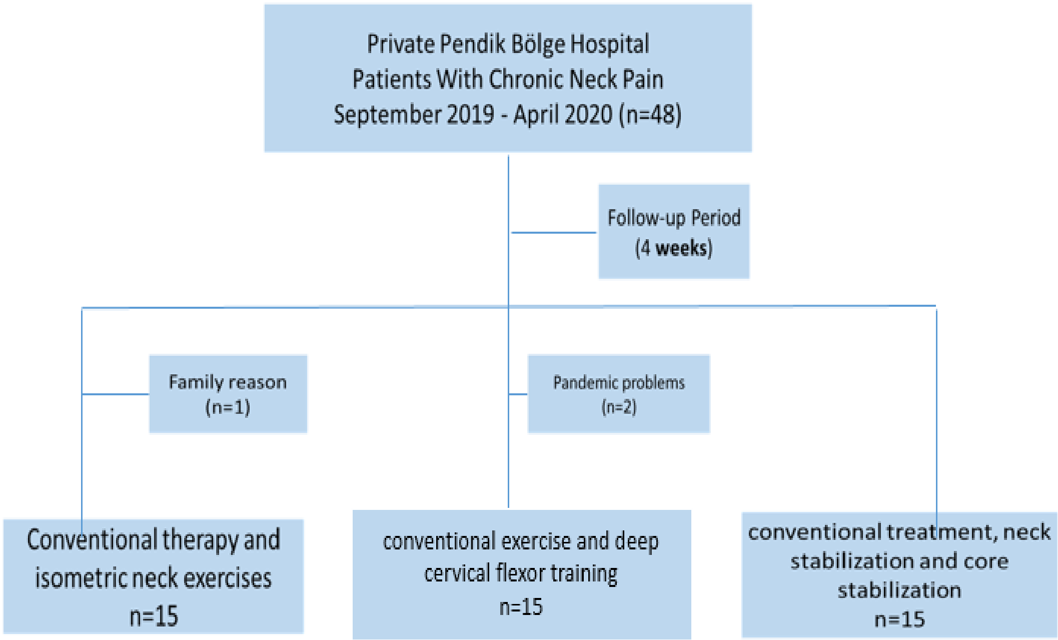
3.2.3.3. Core Stabilization Training

Core stabilization refers to the muscles that provide to stabilize the lumbopelvic region as well as muscles acting to control position of the head, arms, and trunk segment relative to the body's base of support (66). All the subjects in the third group had undergone 4 weeks core stability training which comprises of exercises aimed at increasing spinal stability. In addition to traditional therapy and neck stabilization exercises, core stabilization study was given to the third group.

Core stabilization exercises were started by teaching the patient to basic exercise with an air-inflated pressure sensor StabilizerTM. While the patient is in the supine position with the knees at a 90° flexion, the pressure cuff was placed under the lumbar spine and inflated to 40 mmHg. Exercises were started with a stabilizer to activate the main muscles. The level at which the patient can keep the pressure constant (stable pelvis) was determined while doing exercise. The subjects were first taught the "Abdominal hollowing" (pulling the belly up and in) exercise, which provides transversus abdominis and multifidus co-contraction. After motor control of the core stabilization, basic training was continued progressively in the supine, prone, crawling and sitting on the ball. (straight leg raising, abdominal crunch exercise, bridge exercises, swimming exercises, exercises in crawling position and limb movements in sitting and sitting on the ball) These exercises were performed for 10 repetitions with 10 seconds of contraction and 5 seconds of relaxation (figure 3.5) (figure 3.6).

Figure 3. 5: Straight leg raising and abdominal crunch exercise

Figure 3. 6: Limb movement with core stabilization control for sitting on a fixed surface and sitting on a moving floor


Private Pendik Bölge Hospital
Patients With Chronic Neck Pain
September 2019 - April 2020 (n=48)
Follow-up Period
(4 weeks)
Family reason
(n=1)
Pandemic problems
(n=2)
Conventional therapy and isometric neck exercises
n=15
conventional exercise and deep cervical flexor training
n=15
conventional treatment, neck stabilization and core stabilization
n=15

4. RESULTS

DESCRIPTIVE STATISTCS

Statistical Package for Social Sciences (SPSS) Version 24.0 (SPSS inc., Chicago, IL, USA) statistical program was used for the statistical analysis of the study data. P <0.05 (two-sided) values were considered statistically significant in all analyzes. Whether the data were suitable for normal distribution was determined by "Kolmogoraf Simirnov". According to the analysis results of this test, non-parametric tests were used in the analysis of data that did not conform to normal distribution. In the statistical analysis of the study, the variables considered were defined with mean (AVR), standard deviation (SD), minimum and maximum values.

Groups were compared with the "Mann Whitney U" test in terms of demographic and clinical characteristics. The difference between the groups was analyzed with the "Kruskal Wallis" test. The "Mann Whitney U" test was used to look at which group the difference between groups originated from. The "WilCoxson" test was used to compare the pre- and post-treatment values of the groups.

48 cases included in the study groups were randomized and divided into 3 groups. In Group 1, 1 person was away from the treatment center and due to family reasons; In the second group, 2 people left the study due to the pandemic. Our study was completed with a total of 45 people (27 females, 18 males).

1. Comparison of the Demographic and Clinical Features of the Groups

The initial demographic characteristics (age, height, body weight and body mass index-BMI) of the groups are shown in Table X-1. The groups were evaluated with the "Mann Whitney U" test in terms of their demographic characteristics. Although the mean age of the 2nd and 3rd groups was higher than the 1st group, no statistically significant difference was found between the two groups in terms of age, height, body weight and BMI (p> 0.05).

Table 4. 1: Comparison of demographic characteristics of groups.

	Group 1 (n:15) Mean (min-max)±SD	Group 2 (n:15) Mean (min-max)±SD	Group 3 (n:15) Mean (min-max)±SD	p
Age (years)	38.73 (26-59) ± 12.3	42.27 (27-60) ±10.64	42.07(26-59) ±10.86	0.46
Height (cm)	1.69(1.55-1.81) ±0.08	1.70(1.52-1.85) ±0.09	1.69(1.58-1.84)0.70	0,39
Weight (kg)	67.73(50-83) ±11.39	70.66(53-90) ±11.27	71.26(54-90) ±12.08	0,42
BMI	23.4 (19.05-27.04) ±2.4	24.35(19.47-28.58) ±2.66	24.76(20.80-29.32) ±2.72	0.28

Min: minimum, max: maximum, SD: Standard deviation, Mann Whitney U Test, BMI: Body mass Index, $p<0.05$*

2. Comparison of the values of the groups before the treatment

When pain, NYPS, range of motion, NDI and SF-36 parameters were examined between all the three groups, no significant difference was found between the initial measurement values. Pre-treatment values are shown in Table X-2.

