ÇİÇEK DUMAN

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T.C.
YEDITEPE UNIVERSITY
GRADUATE SCHOOL OF HEALTH SCIENCES
DEPARTMENT OF PHYSIOTHERAPY & REHABILITATION

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(MASTER THESIS)

ÇİÇEK DUMAN, PT

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İSTANBUL- 2018

T.C.

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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.

Cicek DUMAN

Signature

DEDICATION

I would like to dedicate my thesis to my beloved and loving parents Ulviye AKCORA and Mehmet Emin DUMAN and my sister, Gizem DUMAN.

I also thank Ugur Gurkan GUNDAY being my constant source of inspiration.

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LIST OF SYMBOLS/ABBREVIATIONS

ANS	Autonomic Nervous System
AP	Anteroposterior
BBS	Biodex Balance System
BoS	Base of Support
CNS	Central Nervous System
CoG	Center of Gravity
CoM	Center of Mass
COR	Cervico-Ocular-Reflexes
CROM	Cervical Range of Motion Tester
CTDs	Connective Tissue Diseases
CTM	Connective Tissue Manipulation/Massage
GM	Gluteus Medius Muscle
GTO	Golgi Tendon Organ
ML	Mediolateral
MS	Muscle Spindle
OLST	One Leg Stance (Single Limb Stance) Test
OV	Overall
RAM	Rapidly Adapting Mechanoreceptors
SAM	Slowly Adapting Mechanoreceptors
TRR	Triple Response Reaction
VCR	Vestibulo-Collic Reflexes
VNC	Vestibular Nuclear Complex
VSR	Vestibulo-Spinal Reflexes
VOR	Vestibulo-Ocular-Reflexes

ABSTRACT

Duman, Ç. (2018) The effects of connective tissue manipulation on balance and proprioception among healthy individuals. Yeditepe University, Institute of Health Sciences, Department of Physiotherapy and Rehabilitation, MSc thesis. Istanbul

Connective Tissue Manipulation (CTM) is a type of manual therapy used in different problems. Despite the well-known effects of CTM, its effects on proprioception and balance have not been investigated as far as, we know. The aim of the study to investigate the effects of CTM on balance and proprioception among healthy individuals. 40 volunteers studying in Bahcesehir University were divided into exercise and study (CTM with exercise) groups equally. Biodex Balance System was used for evaluation of static and dynamic balance. The cervical proprioception was measured by using a cervical range of motion (CROM) device while lumbar proprioception was measured by Stabilizer^{TM} Pressure Biofeedback Unit. Additionally, at the beginnig and end of the study, heart rate and blood pressure were measured by M3 Comfort Digital blood Pressure Monitor. Both study and exercise groups were instructed to perform home exercises for 2 sessions in a week for 6 weeks (12 sessions in total). Additionally, CTM was applied to the volunteers in study group for 6 weeks, 2 sessions in a week. At the end of the study, a significant difference between heart rate or blood pressure measurements of the groups cannot be found. On the other hand, a significant difference between groups were found in cervical flexion with ($p \leq 0{,}01$) and without ($p \leq 0{,}05$) vision and lumbar proprioception with and without vision ($p \leq 0{,}01$). Since the “overall” scores are more reliable than the “anteroposterior” and “mediolateral” scores of the Biodex Balance System, intergroup comparison of the groups were interpreted according to the overall scores. Improvement in static and dynamic balance on right foot ($p \leq 0{,}01$), bilateral dynamic balance ($p \leq 0{,}05$), and static balance on left foot ($p \leq 0{,}01$) were found significant between the groups. On the other hand, when all scores (overall, anteroposterior, mediolateral) were examined, pre-and-post measurements of both dynamic and static balance were found significant ($p \leq 0{,}05$) in study, while exercise group showed a significant improvement mostly in dynamic balance scores. Considering all of these, we believe that the application of CTM with exercise improves proprioception and balance, especially static balance, in healthy subjects. Further studies are needed to be done with larger groups and addition of a control group to the study will increase the strength of the study.

Key words: Connective tissue massage, Connective Tissue Manipulation, Postural Balance, Proprioception

ÖZET

Duman, Ç. Sağlıklı bireylerde konnektif doku masajının denge ve propriyosepsiyon üzerine etkisi. Yeditepe Üniversitesi, Sağlık Bilimleri Enstitüsü, Fizyoterapi ve Rehabilitasyon ABD, Master Tezi. İstanbul.

Konnektif doku masajı (KDM), farklı rahatsızlıklarda kullanılan bir tür manuel tedavidir. KDM'nin iyi bilinen etkilerine rağmen, propriosepsiyon ve denge üzerindeki etkileri, bildiğimiz kadarıyla araştırılmamıştır. Çalışmanın amacı sağlıklı bireyler arasında KDM'nin denge ve propriosepsiyon üzerine etkilerini araştırmaktır. Bahçeşehir Üniversitesi'nde okuyan 40 gönüllü öğrenci, eşit olarak egzersiz ve çalışma (egzersiz ve KDM) olmak üzere 2 gruba ayrıldı. Statik ve dinamik dengenin değerlendirilmesi için Biodex Denge Sistemi kullanıldı. Servikal propriyosepsiyon servikal hareket (CROM) cihazı kullanılarak ölçülürken, lomber propriyosepsiyon Stabilizer^{TM} Pressure Biofeedback ile ölçüldü. Ek olarak, çalışmanın başlangıcında ve sonunda dijital kan basıncı monitörü tarafından kalp hızı ve kan basıncı ölçüldü. Her iki gruba, 6 hafta boyunca haftada 2 seans (toplamda 12 seans) ev egzersizleri öğretildi. Ayrıca, çalışma grubundaki gönüllülere 6 hafta boyunca, haftada 2 seans KDM uygulandı. Çalışmanın sonunda, grupların kalp hızı veya tansiyon ölçümleri arasında anlamlı bir fark bulunamamıştır. İki grup arasında göz açık ($p \leq 0,01$) ve göz kapalı ($p \leq 0,05$) boyun fleksiyonu ve göz açık ve göz kapalı lomber propriosepsiyon ($p \leq 0,01$) değerlerinde anlamlı fark bulundu. Biodex Denge Sisteminin "overall" skorları "anteroposterior" ve "mediolateral" skorlarından daha güvenilir olduğundan, grupların gruplar arası karşılaştırması, genel skorlara göre yorumlandı. Sağ ayak üzerinde duruşta statik ve dinamik dengede ($p \leq 0,01$), bilateral dinamik dengede ($p \leq 0,05$) ve sol ayak üzerinde duruşta statik dengede ($p \leq 0,01$) gruplar arasında anlamlı fark gözlemlendi. Öte yandan, tüm skorlar (overall, anteroposterior, mediolateral) incelendiğinde hem dinamik hem de statik denge öncesi ve sonrası ölçümleri çalışma grubunda anlamlı bulunurken ($p \leq 0,05$), egzersiz grubu ise çoğunlukla dinamik denge puanlarında anlamlı bir iyileşme gösterdi. Tüm bunlar göz önünde bulundurulduğunda, egzersizle birlikte KDM uygulanmasının, sağlıklı deneklerde propriyosepsiyonu ve dengeyi, özellikle statik dengeyi, geliştirdiğine inanıyoruz. Ancak daha büyük gruplarla yapılacak olan daha fazla çalışmaya ihtiyaç vardır ve çalışmaya bir kontrol grubu eklenmesi çalışmanın gücünü arttıracaktır.

Anahar Kelimeler: Konnektif doku masajı, Konnektif doku manipulasyonu, Postural denge, Propriyosepsiyon

1. INTRODUCTION

Connective Tissue Manipulation (CTM) is a type of manual therapy used in both somatic and visceral problems. It is known in the literature that CTM balances the functioning of the autonomic nervous system (ANS) and increases circulation, resulting in decreased pain, muscle relaxation and increased mobility (1). Additionally, the frictional force generated during application accelerates the blood flow of both the skin and the parasympathetic ganglion. When the veins in the skin are thought to be controlled by ANS, it is understood how the CTM balances the ANS with such strong influence (2).

Despite the well-known effects of CTM, its effects on proprioception and balance have not been investigated as far as, we know. Proprioception is a broad concept that includes balance with the contributions of visual and vestibular inputs, postural control, joint kinesthesia, position sense and muscle reaction time (3). Proprioception allows us to feel the position of the body and how / where the limbs are positioned relative to this position. This feeling has a great importance of development of balance, hence preventing falls or injuries (4).

Proprioception and balance are senses that are affected even in orthopedic, neurological, pediatric and even internal diseases (5). Although tissue healing and muscle strength are at optimal levels in treated patients, the individual continues to have difficulty in daily life as long as proprioception, and therefore balance, has not been developed. Moreover, the risk of re-injury increases. This is also same for healthy individuals. Even if the person has no other illness, falls, injuries and sprains based upon falls can be observed if the person is not able to maintain balance (6).

There are various exercises and manual techniques to improve balance and proprioception (7). Most of these manual therapy techniques are mobilization, manipulation, post-isometric relaxation, myofascial relaxation and traction massage. At the same time, it has been observed that many parameters such as range of motion, tissue tension, wound healing process and pain perception were examined in the studies in the literature, but the effects of CTM on balance and proprioception have not been investigated.

Therefore, we aim to investigate the effects of CTM on balance and proprioception among healthy individuals studying in Bahcesehir University.

2. THEORETICAL FRAMEWORK AND LITERATURE REWIEV

2.1 Balance (Equilibrium)

Balance is thought with the terms of stability and postural control. **Balance** is defined as keeping the center of gravity within the support surface. **Stability** is the ability to maintain balance position in order to avoid falling or to regain the balance position if it is lost. **Postural control** is a prerequisite to protect or restore the balance during any posture or activity (8).

Activities of daily living require different types of balance control. **Static Balance** is the ability to maintain a stable posture when standing and sitting. **Dynamic Balance** is the ability of a person to maintain balance during a motion or while switching between positions (9, 10). And the **Automatic Postural Reactions** are the ability to maintain balance in response to unexpected external disturbances (for example; raising the arms while falling) (9).

The conditions required for the postural balance are as follows (11, 12, 13):

- Being the boundary of the Base of Support (BoS - the area between the feet) is broad
- Being the body Center of Mass (CoM - the point where the mass of the body is equally distributed) is close to the BoS
- Being the CoM passes from or near the Center of Gravity (CoG - the point where forces caused by gravity are equal to zero)
- Being that the CoM falls into the boundaries of BoS

When the balance is lost in the standing position, three basic strategies of motion can be used in order to maintain balance: ankle, hip and stepping strategy. **The ankle strategy** is a strategy in which the body moves around the ankle to maintain balance during small oscillations, and the force produced in this strategy is perpendicular to the floor and radiates distally to proximally. **The hip strategy** is used in situations where it is difficult to use the ankle strategy, when standing on a narrow support surface, or when the body needs to change its center of gravity quickly. In this strategy, an angular moment is applied at the hip level to move the body center of gravity quickly and a horizontal force is produced parallel to the floor. In cases where these strategies are inadequate, **the**

stapping strategy is used to shift the support surface to the direction that the center of gravity of the body changes (12, 14).

Ability to maintain balance depends on three major factors (15):

- Healthy sensory systems to get a certain information about the position of the body
- Brain's ability to process this information
- Healthy musculoskeletal system to coordinate movements required to maintain balance

2.1.1 Information Systems (Sensory input):

Three different sensory systems work organizedly to provide and maintain balance (16). Healthy individuals standing on a firm surface adjust their balances with information coming from somatosensory (proprioceptive) system (70%), vestibular system (20%) and visual system (10%). On the other hand, if the platform is unstable, they increase sensory weighting to vestibular and visual information as they decrease their dependence on surface somatosensory inputs to keep balance (17).

In this topic, these systems are briefly mentioned, while the proprioception is explained in detail on page 8.

2.1.1.1. Visual System

Visual system provides the central nervous system (CNS) with subjective information related to position and perception of midline during movement. It can be thought as visual proprioception and is a reference point to the vertical and spatial awareness. (18) There are two different reflex mechanisms that control eye movements. **Cervico-Ocular-Reflexes (COR)** use the information getting from the joints, muscles and ligaments of the neck, while the **Vestibulo-Ocular-Reflexes (VOR)** use vestibular information in order to maintain visual fixation on an object during head movements via the extrinsic eye muscles (trochlear, oculomotor and abducens) (19, 20).

2.1.1.2. Vestibular System

The vestibular system consists of specialized structures that perceive gravity, the spatial position of the head, the type of movement of the body, and the change of position.

This position and movement information is mainly provided by the vestibular end-organs located in both inner ears. These end-organs are named as “saccule”, “utricle” and “anterior, posterior and lateral semicircular canals”. The physical stimuli created by gravity and movements are converted into electrochemical stimuli in these organs and are carried to CNS by 8th cranial nerve (Vestibulocochlear Nerve) (21, 22).

Widened ends of semicircular canals called “ampulla” contains sensory hairs which function in perception of rotational movements of the head. On the other hand, both sensory hair and calcium carbonate cristals (otoconia) are located in utricle and saccule which make these organs sensitive to linear movements and gravity (19).

In addition to COR and VOR, by triggering muscle activity in the extremities, trunk and neck, **Vestibulo-Spinal Reflexes (VSR)** stabilize the head and help maintain upright stance. Furthermore, by initiating neck responses, the **Vestibulo-Collic (VCR)** and the **Cervico-Collic Reflexes** help stabilization of the head in the vertical position (23).

2.1.1.3. Proprioceptive System

Proprioception is a sense which gives information about the movements and positions of the body parts or joints in space or relative to each other (12). It can be divided into two subgroups: a) Static Proprioception: the conscious perception of the position of the body parts relative to one another, and b) Dynamic Proprioception (Kinesthesia): sense of movement speed (12). By considering the neuromuscular system feedback provided by the dynamic proprioceptors, the proprioception can be thought of as a complex neuromuscular process involving both afferent input and efferent signals (3).

2.1.2. Motor Control Systems

Cerebellum and Vestibular Nuclear Complex (VNC) are the central proccessors of the balance-related informations (19).

2.1.2.1. Vestibular Nuclear Complex

Four major and seven minor vestibular nuclei which are located in the pons and medulla receive information from both somatic receptors (especially from the proprioceptors located in neck muscles) and vestibular and visual systems (19, 24). VNC combines these informations and send them to the different ares of CNS such as cerebral cortex, spinal cord and cerebellum to initiate the appropriate reactions (VOR, VSR, VCR etc.) (20, 24).

2.1.2.2. Cerebellum

Cerebellum consists of two hemispheres on the right and left, called **hemispherium cerebelli**, and there is a narrow segment **(vermis cerebelli)** which connects these two hemispheres. It can be divided into 3 lobes anatomically by two fissures: **Lobus Cerebelli Anterior** (in front of the fissura prima)**, Lobus Cerebelli Posterior (Medius)** (between fissura prima and posterolateralis) and **Lobus Cerebelli Flocculonodularis** (behind the fissura posterolateralis) (25). (Figure 2.1. and 2.2.)

The phylogenetic and functional description categorizes the cerebellum into the 3 main parts:

Vestibulo-cerebellum (Archicerebellum): It comprises of the flocculonodular lobe and recieves information via Vestibulocochlear (VIII) Nerve. It plays a major role for regulation of eye movements, integration of vestibular information and maintaining equilibrium by getting the information of head movement and head position with respect to gravity (26, 27, 28).

