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# ASSESSING PROPRIOCEPTION

## PROPRİYOSEPSİYONU DEĞERLENDİRME

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**Abstract**

**Proprioception is the sense of the relative position of parts of the body and strength of effort being employed in movement. Proprioception is essential for well-adapted sensorimotor control. Although proprioceptive deficits are known to be a common after several neurological and orthopedic conditions such as stroke, Parkinson's disease, peripheral sensory neuropathies, or injuries to ligaments, joint capsules, and muscles, there is no objective, accurate, and reliable method available in clinical settings to assess proprioceptive function. In this chapter specific techniques developed to assess proprioception will be briefly discussed.**

**Keywords:** assessment, equipment, joint position sense, proprioception.

***Özet***

***Propriyoseption, vücudun parçalarının göreceli konumunun ve hareket sırasında işe yönelik harcanan efor direncinin hissi anlamına gelmektedir. İyi bir sensorimotor kontrol için propriyosepsiyon gereklidir. İnme, Parkinson hastalığı, periferik duyu nöropatileri gibi ya da ligamentler, eklem kapsülleri ve kaslarda yaralanmalar gibi çeşitli nörolojik ve ortopedik koşullardan sonra propriyoseptif bozulmaların yaygın olduğu bilinse de, klinik pratikte propriyoseptif fonksiyonların ölçümünde objektif, doğru ve güvenilir bir yöntem bulunmamaktadır. Bu bölümde, propriyosepsiyonun değerlendirilmesi için geliştirilen spesifik teknikler kısaca tartışılacaktır.***

***Anahtar Kelimeler:*** *değerlendirme, ekipman, eklem pozisyon duyusu, propriyosepsiyon.*



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## 1. Introduction

Proprioception is the sense of the relative position of parts of the body and strength of effort being employed in movement. Proprioception is essential for well-adapted sensorimotor control (Suetterlin & Sayer, 2014). Several assessment methods and techniques have been developed to test proprioception accurately(Clark, Röijezon, & Treleaven, 2015).

For an intact proprioception, receptors in striated muscles and Golgi tendon organs must function properly. Although proprioception perceived as a role of the peripheral nervous system, it is becoming more evident that there processing of proprioception is a function of the central nervous system (Niessen, Veeger, & Janssen, 2009). It is the central nervous system integrating information coming from proprioceptors and also from the vestibular system into an overall sense of body awareness. An impact proprioception is vital for the neural control of locomotion. Conversely, an impaired proprioception negatively affects the control of spatial movements (Proske et al., 2012).

Proprioception has conscious and unconscious components. The unconscious component, controlled partially by the cerebellum, is seen soon after the infant gains neck movement control. It can be assessed by tilting body on one side and observing the eyes leveled to a horizontal line by tilting the head to opposite side (Bhanpuri, Okamura, & Bastian, 2013).

## 2. Assessing Proprioception

Although proprioceptive deficits are known to be a common after several neurological and orthopedic conditions such as stroke, Parkinson's disease, peripheral sensory neuropathies, or injuries to ligaments, joint capsules, and muscles (Bosco & Poppele, 2001), there is no objective, accurate, and reliable method available in clinical settings to assess proprioceptive function (Hillier, Immink, & Thewlis, 2015). In clinical practice many clinicians prefer to test proprioceptive acuity by detecting a patient's capability to discriminate the upwards or downwards position of a finger or toe. However, assessing proprioception accurately in the laboratory is much more complex work. Many assessment techniques utilize custom-built devices or costly computerized equipment although the use of them is not feasible in the clinical settings. Clinicians have tried to develop new evaluation methods for the spine and extremities, but a further advancement of clinical tests are needed (Gandevia, 2014).

Recently, researchers use various instruments such as goniometers, inclinometers or pressure sensors to develop an accurate and easy-to-use method to assess proprioception in a clinical context (Hillier et al., 2015).

### *2.1.Specific tests*

There are several means by which physiotherapists can assess proprioception, depending on the body part being evaluated.