Table 4. 2: Pre-treatment value of Pain, NYPS, Joint Range of Motion, NDI and SF-36 Measurements of the Groups

	Group 1 (n:15) Mean (min-max)±SD		Group 2 (n:15) Mean (min-max)±SD		Group 3 (n:15) Mean (min-max)±SD		p
Pain (VNS)	6.40	(5-8)±1.056	6.80	(5-8) ±1.01	6.67	(5-8) ±0.97	0.56
Posture	76.33	(65-90) ±6.93	76	(65-85) ±5.07	74	(65-80) ±5.07	0.49
ROM FLEKS	40.67	(35-50) ±4.60	39.73	(35-45) ±3.36	39.73	(35-45) ±3.49	0.87
Rom ekst	45	(40-50) ±3.46	42.27	(35-55) ±5.67	42.33	(40-50) ±2.94	0.07
Rom lat flek r	34.67	(30-45) ±4.10	31.13	(27-35) ±2.94	32.47	(27-37) ±3.18	0.05
Rom lat fleks l	35.33	(30-40) ±3.59	32	(27-37) ±3.29	33.13	(27-40) ±3.70	0.08
Rom rot fark r	51.33	(40-57) ±4.90	45.07	(35-56) ±5.16	45.13	(35-51) ±4.74	0.13
Rom rot fark l	48.60	(38-55) ±4.99	45.13	(37-56) ±4.96	46.13	(37-52) ±4.43	0.09
NDI	27.27	(16-34) ±5.36	30	(23-34) ±3.60	28.67	(23-34) ±3.47	0.31

SF-36 PCS	166.56	(115-253) ±39.78	146.36	(115-181.5) ±23.70	153.60	(115-195) ±23.49	0.25
SF-36 MCS	200.22	(125-295) ±51.38	185.75	(125-242.50) ±42.01	195.34	(125-242.5) ±46.82	0.67

Min: minimum, max: maximum, SD: Standard deviation, Kruskal Wallis Test p<0.05*

3. Comparison of Intra-and Between-Groups Pain, Posture, Range of Motion, NDI and SF-36 Values

The comparison of pain, posture, range of motion, NDI and SF-36 values of the patients within and between groups are shown in Table X-3 and Table X-4, respectively. In all groups, a significant improvement was found in pain, posture, ROM, NDI and SF36 values in the in-group evaluation results (p <0.05).

Table 4. 3: Comparison of Within-Group Pain, Posture, Range of Motion, NDI and SF-36 Values

		B.T **Mean(min-max) ±SD**	**A.T.** **Mean(min-max) ±SD**	**P**
PAIN	Group 1	6.40 (5-8) ±1.05	3.47(2-5) ±1.06	**0.00***
	Group 2	6.80(8-5) ±1.01	2.87(2-4) ±0.74	**0.00***
	Group 3	6.67 (5-8) ±0.97	2.53(1-4) ±0.74	**0.00***
Posture	Group 1	76.33(65-90) ±6.93	80(70-90) ±5.35	**0.01***
	Group 2	76(65-85) ±5.07	84.33(80-90) ±2.58	**0.00***
	Group 3	74(65-80) ±5.07	84.33(80-90) ±2.58	**0.00***
ROM FLEKS	Group 1	40.67(35-50) ±4.60	43.93(38-50) ±4.60	**0.00***

	Group 2	39.73(35-45) ±3.36	46.20(42-50) ±2.88	**0.00***
	Group 3	39.73(35-45) ±3.49	44.93(40-50) ±3.26	**0.00***
ROM EKST	Group 1	45(40-50) ±3.46	48.20(45-57) ±3.82	**0.00***
	Group 2	42.27(35-55) ±5.67	48.93(42-57)4.41	**0.00***
	Group 3	42.33(40-50) ±2.94	47.73(45-57) ±3.51	**0.00***
ROM LAT. FLEKS R	Group 1	34.67(30-45) ±4.10	37.40(35-45) ±3.15	**0.00***
	Group 2	31.13(27-35) ±2.94	36.73(35-42) ±2.43	**0.00***
	Group 3	32.47(27-37) ±3.18	36.73(35-42) ±2.43	**0.00***
Rom lat fleks l	Group 1	35.33(30-40) ±3.59	37.93(35-45)3.15	**0.00***
	Group 2	32(27-37) ±3.29	37(33-42) ±2.67	**0.00***
	Group 3	33.13(27-40) ±3.70	37.67(34-42) ±2.71	**0.00***
Rom rot fark r	Group 1	51.33(40-57) ±4.90	51.33(40-57) ±4.90	**0.00***
	Group 2	45.07(35-56) ±5.16	50.47(45-60) ±4.10	**0.00***
	Group 3	45.13(35-51) ±4.74	50.27(45-55) ±3.73	**0.00***
Rom rot fark l	Group 1	48.60(38-55) ±4.99	51.13(40-57) ±4.77	**0.00***
	Group 2	45.13(37-56) ±4.96	51.27(44-61) ±4.38	**0.00***
	Group 3	46.13(37-52) ±4.43	51.07(44-57) ±4.25	**0.00***
NDI	Group 1	27.27(16-34)5.36	18.27(10-26) ±4.69	**0.00***

	Group 2	30(23-34) ±3.60	14.53(11-24) ±3.15	**0.00***
	Group 3	28.67(23-34) ±3.47	13.40(10-18) ±2.26	**0.00***
SF-36 PCS	Group 1	166.56(115-253) ±39.78	199.76(155-272.5) ±36.14	**0.00***
	Group 2	146.36(115-181.5) ±23.70	235.33(175-272.5) ±32.56	**0.00***
	Group 3	153.60(115-195) ±23.49	233.7(175-272.5) ±34.98	**0.00***
SF-36 MCS	Group 1	200.22(125-295) ±51.38	234.52(160-315) ±54.98	**0.00***
	Group 2	185.75(125-242.50) ±42.01	252.27(174-315) ±43.23	**0.00***
	Group 3	195.34(125-242.5) ±46.82	252.9(174-315) ±48.38	**0.00***

Min: minimum, max: maximum, SD: Standard deviation, B.T:before treatment, A.T:after treatment, WilCoxson Test $p<0.05$*

While a significant difference was found between Group 1 and Group 2 in all parameters, a significant difference was observed between Group 1 and Group 3 in all parameters except ROM extension and left ROM lateral flexion. When Group 2 and Group 3 were compared, there was no significant difference in all parameters between two groups.

4. Comparison of Pain, Posture, Joint Range of Motion, NDI and SF36 Values of Cases Between Groups

When pain, NYPS, range of motion, NDI and SF-36 parameters were examined between the groups, there are significant improvement was observed between the groups. While pain and posture improved mostly in Group 3, ROM and quality of life improved more in group 2. After treatment, all groups showed improvement within and between each other. The changes are shown in Table 4-4.

