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Various methods to assess Knee proprioception: A review

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***Abstract*---**Introduction: Proprioception is a vital aspect of motor control and when degraded or lost can have a profound impact on function in diverse clinical populations. This systematic review aimed to identify clinically related tools to measure proprioceptive acuity. The major purpose of this systematic review was to identify and categorise the methods that have been developed and utilised to test proprioceptive accuracy in a comprehensive manner. Methods: The pub med, Scopus, Web of Science and the other search engine/databases used: Cochrane database / SCIRE / PEDro / CINAHL/ EMBASE, ERIC were systematically searched. Conclusions: The TTDPM method has less relative ecological validity, but has high conceptual purity, Although JPR tests may have less relative test validity, but more clinically feasible, The AMEDA method appears to have better ecological validity and relatively better test validity and data validity.

***Keywords*---**various methods, Knee, proprioception.

Introduction

Proprioception means perception of our-selves, or in other words it means, perception of the relative positions of the parts of our body. Therefor perception is defined as “The ability of an individuals to determine body segment positions and movements in space, and is based on sensory signals provided to the brain from muscles, joint and skin receptors”.[1] Proprioception can be elaborated as the sensory feedback contributing to muscle sense, postural equilibrium, and joint stability. Proprioceptors are mechanoreceptors that are located in the skin, muscles, tendons, ligaments, and joint capsules.[2]

Most studies have tested knee proprioception in the sagittal plane and non-weight-bearing (NWB) position. To examine proprioceptive mechanisms, different techniques have been reported in the literature. There are three main testing techniques for assessing proprioception – threshold to detection of passive motion (TTDPM), joint position reproduction (JPR), also known as joint position matching, and active movement extent discrimination assessment (AMEDA). These tests have been developed from different concepts, are conducted under different testing conditions, and arguably assess different aspects of proprioceptive modalities.[3] The major purpose of this systematic review was to identify and categorise the methods that have been developed and utilised to test proprioceptive accuracy in a comprehensive manner, that is, taking into account all key components of proprioception (i.e. sense of joint position and movement, force and heaviness). As a result, the publication may be able to assist practitioners and researchers in determining the method that best meets their goals for assessing proprioceptive accuracy.

Method

Provide sufficient details to allow the work to be reproduced by an independent The Database used were- pub med, Scopus, Web of Science and the other search engine/databases used: Cochrane database / SCIRE / PEDro / CINAHL/ EMBASE, ERIC. The University library and research centre were also approached for e-copy and possible hand search of articles. The criteria for inclusion of articles were all research designs like Systematic review, Meta-analysis, Randomized Control trials, Cohort studies, Case Report, Case Series, Narrative Reviews and editor's notes published in English language and full articles providing data on proprioception, various methods to assess knee proprioception. The key words used were – joint position sense, knee proprioception, methods of assess knee proprioception

Inclusion criteria

- Studies with lower limb proprioception, knee proprioception and emphasizing on knee proprioception measurement.
- Clinical Trials
- Case Control Studies
- Full text articles available
- The criteria for inclusion of articles were all research designs like Systematic review, Meta-analysis, Randomized Control trials, Cohort studies, Case Report, Case Series, Narrative Reviews and editor's notes published in English language and full articles providing data on sports related overuse injuries and physiotherapy and/or physical rehabilitation as the primary management.
- The articles included in the study were then appraised and reviewed

Exclusion criteria

- Studies not specifying the methodology for measuring knee proprioception
- Only abstract

Result

SR. NO.	YEAR & AUTHOUR	STUDY TITLE	METHOD USED	CONCLUSION
1.	Partha Ranjan Das, Sunita Yadav, Ankita, Mottar Raja Rijwi, Preeti Saini, Deepti Sharma. January-December 2020.[4]	"Gender specific effect of obesity on knee proprioception in weight bearing and non-weight bearing position."	Variable such as age, gender, height, body weight and BMI were evaluated. Subjects with BMI 30 or more were taken for further joint position test of knee joint. Subjects were positioned in single limb standing and high sitting position and asked to replicate the target angle. Performed angle was recorded and compared with actual angle.	Obese females subject has reduced proprioception than obese male subjects in which responsible factor are additive effect of both ligament laxity and excessive weight in female lead us to such a result. Irrespective of the gender specific result it is well recommended for undergoing close chain kinematics protocol exercises which can help in developing lower limb joint proprioception.
2.	Nihat Sarıalioğlu. August 2019.[5]	"Analysis Of The Relationship Between Proprioceptive Sensory Functions And Body Mass Index Parameters Of Football And Volleyball Players."	16 male football players and 16 male volleyball players, whose average age was 21,40 years, voluntarily participated in this research. CSMI TecnoBody PK-252 isokinetic balance system measuring instrument was used to determine proprioceptive	It could be said that there was a correlation between some anthropometric data (BW, BMI) and proprioceptive sense functions. However, it is considered that the number of similar studies should be increased in order to reach a final judgement.