Spino-cerebellum (Paleocerebellum): It consists of the vermis and paravermis and receives proprioceptive information from the spinal cord (29). It receives information from cortex, spinal cord neurons and proprioceptors so that to use this information to corrective, anticipatory and responsive adjustments. If it is damaged, there will be uncoordinated limb movements (28).

Cerebro-cerebellum (Neocerebellum): It consists of the lateral hemispheres and via the pons, receives information from the contralateral cerebrum (30). It deals with the regulation of higher level of functions such as planning or preparation of movement or being a part of motor learning process. If it is damaged, movement of the joints are sequential, not simultaneous (31).

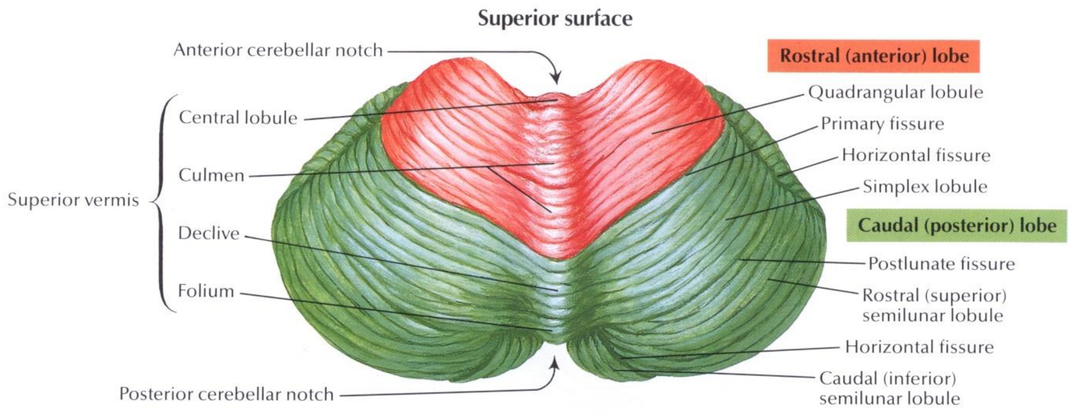


Figure 2. 1. Cerebellum, Superior Surface (32)

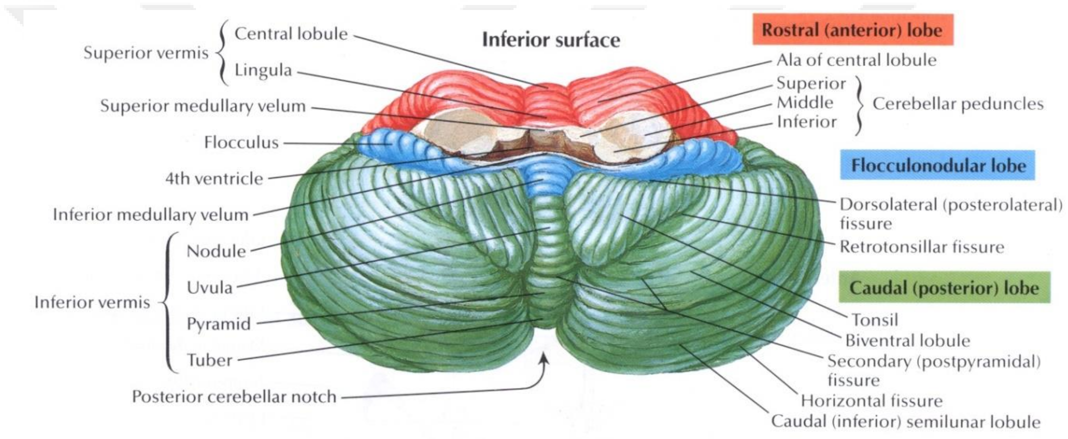


Figure 2. 2. Cerebellum, Inferior Surface (32)

2.1.3. Musculoskeletal Component of Balance

Many muscles of the body involved in the maintaining balance. However, coordinated actions of lower extremity and trunk muscles primarily provide maintainig balance (5). For example, abdominal and spinal muscles of the body are referred as the core muscles and responsible for spinal and pelvic stability. Since many major muscle groups of upper and lower extremity are atteched to the core region, strong core muscles contribute effective energy tranfer between upper and lower segments of the body and improves posture and balance (33). For this reasons, lower extremity and trunk muscles can be thought as key muscles of the balance and strength of these muscles is an important factor to maintaining balance (15, 34).

2.2 Assessment of Balance

Evaluation of balance helps to identify the risk of falling and to develop treatment approaches to prevent problems that may arise. Balance can be evaluated with clinical, functional or computerized tests. Although computerized tests can give more accurate results and are possible to use for training purposes as well as evaluation, clinical and functional tests are more frequently used in clinics, because they are cheap and easy to use (12, 35).

There are various tests to assess static and dynamic balance and the most frequently used ones can be seen at Table 2.1.

Table 2. 1. Frequently used static and dynamic balance tests according to their scoring (12, 36, 37)

	Static Tests		**Dynamic Tests**	
Errors in a unit of time	*Flamingo Balance Test*	The person stands on a 50 cm long, 4 cm high and 3 cm wide wooden platform and tries to hold the unsupported leg for 1 minute.		
	Balance Error Scoring System	The participant closes eyes and tries to maintain 3 different postures (double-leg, single-leg and tandem) on 2 different surfaces (flat and foam) for 20 seconds.		
The time that a participant can keep the position	*One Leg Stance (Single Limb Stance) Test (OLST)*	Test starts with that the person raises his/her leg and finishes if she/he uses the arms or raised foot or moves the weightbearing foot to maintain balance	*Timed Up & Go Test*	It starts when the sitting person stands up from a chair, walks down the 3-meter area, turns, walks back and finish when she/he sits down again. If the total time is longer than 13,5 seconds, it is thought as increased risk of falls.
	Stork Test	The testing procedure is the same with the OLST but with 2 differences: 1. the raised foot must be placed against the inside knee of the opposite leg, and 2. the heel of the supporting leg must be raised from the floor.	*Five Times Sit to Stand Test*	The person rises from a chair and returns to the seated position as quickly as possible for five times. Participants must cross the arms over the chest during the test.

Presence of sway or not	*Romberg Test*	Primarily used with vestibular and proprio-ceptive disorders. The person is asked to place his/her feet together and the arms adjacent to the body. Then, she/he closes the eyes. Thus, the auxiliary role of the sense of vision in the balance is eliminated.		
Distance that a participant can reach			*Functional Reach Test*	It assesses the forward stability of a standing person who extends one arm as far forward as possible without raising both heels from the ground.
			Star Excursion Balance Test	To get a star shape, two of four pieces of tape (6-8 feet each) uses to form a '+', other two of them being placed over top to form an 'x'. A 45° angle separates all lines from each other. The aim is to maintain balance on one leg while reaching as far as possible with the contralateral leg.

2.3 Proprioception

As mentioned before, proprioception is a somatosensory feeling that gives information about the body movements and position (12). This feeling is conveyed to the central nervous system in two ways: tractus spinocerebellaris anterior et posterior and lemniscus medialis which is formed by fasciculus gracilis and fasciculus cuneatus (see Table 2.2) (38).

Table 2. 2. Ascending pathways of proprioceptive information

Sense	Receptor	Tractus	Terminal Area
Two-point Discrimination, Vibration, Concious Proprioception	Meissner's Corpuscles, Pacinian Corpuscles, Tendon Organs Muscle Spindles	Fasciculus Gracilis, Fasciculus Cuneatus, Lemniscus Medialis	Gyrus Postcentralis
Unconcious Proprioception	Tendon Organs Muscle Spindles	Tractus Spinocerebellaris Anterior et Posterior	Cortex Cerebelli

The muscle-joint sensation conveyed by tractus spinoserebellaris anterior et posterior is terminated in cortex cerebelli and is called ***unconscious proprioception***. On the other hand, the muscle-joint sensation conveyed by the lemniscus medialis is terminated in the gyrus postcentralis and is called ***conscious proprioception*** (38, 39). The conscious proprioception provides the personal awareness about the position of arms, legs, and whole body, while the unconscious proprioception regulate motor properties such as muscle tone, muscle contraction, and coordination between muscles (12).

2.3.1 Proprioceptors and Their Functions

Sensory receptors can be basically divided into three groups by their location: a) Exteroceptors (superficial, on the skin), b) Proprioceptors (in the muscles, tendons and joints), and c) Interoceptors (in the viscera, glands and vessels). On the other hand, they can be classified by the stimulus to that they respond: a) Mechanoreceptors (Displacement of self or adjacent cells), b) Thermoreceptors (changes in temperature), c) Chemoreceptors (Chemical stimulus), and Nociceptors (Pain). These two classification are interrelated such that mechanoreceptors also can be proprioceptors (40).

Mechanoreceptors demonstrate different adaptive neurophysiological responses to certain stimulus. Rapidly Adapting Mechanoreceptors (RAMs) decrease their discharge rates within milliseconds at the onset of a continuous stimulus and therefore, detect changes in stimulus and velocity. Slowly Adapting Mechanoreceptors (SAMs) remain discharging in response to a continuous stimulus and thus, they respond to intensity and duration of the stimulus (3, 41). For this reason, whether the proprioceptors are sensitive to static proprioception or the others are sensitive to dynamic proprioception is change according to the group they are involved in.

In a healthy body, proprioceptive input is received from 4 afferents; muscle spindles, golgi tendon organs, joint receptors and cutaneous receptors (42) (Figure 2.3.).

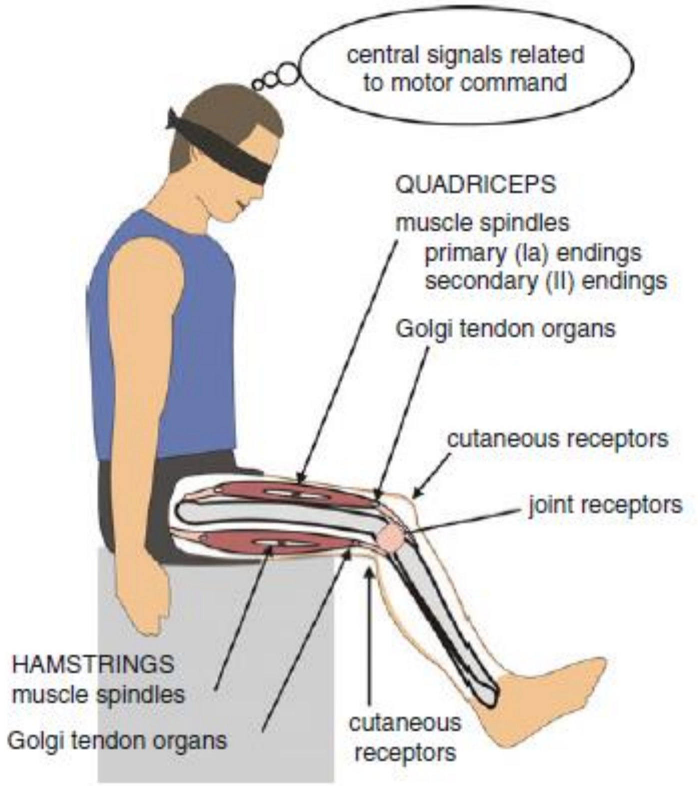


Figure 2. 3 Kinesthetic signals (43)

2.3.1.1. Golgi Tendon Organs

Golgi Tendon Organs (GTOs) which are located at the musculotendinous junction are elipsoidal in shape and encapsulated SAMs. They detect the intermuscular tension such as that created during muscle contraction, so they can be thought as perfect force sensors. The primary task of the GTO is to protect the muscle and the tendon against damage by Golgi Tendon Reflex. The powerful contraction of the muscle activates afferent fibers by GTO and the impulses transmitted to CNS. In the spinal cord, these fibers synapse with an inhibitory interneuron and an excitatory (stimulatory) interneuron. The inhibitory interneurons activated to relax the homonymous muscle which was originally contracted. This inhibitory effect known as *autogenic inhibition*. At the same time, afferent fibers also fire stimulatory interneurons and lead to relaxation of the synergistic muscles and contraction of the antagonistic muscles. This reflex arch describes the concept of *reciprocal inhibition* (44, 41, 45, 46).

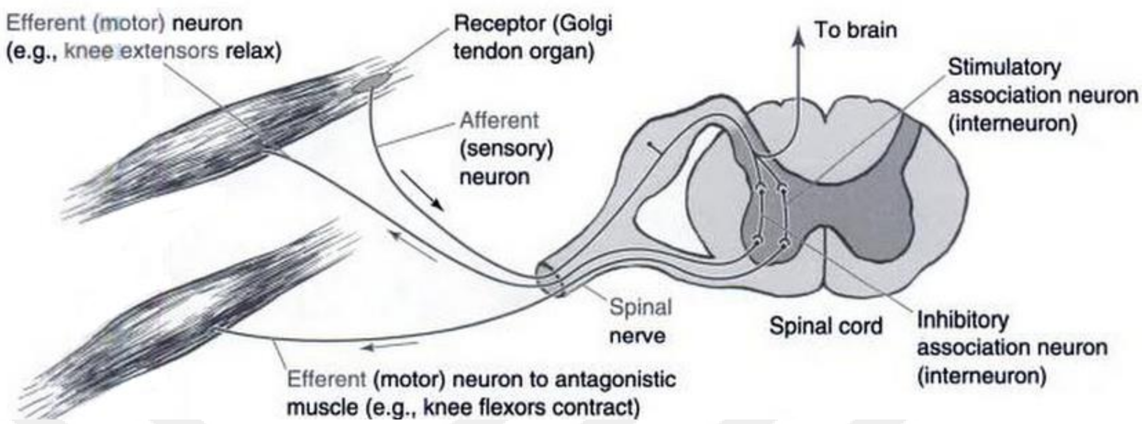


Figure 2. 4 Neurophysiology of golgi tendon organ function (44)

2.3.1.2. Muscle Spindles

Muscle spindles (MSs) are located within the muscles and parallel to the muscle fibers (extrafusal fibers). The length of MSs changes depending on the prolongation or shortening of a muscle. MSs detect the changes in muscle length and the velocity of contraction. It consists of a fluid-filled capsule which contains 4 to 20 specialized muscle fibers which are known as intrafusal fibers. Intrafusal fibers can be recognized as two different types according to numbers and distribution of their nuclei: **a) Nuclear bag fibers** - Nuclei are in the middle part, and **b) Nuclear chain fibers** - Nuclei are distributed along their length (47, 48, 49, 50).