Table 4. 4: Comparison of Pain, Posture, Joint Range of Motion, NDI and SF36 Values Between Groups

	Group 1 Δ Mean±SD	Group 2 Δ Mean±SD	Group 3 Δ Mean±SD	P
Pain	2.93±0.46	3.93±0.79	4.13±0.83	**0.00***
Posture	3.66±4.41	8.33±4.87	10.33±4.80	**0.00***
ROM FLEKS	3.26±1.83	6.46±1.50	5.20±2.14	**0.00***
Rom ekst	3.20±2.42	6.66±2.76	5.40±2.69	**0.00***
Rom lat flek r	2.73±1.70	5.60±1.50	4.80±1.89	**0.00***
Rom lat fleks l	2.60±2.35	5.00±2.03	4.53±2.38	**0.04***
Rom rot fark r	3.26±2.05	5.40±1.95	5.13±2.26	**0.03***
Rom rot fark l	2.53±1.99	6.13±1.35	4.93±2.46	**0.00***
NDI	9.00±2.61	15.46±3.44	15.26±3.10	**0.00***
SF-36 PCS	33.20±14.19	88.96±29.84	80.10±30.59	**0.00***
SF-36 MCS	34.41±20.43	66.51±32.43	57.56±25.49	**0.01***

SD: Standard deviation, Δ: difference between groups, Mann Whitney U Test p<0.05*

Table 4. 5: Comparison of Pain, Posture, Joint Range of Motion, NDI and SF36 Values Between Group 1 and Group 2

	Group 1 Δ Mean±SD	Group 2 Δ Mean±SD	P
Pain	2.93±0.46	3.93±0.79	**0,00***
Posture	3.66±4.41	8.33±4.87	**0,010***
ROM FLEKS	3.26±1.83	6.46±1.50	**0,00***
Rom ekst	3.20±2.42	6.66±2.76	**0,001***
Rom lat flek r	2.73±1.70	5.60±1.50	**0,00***
Rom lat fleks l	2.60±2.35	5.00±2.03	**0,006***
Rom rot fark r	3.26±2.05	5.40±1.95	**0,007***

Rom rot fark l	2.53±1.99	6.13±1.35	**0,00***
NDI	9.00±2.61	15.46±3.44	**0,00***
SF-36 PCS	33.20±14.19	88.96±29.84	**0,00***
SF-36 MCS	34.41±20.43	66.51±32.43	**0,003***

SD: Standard deviation, Δ: difference between groups, Mann Whitney U Test p<0.05*

Table 4. 6: Comparison of Pain, Posture, Joint Range of Motion, NDI and SF36 Values Between Group 1 and Group 3

	Group 1 **Δ** **Mean±SD**	**Group 3** **Δ** **Mean±SD**	**P**
Pain	2.93±0.46	4.13±0.83	**0,00***
Posture	3.66±4.41	10.33±4.80	**0,00***
ROM FLEKS	3.26±1.83	5.20±2.14	**0,013***
Rom ekst	3.20±2.42	5.40±2.69	**0,026***
Rom lat flek r	2.73±1.70	4.80±1.89	**0,04***
Rom lat fleks l	2.60±2.35	4.53±2.38	**0,034***
Rom rot fark r	3.26±2.05	5.13±2.26	**0,025***
Rom rot fark l	2.53±1.99	4.93±2.46	**0,007***
NDI	9.00±2.61	15.26±3.10	**0,00***
SF-36 PCS	33.20±14.19	80.10±30.59	**0,00***
SF-36 MCS	34.41±20.43	57.56±25.49	**0,01***

SD: Standard deviation, Δ: difference between groups, Mann Whitney U Test p<0.05*

Table 4. 7: Comparison of Pain, Posture, Joint Range of Motion, NDI and SF36 Values Between Group 2 and Group 3

	Group 2 Δ Mean±SD	Group 3 Δ Mean±SD	P
Pain	3.93±0.79	4.13±0.83	**0,508***
Posture	8.33±4.87	10.33±4.80	**0,268***
ROM FLEKS	6.46±1.50	5.20±2.14	**0,072***
Rom ekst	6.66±2.76	5.40±2.69	**0,215***
Rom lat flek r	5.60±1.50	4.80±1.89	**0,211***
Rom lat fleks l	5.00±2.03	4.53±2.38	**0,569***
Rom rot fark r	5.40±1.95	5.13±2.26	**0,733***
Rom rot fark l	6.13±1.35	4.93±2.46	**0,109***
NDI	15.46±3.44	15.26±3.10	**0,868***
SF-36 PCS	88.96±29.84	80.10±30.59	**0,428***
SF-36 MCS	66.51±32.43	57.56±25.49	**0,408***

SD: Standard deviation, Δ: difference between groups, Mann Whitney U Test $p<0.05$*

5.DISCUSSION

In this study, the relationship between isometric exercise, cervical stabilization and core stabilization in 45 patients with chronic neck pain was evaluated.

In addition to electrotherapy, which includes ultrasound vacuum and hotpack applications in patients with chronic neck pain, isometric exercises and stretching were given to one group, deep neck flexor muscle exercises and deep neck flexor muscle exercises and core stabilization exercises in one group. This is a study that examines and compares the effects of these methods on pain, range of motion, posture and quality of life. After the treatment, it was found that there was a significant reduced in neck pain severity in all three groups, and a significant increased in range of motion in all directions and improvement quality of life.

When pain, NYPS, range of motion, NDI and SF-36 parameters were found a significant improvement between the groups. Pain and posture improved more in Group 3, and ROM and quality of life improved more in Group 2. After treatment, all groups improved within and among themselves.

The demographic characteristics of the groups (age, body weight, height and body mass index-BMI) were examined. Although the mean age of the 2nd and 3rd groups was higher than the 1st group, when analyzed statistically, no significant difference was found between the two groups in terms of age, height, body weight and BMI. We think that there is no significant difference, the groups have similar characteristics and that ensuring homogeneity between the groups increases the strength of our study.

McLean and colleagues stated in their study that the higher incidence of neck pain is in women. It was thought that the lower neck muscle strength and endurance in women compared to men may cause this. The prevalence of neck pain is greater than 40 years old shown (67). The average age of the individuals participating in our study is between 38 in group 1 and 42 in group 2 and 3. Our findings are consistent with the literature in terms of age range. It was observed that more female patients than the 45 patients who participated in our study had neck pain (27 female, 18 male).

In study which is conducted by Gupta and colleagues, 30 dentists with chronic neck pain attended. Deep neck flexor training was given to one group, while conventional isometric exercises were given to the other group. At the end of 4 weeks, pain (VAS) was evaluated by digital photograph technique for neck disability index and anterior head position. Although pain and functionality decreased in both groups, posture improved only in the experimental group. As a result, deep neck flexor training gives more effective results in people with anterior head position (68). In our study, deep neck flexor muscle training compared to the isometric exercise group was more likely to reduce pain. However, in the other group, additionally applied core stabilization exercises were found to be more influential in decreasing pain.

Chung et all conducted that craniocervical flexion exercise and ısometric exercise programs reduced in pain and perceived disability in the NDI. Craniocervical flexion exercises was useful for correting the cervical lordosis, the strengthening of deep cervical flexor muscles, and the active motion of all three planes compared with a neck ısometric exercise muscle retraining program. Craniocervical flexion exercise programs improves the ability to control a neutral cervical posture. This development in the cervical posture leads to a reduction in pain (69). Our study supports this study. Accordingly, the improvement in pain degree and posture was higher in the group given core stabilization exercises in addition to cervical stabilization.

Kim, J.Y. et all reported that 28 people with chronic neck pain were studied the general strengthening exercise group and the deep cervical flexor muscle activation group. NDI and numeric rating scale (NRS) for pain were determined and radiological evaluation of neck-shoulder postures, neck flexion angle and forward shoulder angle was evaluated before. Deep cervical flexor muscle activation exercise was effective to decrease pain, improvement neck functions, and maintain correct head posture in the patients suffering from neck pain. The Deep cervical flexor muscle activation exercise significantly decreased the NRS scores after exercise according to the general strengthening exercise group (70). In our study, as a result of 4 weeks, pain was significantly reduced in cervical stabilization studies with core stabilization according to the cervical stabilization exercises. Our study has been an original study because there were no articles that perfom neck exercises together with core stabilization in the previous studies.