### *2.2. Thumb Finding Test*

It is also called dynamic position sense test. The tester places one upper limb of the subject. Positioning might be in an active or passive manner. Then the subject is asked to touch the placed thumb with their contralateral thumb and forefinger while eyes are shut. A successful test requires specific cognitive abilities such as intact inter-hemispheric communication. It is an essential and easy-to-perform test, as no equipment is needed(Smith, Akhtar, & Garraway, 1983).

### *2.3. Finger–Nose Test*

It is a basic test similar to thumb finding test. One or both limbs are actively or passively placed by the tester, and the subject asked to touch their nose with their forefinger while eyes are shut. It is a basic, bedside assessment test as it does not require any equipment. Both Thumb Finding Test and the Finger-Nose Test requires the proprioceptive sense and localization of the body segments in space (Taylor & McCloskey, 1988).

### *2.4. Distal Proprioception Test*

It is one of the basic tests to assess proprioception of the distal joints. The examiner grasps the sides of the great toe and performs up/down movements while eyes of the subject are open. Then the subject repeats the same movement while the eyes are closed. The examiner scores for correct perception of movement and direction. Although it is a simple bedside test, inter-examiner variability in the magnitude of moving digits and low sensitivity in detecting proprioceptive deficit is a problematic area (Richardson, 2002).

### *2.5. Dual Joint Position Test*

It is a closely related version of distal proprioception test, which requires simultaneous movement of two fingers with combinations of both up, both down, or one up/one down. The test requires the touch of the examiner to the subject's digit, which is a confounder for proprioception (Beckmann, Çiftçi, & Ertekin, 2013).

### *2.6. Field Sobriety Test*

It is mostly used by police officers to check for alcohol intoxication (Burns, 2003). In this test, the subject is asked to touch his or her nose with eyes closed. Error up to 2 cm is accepted as normal proprioceptive function.

### *2.7. Lumbar Proprioception Equipment*

This technique is described by Taimela et al (Taimela, Kankaanpää, & Luoto, 1999). It assesses the proprioception of trunk. A motor-driven machine fixes the thorax of the subject and rotates lower body throughout lumbar spines of L4 and L5. The subject asked to indicate regaining of original neutral position either actively or when passive motion reaches neutral position. Although the test is acceptable for research population, the use in the clinical population may not be feasible as it utilizes the sophisticated equipment

### *2.8. Spinal Motion Apparatus*

This procedure developed by Pankhurst and Burnett (Parkhurst & Burnett, 1994), for assessing the proprioception of lower back. It is composed of a motor-operated device that produces passive motion of lumber spine in 3 planes while the trunk stayed fixed. The subject detects motion and identifies the neutral position or the direction of movement. It assesses movement in three planes as an advantage; however the use in a clinical population may not be feasible as it utilizes the complex equipment.

### *2.9. Active Movement Extent Discrimination Device*

Developed by Hobbs to assess lumbar proprioception (Hobbs, Adams, Shirley, & Hillier, 2010). It depends on discriminating the position differences in 11-19° of lumbar flexion. It consists of free standing with stopper at five preset distances. In the test the subject had to discriminate preset trained flexion positions while standing. The test's disadvantage is that the subject's head is also moving through the test so the vestibular system might be adding to the proprioceptive sense.

### *2.10. Neck Proprioception Testing Device*

It is a technique developed by Lee et al. for assessing cervical proprioception (Lee, Nicholson, Adams, & Bae, 2005). It depends on discriminating positional differences in cervical rotation of 25-41 degrees and cervical retraction of 1 to 1.8 cm. It is a cervical version of Active Movement Extent Apparatus. The subject asked to identify the preset active rotation and retraction positions while sitting. The test's disadvantage is that the subject's head is also moving through the test so the vestibular system might be adding to the proprioceptive sense.

### *2.11. Manipulandum*

This device is developed by Bevan et al. [18], and Cordo et al.[19](Bevan, Cordo, Carlton, & Carlton, 1994; Cordo, Carlton, Bevan, Carlton, & Kerr, 1994). It assesses the proprioception of elbow by passive recognition of joint angle or estimation of distance. The test requires the forearm and upper arm of the subject banded to a motorized mechanism that generates a passive change in the joint angle. The subject asked to indicate the time their elbow reaches one of the pre-trained joint angles or distance. Manipandulum can also be used in the upper arm by discriminating 2 tilting pathways and two bowed pathways.