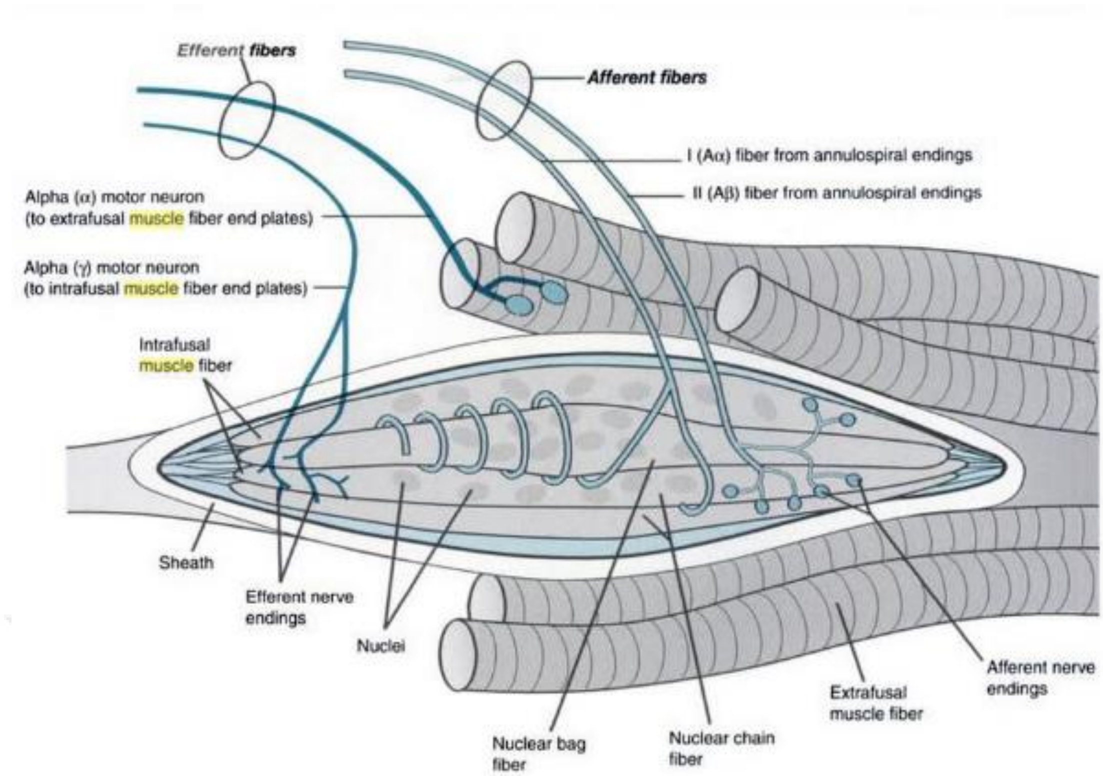


Figure 2. 5 The muscle spindle (51)

Although extrafusal fibers are innervated by a single motor neuron (α), intrafusal fibers have both motor (γ) and sensory (group Ia and II) innervation. Because there is no contractile element in the centeral region of the muscle spindle, it can be thought as this is the sensory area of the spindle. When this region is stretched, the information is tranferred to the CNS. If the extrafusal muscle is suddenly stretched or the contractile ends of the MS are contracted, sensory neurons located at the central region of the MS are stimulated. This sensory information transferred to the spinal cord and the α motor neurons of the same muscle are fired to resist more stretching (myotatic reflex) and the antagonist muscle relax not to resist this stretching (reciprocal inhibition). Furthermore, the sensory region of the spindle always generate impulses transferred to cerebral cortex to provide feedback with relating to muscle position and tonus (47, 48, 52, 53).

2.3.1.3. Joint Receptors

When the position of a joint changes, compression and/or stretching occurs. Mechanoreceptors existing in and around the joint respond to these position changes of the joint capsule and ligaments and are called joint receptors (23, 54).

Ruffini Endings

Ruffini Endings are spindle-shaped, spray-like SAMs. They are located in the deeper layers on the skin, ligaments -especially near the origin and insertion-, and primarily on the flexion side of the joint capsules. Large numbers of collagen fibers encapsulate the nevre branches and make their appearance as a cylinder. They are sensitive to stretching but not to compression and contribute to control of tissue position (55, 56).

Pacinian Corpuscules

They are encapsulated, oval shaped RAMs found in fibroadipose tissue, capsule, ligaments and menisci. These corpuscules regarded as the most sensitive mechanoreceptors, are sensitive to vibration as they can feel the motion at the nanometer level. They are sensitive to compression, thus they can detect gross pressure changes. They are inactive at rest or during constant speed while, they fire at the onset or cessation of the movement (56, 41, 55, 12).

2.3.1.4. Cutaneous Receptors

Some of the cutaneous and subcutaneous mechanoreceptors such as the rapidly adapting meissner's corpuscles (stroking) and pacinian corpuscles (vibration), or the slowly adapting merkel disk (pressure) and ruffini endings (skin stretch), in combination with hair cells, deliver important feedback about the environment and can supplement joint position sense and movement detection (23, 57).

2.4. Assessment of the Proprioception

There is not a single measurement method for assessing proprioception because the neurophysiological processes are too complex. There are three different assessment consepts which are mainly used in clinics. First technique is named as **Joint Position Detection (Joint Position Matching)**. In this test, participants are asked to place their ipsilateral or contralateral limb to previously experienced joint positions and the difference between the angles of the reference point and the position matched by the participant is recorded as joint angle error. This test can be done actively or passively (58, 50).

The other two tests are used for the detection of motion. One of them is called as **Passive Motion Detection Threshold** and assess the threshold amount or speed of motion required for detection of participant. The other is known as **Passive Motion Direction Discrimination** which is used for that the subjects try to discriminate different movement directions (50).

To evaluate proprioception, although clinical tests (Proprioceptive Finger Nose Test, Proprioceptive Movement Test, Proprioceptive Space Test, Past Pointing Test) can be used, devices that follow various isokinetic dynamometers and electromagnetic trail can be used, too.

2.5. Diseases Affecting Balance and Proprioception

The basic pathologies affecting balance and proprioception are briefly as follows (10, 50, 59):

- Central nervous system pathologies (Multiple Sclerosis, Hemiplegia, Parkinson disease),
- Vestibular disorders (Meniere Disease, labyrinthitis)
- Muscle weakness especially around load bearing joints,
- Excessively increased or decreased muscle tone,
- Impaired movement patterns,
- Dizziness – vertigo,
- Orthopedic problems (muscle strains, joint diseases, bone fractures)
- Haemodynamic disorders

Besides, limitation of joint range of motion, muscle strength imbalances, pain and some postural abnormalities such as kyphosis may contribute to proprioception and balance disorder by causing changes in movement pattern (60). Moreover, diabetes was associated with vestibular dysfunction and causes balance problems (61).

Furthermore, the inadequate functioning of the proprioceptive system can lead to inadequate neuromuscular control, failure to perform protective muscle activities, and impaired joint stabilization. All of these lead to further deterioration of the function of the proprioceptive system, consequently balance, and the loop starts again (62).

2.6. Treatment of Balance and Proprioception

Any exercise cannot be classified as approaches directed just toward proprioception or balance, as these interact with each others (63). The purpose of the therapy is to increase motor ability in activities such as standing, walking, posture rather than increasing muscle strength (64).

The treatment should be arranged according to the followings (64, 65):

- It must include different angular stresses and velocities in different muscle groups, especially working together
- Rotational exercises should be chosen rather than just linear movements
- Exercises can be done in front of a mirror so that the body and head-neck straightness can be controlled.
- Education must proceed from simple to complicated; for example; stable planes to unstable planes.

2.7. Connective Tissue (Supporting Tissue, Communicative Tissue)

Connective tissue (CT), a derivative of the mesoderm, is one of the four main tissues of the body. It connects different structures in the body with each others. Different kinds of CT form capsule, ligament, tendon, articular cartilage, fibrocartilage, and specialized tissues (66, 67).

2.7.1. Anatomy of the Connective Tissue

All types of the CT consist of 2 basic elements which are cells and extracellular matrix and the character of a tissue formed by CT depends on the organization of the cells. The most important feature distinquishes the connective tissue from the other tissues is the cells separated from each other by extracellular matrix which gives connective tissue types most of their functional characteristics. (20, 68)

2.7.1.1. Extracellular Matrix of the CT

It consist of 3 major components: (1) protein fibers, (2) ground substance, (3) fluid.

Three types of **protein fibers** help form connective tissue. *Collagen fibers* are formed from collagen which is the most abundant protein in the body. Of the at least 15 types of collagen, 6 types (type I - in bones, tendons, dermis of skin, teeth; type II - in cartilage; type III - in) are most common. *Reticular fibers* are not as strong as collagen fibers, yet the networks of them fill space between tissues and organs. *Elastic fibers* comprise of a protein called elastin which has the ability to return to its original shape after distention or compression and therefore its sites of occurrance are walls of major blood vessels (66, 20).

Ground substance is a water-saturated matrix or gel keeping collagen and elastin fibers. It consist primarily of proteoglycans which are large molecules formed by numerous polysaccharides called glycosaminoglycans (20, 68).

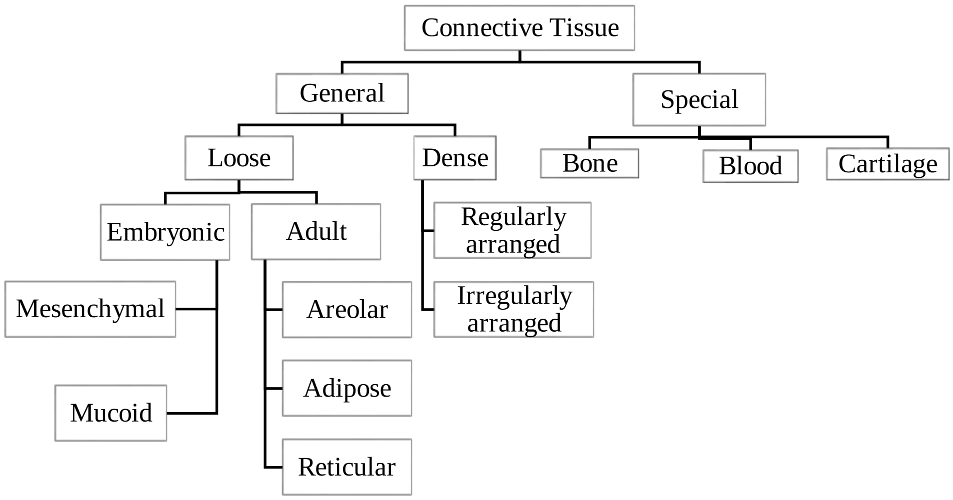
2.7.1.2. Cells of the CT

There are mainly two types of cells in CT. *Resident cells* are consist of predominantly fibroblasts, adipocytes and mesenchymal stem cells. Besides, there are some special cells for cartilage (chondroblasts and chondrocytes) and bone (osteoblasts, osteocytes and osteoclasts). On the other hand, *migrant cells* (macrophages or histocytes, plasma cells, mast cells, pigment cells, lymphocytes and monocytes) consist of cells derived from bone marrow and reach the CT via the circulatory system (69).

2.7.2 Classification of the CT

Loose CT consists of large amounts of fat cells and ground substance that fill the interstices between cells (fibrocytes, fibroblasts) and fibers and surrounds neurovascular bundles and fills the spaces between muscles and fascial planes. *Dense fibrous CT* is composed of mainly collagen fibers. While dense regular CT is forming the substance of periosteum, tendons, and ligaments, irregular one forms the substance of periosteum and deep fascia (see Table 2.3) (70).

Table 2. 3 Classification of the connective tissue



2.7.3. Functions of the CT (69, 71)

- Connects different tissues
- Gives shape to the organs and protects-supports different organs in the body
- Involves in defence mechanism of the body
- Helps nutrition regulations of the tissues

2.7.4. Connective Tissue Diseases and Disorders (CTDDs)

It's useful to divide CTDDs into two major categories. First category is called "Disorder" and can be thought inherited, usually because of a single-gene defect, while the second one is called "Disease" and is characterized by immune system dysfunctions (especially impairment of B-cell and T-cell functions) and autoantibodies which directly target at CT (72, 73, 74).

Hereditery disorders are rare and can be exemplified as follows (73):

- Ehlers-Danlos Syndrome,
- Marfan Syndrome,
- Fibrodysplasia Ossificans Progressiva,
- Osteogenezis Imperfekta,
- Alport Syndrome,
- Stickler Syndrome,
- Beal’s Syndrome.

Connective Tissue Diseases (CTDs) characterized by inflammation can be exemplified as follows (72, 75):

- Systemic Lupus Erythematosus,
- Systemic Sclerosis,
- Rheumatoid Arthritis,
- Vasculitis,
- Sjögren’s Syndrome,
- Dermatomyositis/Polymyositis,
- Mixed/Overlap CTD.

2.7.5. Treatment of CTDDs

The aim of the treatment is to control symptoms and maintain function (76). Each diseases and disorders has its own special treatment protocol according to causes, symptoms and extend of the disease. Generally, ***medical agents*** such as steroids and antimalarials and intravenous immunoglobulin and NSAIDs are used for their immunesuppresive effects and to rapid relief of symptoms (77). Secondly, ***rehabilitation*** is the basis of effective treatment plan. It helps to increase strength, range of motion and endurance, to prevent atrophy and deformities and to reduce pain. For these reasons, rehabilitation programs created by an expert improve function and increase quality of life (78, 79).

2.8 Connective Tissue Manipulation (CTM)

CTM is a soft tissue manipulative technique and also a reflex therapy which is characterized by localised and specific strokes performed in where the fascia is superficial or palpable. A shear force is created between the skin-underlying fascia or dermis-hypodermis and angulatory force is applied to the collagen fibers to produce reflex and mechanical effects (80, 81).

In 1928, Elizabeth Dicke who is a German having a disease called endarteritis obliterans, pioneered CTM technique. She applied short and long stretching tractions to her back with the purpose of relieving her discomfort and she observed a sensation of tingling and warmth in her legs after the back treatment (82, 83). After that, Maria Ebner is credited with popularizing CTM in England and then the other countries (84).

2.8.1. Mechanism of Action of the CTM

CTM has both local, segmental and suprasegmental (general) effects.

Local Effects of CTM

Cutting sensation which is the sign of stimulation of the facial layer is the characteristic to a CTM stroke and triple response reaction (TRR) is produced in the skin (2, 81). In the first phase of TRR, a red line will be seen because of the mechanical trauma of the mast cells results in release of heparin and histamin which are important vasodilators. In the second phase, a red flare will be seen since stimulation of autonomic nevre endings causes to reduce sympathetic vasoconstrictor tone of the horizontal plexi of blood vessels by releasing of noradrenaline and results in vasodilatation (2, 81, 85). This can be thought as the first effect of CTM on the autonomic nervous system (81).

Also, because the stimulation of the mechanoreceptors by the shear force produced by the CTM strokes plays a role as a gait-control on the pain (85). Both the gait control theory and the increase blood flow to the application area can explain how CTM reduces pain and subacute and chronic inflammation (82, 86).

On the other hand, both the elastic and viscous components of the connective tissue are stretched by CTM. Thus remodelling of collagen can be promoted (80, 81). Furthermore, strokes applied by CTM can help to mobilize connective tissue and improve function (82).

Segmental and Suprasegmental (General) Effects of CTM

Because of the normal embriological development, peripheral nervous system innervates the body parts by following a segmental distribution. Dermatomes and myotomes innervated from the same level of the medulla spinalis of the internal organs with impaired function can reflect this disturbance as increase of tonus (Mckenzie Zones), hypersensitivity or trophic changes (Head Zones) (87, 88, 89). (Figure 2.6., Figure 2.7.)