Iqbal, Z.A. et al. divided the patients into two groups in their study with 30 teachers aged 25 to 45 years. They applied deep cervical flexor training with a pressurized biofeedback device to the first group and only conventional therapy to the second group. In this 4-week study, deep cervical flexor training significantly decreased according to the neck disability index assessment (NDI)(7). In our study, there was a significant improvement in the group doing deep cervical flexor training compared to those who did isometric exercises. However, there is no significant difference between the core exercising group and the deep cervical flexor training group.

Taesung et al. divided the participants into two groups in their study of 53 patients suffering from chronic neck pain. Deep cervical flexor training was applied to the first group, deep cervical flexor training and thoracic manipulation to the second group. After 6 weeks of training, deep cervical flexor training and thoracic manipulation training have been reported that is more effective in decreasing neck disability index scores (71).

Eun-Young Kim et all studied with 25 students who had forward head postures that caused excessive use of smartphone. They are divided into a deep neck flexor training group and an extension based Mackenzie exercise group for four weeks. Their study examined NDI, changes in the degree of respiratory with the device evaluating pulmonary volumes and ventilation, and the test of deep cervical flexors with a biofeedback unit after the treatment. Evaluation of forward vital capacity and the degree of breathing in expiratory volumes resulted no statistically significant changes in the pressure biofeedback unit based deep cervical flexor training exercise group and the McKenzie cervical exercise group. However, it revealed statistically significant changes in NDI in both groups (72). In our study, our cervical stabilization exercise group proved more effective in measuring the neck disability index compared to the conventional treatment group. However, there is no significant difference between the additional core stabilization exercise group with cervical stabilization and the cervical stabilization group.

Javanshir et all evaluated 60 patients with chronic neck pain in 2 groups (craniocervikal flexion exercise program and cervical flexion exercise program). One group were trained using pressure biofeedback device. Another group in the supine position were studied to raise their head as far as possible throughout their full range of motion slowly without feeling any discomfort or reproducing symptoms. At the end of the treatment, a significant increase in longus colli muscle size was observed in the craniocervical flexion exercise group compared to the other group, while no change was observed in the SCM muscle on ultrasonography. A statistically significant increase in SCM thickness was found in the cervical flexion exercise group. Significant increases in numaric pain rating scale and improvement in neck disability index were found in both groups. According to this study, it is seen that training the neck flexor muscles in a normal pattern within the cranicervical flexion exercise group causes the deep neck flexor muscles to strengthen and muscle size to increase. The changes of longus colli and capitis muscle may be indicative of changing capacity of this muscle group to better stabilization the cervical spine and posture in patients suffering from chronic neck pain (73). Although the change in the muscles was not considered in our study, pain and quality of life increased in the group in which cervical stabilization was studied. Stabilization exercises should be given to patients suffering from chronic neck pain due to muscle imbalance.

In a study conducted by Kang et all, 20 students were evaluated a cervical range of motion after deep cervical flexor muscle training with a pressure biofeedback device and conventional deep cervical flexor training for six weeks. Cervical range of motion in the deep cervical flexor training increased significantly compared another group that contains chin tuck, stretching and rom exercises. So, deep cervical flexor training with a pressure biofeedback device is a effective method for increasing neck movement and muscular endurance in people with forward head posture (74).

Lee et all evaluated that 44 patients with suffering neck pain divided into three groups; neuromuscular control exercise group (upper limb pattern Rolling exercises), self strech group and neck stabilization exercise with the pressure biofeedback device group. In comparison, the neuromuscular control exercise group showed a significant reduction in pain according to the results of the other two groups. There was no significant difference in ROM values of the groups after treatment (75). In our study, ROM increased in all groups. While there was a significant difference in all values between Group 1 and Group 2, a significant difference was found between Group 1 and Group 3 in all values except neck extension and neck left lateral flexion. In the comparison of these values, there was no significant difference between Group 2 and Group 3 in all parameters. According to these results, adding cervical stabilization exercises to classical neck pain treatment is important for the development of ROM. However, the application of core stabilization exercises did not affect the neck range of motion.

Sikka et all studied that 30 students who used long times computer, divided into two group. Deep cervical flexor training and postural training were given to the experimental group, while only postural training was given to the control group. This 4-week study showed that the postural training of DCF training did not cause a significant improvement in forward head posture in students who regularly use computers. But, according to this study, the assessment of NDI in the deep neck flexor study and postural training group was significantly higher than in the other group (76).

Sitharthan et all reported that 30 patients received two different treatments and divided into two groups (neck stabilization exercise group with pressure biofeedback stabilizer and isometric neck exercise group). This study showed that the biofeedback device is effective. There was a statistically significant difference in reducing pain and improving neck disability index in patients exercised with the biofeedback device (77). In our study, the group with neck cervical stabilization exercises improved more than the isometric exercise group. But there was no significant difference with core stabilization.

In study, which is reported by Wing Chiu et all, 20 asymptomatic persons and 20 persons with chronic neck pain participated. Craniocervical flexion test (CCFT) was performed in both groups and this test measures the performance of the deep cervical flexor muscle. People with chronic neck pain (mean 24 mmHg) were able to perform the test lower than people without symptoms (mean 28 mmHg). This study provided evidence that a disorder that characterizes neck pain may have poor ability to perform CCFT (29).

Cunha and colleagues conducted that 31 patients divided into two grups. First group were performed the global posture reeducation program, second group were performed classic static muscle stretching. Also, both of groups used manuel therapy. The global posture reeducation program contained to stretch the posterior and anterior muscle chain. VAS, range of motion, quality of life (SF-36) of the patients were evaluated. SF-36 improved after treatment, but there was no significant differences between groups (3). Contrary to their studies, the specific deep neck flexor muscle group was studied in our study. Accordingly, improvement is more in our deep neck flexor muscle study group in both physical and mental evaluation in Sf-36. There was no significant improvement in the group in which core stabilization was added to cervical stabilization.

Contrary to our study, Addala et al. divided 70 patients with a diagnosis of chronic neck pain into two groups. Deep neck flexor muscle training was performed on a group with a pressurized biofeedback device. Neck stabilization exercise group includes chin tuck for deep cervical flexor muscles, cervical extension, shoulder shrugs and shoulder rolls exercises to relieve muscle tension. As a result of the 4-week study, VAS, NDI, and muscle tests were effective in two groups (78). In our study, the group was given a combination of deep neck flexor muscle group exercises and neck stabilization exercises. Compared to the conventional exercise group, this approach is more significant in all parameters in the treatment.

Kang et all conducted that 60 individuals divided two groups. First group who participated worker with computers for over 6 hours per day, second group who participated rarely worker with computers were evaluated head-neck posture. It is the angle defined in the lateral picture taken during computer programs. The COG of individuals with using computers finded more toward the anterior than another group. There was an imbalance between the anterior and posterior muscle groups (79). In our study, the Reedco’s posture scale was used in the evaluation of posture because of exercise group was performed in the core region. According to the posture scale, it increased more in the group where core stabilization exercises were applied in addition to cervical stabilization. But in our study we did not specifically evaluate the head and neck posture. We do not have clear conclusions on how deep neck flexor training affects head position.