			sensory values. Measurements were performed in 30 seconds with difficulty level 10 by multiaxial proprioceptive assessment module as both feet. Balance parameters were recorded as stability indicator (SI), average force variance (AFV) and average tracking error (ATE).	
3.	Hajar Moravveji, Ali Ghanbari & Fahimeh Kamali. 2017.[2]	"Proprioception of Knee Joint in Athletes and Non-Athletes Obese."	In this case control study, we had 60 participants, aged 18 to 35 in four groups (15 athletes obese; 15 athletes with normal weight; 15 non-athletes obese; 15 non-athletes with normal weight). The average Body Mass Index for the obese groups was 33.50± (3.10) kg/m^2 and for the normal weight groups was 23.77± (2.94) kg/m^2. We used a Biodex Multi-Joint System 4 Isokinetic Dynamometer to examine proprioception acuity as the	The obese groups showed a deficit in the proprioception function in knee extension movement. Furthermore, the findings suggest that doing regular weight bearing training is associated with better proprioceptive function, even in obese groups. It could manifest that the deleterious effect of obesity on the knee joint proprioception might be stronger than the beneficial influence of exercise training.

			amount of a subject's error when trying to reproduce a test knee extension angle (a measure of the joint position sense). We tested proprioception actively (active reproduction test; AAR) and passively (passive reproduction test; PAR) in the right leg.	
4.	Rania N. Karkousha. March 2016.[6]	"Sex differences of knee joint repositioning accuracy in healthy adolescents."	A total of 64 healthy adolescents (32 males, 32 females) aging from 15 to 18 years participated in this study. Active angle repositioning test was used to assess the proprioceptive accuracy of the right knee joint at 45° knee flexion by using a Biodex system 3 pro-isokinetic dynamometer.	Sex-based difference in the accuracy of knee joint proprioception may imply that knee proprioceptive sensitivity might potentially contribute to the high incidence of knee injury in females compared with males, particularly during adolescence.
5.	Peeyoosha Nitsure, Shruti Prabhu. January 2015.[7]	"Study of Differences in Proprioception of Knee Joint with Age, Gender and Lower Limb Dominance in Healthy Asymptomatic Individuals: An Observational	90 healthy asymptomatic individuals were allocated to 3 groups by age as 21-40 yrs, 41-60 yrs and 61-80 years. Proprioception was assessed for bilateral knee joint using digital	There was steady decline observed in proprioception with increasing age. There was no significant difference in gender at younger age but proprioception declined in females more

		Study."	goniometer. The individuals were also assessed for lower limb dominance. Average of 3 readings was considered for analysis.	than their male counterparts at older age group and there was no difference observed with dominance of lower limbs.
6.	Noel Macwan, Lata D Parmar. May 2015.[8]	"Proprioceptive Impairments in OA Knee Patients."	94 Normal and 54 OA Knee patients were assessed to test Joint Position sense using Universal Goniometer. JPS was measured for Test angles 30^{o}, 45^{o} and 60^{o} toward extension. At all angles test was performed three times in sequence. Radiologist gave K L scores.	Caution need to be exercised before concluding on proprioception impairment in OA knee patients.
7.	Lin Li, Zhong-Qiu Ji, Yan-Xia Li, Wei-Tong Liu. Oct. 2015.[9]	"Correlation study of knee joint proprioception test results using common test methods."	Different proprioception test methods, the joint angle reset method, the motion minimum threshold measurement method and the force sense reproduction method were used to test the knees of 30 healthy young men.	No correlation was found among the results obtained using the joint angle reset method, the motion minimum threshold measurement method and the force sense reproduction method. Therefore, no correlation was found among the position sense, the motion sense and the force sense represented by

				these methods. Using the results of only one of the test methods to represent proprioception is one-sided. Force sensation depends more on the sensory input of information from the Golgi tendon organs, motion sense depends more on the input information of the muscle spindles, and position sense relies on the double input information of the muscle spindles and the Golgi tendon organs.
8.	Seyed Mohsen Mir, Saeed Talebian, Nasrin Naseri, Mohammad-Reza Hadian. Jan. 2014.[10]	"Assessment of Knee Proprioception in the Anterior Cruciate Ligament Injury Risk Position in Healthy Subjects: A Cross-sectional Study."	Thirty healthy male athletes participated in the study. Joint position sense was evaluated by active reproduction of the anterior cruciate ligament injury risk position and normal condition. The dominant knees of subjects were tested. Biometrics' "SG" series twin axis electrogoniometer (Biometrics Ltd, UK) was used to measure JPS.	The poorer joint position sense in non-contact anterior cruciate ligament injury risk position compared with the normal condition may contribute to the increased incidence of anterior cruciate ligament injury.