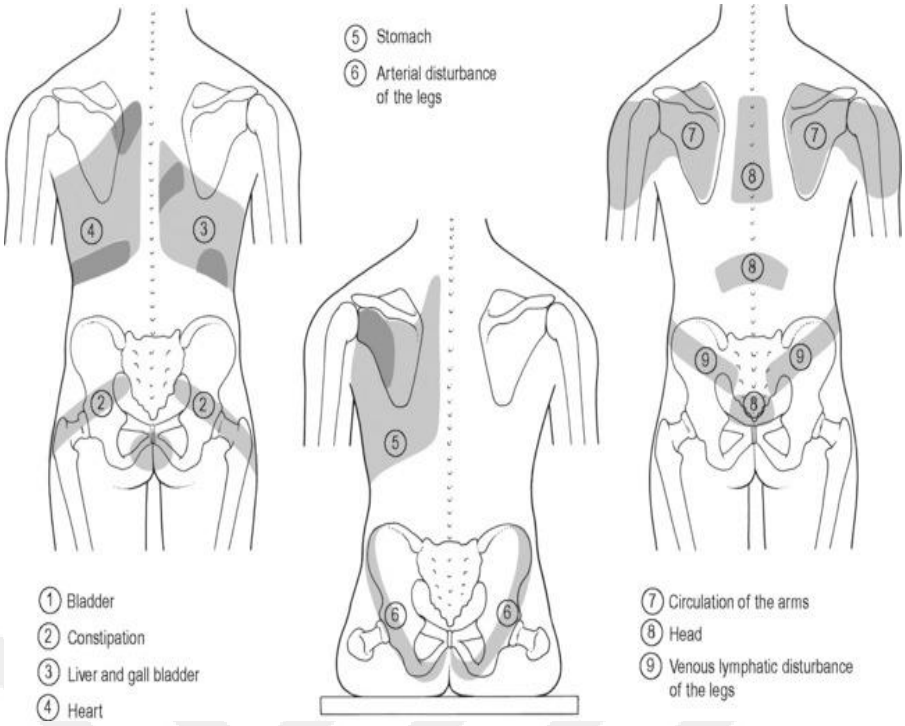


Figure 2. 6 Head's Zones (90)

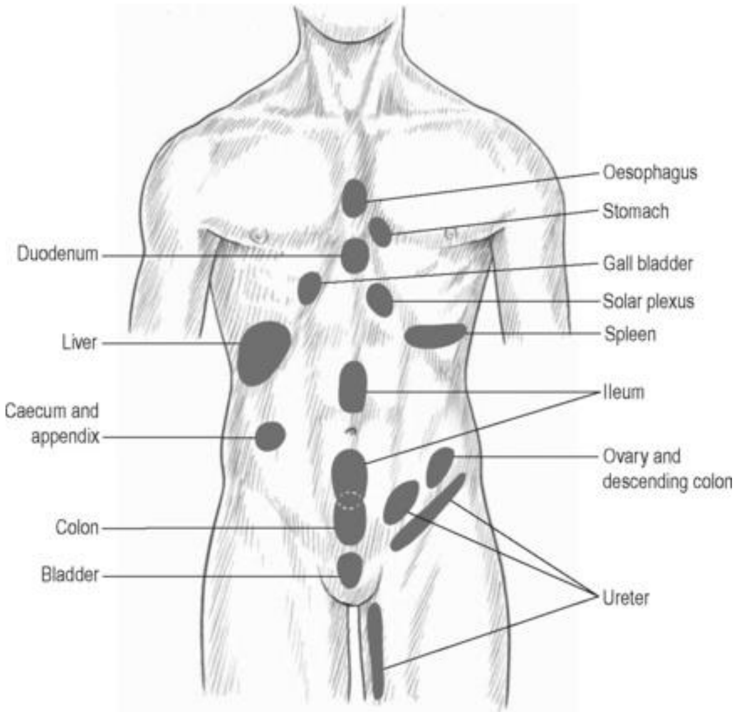


Figure 2. 7 McKenzie's zones (90)

When the sensory stimuli pass into the spinal cord via the posterior nerve roots, some of them are transmitted to the higher centers via the cord, some of them are transmitted to the autonomic preganglionic neurons and the others remains the same level of the segment (86, 91). **Segmental autonomic effect** is the reflex effect is produced in the visceral organs innervated from the same spinal segment and result in the functional changes**.** (Figure 2.8.) This connection between deep and superficial tissues is provided by the neural mechanisms known as cutaneo-visceral reflexes (92, 82). On the other hand, **generalized (suprasegmental) autonomic** effect is used for trigger a global reflex such as feeling of relaxation, improvement of sleep pattern, raise of mood and reduction in anxiety because of the anatomical structure of the autonomic nervous system (2, 86). CTM can be distinguished from traditional massage with this direct effect on the autonomic nervous system (82).

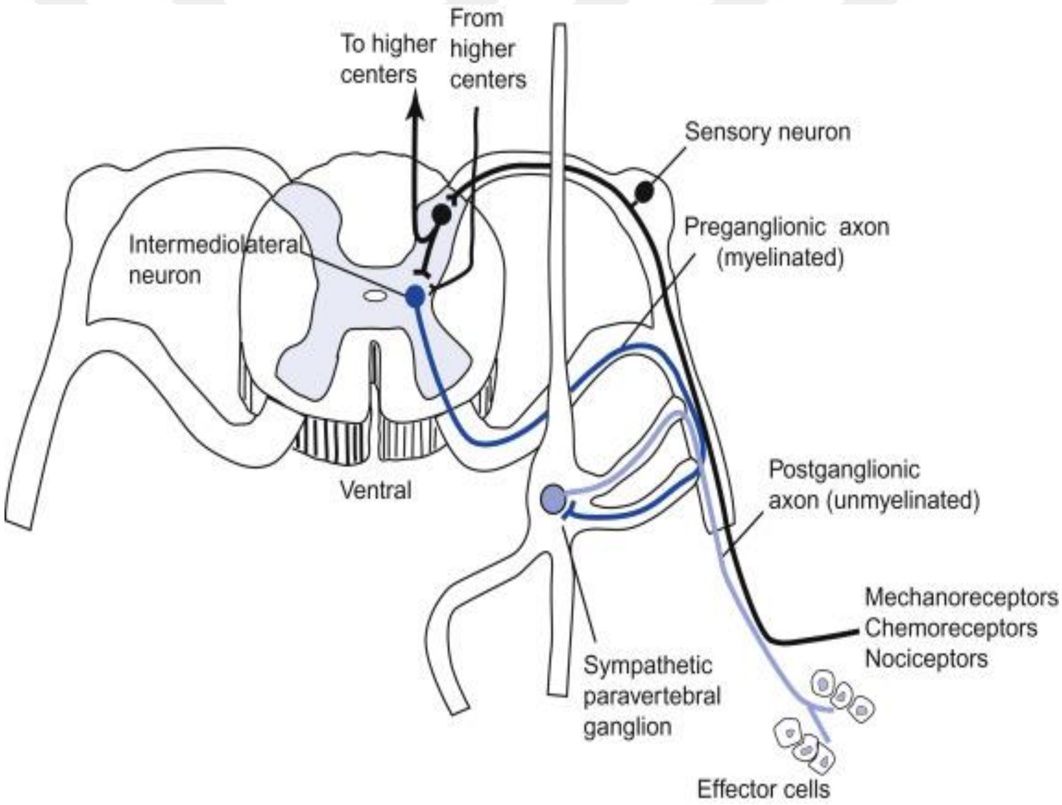


Figure 2. 8 An autonomic reflex (91)

2.8.2. Indications and Contraindications (82, 93, 85)

Indications

- Headache (migraine and tension-type headache),
- Low back pain (lumbago, disc herniation, nerve root pain, sacroiliac strains, mechanical back pain),
- Rheumatic diseases (osteoarthritis, rheumatoid arthritis, periarthritis),
- Connective tissue diseases and scar tissue (scleroderma, polymyositis, dermatomyositis)
- Circulatory problems (peripheral vascular diseases, intermittent claudication, Raynaud's phenomenology, varicose veins),
- Neurological problems (poliomyelitis, multiple sclerosis, sciatica, hemiplegia, parkinson, subacute combined degeneration of medulla spinalis, cerebral paralysis)
- Gynecological, obstetric and hormonal disorders (amenore, dysmenorrhea, climacteric disorders, pregnancy, labor, lactation, hysterectomy and other gynecological operations)
- Psychiatric problems (anxiety, depression)
- Respiratory diseases,
- Diseases of the digestive system (gastro-intestinal gastritis, intestinal-duodenal ulcer, colitis, constriction, gastrointestinal reflex caused by skin stimulation)
- Visceral dysfunctions (liver and gall bladder - to increase circulation reflex after acute condition),
- In cases of sympathetic pain (autonomic disorders-Fibromyalgia Syndrome)

Contraindications

- Malign tumors,
- tuberculosis,
- acute inflammation of internal organs
- mental diseases
- haemorrhage
- early or late stage of pregnancy

3. MATERIAL AND METHOD

This research was approved by Medical Ethics Committee of Medical, Surgical and Drug Researches of Yeditepe University Medical Faculty (Meeting Date: 18.04.2018, Decision Number: 837)

3.1 Individuals

The study included 40 voluntary students (man - 25% ; woman, 75%) in the mean age of 22,18 ± 2,35 years (Min-Max= 19-27 yrs) studying in Bahcesehir University, Istanbul. They involved to the study on a voluntary basis and were divided into exercise and study (CTM with exercise) groups by lottery method.

All the participants were informed about the procedures they would undergo and their written consents were taken. Moreover, written informed consents were obtained from volunteers involved in this study.

The sample size was calculated before starting to study by the G*Power 3.1.9.2. In order to find a meaningful difference between the pre-treatment and post-treatment Biodex Balance System (BBS) measurements, study group should include at least 18 individuals when the type I error was 0.5 and 95% power value ($1-\beta = 0.95$). Considering the data loss that may occur during the study period, 20 volunteers were planned for each group.

Inclusion criteria

- Being voluntary
- Being healthy enough not to be constantly under the control of a health institution
- Being over 18 years old

Exclusion criteria

- Having neurological or orthopedic problems that can influence lower extremity functions and balance,
- Having any kind of vestibular system problems (Vertigo, Meniere etc.)
- Having a surgery from lumbar, thoracic or/and cervical regions.

The volunteers were numbered according to the order of their application. At the and of the applications, small papers were numbered from 1 to 40, and among these papers, the first

20 people selected by the lottery method were included in the study group, and the rest were included in the exercise group.

3.2 Evaluation Methods

At the beginning and end of the study, the following evaluations were made for the participants who participated in the study.

3.2.1 Questionnaire

The data was collected from self report, paper based, cross-sectional questionnaire and clinical examination. The questionnaire focused on demographic items such as age, gender, body weight, height, dominant side, tobacco smoking, alcohol consumption, chronic diseases, use of any drug and past surgeries. And also their habbit of physical activity including the sports and/or exercise type that they perform regularly.

3.2.2. Heart Rate and Blood Pressure (Heart Parameters)

We used M3 Comfort (HEM-7134-E) Digital Blood Pressure Monitor in combination with the Intelli Wrap Cuff (HEM-FL31) (Kyoto, Japan) to measure heart rate and blood pressure. We used the standard recommendations and the manufacturer's instructions for the measurement (94). The cuff was placed on the arm in relation to brachial artery. Volunteers were informed about avoiding exercise and not eating or drinking half an hour before blood pressure measurement. It was noted that the clothing was not squeezing the arm. The volunteers were positioned on a chair with back support, both feet on the floor and the upper arm supported at the level of the heart and were asked not to contract any muscle of upper arm (see Figure 3.1).

Figure 3. 1 Assessment of heart rate and blood pressure

3.2.3. Balance

Biodex Balance System (BBS) was used for evaluation of static and dynamic balance. The BBS, which consists of a monitor connected multi-axis platform, objectively measures static and dynamic balance and records measurement results as degrees for three directions: medial lateral stability index, anterior-posterior stability index, and overall stability index. These indices show the fluctuations around the zero point (95, 96). The mobility of the platform can be changed by 12 levels. In this way, the dynamic balance can be measured. On the other hand, the platform can be fully locked, allowing the static balance to be measured (97).

Postural Stability Protocol has been selected from 5 test protocols. In this protocol, the aim is to try to match the ball seen on the screen to the midpoint of the ring shaped screen by transferring the weight on the platform. Firstly, static platform were used and volunteers stand on both foot, then on right and left foot (see Figure 3.2). Then, the same measurements were repeated on dynamic platform which is level 4 out of 8. In general, level 4 is assumed as medium level in the previous studies (98). Each measurement was tested in 3 repetitions. Each of these 3 repetitions lasted for 20 seconds and there was 10 seconds resting time between each repetition. Mean of these repetitions were noted as the score of that measurement. A total of 6 different measurements were obtained.

Figure 3. 2 Assessment of balance

3.2.4. Cervical Proprioception

The cervical proprioception was measured by using a cervical range of motion tester (CROM, Performance Attainment Associates, Lindstrom, MN, USA) in our study. It is glasses-shaped measurement device which indicate the position of the head and consist of two inclinometers which are in sagittal and frontal planes, so it can measure all 6 directions (flexion, extensiton, right and left lateral flexion and right and left rotation) of movement (99, 100). For these reasons, it is videly used in many clinical experiments to assess the proprioception as well as to measure the neck range of motion (101).

To assess cervical proprioception, flexion and right and left lateral flexion were chosen (see Figure 3.3). We asked to volunteers to sit in a proper position while the legs flexed in 90 degrees angle. When they put on the CROM, we asked them to bend the head forward and we stopped them when they reached 30 degrees and asked them to feel the amount of movement and muscle tension. We repeated the procedure 3 times with eyes open and 3 times with eyes closed. Then we asked the volunteers to flex their heads three times and stop when they thought they reached 30 degrees. Average of each flexion degrees that they stop was noted as score. Then the same procedure was repeated for right and left lateral flexion.

Figure 3. 3 Assessment of cervical proprioception

3.2.5. Lumbar Proprioception

Stabilizer^{TM} Pressure Biofeedback Unit (Chattanooga Group Inc., Hixson, TN 37343, USA) was used to detect lumbar proprioception. It consist of three-chamber pressure cell connected to gauge and inflation bulb. This unit is used clinically for the strengthening of the abdominal and erector muscles or teaching the stabilization exercises as it gives visual biofeedback (102, 103). In our study, it was used for not to doing exercise but to measure the ability of the person to return to the pressure level which is taught before.

Volunteers were in hook-lying position. They were asked to perform posterior pelvic tilt and the pressure cell was inflated to 40 mmHg (102). Then, they were asked to relax their pelvic position. Later, the posterior pelvic tilt was performed 3 times with the eyes open and 3 times with the eyes closed so that the volunteers could feel the amount of contraction in the muscles at 40mmHg. Then the test began.

As in the trials, the volunteers made three posterior pelvic tilt with eyes open and 3 times eyes closed and said "I feel this is the correct position" when they thought they reached 40mmHg. Averages of 3 measurements were recorded as result.

3.3. Intervention Methods

Both study and exercise groups were instructed to perform home exercises for 2 sessions in a week for 6 weeks (12 sessions in total). On the other hand, CTM was applied to the volunteers in study group for 6 weeks, 2 sessions in a week.

3.3.1. Exercises

All participants were asked to do the given 11 balance, stretching and strengthening exercises twice a week for 6 weeks. All of the exercises were taught in the first assessment day, after the all measurements collected. All participants were controlled every week by social media and face-to-face conversations. The exercises were progressed day by day. Some of the exercises were showed in Figure 3.4, 3.5, 3.6, 3.7, 3.8.