Thongprasert et all conducted that 66 patients divided into three groups (patients with subacute low back pain, patients with chronic low back pain and patients with asymtomatic low back pain). All the participants were performed the craniocervical flexion test (CCFT). The activation score of the test was significantly lower in patients with subacute and chronic low back pain than the control group. Also, the test performans was significantly lower in patients with subacute and chronic low back pain than the control group. The result of their study that reduced performance of cervical stabilizer muscles using the CCFT was shown in the majority participants with low back pain. This findings emphasized the relationship between cervical and lumbar stabilizers in muscle control (80). The aim of our study is that the posture of the patients suffering from chronic neck pain will cause weakness in the neck and core stabilizer muscles, and a complex treatment should be applied to the patients. It is necessary to evaluate the general body of patients with neck pain as a whole.

In a systematic review by Yikang and colleagues, conducted a metaanalysis on the treatment of neck pain with core stability exercise, providing more reliable evidence for future studies. They reported that exercise is a medicine in patients with neck pain. They stated that stability training exercises such as yoga, pilates, sling, bobath balls can be used in patients with neck pain and back pain. However, high quality studies on this topic were found to be insufficient. In their meta-analysis study, it was reported that core stabilization exercises were more effective in reducing pain and improving physical function when general exercises were compared with core stabilization exercises (81). In our study, we observed that core stabilization was more effective than conventional therapy on pain and physical function in patients with neck pain.

Limitations of the Study

Since neck pain is a chronic condition, it is important to improve the long-term pain, disability and quality of life of the treatment methods applied to patients. In our study, long-term follow-up evaluations could not be made due to the education, work life, socio-cultural and economic conditions of the patients. Therefore, in addition to these exercises, it is beneficial to carry out future studies to investigate and compare the long-term effects of neck stabilization exercises and core stabilization exercises, and to determine effective treatment approaches in physiotherapy and rehabilitation science.

In addition, a long-term exercise program should be given to see the effectiveness of exercise therapy. In this study, the treatment program could be applied to patients for 4 weeks, 3 days a week, for a total of 12 sessions. Significant improvements were observed in the patients during this time period as well.

The assessment of the patients had to be measured by the specific head posture rather than assessing the general posture with the Reedco's posture Scale. This can be evaluated with photogrammetry. If this assessment could be made, the effect of stabilization exercises on the region could be better demonstrated, especially due to the relationship between the forward head posture and decreased deep cervical muscles. In our study, postural changes were evaluated limited and cervical region muscle strength was not evaluated.

The effectiveness of the three treatment programs was not compared with a control group that received no treatment. We could not create a group without treatment because the patients who came to the clinic had pain.

In the literature, there is no study on core stabilization studies other than neck exercises in neck pain. While this made our treatment unique, it created a limitation that we could not compare the results with other articles.

6. CONCULUSION

45 patients with chronic neck pain were included in our study. The cases were divided into three groups as conventional treatment group, cervical stabilization group, and core stabilization exercises in addition to cervical stabilization. In the cervical stabilization group, motor control training including deep cervical flexor muscle exercises, neck isometric exercises and neck stretching exercises were applied to the conventional group. Cervical stabilization exercises and core strengthening and motor control training were given to the group with core stabilization exercises. The patients were included in a total of 12 sessions 3 times a week for 4 weeks. The results of our study evaluating pain, posture, range of motion, NDI and quality of life are summarized.

There is no significant difference between the individuals included in the study in terms of age, height, body weight and BMI. We think that the groups have similar characteristics and that ensuring the homogeneity between the groups increases the strength of our study.

In our study, it was observed that cervical stabilization exercises increased the strength and endurance of deep neck muscles more than the conventional group and consequently provided more improvement in pain. In the group to which we added core stabilization exercises, the improvement in the posture was higher than in the other groups, and we think that the related pain decreased more.

When the difference values of the stabilization and control group before and after treatment were compared, it was seen that the stabilization group increased more in all parameters compared to the conventional group. There was a significant difference in all parameters except neck extension and neck left lateral flexion in the core stabilization group compared to the conventional group. But there was no significant difference between the core stabilization group and the cervical stabilization group. We think that a greater increase in neck range of motion occurs because the stabilization program includes deep cervical muscle training and scapular correction training.

In our study, a significant improvement was observed in the neck disability index values due to the decrease in pain in all three groups after treatment. A greater increase in NDI was observed in the cervical stabilization group compared to the conventional group. We think that examining the long-term follow-up results of the patients will be useful in determining whether core stabilization exercises are effective compared to other methods.

In our study, there was a significant improvement in physical and mental assessment of quality of life in all our groups. However, there was a greater increase in the cervical stabilization group compared to the other groups. We think that it will give better results in the long term when done combinated cervical and core stabilization.

Our hypothesis 1 that we say deep neck flexor training is more effective than conservative treatment of neck pain is supported.

The hypothesis 1-2 that we said that core stabilization exercises and deep neck flexor training are more effective than conservative treatment in patients with chronic neck pain, are supported in our study.

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8. APPENDIX

Appendix 8.1. Data collection form

Yeditepe Üniversitesi

Sağlık Bilimleri Enstitüsü

Fizyoterapi ve Rehabilitasyon Anabilim Dalı

Demografik Özellikler Tarih : …./..../…..

1) Hastanın Adı Soyadı:

2) Doğum Tarihi:

3) Telefonu:

4) Cinsiyet: Kadın ( ) Erkek ( )

5) Boy uzunluğu (cm) :

6) Vücut ağırlığı (kg) :

7) Eğitim durumunuz ( ) ilkokul mezunu ( ) lise mezunu

   ( ) üniversite mezunu ( ) okuryazar değilim

8) Herhangi bir sürekli hastalığınız var mı?

( ) Sürekli bir hastalığım yok

( ) Ortopedik Hastalık ( ) Nörolojik Hastalık

( ) Romatizma ( ) Diğer………………

9) Herhangi bir ameliyat geçirdiniz mi? ( ) Evet ……………….Belitiniz ( ) Hayır

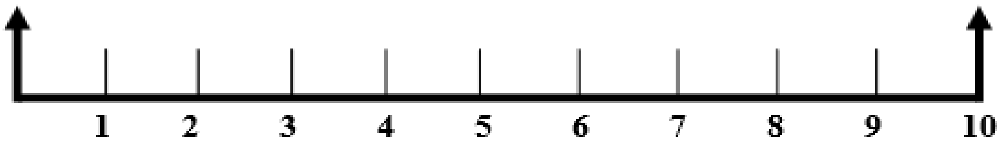
10) Sürekli kullandığınız ilaç var mı? Varsa belirtiniz…………

11) Ne kadar zamandır boyun ağrısı çekiyorsunuz?
( ) 0-3 ay ( ) 3-6 ay ( ) 6-12 ay ( ) 1 yılı aşkın süredir

12) Ağrı şiddetini aşağıdaki ölçek üzerinden işaretleyiniz.