### *2.12. Kinarm*

Developed by Bhanpuri et al. to assess proprioception of elbow (Bhanpuri, Okamura, & Bastian, 2012). It depends on subject's apprehension of movement and then the perception of the magnitude of motion of the elbow. It uses a robot system on which the forearm and upper arm of the subject strapped. Subjects state if they sense a shift or not and indicate the magnitude of the second movement is greater or less than first.

### *2.13. Shuttle Miniclinic Constant Resistance Device*

It is developed by Lin et al. to assess the proprioception of hip and knee (Lin, Lien, Wang, & Tsauo, 2006). A continuous resistance mechanism affixed to sole to yield increase or decrease in hip and knee joint angles. The subject asked to push on a device to extend limb from beginning position of 60° hip flex and 90° knee flex to a pre trained position while being in prone position.

### *2.14. Movement Detection Apparatus*

It is described by Matre et al.(Matre & Knardahl, 2003). It depends on detecting the threshold for movement and direction precision of the joint. The test uses a motor-operated rotating platform with an axle arranged with the ankle of the subject. Subject asked to state the-the detection and direction of the motion while his or her foot pivoted in dorsi- or plantar flexion direction.

### *2.14. Cervicocephalic Kinesthesia*

Kristjansson et al. described the test. It has fast track sensors. In different studies, various uses of the test described such as relocation of the head to the natural position after active turn to left and right or active relocation to 30° turn from the natural head position. Passive trunk rotation of 30° or figure of eight motion can also be used before subjects repositioning head to a natural position (Kristjansson, Dall'Alba, & Jull, 2001).

### *2.15.. Thoracolumbar Proprioception Test*

It is described by Gill and Callaghan (Gill & Callaghan, 1998). It depends on the active reproduction of thoracolumbar movement. A lumbar motion monitor measures the error between pelvis and trunk harness. The subject reproduces the position in flexion, rotation, lateral flexion planes after the baseline active test position.

### *2.16. Arm Position Matching Task*

Described by (Dukelow et al., 2010). It requires active reproduction of spatial coordinates by the contralateral arm after passive positioning of an arm.

### *2.17. Joint Position Sense*

Joint position sense is commonly tested using either active or passive copy of joint positioning. It can be used in cervical or lumbar spine, knee, upper limb, lower limb joints. While assessing the proprioception in the cervical spine, examiners generally use a laser pointer attached to a headband. In the test subject is asked to relocate to the neutral starting position with the eyes closed after performing an active head movement. The discrepancy between the initial active and relocation positions measured in millimeters, and the error in joint position computed in degrees (Chen & Treleaven, 2013). Active joint position sense testing is possible to be restrained by pain. The test also demands sufficient motor control of the subject. Passive joint control tests do not require motor control of the subject. However, both active and passive joint position sense tests need the kinesthetic memory of pre-established position.

### *2.18. Limb Position Copying and Reproducing Tests*

Described by Kaplan (Kaplan, Nixon, Reitz, Rindfleish, & Tucker, 1985). This test can be used for assessing the proprioception of various joints such as knee or elbow. The test requires active reproduction of ipsi- and contralateral positions of the limb. Goniometer measures the error between reproduction and the target.

### *2.19. Cumulative Somatosensory Impairment Index*

Described by Deshpande et al (Deshpande, Metter, & Ferrucci, 2010), the test was used in diabetic peripheral arterial disease or stroke patients to assess the proprioception of lower extremity. In the test procedure, reference ankle is positioned by the examiner as neutral or with a degree of 10-20 and subject matches position.

## 3. Conclusion

Proprioception is a sense that is essential for healthy interaction with the environment. Loss of proprioception leads to a significant functional impairment. Although proprioception is an important clinical entity, the technique for accurate clinical assessment of proprioception is a debate. Many of the clinical tests require an intact working memory and interhemispheric connection. Various techniques utilize complex technical equipment, so the use in a clinical population may not be feasible as it. Further research is required to develop more objective, accurate, and reliable methods to assess proprioception in clinical settings.

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