Figure 3. 4 Posterior pelvic tilt exercise

Figure 3. 5 Quadruped (bird dog exercise)

Figure 3. 6 Bridge exercise

Figure 3. 7 Single leg stance

Figure 3. 8 Back extension exercise

3.3.2. Connective Tissue Manipulation

CTM applied to lumbosacral area (basic region), lower toracal, scapular, interscapular and cervical regions, respectively (82). During the application, the volunteers were placed on a treatment table, all back and sacral areas were naked and hips, knees and ankles flexed in a 90 degree angle (93). The CTM lasted approximately 30 minutes for each volunteer. It contained strokes delivered with the distal phalanx of the middle finger in a direction perpendicular to the tissue (see Figure 3.9). The strokes were delivered at slow speed, creating traction between the cutaneous and subcutaneous tissues. Thus, friction was induced in the superficial fascia and the mechanoreceptors were stimulated (104, 87).

Figure 3. 9 Application of CTM

Before the study, the cases were informed about the progress of the application of CTM and the mechanism of action. They were warned that they would feel a painless, slightly cutting and scratchy sensation and the occurrence of hyperemia in the back region is due to local reactions was explained before study (104) (see Figure 3.10).

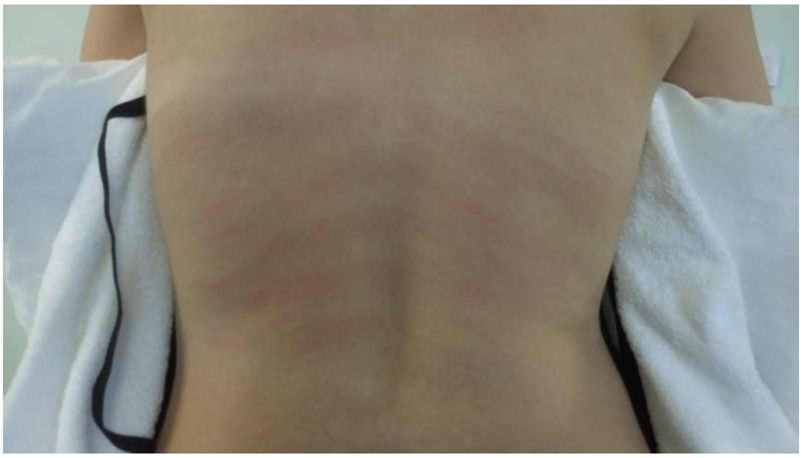


Figure 3. 10 Hyperemia in thoracal region

3.4. Statistical Method

SPSS 23 for Windows (SPSS Inc. Chicago, IL, USA) was used to analyze the outcomes. The variables were investigated using visual (histograms, probability plots) and analytical methods (Shapiroe Wilks test) to determine the normality of the distribution. Descriptive analyses were presented using mean and standard deviation (SD), and frequency tables for the ordinal variables. Wilcoxon test was used to compare the heart parameters, CROM, Stabilizer and Biodex Balance System scores before and after the study. Heart parameters, CROM, Stabilizer and Biodex Balance System scores between groups were analyzed by the Mann-Whitney U test. An overall p-value of equal or less than 0.05 was considered to be statistically significant.

4. RESULTS

The study was conducted between the period of April 2018 to August 2018. 'Statistical Package Analyze for Social Sciences' (SPSS) version 23.0 was used for data analyses in our study. The level of significance were accepted as $p \leq 0,05$.

The values of mean age, height, weight, and body mass index of groups were given on Table 4.1. while the distribution of gender was given in the Figure 4.1. According to the findings, there is no significant difference in characteristics between the groups before the study ($p>0,05$).

Table 4. 1. Physical characteristics of the study and control groups

		EG (n=20)	SG (n=20)	z	p
Age	Min-Max	19 – 26	19 – 27	-0,92	0,35
	Mean±SD	21,80 ± 2,30	22,55 ± 2,39		
Height (m)	Min-Max	1,59 – 1,87	1,36 – 1,89	-1,07	0,28
	Mean±SD	1,70 ± 0,07	1,67 ± 0,12		
Weight (kg)	Min-Max	46 – 82	45 – 93	-0,01	0,98
	Mean±SD	61,10 ± 11,65	61,50 ± 14,05		
BMI (kg/m^2)	Min-Max	15,92 – 27,55	18,20 – 32,44	-0,83	0,40
	Mean±SD	20,87 ± 3,15	21,91 ± 3,65		

SG: Study Group, EG: Exercise Group, BMI: Body Mass Index, Data expressed as mean ± Standard Deviation. Significance was set as $p \leq 0,05$.

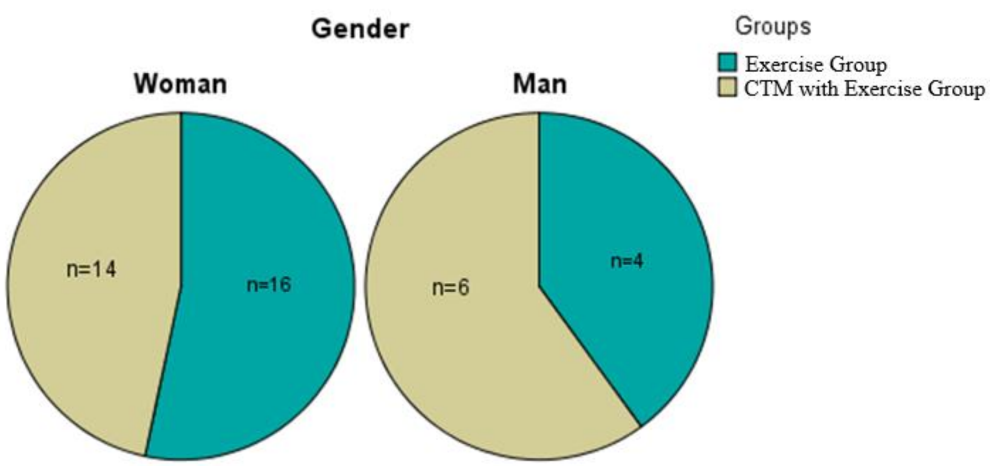


Figure 4. 1 Distribution of gender

Table 4. 2. Distribution of dominant side, alcohol and smoking habits, physical activity habit, and perceived performance level in the groups.

		Study Group n (%)	Exercise Group n (%)
Dominant Side	**Right**	19 (95)	19 (95)
	Left	1 (5)	1 (5)
Smoking Habit	**Never**	13 (65)	13 (65)
	Quit	3 (15)	2 (10)
	Yes	4 (20)	5 (25)
Alcohol Consumption Habit	**No**	6 (30)	5 (25)
	Only special days	6 (30)	10 (50)
	Several times a month	5 (25)	4 (20)
	Few times a week	3 (15)	1 (5)
Exercise Habit	**No**	9 (45)	8 (40)
	Less than 3 days	4 (20)	7 (35)
	3 days or more	7 (35)	5 (25)
Perceived Performance Level	**Very weak**	0 (0)	1 (5)
	Weak	3 (15)	4 (20)
	Moderate	11 (55)	9 (45)
	Good	5 (25)	4 (20)
	Very good	1 (5)	2 (10)

n: Number of the participants, %: percentage

Dominant side, smoking, alcohol consumption and physical exercise habits and perceived performance level were examined in Table 4.2. According to these findings, %65 of the individuals in both groups do not smoke and also %55 of them exercise regularly.

Table 4. 3. Difference of the heart parameters according to the genders in the study group

	Women Mean ± SD	Men Mean ± SD	z	p
Heart Rate	-8,64 ± 8,52	0,17 ± 17,90	-1,58	0,11
Systolic Blood Pressure	-12,79 ± 7,04	-1,83 ± 6,67	-2,81	**0,00***
Diastolic Blood Pressure	-11,50 ± 8,75	0,00 ± 5,52	-2,56	**0,01***

Data expressed as mean ± Standard Deviation. Significance was set as p≤0,05.

Pre-and-post measurement difference of the heart parameters according to the genders in the study group were showed at Table 4.3. According to these findings, systolic and diastolic blood pressure scores were significantly decrease in women than men (p≤0,01).

Table 4. 4. Comparison of heart parameters between study and exercise groups before interventions

	Study Group Mean ± SD	Exercise Group Mean ± SD	z	p
Heart Rate	83,50 ± 11,53	83 ± 12,96	-0,28	0,77
Systolic Blood Pressure	107,40 ± 10,95	106,5 ± 15,97	-0,55	0,57
Diastolic Blood Pressure	73,75 ± 8,26	75,50 ± 8,95	-0,81	0,41

Data expressed as mean ± Standard Deviation. Significance was set as p≤0,05.

Table 4.5 shows the deviation from the target angle (30°) measured by the CROM. According to this table, there is no significant difference between the groups before the interventions (p>0,05).

Table 4. 5. Comparison of cervical proprioception between study and exercise groups before interventions

		Error of Angle		Z	p
	Movement of Cervical Region	**Study Group Mean ± SD**	**Exercise Group Mean ± SD**		
With Vision	Flexion	3,90 ± 2,71	3,30 ± 2,45	-0,50	0,61
	Lateral Flexion (R)	3,20 ± 2,70	2,80 ± 1,36	-0,17	0,86
	Lateral Flexion (L)	2,50 ± 2,32	3,10 ± 2,19	-1,12	0,26
Without Vision	Flexion	4,70 ± 2,53	4,50 ± 2,96	-0,30	0,75
	Lateral Flexion (R)	4,60 ± 3,31	4,30 ± 2,17	-0,02	0,97
	Lateral Flexion (L)	3,20 ± 1,98	2,60 ± 2,43	-1,42	0,15

R: Right, L: Left, Data expressed as mean ± Standard Deviation. Significance was set as p≤0,05.

Table 4.5 shows the deviation from the target angle (30°) measured by the CROM. According to this table, there is no significant difference between the groups before the interventions (p>0,05).

Table 4. 6. Comparison of lumbar proprioception between study and exercise groups before interventions

	Movement of Lumbar Region	Error of Pressure		Z	p
		Study Group Mean ± SD	Exercise Group Mean ± SD		
With Vision	Posterior Pelvic Tilt	4,90 ± 2,93	3,10 ± 3,27	-2,15	**0,03***
Without Vision	Posterior Pelvic Tilt	5,30 ± 3,06	3,60 ± 3,53	-2,42	**0,01***

Data expressed as mean ± Standard Deviation. Significance was set as p≤0,05.

Table 4.6 shows the deviation from the target pressure (40 mmHg) measured by the Chatanooga Stabilizer. According to this table, there is a statistically significant difference in lumbar proprioception between the groups before the study (p<0,05). As shown in the table, the deviation from the target is bigger in CTM with exercise group than in exercise group. This means the proprioception of the study group is worse than the exercise group.

Table 4. 7. Comparison of balance between study and exercise groups before interventions

Position of Assessment	Direction of the Weight Shift	Study Group Mean ± SD	Exercise Group Mean ± SD	z	p
Bilateral Static	OV	0,57 ± 0,40	0,39 ± 0,11	-1,28	0,19
	AP	0,39 ± 0,26	0,29 ± 0,17	-1,16	0,24
	ML	0,31 ± 0,34	0,19 ± 0,09	-1,81	**0,07***
Unilateral Static (L)	OV	1,24 ± 0,38	1,12 ± 0,33	-1,13	0,25
	AP	0,76 ± 0,16	0,75 ± 0,27	-1,09	0,27
	ML	0,81 ± 0,39	0,64 ± 0,20	-1,21	0,22
Unilateral Static (R)	OV	1,31 ± 0,61	0,99 ± 0,37	-2,50	**0,01***
	AP	0,79 ± 0,24	0,70 ± 0,28	-1,56	**0,01***
	ML	0,81 ± 0,62	0,54 ± 0,17	-2,08	**0,03***
Bilateral Dynamic	OV	0,83 ± 0,29	0,87 ± 0,30	-0,50	0,61
	AP	0,58 ± 0,22	0,59 ± 0,24	-0,06	0,94
	ML	0,48 ± 0,18	0,50 ± 0,18	-0,35	0,72
Unilateral Dynamic (L)	OV	1,18 ± 0,43	1,27 ± 0,47	-0,48	0,62
	AP	0,87 ± 0,34	0,88 ± 0,36	-0,02	0,97
	ML	0,63 ± 0,31	0,75 ± 0,32	-1,26	0,20
Unilateral Dynamic (R)	OV	1,45 ± 0,60	1,31 ± 0,68	-1,10	0,27
	AP	0,89 ± 0,28	0,86 ± 0,46	-0,96	0,33
	ML	0,94 ± 0,61	0,78 ± 0,58	-1,10	0,26

R: Right, L: Left, OV: Overall, AP: Anteroposterior, ML: Mediolateral, Data expressed as mean ± Standard Deviation. Significance was set as $p \leq 0{,}05$.

The initial assessment findings of Biodex Balance System were shown at Table 4.7. Only the measurements done in standing position on right foot on the static plate and the medio-lateral measurement done on both feet on the static plate were statistically significant ($p \leq 0{,}05$). Except these, there is no significant difference between the groups before the study related to balance ($p > 0{,}05$).

Table 4. 8. Intragroup comparison of pre-and-post measurements of heart parameters and intergroup comparison of this difference

<table>
<tr><th colspan="3" rowspan="2"></th><th colspan="2">Study Group</th><th colspan="2">Exercise Group</th><th colspan="2">Δ between Groups</th></tr>
<tr><th>Mean ± SD</th><th>p
z</th><th>Mean ± SD</th><th>p
z</th><th>p</th><th>z</th></tr>
<tr><td rowspan="6">Heart Parameters</td><td rowspan="2">Heart Rate</td><td>pre</td><td>83,50 ± 11,53</td><td rowspan="2">0,04*
-2,03</td><td>83 ± 12,96</td><td rowspan="2">0,76
-0,29</td><td rowspan="2">0,15</td><td rowspan="2">-1,40</td></tr>
<tr><td>post</td><td>77,50 ± 7,70</td><td>83,60 ± 10,90</td></tr>
<tr><td rowspan="2">Systolic Blood Pressure</td><td>pre</td><td>107,40 ± 10,95</td><td rowspan="2">0,00**
-3,56</td><td>106,5 ± 15,97</td><td rowspan="2">0,03*
-2,09</td><td rowspan="2">0,10</td><td rowspan="2">-1,63</td></tr>
<tr><td>post</td><td>97,90 ± 14,51</td><td>101,70 ± 13,38</td></tr>
<tr><td rowspan="2">Diastolic Blood Pressure</td><td>pre</td><td>73,75 ± 8,26</td><td rowspan="2">0,00**
-3,12</td><td>75,50 ± 8,95</td><td rowspan="2">0,05*
-1,90</td><td rowspan="2">0,21</td><td rowspan="2">-1,26</td></tr>
<tr><td>post</td><td>65,70 ± 9,77</td><td>72,20 ± 10,06</td></tr>
</table>

Data expressed as mean ± Standard Deviation. Significance was set as p≤0,05.