Hiç ağrı olmaması En

dayanılmaz ağrı



Appendix 8.2. Participant consent form

ARAŞTIRMAYA KATILIM ONAM FORMU

Bu çalışma Sağlık Bilimleri Enstitüsü, Fizyoterapi ve Rehabilitasyon Anabilim Dalı yüksek lisans tezi için hazırlanan 'Kronik Boyun Ağrısı olan Hastalarda Derin Servikal Fleksör Eğitimine ek olarak verilen Core Stabilizasyon Eğitiminin Etkisinin Karşılaştırılması' adı çalışmadır. Araştırmada elektroterapi, germe ve izometrik egzersizleri içeren konvansiyonel tedavi yaklaşımı planlanmıştır. Konvansiyonel tedaviye ek olarak bir gruba basınçlı stabilizer aleti ile derin servikal fleksör kas çalışması ve diğer gruba basınçlı stabilizer aleti ile core stabilizasyon çalışması yapılacaktır. Araştırmada New York Postur Analizi, Boyun Ağrı ve Disabilite İndeksi, Sayısal Ağrı Skalası, hareket açıklığı ve yaşam kalitesi değerlendirmesi ölçülecektir. Araştırma ile ilgili sizden doldurmanızı istediğimiz formları doğru bir şekilde doldurmanızı ve herhangi bir şikayetiniz ya da rahatsızlığınız olduğunda bize bildirmeniz gerekmektedir. İstediğiniz zaman çalışma dışına çıkma hakkınız olduğunu bilmenizi isteriz. Bu araştırma kapsamında yapılacak olan değerlendirmelerde herhangi bir risk bulunmamakta ve yapılacak hiçbir değerlendirme size zarar vermeyecektir. Bu araştırma dahilinde sizden herhangi bir ücret talep edilmemektedir. Bu araştırmada yer almanız nedeniyle size hiçbir ödeme yapılmayacaktır. Kişisel bilgileriniz herhangi bir amaçla, kurum yöneticileri veya üçüncü kişilerle paylaşılmayacaktır.

Katılımınız için teşekkür ederiz.

Danışman : Assoc. Prof. Dr. Rasmi MUAMMER

Araştırmacı : Fzt. Beste Hazal GÜMÜŞÇÜ

Kronik boyun ağrısı olan hastalarda derin servikal fleksör eğitimine ek olarak verilen core stabilizasyon eğitiminin etkisinin karşılaştırılması içeren bu çalışmaya hiçbir baskı ve zorlama olmaksızın kendi rızamla katılmayı kabul ediyorum.

Gönüllünün Adı / Soyadı / İmzası /Tarih

Açıklamaları Yapan Kişinin Adı / Soyadı / İmzası / Tarih

Appendix 8.3. Ethical Committee Aproval

T.C. YEDİTEPE ÜNİVERSİTESİ

Sayı : 37068608-6100-15- 1722 **11/07/2019**
Konu: Klinik Araştırmalar
Etik kurul Başvurusu hk.

İlgili Makama (Beste Hazal Gümüşcü)

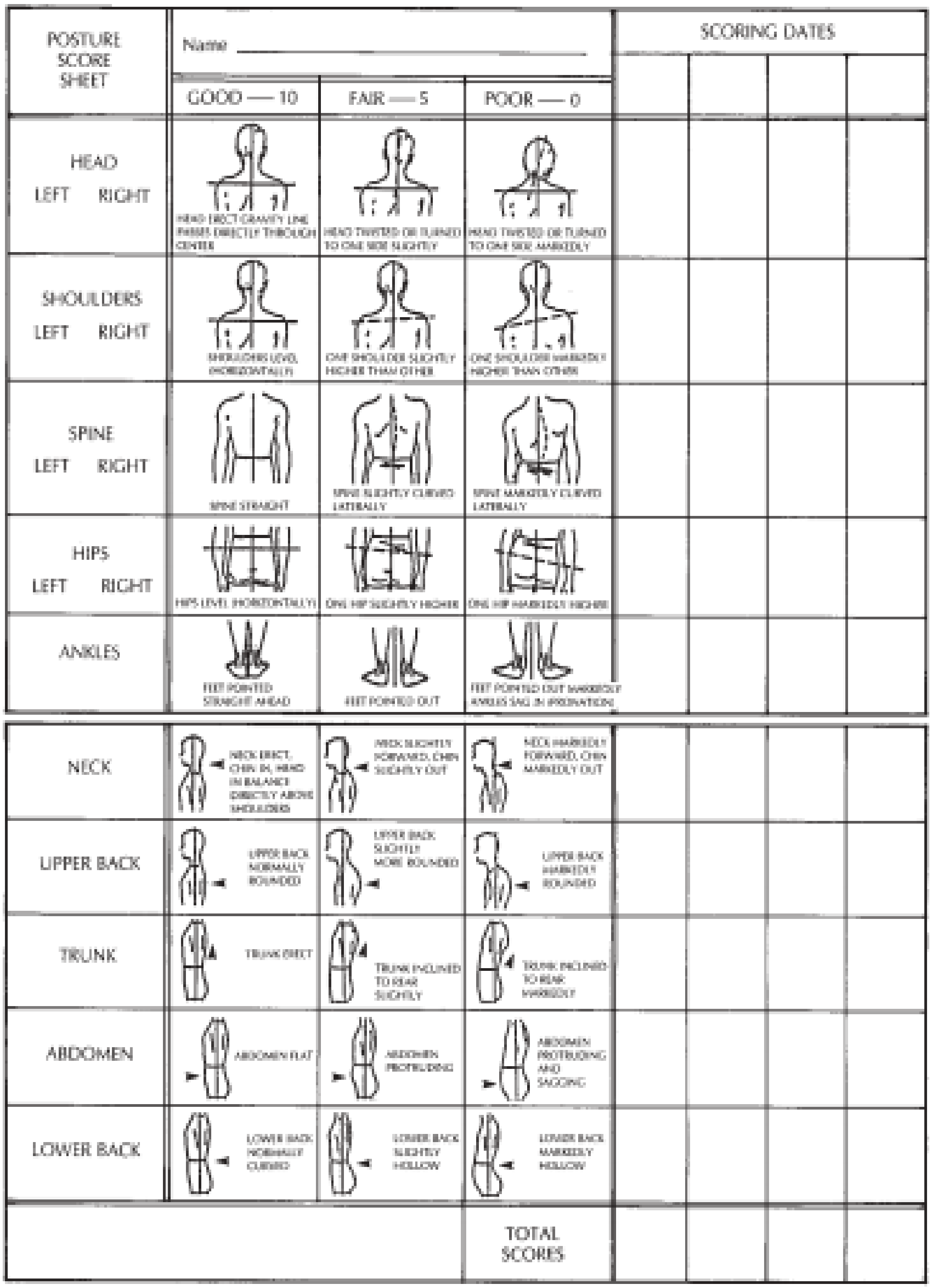
Yeditepe Üniversitesi Sağlık Bilimleri Fakültesi Fizyoterapi ve Rehabilitasyon Bölümü Doç. Dr. Rasmi Muammer'in sorumlu araştırmacı olduğu **"Kronik Boyun Ağrısı Olan Hastalarda Derin Servikal Fleksör Eğitimine Ek Olarak Verilen Core Stabilizasyon Eğitiminin Etkisinin Karşılaştırılması''** isimli araştırma projesine ait Klinik Araştırmalar Etik Kurulu (KAEK) Başvuru Dosyası **(1690)** kayıt Numaralı KAEK Başvuru Dosyası), Yeditepe Üniversitesi Klinik Araştırmalar Etik Kurulu tarafından **10.07.2019** tarihli toplantıda incelenmiştir.

Kurul tarafından yapılan inceleme sonucu, yukarıdaki isimi belirtilen çalışmanın yapılmasının etik ve bilimsel açıdan uygun olduğuna karar verilmiştir (**KAEK Karar No: 1070**).