Pre-and-post measurement findings related to heart parameters and the comparison of this difference between groups were showed at Table 4.8. In study group, the difference between pre-and-post measurements were found statistically significant (p≤0,05), while only the difference in measurements related to systolic blood pressure were significant in control group (p≤0,05). On the other hand, there is no statistical significant between group according to heart parameters (p>0,05)

Table 4. 9. Intragroup comparison of pre-and-post cervical proprioception measurements and intergroup comparison of this difference

				Study Group		Exercise Group		Δ between Groups	
				Mean ± SD	**p** **z**	**Mean ± SD**	**p** **z**	**p**	**z**
Cervical Proprioception	**With Vision**	Flexion	pre	3,90 ± 2,71	**0,00****	3,30 ± 2,45	0,41	**0,01***	-2,37
			post	1,10 ± 1,51	-3,56	2,80 ± 1,88	-0,80		
		Lateral Flexion (R)	pre	3,20 ± 2,70	**0,01****	2,80 ± 1,36	**0,02***	0,66	-0,43
			post	1,40 ± 1,60	-2,35	1,50 ± 1,43	-2,31		
		Lateral Flexion (L)	pre	2,50 ± 2,32	**0,02***	3,10 ± 2,19	0,20	0,55	-0,58
			post	1,30 ± 1,62	-2,18	2,40 ± 2,21	-1,25		
	Without Vision	Flexion	pre	4,70 ± 2,53	**0,00****	4,50 ± 2,96	0,29	**0,04***	-2,01
			post	1,50 ± 2,32	-3,33	3,65 ± 2,70	-1,05		
		Lateral Flexion (R)	pre	4,60 ± 3,31	**0,00****	4,30 ± 2,17	**0,00****	0,39	-0,85
			post	1,60 ± 1,78	-2,92	2,30 ± 1,75	-3,08		
		Lateral Flexion (L)	pre	3,20 ± 1,98	**0,01****	2,60 ± 2,43	0,40	0,13	-1,57
			post	1,40 ± 1,31	-2,56	2,10 ± 1,19	-0,83		

L: Left, R: Right, Data expressed as mean ± Standard Deviation. Significance was set as p≤0,05.

Pre-and-post measurements of the deviation from the target angle (30°) done to assess cervical proprioception and the comparison of this difference between groups were showed at Table 4.9. All measurements done by CROM were significant (p<0,05) in study group. However, exercise group showed statistically significant improvement in only 2 parameters which are open-eyed right lateral cervical flexion (p=0,02) and closed-eye right lateral cervical flexion (p=0,00). The comparison of the groups were also statistically significant only for open-eye (p=0,01) and closed-eye (p=0,04) cervical flexion.

Table 4. 10. Intragroup comparison of pre-and-post proprioception measurements and intergroup comparison of this difference

				Study Group		Exercise Group		Δ between Groups	
				Mean ± SD	**p** **z**	**Mean ± SD**	**p** **z**	**p**	**z**
Lumbar Proprioception	**With Vision**	Posterior Pelvic Tilt	pre	4,90 ± 2,93	**0,00**** -3,55	3,10 ± 3,27	0,59 -0,53	**0,00****	-3,83
			post	1,40 ± 1,72		2,90 ± 2,46			
	Without Vision	Posterior Pelvic Tilt	pre	5,30 ± 3,06	**0,00**** -3,76	3,60 ± 3,53	0,38 -0,86	**0,00****	-3,43
			post	1,30 ± 1,34		2,70 ± 2,27			

Data expressed as mean ± Standard Deviation. Significance was set as p≤0,05.

Pre-and-post measurements of the deviation from the target pressure (40mmHg) done to assess lumbar proprioception and the comparison of this difference between groups were showed at Table 4.10. All measurements done by Chatanooga-Stabilizer were significant (p<0,01) in study group. On the contrary, the exercise group showed no statistically significant improvement (p>0,05). On the other hand, the comparison of the groups were statistically significant for lumbar proprioception with both vision and vithout vision (p<0,01).

Table 4. 11. Intragroup comparison of pre-and-post balance measurements and intergroup comparison of this difference

				Study Group		Exercise Group		Δ between Groups	
				Mean ± SD	p z	Mean ± SD	p z	p	z
BALANCE	Bilateral Static	OV	pre	0,57 ± 0,40	**0,01**** -2,53	0,39 ± 0,11	**0,05*** -1,92	0,24	-1,15
			post	0,34 ± 0,10		0,34 ± 0,08			
		AP	pre	0,39 ± 0,26	**0,02*** -2,29	0,29 ± 0,17	0,77 -0,28	0,09	-1,65
			post	0,26 ± 0,08		0,28 ± 0,09			
		ML	pre	0,31 ± 0,34	**0,00**** -3,40	0,19 ± 0,09	0,70 -1,80	**0,02***	-2,29
			post	0,14 ± 0,06		0,15 ± 0,06			
	Unilateral Static (L)	OV	pre	1,24 ± 0,38	**0,00**** -3,61	1,12 ± 0,33	**0,02*** -2,28	**0,01****	-2,41
			post	0,79 ± 0,29		0,95 ± 0,18			
		AP	pre	0,76 ± 0,16	**0,00**** -3,41	0,75 ± 0,27	0,27 -1,08	**0,03***	-2,15
			post	0,56 ± 0,19		0,68 ± 0,16			
		ML	pre	0,81 ± 0,39	**0,00**** -3,51	0,64 ± 0,20	**0,02*** -2,30	**0,00****	-2,81
			post	0,43 ± 0,13		0,56 ± 0,13			
	Unilateral Static (R)	OV	pre	1,31 ± 0,61	**0,00**** -3,63	0,99 ± 0,37	0,72 -0,35	**0,00****	-3,47
			post	0,77 ± 0,25		0,92 ± 0,19			
		AP	pre	0,79 ± 0,24	**0,00**** -3,40	0,70 ± 0,28	0,39 -0,84	**0,00****	-2,86
			post	0,51 ± 0,17		0,62 ± 0,11			
		ML	pre	0,81 ± 0,62	**0,00**** -3,54	0,54 ± 0,17	0,38 -0,87	**0,00****	-2,70
			post	0,44 ± 0,20		0,50 ± 0,14			
	Bilateral Dynamic	OV	pre	0,83 ± 0,29	**0,00**** -3,58	0,87 ± 0,30	**0,00**** -2,94	**0,04***	-1,98
			post	0,49 ± 0,21		0,69 ± 0,25			
		AP	pre	0,58 ± 0,22	**0,00**** -3,28	0,59 ± 0,24	**0,03*** -2,14	0,12	-1,52
			post	0,36 ± 0,15		0,48 ± 0,22			
		ML	pre	0,48 ± 0,18	**0,00**** -3,22	0,50 ± 0,18	**0,00**** -2,85	0,24	-1,17
			post	0,31 ± 0,17		0,39 ± 0,16			
	Unilateral Dynamic (L)	OV	pre	1,18 ± 0,43	**0,00**** -3,73	1,27 ± 0,47	**0,00**** -3,17	0,13	-1,50
			post	0,72 ± 0,28		0,95 ± 0,36			
		AP	pre	0,87 ± 0,34	**0,00**** -3,73	0,88 ± 0,36	**0,00**** -3,14	**0,08***	-1,74
			post	0,51 ± 0,19		0,67 ± 0,35			
		ML	pre	0,63 ± 0,31	**0,00**** -2,66	0,75 ± 0,32	0,11 -1,56	0,65	-0,45
			post	0,49 ± 0,27		0,59 ± 0,29			
	Unilateral Dynamic (R)	OV	pre	1,45 ± 0,60	**0,00**** -3,92	1,31 ± 0,68	**0,00**** -3,38	**0,00****	-2,63
			post	0,87 ± 0,44		1,06 ± 0,64			
		AP	pre	0,89 ± 0,28	**0,00**** -3,83	0,86 ± 0,46	**0,03*** -2,08	**0,02***	-2,26
			post	0,53 ± 0,21		0,70 ± 0,38			
		ML	pre	0,94 ± 0,61	**0,00**** -3,82	0,78 ± 0,58	**0,00*** -2,59	**0,00****	-2,76
			post	0,51 ± 0,38		0,63 ± 0,42			

OV: Overall, AP: Anteroposterior, ML: Mediolateral, Data expressed as mean ± Standard Deviation. Significance was set as $p \leq 0{,}05$.

The comparison of the Biodex Balance System findings between pre and post measurements in the groups and the comparison of that difference among the groups were showed in Table 4.11. The improvement of all testing positions done by the study group were statistically significant ($p<0,01$). The exercise group also showed improvement in tests done in all positions except standing on a static plate on right foot. However, these improvements did not include all scores of the testing positions. Additionally, all scores done on left foot (on the static platform) and on right foot (on both static and dynamic platforms) were found statistically significant between groups ($p\leq0,05$). For the other testing positions, ML score of bilateral assessment on static platform, OV score of bilateral assessment on dynamic platform, AP score of the left foot on dynamc platform were found statistically significant ($p\leq0,05$).

5. DISCUSSION

We aimed to determine the effects of connective tissue massage on balance and proprioception when applied to the lumbar, lower thoracal, interscapular, scapular and cervical regions. We also sought to compare these findings with the effects of balance exercises.

It is known that balance and proprioception are affected by gender and age. Raschner et al studied 11-18 years old ski-racers for 10 years and investigated differences in postural stability between genders at various age periods. They found that females showed better stability and sensory scores than males. (105)

In another study done by Pasma et al (106), center of pressure movements were measured in two different age groups. 35 healthy young and 75 healthy old participants compared. They found that older participants had greater scores (representing worse balance) in the mediolateral direction compared to the younger adults.

In our study, there was no significant difference between the study and exercise groups in terms of gender, age, height, weight and BMI of the subjects. This increases the reliability of our study since it eliminates the doubt that the results obtained between the two groups may be due to other confounding factors.

In addition to the aspects mentioned above, we also examined how application of CTM with exercise affects heart parameters, balance, and cervical and lumbar proprioception of male and female volunteers in the study group. In the literature, there is no study showing the effects of CTM on different gender and age groups. In general, studies have been conducted to investigate the effects of CTM on pain, mostly related to fibromyalgia or related to menstrual period syndrome (107, 108). Fibromyalgia syndrome is observed more frequently in women (107). For these reasons, the majority of studies in the literature include female subjects.

According to the statistical analysis of our study, the only significant difference between gender groups was observed in systolic and diastolic heart pressure. It is thought that there was no significant difference found between other parameters related to balance and proprioception is due to an unequal number of male and female subjects in the study group. Therefore, it is important that future studies should observe equal numbers of male and female volunteers.

Balance training is widely used by patients to improve health and by athletes to enhance athletic performance. Furthermore, it is used for healthy individuals to prevent falls and lower limb injuries (109). In a systematic review done by DiStefano et al. (110), 16 articles were examined and they found that none of the balance training programs resulted in decreased balance, even though some of the studies did not demonstrate significant improvements.

In another study done by Haksever et al (111) 18 healthy men participated in a balance training program with standard balance equipment. The authors claimed that balance training with standard balance equipment may be used for the development of dynamic and static balance in healthy subjects.

Although balance exercises have proven effective in improving balance, there is no study on how balance exercises combined with CTM affect balance. In our study, we used the Biodex Balance System to assess postural stability in intra-group and inter-group examinations. In the literature, Biodex Balance System has been proven to be reliable in the evaluation of balance (112, 113). In our exercise group, all parameters obtained by the Biodex Balance System decreased but only some of them, especially related to dynamic balance, were found to be statistically significant. However, in the study group, statistically significant decreases found in all parameters shows the person’s increased ability to maintain stability in anteroposterior and mediolateral directions and overall.

In 1989, Gottschalk et al. explained that the gluteus medius (GM) muscle is responsible for the stabilization of the hip joint in the initial phase of the gait cycle and also prevents dropping of the pelvis to the unsupprted side (114). In our study, the exercise list we gave to the volunteers included many single-leg exercises. Since the GM muscle is the primary fronral plane stabilizer of the hip (115), these exercises may help to improve the GM and may allow for improvement of balance. This information helped us understand the improvement of pre and post balance measurements in our exercise and CTM with exercise groups.

Moreover, in a study done by Leavey et al. (116), 48 healthy college students divided into 4 different groups as proprioception, gluteus medius strengthening, combination of proprioceotion and strength exercises and control groups. They assessed the effects of exercise types on dynamic balance. Dynamic balance assessment done by Star Excursion Balance Test. They revealed that although there was no significant difference between groups, all 3 training programs resulted in significant improvements from pre-test to post-test. The combination group demonstrated the most improvement. This improvement was followed by the strengthening and proprioception groups. The greatest mean improvements were observed in the posteromedial, posterior, and posterolateral reach directions. Similarly, our exercise group showed significant improvement in most of the scores of dynamic balance rather than static balance. In this respect, we can say that our study is similar to the literature.

There are some studies comparing the effects of exercise and CTM with exercise in patients with illnesses. Celenay ST et al. (117), observed that stabilization exercises with CTM might be effective for reducing symptoms related to night pain, anxiety, and mental health in patients with chronic mechanical neck pain compared to stabilization exercises alone. Another study done by Celenay ST et al. (118) suggested that exercises with CTM might be superior to exercise alone in improving pain, fatigue, difficulty sleeping, and role limitations due to physical health in women with fibromyalgia syndrome.

On the other hand, according to our knowledge, there is no study in the literature comparing two healthy groups (exercise and CTM with exercise) in terms of balance. In our study, we performed inter-group examinations of static and dynamic balance. Out of 18 scores, the difference of 12 scores related to the improvement of balance between the study and exercise groups were found to be statistically significant. Since the "overall" scores are more reliable than the "antero-posterior" and "medio-lateral" scores (112), it is possible to say that the study group's unilateral static right and left foot, bilateral dynamic and unilateral dynamic right foot scores were significantly improved compared with the "only exercise" group.

The thoracolumbar region is called the "basic region" and therapists should always start application of CTM from this area regardless of where the treatment area is. This information suggests that the sacrolumbar and thoracolumbar regions are important regions in CTM. Therefore, it is possible that the difference in balance improvements between the groups may be caused by the thoracolumbar fascia. The thoracolumbar fascia is an important structure. It connects the lower limbs via the gluteus maximus to the upper limbs via the latissimus dorsi. The fascia with the abdominal muscles and multifidius, create a stabilizing corset effect known as core stabilization (119).

In a study done in 2016, Park et al. (120) worked with archers by giving them pilates core stability exercises over the course of 12 weeks. They compared the study group with the control group (non-exercise group) in terms of static and dynamic balance. The Humac Norm Balance System was used to assess both static and dynamic balance. The results indicated that the medial and lateral scores of static balance and the overall scores of the dynamic balance were significantly improved in the exercise group.

Chung et al. (121) studied with 16 stroke patients by giving general training exercises to half of them and core stabilization exercises to the other half. They used the Timed-Up and Go Test to evaluate dynamic balance. Four weeks later, the core exercise group showed a significant improvement in balance.

Since the thoracolumbar fascia is related to core stabilization, it was considered as one of the reasons for the significant difference of the improvement of balance between the two groups.

We also examined the cervical proprioception by using a CROM device to determine the effects of CTM on cervical propriocepton and to find out if there was an intragroup improvement or an intergroup difference related to the improvement. In clinical practice, the CROM device is an easy and effective tool to evaluate cervical proprioception (122).

There are many studies planned with this CROM device in the literature. Wibault et al. (123) compared head repositioning accuracy using the CROM device between 71 individuals with cervical radiculopathy and 173 neck-healthy individuals. Their results supported the use of the CROM device for quantifying cervical proprioception impairment in individuals with cervical radiculopathy in clinical practice.

In our study, the cervical proprioception of the CTM group significantly improved in all testing scores done before and after the study ($p<0,05$). On the other hand, our exercise group showed significant improvement in only 2 scores out of 6. When we consider the exercise list given to the volunteers, it did not contain any specific exercises related to cervical proprioception. That is why it was expected that there would be less improvement in cervical proprioception of the exercise group than the study group.

However, the effect of balance and strength exercises on proprioception is a known fact (124). In a study done by Beinert et al (125) thirty-four participants were divided into two groups. The intervention group performed single leg stance, tandem stance and standing on a wobble board over a period of five weeks, three times per week. The control group was not given any exercise. After the study, they found a significant difference in joint repositioning accuracy and decreased pain between the intervention and control groups. Therefore, significant improvement in 2 scores obtained in our control group is consistent with the literature and accepted as normal.

In the inter-group comparison of our study, although there was only a significant difference in the flexion scores with and without vision, we believe that the addition of CTM to a training program is a good way to improve cervical proprioception. This study may have failed to prove the effectiveness of combined CTM and balance exercises over balance exercises alone because of the small numbers of participants. Future studies done with more participants are required.

We also investigated how CTM with exercise affects lumbar proprioception. A review done by Tong et al. in 2017 showed that there are many different methods used to detect lumbar proprioception such as electrogoniometers, electronic sensors, lumbar motion devices, and tape measurement (126).

In our study, we used a Stabilizer™ Pressure Biofeedback Unit (Chattanooga Group Inc., Hixson, TN 37343, USA) to measure lumbar proprioception. We used posterior pelvic tilt as a target position. To the best of our knowledge, this study is the first to use a Stabilizer™ Pressure Biofeedback Unit in the assessment of lumbar proprioception.

A statistically significant difference was observed between the pre and post study measurements of the CTM group, and no significant difference was found in the exercise group. Although pre study measurements of the study group were significantly worse than the exercice group, post study measurements of the study group were significantly better than the exercise group, specifically the measures for eyes open and eyes closed.

When we consider the thoracolumbar fascia again, we can say that its high density of mechanoreceptors is extremely responsible for afferent proprioceptive information (127). As mentioned before, CTM increases the blood flow of the application area. This may result in the stimulation of the proprioceptors located in the thoracolumbar fascia which may be the reason for the significant differences in lumbar proprioception between the two groups.

In our study, a significant change between pre and post measurements was observed in all of the heart parameters of the study group, while a significant decrease in systolic and distolic blood pressure was observed in the exercise group. When the heart parameters of the two groups were compared, no significant difference was found.

In literature, there are many studies providing that balance and strengthening exercises contribute to the decrease of blood pressure. Tai Chi is one of the exercise programs that has been shown to do this. In a study done by Thorntorn et al, 17 healthy women were recruited for a 12 week Tai Chi exercise program while 17 matched women were recruited as a control. The results revealed that both systolic and diastolic blood pressure decreased significantly in the study group (128).

In another study, Ghroubi and colleagues (129) divided 40 obese patients into an isokinetic with aerobic exercise group and an aerobic exercise only group. The study lasted 2 months and patients participated in 3 sessions per week. The isokinetic exercises included extensor and flexor muscles of the lower limbs and spine. At the end of the study, although an improvement in systolic and diastolic arterial blood pressure was observed in both groups, the decrease in blood pressure was statistically greater in the group performing isokinetic and aerobic exercise. Additionally, the change between pre and post measurement of both systolic and diastolic blood pressure parameters were found statistically significant between groups.

This supports the improved systolic and diastolic blood pressures found in the exercise group and the CTM with exercise group in our study, because the exercise program given to both groups included both balance and strengthening exercises.

On the other hand, improvement between the groups was not found to be statistically significant. This result is compatible with the studies in the literature. In a study done by Vergili and Yuksel (130), 60 healthy women older than eighteen years were included in their study. One session of connective tissue manipulation was performed on 30 of them while one session placebo manipulation was applied to the other 30. At the end of the study, they did not observe any significant acute changes in blood pressure or heart rate.

In another study, both acute and long term effects of CTM on healthy middle-aged women were divided into a CTM group and a placebo ultrasound group. The frequency of treatment was 3 sessions for a week for 3 weeks. At the end of the study, CTM was found ineffective for heart rate, and systolic and diastolic blood pressure (87).

Several limitations exist in our study. First, the sample size was small. Following studies must be done with larger groups. Secondly, although the number of men and women were similar between groups, it could may be better for each group to contain an equal number of men and women to determine the effects of CTM and exercise between gender groups.

Furthermore, existance of a control group that does not receive any intervention could increase the strength of the study.

6. CONCLUSION

In brief, at the end of the study, a significant difference between groups were found in cervical proprioception in terms of flexion with ($p \leq 0,01$) and without ($p \leq 0,05$) vision and lumbar proprioception with and without vision ($p \leq 0,01$). Since the “overall” scores are more reliable than the “antero-posterior” and “medio-lateral” scores of the Biodex Balance System, intergroup comparison of the groups were interpreted according to the overall scores. Improvement in static and dynamic balance on right foot ($p \leq 0,01$), bilateral dynamic balance ($p \leq 0,05$), and static balance on left foot ($p \leq 0,01$) were found significant between the groups. On the other hand, when all scores (overall, anteroposterior-mediolateral) were examined, pre-and-post measurements of both dynamic and static balance were found significant ($p \leq 0,05$) in study group, while exercise group showed a significant improvement mostly in dynamic balance scores.

The significant difference between the improvement of lumbar proprioception of the groups might be due to the stimulation of the proprioceptors of the thoracolumbar fascia by CTM. Furthermore, this stimulation might be the reason of the difference of the balance measurements between groups. On the other hand, the reason of the difference between pre- and post measurements of the dynamic balance of both groups might be increased gluteus medius muscle strength.

Considering all of these, we believe that the application of CTM with exercise improves proprioception and balance, especially static balance, in healthy subjects. Further studies are needed to be done with larger groups and addition of a control group to the study will increase the strength of the study.

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APPENDIXES

Appendix 1: Ethical Approval

T.C. YEDİTEPE ÜNİVERSİTESİ

Sayı : 37068608-6100-15-1477
Konu: Klinik Araştırmalar
Etik kurul Başvurusu hk.

19/04/2018

İlgili Makama (Çiçek Duman)

Yeditepe Üniversitesi, Fizyoterapi ve Rehabilitasyon Bölümü Yrd. Doç. Dr. Feyza Şule Badıllı Demirbaş'ın sorumlu olduğu **"Sağlıklı Bireylerde Konnektif Doku Masajının Denge ve Propriyosepsiyon Üzerine Etkisi"** isimli araştırma projesine ait Klinik Araştırmalar Etik Kurulu (KAEK) Başvuru Dosyası (**1453** kayıt Numaralı KAEK Başvuru Dosyası), Yeditepe Üniversitesi Klinik Araştırmalar Etik Kurulu tarafından **18.04.2018** tarihli toplantıda incelenmiştir.

Kurul tarafından yapılan inceleme sonucu, yukarıdaki isimi belirtilen çalışmanın yapılmasının etik ve bilimsel açıdan uygun olduğuna karar verilmiştir (**KAEK Karar No: 837**).

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

Yeditepe Üniversitesi 26 Ağustos Yerleşimi, İnönü Mahallesi Kayışdağı Caddesi 34755 Ataşehir / İstanbul
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Appendix 2: Informed Consent and Evaluation Form

Araştırmanın Adı : "Sağlıklı Bireylerde Konnektif Doku Masajının Denge Ve Propriyosepsiyon Üzerine Etkisi"

Sorumlu Araştırmacının Adı : Yrd.Doç.Dr. Feyza Şule Badıllı Demirbaş
Diğer Araştırmacının Adı : Fzt. Çiçek Duman

Sayın Gönüllü,

"Sağlıklı Bireylerde Konnektif Doku Masajının Denge ve Propriyosepsiyon Üzerine Etkisi" isimli bir çalışmada yer almak üzere davet edilmiş bulunmaktasınız. Bu çalışma, araştırma amaçlı olarak yapılmaktadır. Çalışmaya katılma konusunda karar vermeden önce, araştırmanın neden ve nasıl yapılacağını, sizinle ilgili bilgilerin nasıl kullanılacağını, çalışmanın neler içerdiğini, olası yararlarını, risklerini ve rahatsızlıklarını bilmeniz gerekmektedir. Bu nedenle bu formun okunup anlaşılması büyük önem taşımaktadır. Eğer anlayamadığınız ve sizin için açık olmayan şeyler varsa ya da daha fazla bilgi isterseniz bize sorunuz.

Bu çalışmaya katılmak tamamen **gönüllülük** esasına dayanmaktadır. Çalışmaya **katılmama** veya katıldıktan sonra herhangi bir anda çalışmadan **çıkma** hakkına sahipsiniz.

Çalışma hakkında tam olarak bilgi sahibi olduktan sonra ve sorularınız cevaplandıktan sonra eğer katılmak isterseniz sizden bu formu imzalamanız istenecektir. Çalışmaya katılmayı kabul etmeniz konumunda, farklı tedavi gruplarına atanma olasılığınız bulunduğunu lütfen unutmayınız.

Araştırma Sorumlusu
Yrd.Doç.Dr. Feyza Şule Badıllı Demirbaş

Araştırmanın Amacı:

Propriyosepsiyon, vücudun konumunu ve uzuvların bu konuma göre nerede/nasıl durduğu bilgisini hissetmemizi sağlar. Bu bilgiden yola çıkarak vücut dengeyi koruyabilir hale gelmektedir. Denge ve propriyosepsiyon ortopedik, nörolojik, pediatrik ve hatta dahili hastalıklarda bile etkilenim gösteren duyulardır. Tedavi edilen hastalarda kas gücü ve doku iyileşmesi optimal seviyelere gelmiş olsa bile, propriyosepsiyon, dolayısıyla denge gelişmediği müddetçe birey, gündelik hayatta zorluk çekmeye devam etmektedir. Dahası, denge ve propriyosepsiyonun iyileşme sürecinde gelişmemiş olması, kişinin tekrar yaralanması riskini arttırır. Bu konum, sağlıklı bireyler için de geçerlidir. Kişinin başka hiçbir hastalığı olmasa bile, denge sağlamakta yetersiz ise, düşme, düşmeye bağlı yaralanma ve ayak bileği burkulmaları gözlemlenebilir.

Denge ve propriyosepsiyonun gelişmesi için çeşitli egzersizler ve manuel girişimler bulunmaktadır. Bu manuel terapi tekniklerinin pek çoğunu mobilizasyon, manipulasyon ve post-izometrik relaksasyon, miyofasyal gevşetme, traksiyon masajı gibi yumuşak doku teknikleri oluşturmaktadır. Aynı zamanda yapılan çalışmalarda; eklem hareket açıklıkları, dokuların gerginliği, yaralanmada iyileşme süreci ve ağrı algısı gibi kişinin hayat standardını etkileyebilecek pek çok parametrenin incelendiği ancak denge ve propriyosepsiyonun araştırılmadığı gözlemlenmiştir.

Konnektif Doku Masajı (KDM) hem bedenle hem de iç organlarla ilgili problemlerde kullanılan bir manuel terapi çeşididir. Literatürde, KDM'nin otonom sinir sisteminin (OSS) işleyişini dengelediğine ve dolaşımı arttırarak ağrıda azalma, kas gevşemesi ve hareketlilik artışı gibi etkiler sağladığına dair pek çok kanıt bulunmaktadır. Ancak güncel literatürde KDM'nin denge ve proriyosepsiyon üzerine etkileri henüz araştırılmamıştır.

Lomber, torakal ve servikal bölgelere uygulanacak KDM aracılığıyla omurga çevresindeki mekanoreseptörlerin daha kolay uyarılabileceği, aynı zamanda enerjinin yükselişiyle dikkat ve odaklanmanın artacağı, böylece propriyosepsiyonda, dolayısıyla dengede gelişme kaydedileceği düşüncesi çalışmamızın temelini oluşturmuştur. Ayrıca OSS'nin düzenlenmesi ile servikal bölgenin, dolayısıyla vestibular sistemin kan akışının düzenleneceği bilgisi, vestibular sistem ile kontrolü sağlanan dengenin olumlu gelişim göstereceği fikrini bizlere vermiştir. Ancak KDM'nin bu duyular üzerine etkisi bildiğimiz kadarıyla henüz araştırılmış değildir.

Güncel literatürdeki yukarıda da bahsi geçen eksiklikler sebebiyle çalışmamızın amacı KDM'nin denge ve propriyosepsiyon üzerine etkilerinin araştırılmasıdır.

Araştırmaya Katılması Beklenen Gönüllü Sayısı:

40 kişi

Araştırmanın Yapılacağı Yer:

Bahçeşehir Üniversitesi Sağlık Bilimleri Fakültesi Ergoterapi Laboratuvarı

Araştırma Sırasında Gönüllüye Uygulanacak Olan Yöntemlerin Tümü:

Gönüllüye Uygulanacak Değerlendirme Ölçekleri – Biodex Balance System ile statik ve dinamik dengenin ölçümü, Chattanooga Stabilizer Pressure Biofeedback ile lomber bölgenin propriyosepsiyonunun ölçümü, Baş-Boyun Eklem Hareket Açıklığı Ölçüm Cihazı (C-ROM) ile servikal bölge hareket açıklığının ölçümü, Nabız ve tansiyon ölçümü

Gönüllüye Uygulanacak Tedavi Yöntemleri – Denge ve propriyosepsiyon egzersizleri, Konnektif Doku Masajı

Araştırmada Uygulanacak Tedaviler:

Denge ve Propriyosepsiyon Egzersizleri – Program, yatarak ve ayakta yapılacak olan, gövde kaslarını güçlendirici ve dengeyi arttırıcı ev egzersizlerinden oluşacaktır. Denge egzersizleri haftada 2 seans olarak, 6 hafta boyunca (toplam 12 seans) uygulanacaktır. Seans süresi 45-60 dk olacaktır.

Konnektif Doku Masajı Uygulaması – Cilt üzerine, fizyoterapistin tek parmağı aracılığıyla, sıraları belirli çekmeler olarak uygulanan manuel terapi protokolüdür. Protokolün sadece lomber, torakal ve servikal bölgeler için hazırlanmış kısmı gönüllülere uygulanacaktır. Gönüllünün uygulamaya hazırlanması ile birlikte yaklaşık olarak 30 dk sürecektir.

Araştırmanın Süresi:

Haftada 2 seans olarak, 6 hafta boyunca (toplam 12 seans) sürmesi öngörülmektedir.

Çalışmanın Riskleri ve Rahatsızlıkları:

KDM invaziv olmayan bir manuel terapi şeklidir. Uygulama sırasında hastada tırmalanma ya da basınç hissi oluşması normal bir reaksiyondur. Kırmızı keskin çizgi, etrafında dağınık kırmızılık, ilk çizginin etrafında hafif kabartı gibi deri irritasyonları gözlemlenebilir. Otonomik dengesi çabuk değişen bireylerde terleme, tansiyonda, nabızda ve periferik ısıda değişiklikler gözlemlenebilir.