Prof. Dr. Turgay ÇELİK
Yeditepe Üniversitesi
Klinik Araştırmalar Etik Kurulu Başkanı

Yeditepe Üniversitesi 26 Ağustos Yerleşimi, İnönü Mahallesi Kayışdağı Caddesi 34755 Ataşehir / İstanbul
T. 0216 578 00 00 www.yeditepe.edu.tr F. 0216 578 02 99

Appendix 8.4. Reedco Posture Score Sheet



POSTURE SCORE SHEET	Name ____			SCORING DATES			
	GOOD — 10	FAIR — 5	POOR — 0				
HEAD LEFT RIGHT	HEAD ERECT GRAVITY LINE PASSES DIRECTLY THROUGH CENTER	HEAD TWISTED OR TURNED TO ONE SIDE SLIGHTLY	HEAD TWISTED OR TURNED TO ONE SIDE MARKEDLY				
SHOULDERS LEFT RIGHT	SHOULDERS LEVEL (HORIZONTALLY)	ONE SHOULDER SLIGHTLY HIGHER THAN OTHER	ONE SHOULDER MARKEDLY HIGHER THAN OTHER				
SPINE LEFT RIGHT	SPINE STRAIGHT	SPINE SLIGHTLY CURVED LATERALLY	SPINE MARKEDLY CURVED LATERALLY				
HIPS LEFT RIGHT	HIPS LEVEL (HORIZONTALLY)	ONE HIP SLIGHTLY HIGHER	ONE HIP MARKEDLY HIGHER				
ANKLES	FEET POINTED STRAIGHT AHEAD	FEET POINTED OUT	FEET POINTED OUT MARKEDLY ANKLES SAG IN (PRONATION)				
NECK	NECK ERECT, CHIN IN, HEAD IN BALANCE DIRECTLY ABOVE SHOULDERS	NECK SLIGHTLY FORWARD, CHIN SLIGHTLY OUT	NECK MARKEDLY FORWARD, CHIN MARKEDLY OUT				
UPPER BACK	UPPER BACK NORMALLY ROUNDED	UPPER BACK SLIGHTLY MORE ROUNDED	UPPER BACK MARKEDLY ROUNDED				
TRUNK	TRUNK ERECT	TRUNK INCLINED TO REAR SLIGHTLY	TRUNK INCLINED TO REAR MARKEDLY				
ABDOMEN	ABDOMEN FLAT	ABDOMEN PROTRUDING	ABDOMEN PROTRUDING AND SAGGING				
LOWER BACK	LOWER BACK NORMALLY CURVED	LOWER BACK SLIGHTLY HOLLOW	LOWER BACK MARKEDLY HOLLOW				
			TOTAL SCORES				

Appendix 8.5. Neck Disability Index

NECK DISABILITY INDEX

THIS QUESTIONNAIRE IS DESIGNED TO HELP US BETTER UNDERSTAND HOW YOUR NECK PAIN AFFECTS YOUR ABILITY TO MANAGE EVERYDAY -LIFE ACTIVITIES. PLEASE MARK IN EACH SECTION THE **ONE BOX** THAT APPLIES TO YOU. ALTHOUGH YOU MAY CONSIDER THAT TWO OF THE STATEMENTS IN ANY ONE SECTION RELATE TO YOU, PLEASE MARK THE BOX THAT **MOST CLOSELY** DESCRIBES YOUR PRESENT -DAY SITUATION.

SECTION 1 - PAIN INTENSITY

- [ ] I have no pain at the moment.
- [x] The pain is very mild at the moment.
- [ ] The pain is moderate at the moment.
- [ ] The pain is fairly severe at the moment.
- [ ] The pain is very severe at the moment.
- [x] The pain is the worst imaginable at the moment.

SECTION 2 - PERSONAL CARE

- [ ] I can look after myself normally without causing extra pain.
- [ ] I can look after myself normally, but it causes extra pain.
- [ ] It is painful to look after myself, and I am slow and careful.
- [ ] I need some help but manage most of my personal care.
- [ ] I need help every day in most aspects of self -care.
- [ ] I do not get dressed. I wash with difficulty and stay in bed.

SECTION 3 – LIFTING

- [ ] I can lift heavy weights without causing extra pain.
- [x] I can lift heavy weights, but it gives me extra pain.
- [ ] Pain prevents me from lifting heavy weights off the floor but I can manage if items are conveniently positioned, ie. on a table.
- [x] Pain prevents me from lifting heavy weights, but I can manage light weights if they are conveniently positioned.
- [ ] I can lift only very light weights.
- [x] I cannot lift or carry anything at all.

SECTION 4 – WORK

- [ ] I can do as much work as I want.
- [ ] I can only do my usual work, but no more.
- [ ] I can do most of my usual work, but no more.
- [ ] I can't do my usual work.
- [ ] I can hardly do any work at all.
- [ ] I can't do any work at all.

SECTION 5 – HEADACHES

- [ ] I have no headaches at all.
- [ ] I have slight headaches that come infrequently.
- [ ] I have moderate headaches that come infrequently.
- [x] I have moderate headaches that come frequently.
- [ ] I have severe headaches that come frequently.
- [ ] I have headaches almost all the time.

SECTION 6 – CONCENTRATION

- [ ] I can concentrate fully without difficulty.
- [ ] I can concentrate fully with slight difficulty.
- [ ] I have a fair degree of difficulty concentrating.
- [ ] I have a lot of difficulty concentrating.
- [ ] I have a great deal of difficulty concentrating.
- [ ] I can't concentrate at all.

SECTION 7 – SLEEPING

- [ ] I have no trouble sleeping.
- [ ] My sleep is slightly disturbed for less than 1 hour.
- [ ] My sleep is mildly disturbed for up to 1-2 hours.
- [x] My sleep is moderately disturbed for up to 2-3 hours.
- [ ] My sleep is greatly disturbed for up to 3-5 hours.
- [ ] My sleep is completely disturbed for up to 5-7 hours.

SECTION 8 – DRIVING

- [ ] I can drive my car without neck pain.
- [ ] I can drive as long as I want with slight neck pain.
- [ ] I can drive as long as I want with moderate neck pain.
- [x] I can't drive as long as I want because of moderate neck pain.
- [ ] I can hardly drive at all because of severe neck pain.
- [ ] I can't drive my care at all because of neck pain.

SECTION 9 – READING

- [x] I can read as much as I want with no neck pain.
- [ ] I can read as much as I want with slight neck pain.
- [ ] I can read as much as I want with moderate neck pain.
- [ ] I can't read as much as I want because of moderate neck pain.
- [ ] I can't read as much as I want because of severe neck pain.
- [ ] I can't read at all.

SECTION 10 – RECREATION

- [ ] I have no neck pain during all recreational activities.
- [ ] I have some neck pain with all recreational activities.
- [ ] I have some neck pain with a few recreational activities.
- [x] I have neck pain with most recreational activities.
- [ ] I can hardly do recreational activities due to neck pain.
- [ ] I can't do any recreational activities due to neck pain.

PATIENT NAME ______________________________ DATE ______________

SCORE ___________ [50] BENCHMARK -5 = ___________

Appendix 8.6. SF-36

SF-36 (Short Form 36)

Adınız Soyadınız: ______________________________ Hasta # __________

Aşağıdaki sorular sizin kendi sağlığınız hakkındaki görüşünüzü, kendinizi nasıl hissettiğinizi ve günlük aktivitelerinizi ne kadar yerine getirebildiğinizi öğrenmek amacındadır. Her hangi bir sorunun yanıtı hakkında emin değilseniz bile size en uygun yanıtı verin. Ayrıca 10 uncu sorudan sonraki boşluğa yorumlarınızı yazabilirsiniz.