Her tedavi seansı olan fizyoterapist tarafından yapılacak olup, çalışmaya katılacak kişilerin tansiyonları ve nabızları kontrol edilecektir. Tedavi sırasında ve sonrasında hastanın cildinde basıya ve sürtünmeye ait kızarıklığın yoğunluğu kontrol edilecektir. Tüm bu önlemlere rağmen tıbbi bakım gerektiren bir cilt irritasyonu olması halinde tedavi masrafı sorumlu araştırmacı tarafından karşılanacaktır.

Çalışmada Yer Almanın Yararları:

Bu çalışmayla KDM'nin denge ve propriyosepsiyon üzerine pozitif etkisi olduğu kanıtlanabilirse, çeşitli hastalıklara sahip bireylerde KDM'nin, yaşam kalitesi üzerine etkisi ve mevcut hastalığın gidişatına olan olumlu/olumsuz etkileri araştırılmasına zemin hazırlanabilir, sonrasında ise kliniklerde kullanılan mevcut tedavi yöntemlerinin yanı sıra KDM kullanımı yaygınlaşabilir. Böylece tedavi planındaki egzersiz çeşitliliğini arttırılmasına, dolayısıyla hasta bireylerin aynı tip egzersizlerden sıkılması ihtimalinin önüne geçilmesine; aynı zamanda farklı egzersizlerden faydalanıldığından farklı sistemlerden beyne gelen bilgilerin birleşmesi ile daha etkin bir tedavi planı oluşturulmasına katkıda bulunmuş olacaksınız.

Katılımcının Kişisel Bilgilerin Kullanımı:

Araştırmacılar kişisel bilgilerinizi, araştırmayı ve istatistiksek analizleri yürütmek için kullanacaktır. Çalışmanın sonunda, bu bilgiler hakkında bilgi isteme hakkınız vardır. Çalışma sonuçları çalışma bitiminde tıbbi literatürde yayınlanabilecektir ancak kimliğiniz açıklanmayacaktır.

İzleyiciler, yoklama yapan kişiler, Etik Kurul, Sağlık Bakanlığı ve diğer ilgili sağlık otoriteleri orijinal tıbbi kayıtlarınıza doğrudan erişebilir. Bu yazılı bilgilendirilmiş gönüllü onam formunu imzalayarak yalnızca adı geçen kişi ve kurumlara erişim izni vermiş olacaksınız. Ancak kimlik bilgileriniz gizli tutulacak, kamuoyuna açıklanamayacak; araştırma sonuçlarının yayımlanması halinde dahi kimliğiniz gizli kalacaktır.

Çalışma Hakkında Elde Edilen Yeni Bilgiler Durumunda:

Araştırmaya katılmaya devam etme isteğinizi etkileyebilecek, araştırma konusuyla ilgili yeni bilgiler elde edildiğinde siz veya yasal temsilciniz zamanında bilgilendirilecektir.

Gönüllünün Araştırmaya Katılımının Sona Erdirilmesini Gerektirecek Durumlar veya Nedenler

Çalışmaya katılımınızı engelleyecek tıbbi bir durumuzun olması halinde çalışmaya katılımınız durdurulacaktır.

Gönüllünün Bilgi, Yardım ve İletişim İçin Başvurabileceği Kişi

Adı – Soyadı: Çiçek Duman Telefon: [redacted]

Araştırmaya Katılan Araştırmacılar:

Yrd. Doç.Dr. Feyza Şule Badıllı Demirbaş: Çalışmanın Koordinatörü (Yeditepe Üniversitesi)

Fzt. Çiçek Duman: Yardımcı Araştırmacı (Bahçeşehir Üniversitesi)

Araştırmaya Katılım Onayı:

Yukarıda yer alan ve araştırmadan önce katılımcıya/gönüllüye verilmesi gereken bilgileri okudum ve katılmam istenen çalışmanın kapsamını ve amacını, gönüllü olarak üzerime düşen sorumlulukları tamamen anladım. **Çalışma hakkında yazılı ve sözlü açıklama aşağıda adı belirtilen araştırmacı tarafından yapıldı, soru sorma ve tartışma imkanı buldum ve tatmin edici yanıtlar aldım. Bana, çalışmanın muhtemel riskleri ve faydaları sözlü olarak da anlatıldı.** Bu çalışmayı istediğin zaman ve herhangi bir neden belirtmek zorunda kalmadan bırakabileceğimi ve bıraktığım taktirde herhangi bir olumsuzluk ile karşılaşmayacağımı anladım.

Bu koşullarda söz konusu araştırmaya kendi isteğimle, hiçbir baskı ve zorlama olmaksızın katılmayı kabul ediyorum.

Katılımcının	Araştırmacının
Adı – Soyadı:	Adı – Soyadı:
İmzası:	İmzası:

1) Adı-Soyadı: ....

Cep Telefon Numarası: ....

Acil Durumlarda Ulaşılacak Kişi Adı Soyadı ve Telefon Numarası: ....

2) Doğum Tarihi: ....

3) Cinsiyet:

[ ] Kadın

[ ] Erkek

4) Boy Uzunluğu (cm):

5) Vücut Ağırlığı (kg): 6) BMI:

7) Dominant Taraf:

[ ] Sağ

[ ] Sol

8) Sigara İçiyor Musunuz?

[ ] Hiç İçmedim

[ ] Sigara İçtim Ama Bıraktım (....... yıl, günde ....)

[ ] Hala İçiyorum (........ yıldır, günde ....)

9) Alkol Kullanıyor Musunuz?

[ ] Evet

( ) Her gün düzenli

( ) Haftada birkaç kez

( ) Ayda birkaç kez

( ) Özel Günlerde

[ ] Hayır

10) Herhangi bir sürekli hastalığınız var mı?

[ ] Sürekli bir hastalığım yok.

[ ] Romatizma

[ ] Vestibular Sistem

[ ] Travma

[ ] Ortopedik Problemler

[ ] Nörolojik Problemler

[ ] Diğer

11) Sürekli kullandığınız bir ilaç var mı?

[ ] Evet (..)

[ ] Hayır

12) Şu an herhangi bir ağrı kesici ilaç kullanıyor musunuz?

[ ] Evet
Ne kadar süredir? ....

[ ] Hayır

13) Herhangi bir ameliyat geçirdiniz mi (sünnet hariç)?

[ ] Evet ....

[ ] Hayır

14) Fiziksel aktivite yapıyor musunuz?

[ ] Yapmıyorum.

[ ] Haftada 3 günden az

[ ] Haftada 3 gün veya daha fazla

Fiziksel aktivite türü: ....

Süresi: ....

15) Fiziksel performans düzeyinizi nasıl algılarsınız/nasıl tanımlarsınız?

[ ] Çok zayıf

[ ] Zayıf

[ ] Orta

[ ] İyi

[ ] Çok iyi

NABIZ VE TANSİYON ÖLÇÜMÜ				
	KDM Uygulama Öncesi		**KDM Uygulama Sonrası**	
	Nabız	**Tansiyon**	**Nabız**	**Tansiyon**
Ölçüm				

C-ROM ÖLÇÜMÜ							
		Göz Açık			Göz Kapalı		
		F	RLF	LLF	F	RLF	LLF
Çalışma Öncesi	1 . Ölçüm						
	2. Ölçüm						
	3. Ölçüm						
	Ortalama						
Çalışma Sonrası	1 . Ölçüm						
	2. Ölçüm						
	3. Ölçüm						
	Ortalama						

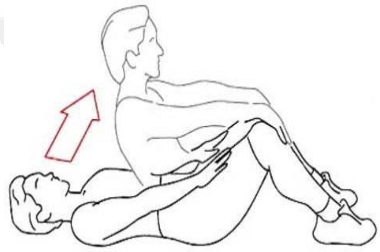
CHATTANOOGA STABILIZER PRESSURE BIOFEEDBACK ÖLÇÜMÜ			
		Göz Açık	Göz Kapalı
Çalışma Öncesi	1 . Ölçüm		
	2. Ölçüm		
	3. Ölçüm		
	Ortalama		
Çalışma Sonrası	1 . Ölçüm		
	2. Ölçüm		
	3. Ölçüm		
	Ortalama		

BIODEX DENGE SİSTEMİ ÖLÇÜMÜ						
	Overall		AP		ML	
	Çalışma Öncesi	Çalışma Sonrası	Çalışma Öncesi	Çalışma Sonrası	Çalışma Öncesi	Çalışma Sonrası
Statik Çift Ayak						
Statik-Tek Ayak (Sol)						
Statik-Tek Ayak (Sağ)						
Dinamik-Çift Ayak						
Dinamik-Tek Ayak (Sol)						
Dinamik-Çift Ayak (Sağ)						

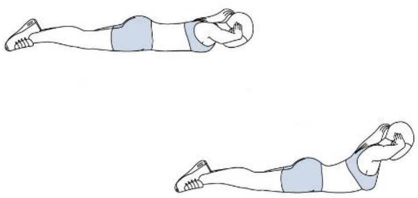
Appendix 3: Home-exercises list given to the volunteers

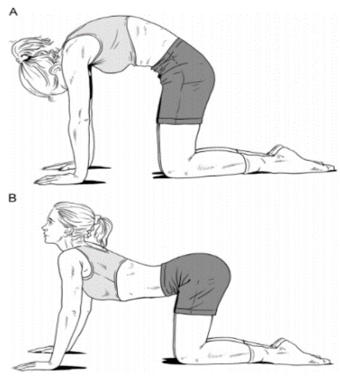
1) 

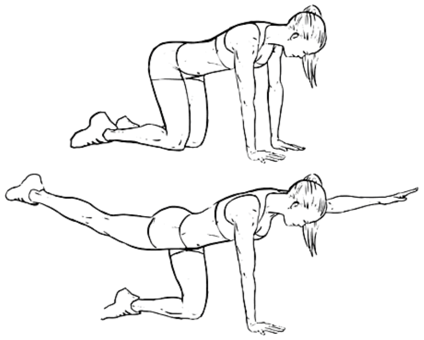
2) 

3) 

4) 

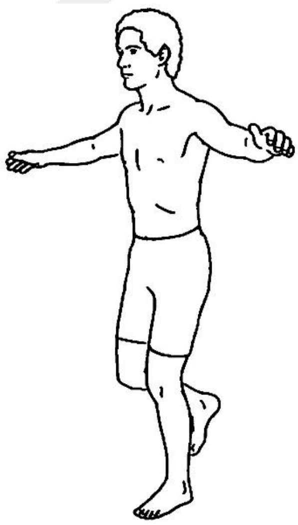
5) 

6) 


7)


8)


9)


10)


11)

Aşağıdaki listede bulunan egzersizlerin tümü, *özel olarak belirtilmediği müddetçe* 10 tekrar olacak şekilde, toplam 12 kere yapılacaktır. Hareketler hatırlatma amaçlı yazılmış olup, değerlendirmenin alındığı gün size öğretilecektir.

1- Ayaklarınızı uzatarak oturun. Dizlerinizin yataktan kalkmamasına özen göstererek ellerinizle ayaklarınızı tutmaya çalışın. 10'a kadar sayın ve gevşeyin.

2- Sırtüstü, dizleriniz bükülü, elleriniz belinizin altında uzanın. Karın ve kalça kaslarınızı kasarak belinizi yatağa doğru bastırın. 10'a kadar sayıp gevşeyin. *(Hareket esnasında poponuz yataktan kalkmamalı, ellerinizi belinizle ezmiş olmalısınız.)*

3- Sırtüstü pozisyonda, dizleriniz bükülü olarak yatın. Kollarınızı dizlerinize uzatıp başınızı ve omuzlarınızı öne doğru hafif kaldırın. 5'e kadar sayıp gevşeyin.

4- Topuklarınızın altında bir top koyarak sırtüstü yatın. Ayaklarınızı topa doğru bastırarak kalçanızı yukarı doğru kaldırın. 10'a kadar sayıp gevşeyin.

5- Yüzüstü pozisyonda, karnınızın altına ince bir yastık ya da katlanmış havlu koyarak yatın. Kollar yanda, başınızı ve göğsünüzü yataktan kaldırmaya çalışın. 5'e kadar sayıp gevşeyin.

6- Ellerinizin ve dizlerinizin üzerinde, emekleme pozisyonunda durun. Karnınızı içeri çekerek başınızı öne doğru eğin ve sırtınızı yukarı kaldırın (omurga ile tam bir tümsek), 5' kadar sayın. Daha sonra başınızı yukarı kaldırıp sırtınızı çukurlaştırmaya çalışın (omurga ile tam bir çukur), 5'e kadar sayın.

7- Ellerinizin ve dizlerinizin üzerinde emekleme pozisyonunda durun. Sağ kolunuzu öne doğru uzatırken sol bacağınızı düz olarak arkaya doğru uzatın. 10'a kadar sayıp gevşeyin. Daha sonra diğer kol ve bacağınızla aynı hareketi tekrarlayın. Son 6 egzersizde ellerinizin ve dizlerinizin altına bir yastık ya da katlanmış bir yorgan koyarak yumuşak bir zemin üzerinde yapın.

8- Yatak veya koltuk üzerine top koyun ve üzerine oturun (Pilates topunuz var ise yere koyarak da yapabilirsiniz). Gövdenin-belin düzgünlüğü bozulmadan, diziniz düz olacak şekilde bir bacağınızı yukarı doğru kaldırın. Dengenizi korumaya çalışarak 10'a kadar sayıp indirin. Daha sonra aynı hareketi diğer bacak için de tekrarlayın.

9- **Flamingo egzersizi:** Dik bir şekilde ayakta durun, gözlerinizi uzak bir noktaya sabitleyin. İki kolunuzu öne doğru, bacaklarınızdan birini dizinizi bükmeden arkaya doğru uzatın. 10 saniye kadar bu pozisyonda kalın, sonra gözlerinizi kapatarak bir 5 saniye daha kalmayı deneyin. **Hareketi 5 kere tekrarlayın.** Diğer bacakla aynısını yapın.

10- Destek almadan bir bacağınız dizden bükülü, tek bacak üzerinde dengede durmaya çalışın. Dizi bükülü olan bacak, yerde duran bacağın yanında kalmalıdır, ancak bitişik olmamalıdır. Bu pozisyonda 30 saniye durmaya çalışın ve **3 kere tekrarlayın.** Her hafta egzersizde gelişme yapılacaktır. Gelişmeler aşağıdaki gibi olmalıdır.

- 1.-2. Egzersiz Günü: Gözleriniz açık olarak yapın.
- 3.-4. Egzersiz Günü: Gözleriniz kapalı olarak yapın.
- 5.-6. Egzersiz Günü: Gözleriniz açıkken bir topu havaya atıp tutmaya çalışın.
- 7.-8. Egzersiz Günü: Yastık, katlanmış bir yorgan gibi yumuşak bir zemin üzerinde gözleriniz açık olarak yapın.
- 9.-10. Egzersiz Günü: Yastık, katlanmış bir yorgan gibi yumuşak bir zemin üzerinde gözleriniz kapalı olarak yapın.
- 11.-12. Egzersiz Günü: Yastık, katlanmış bir yorgan gibi yumuşak bir zemin üzerinde gözleriniz açıkken bir topu havaya atıp tutmaya çalışın

11- Tandem yürüyüş: Bir ayağın topuğu diğer ayağın parmak uçlarına değecek şekilde yerdeki hayali çizginin üzerinde 10 adım atın, sonra 10 adım geri dönerek başlangıç noktasına ulaşın. **Turu 3 kere tekrarlayın**.