1-Genel sağlık durumunuz hakkında aşağıdaki tanımlardan hangisi doğrudur? Lütfen tek bir yanıt veriniz.

Mükemmel ☐
Çok iyi ☐
İyi ☐
Orta (fena değil) ☐
Kötü ☐

2-Bir yıl öncesi ile karşılaştırdığınızda genel sağlık durumunuzu nasıl değerlendirirsiniz?

Bir yıl öncesinden çok daha iyi ☐
Bir yıl öncesinden biraz iyi ☐
Hemen hemen aynı ☐
Bir yıl öncesinden biraz daha kötü ☐
Bir yıl öncesinden çok daha kötü ☐

SAĞLIK VE GÜNLÜK AKTİVİTELER

3-Aşağıdaki sorular bir gün içinde yapabileceğiniz işlerle (aktivitelerle) ilgilidir. Sağlığınız bu aktiviteleri kısıtlıyor mu? Eğer kısıtlıyorsa, ne kadar?

a)Zorlu aktiviteler; örneğin koşma, ağır eşyaları kaldırma, zor sporlara katılma vb	Evet, çok kısıtlı	Evet, biraz kısıtlı	Hayır, hiç kısıtlı değil
b)Orta derecede aktiviteler; örneğin bir masayı kaldırma, elektrikli süpürgeyi itme, hafif sporlara katılma vb	☐	☐	☐
c)Ağır kaldırma ve yük taşıma	☐	☐	☐
d)Çok sayıda merdiven basamağını çıkma	☐	☐	☐
e)Tek bir merdiven basamağını çıkma	☐	☐	☐
f)Öne eğime, çömelme veya diz çökme	☐	☐	☐
g)İki kilometreden çok yürüme	☐	☐	☐
h)Bir kilometre yürüme	☐	☐	☐
i)100 metre yürüme	☐	☐	☐
j)Kendi başına banyo yapma ve giyinme	☐	☐	☐

1

7-Son 4 hafta içinde ne kadar ağrınız oldu?

Lütfen tek bir yanıt veriniz.

Hiç olmadı ☐
Çok az ☐
Az ☐
Orta derecede ☐
Çok ☐
Pek çok ☐

8-Son 4 hafta içinde ağrınız sizin normal çalışmanızı ne kadar etkiledi (hem ev dışında, hem de ev işi olarak)?

Lütfen tek bir yanıt veriniz.

Hiç etkilemedi ☐
Biraz etkiledi ☐
Orta derecede etkiledi ☐
Epey etkiledi ☐
Çok etkiledi ☐

GENEL SAĞLIK

9-Aşağıdaki cümlelerin sizin için ne kadar doğru veya yanlış olduğunu belirtiniz.

Her bir soruya tek bir yanıt veriniz.

	Kesinlikle doğru	Çoğunluk la doğru	Emin değilim	Çoğunluk la yanlış	Kesinlikle yanlış
a)Ben diğer insanlara göre daha kolay hastalanıyorum	☐	☐	☐	☐	☐
b)Tanıdığım kişiler kadar sağlıklıyım	☐	☐	☐	☐	☐
c)Sağlığımın kötüleşmekte olduğunu sanıyorum	☐	☐	☐	☐	☐
d)Sağlığım mükemmel	☐	☐	☐	☐	☐

7-Son 4 hafta içinde ne kadar ağrınız oldu?

Lütfen tek bir yanıt veriniz.

Hiç olmadı ☐
Çok az ☐
Az ☐
Orta derecede ☐
Çok ☐
Pek çok ☐

8-Son 4 hafta içinde ağrınız sizin normal çalışmanızı ne kadar etkiledi (hem ev dışında, hem de ev işi olarak)?

Lütfen tek bir yanıt veriniz.

Hiç etkilemedi ☐
Biraz etkiledi ☐
Orta derecede etkiledi ☐
Epey etkiledi ☐
Çok etkiledi ☐

GENEL SAĞLIK

9-Aşağıdaki cümlelerin sizin için ne kadar doğru veya yanlış olduğunu belirtiniz.

Her bir soruya tek bir yanıt veriniz.

	Kesinlikle doğru	Çoğunluk la doğru	Emin değilim	Çoğunluk la yanlış	Kesinlikle yanlış
a)Ben diğer insanlara göre daha kolay hastalanıyorum	☐	☐	☐	☐	☐
b)Tanıdığım kişiler kadar sağlıklıyım	☐	☐	☐	☐	☐
c)Sağlığımın kötüleşmekte olduğunu sanıyorum	☐	☐	☐	☐	☐
d)Sağlığım mükemmel	☐	☐	☐	☐	☐

DUYGULARINIZ

10-Aşağıdaki sorular duygularınızı ve son bir ay içinde nasıl olduğunuzu anlamak için düzenlenmiştir. Her bir soru için lütfen size en uygun tek bir yanıtı işaretleyin.

	Sürekli	Çoğu zaman	Epey zaman	Bazen	Ara sıra	Hiç bir zaman
a)Kendinizi yaşam dolu olarak mı hissediyorsunuz?	☐	☐	☐	☐	☐	☐
b)Çok sinirli biri mi oldunuz?	☐	☐	☐	☐	☐	☐
c)Kendinizi lağım çukuruna düşmüş gibi hissettiğiniz ve hiçbir şeyin moralinizi düzeltemeyeceğini düşündüğünüz oldu mu?	☐	☐	☐	☐	☐	☐
d)Kendinizi sakin ve barışçı hissettiniz mi?	☐	☐	☐	☐	☐	☐
e)Çok enerjik oldunuz mu?	☐	☐	☐	☐	☐	☐
f)Kendinizi kalbi kırık ve üzgün hissettiniz mi?	☐	☐	☐	☐	☐	☐
g)Kendinizi yıpranmış hissettiniz mi?	☐	☐	☐	☐	☐	☐
h)Mutlu bir insan oldunuz mu?	☐	☐	☐	☐	☐	☐
i)Yorgunluk hissettiniz mi?	☐	☐	☐	☐	☐	☐
j)Sağlığınız sosyal aktivitelerinizi sınırladı mı? (arkadaşları veya yakın akrabaları ziyaret etmek gibi)	☐	☐	☐	☐	☐	☐

Yorum:

Appendix 8.7. Curriculum vitae

Personal Informations

Name	Beste Hazal	**Surname**	GÜMÜŞCÜ
Place of Birth		**Date of Birth**	
Nationality		**TR ID Number**	
E-mail		**Phone number**	

Education

Degree	Department	The name of the Institution Graduated From	Graduation year
Doctorate			
Master	Physical Therapy and Rehabilitation	**İstanbul Yeditepe University**	2021
University	Physical Therapy and Rehabilitation	**İstanbul Yeditepe University**	2016
High school		**Milas Anatolian High School**	2011

Work Experience (Sort from present to past)

Position	**Institute**	**Duration (Year - Year)**
Physical Therapist	Acıbadem Bodrum Medical Center	2019-
Physical Therapist	Pendik Bölge Hospital	2017-2019
Physical Therapist	Arı Special Education and Rehabilitation Center	2016-2017