9.	Ashish Kumar. July 2012.[11]	"Joint Proprioception in Normal and Osteoarthritic Knees."	Fifty-six patients were approached with the proposal of the study. Out of which forty-four were included. The ability to replicate target knee-joint angles was assessed using an electronic goniometer (Tracker Freedom Wireless Goniometer). A trial was allowed at each angle before testing. The knee was positioned in full extension. The subject was then asked to flex the knee joint to a pre-determined target angle of 30°, 45° and 60°. Auditory feedback was constantly provided by the therapist during trial. Hold time was 5 seconds at each targeted angle. After returning to the starting position and having remained there for 10 seconds, the subject was asked to flex the knee again to reach the target angle. At every angle (30°, 45° and 60°) three	Our method of measuring proprioception is easily reproducible. Proprioception deteriorates with aging and more deterioration with degenerative disease in elder.

			readings were taken, mean was calculated and recorded as the patient's joint position sense.	
10.	Dayanand Kiran, Mary Carlson, Daniel Medrano, Darla R. Smith. June 2010.[12]	"Correlation of three different knee joint position sense measures."	Isokinetic dynamometer, electrogoniometer, and two dimensional (2D) video analysis were used for measuring knee JPS. The JPS was measured both in sitting and standing positions. All three measures were employed concurrently to measure knee JPS in sitting position; however, only the electrogoniometer and 2D video analysis were concurrently used in the standing position. The knee JPS was recorded in sitting position at 15^0, 30^0, and 45^0 and in standing at high, mid and low knee flexion positions.	Either 2D video or an electrogoniometer may be used to measure JPS in standing position; however, in sitting position 2D video should not be used if the camera is required to be placed at 10 from the plane of motion.
11.	A.L. Boerboom, M.R. Huizinga, W.A. Kaan b, R.E. Stewart, A.L. Hof, S.K. Bulstra, R.L. Diercks. April 2008.[13]	"Validation of a method to measure the proprioception of the knee."	Sixteen healthy persons from the Orthopaedic department of the UMCG were recruited as volunteers. To compare our data	he method used is an accurate and valid way to measure the TTDPM and thereby to indicate proprioception in

			with the data from Roberts and Fride´n, the standard testing protocol of Lund was followed (validation). First the right leg was tested in the starting position of 20^0 flexion, secondly at 40^0. Thirdly the left leg was tested at 20^0 and finally at 40^0. In each test 10 measurements towards flexion (TF) and 10 towards extension (TE) were done at random. The leg was moved with an angular velocity of 0.58/s. After each measurement the leg was repositioned and the starting position was automatically checked or corrected.	healthy persons. As most research in clinical settings is done in ACL deficient subjects, the following step will be to assess if patients with an ACLrupture have a different TTDPM compared to healthy persons.
12.	L. OLSSON, PT MSc-student1, H. LUND, PT, PhD1, M. HENRIKSEN, PT, MSc-student1, H. ROGIND, MD, PhD-student2, H. BLIDDAL, MD, DMSc, and B. DANNESKIOLD	"Test-retest Reliability of a Knee Joint Position Sense Measurement Method in Sitting and Prone Position."	Thirty-nine healthy volunteers (17 women, 18-50 years old) participated. The JPS was measured as the participant's ability to reproduce the same position in the right knee	Based upon the fair to good reliability of the applied method for measuring JPS over the knee, we suggest the following procedures for determination of JPS over the knee: (i) the JPS should be

	-SAMSØE, MD, DMSc. 2004.[14]		(target vs. estimated angle). The result was expressed as the difference between target and estimated angle. Measurements were repeated three times with three different target angles (prone position: 408, 708, 1008 flexion; sitting position: 308, 508, 708 flexion), and for single leg and both legs. Three test sessions were performed with 1-h and 1-week interval.	calculated as the AE between target and estimate position; (ii) sitting should be preferred to prone; (iii) ipsilateral should be preferred to counter-lateral; (iv) test angle should be in the middle (suggested from 408 to 808 flexion) of the knee joint's range of motion. With these precautions, the test seems to be a reliable measure of JPS in healthy controls.
13.	Danny M. Pincivero, Brad Bachmeier, And Alan J. Coelho. October 2000.[15]	"The effects of joint angle and reliability on knee proprioception. "	Twenty college-aged male and 20 female volunteers were evaluated for proprioception by a newly developed perturbation test. Subjects were in a prone position on an isokinetic chair with their right lower leg attached to a freely moving resistance adapter. The knee was placed in a starting position of 15, 30, or 60 degrees of flexion. While relaxed, the knee	The major findings of this study suggest that the detection of passive knee movement, and the subsequent voluntary response, may be dependent on joint angle. Considerations of the present method for proprioception assessment are warranted to enhance test-retest reliability.

			was dropped into extension, and the subjects were instructed to "catch their leg" when movement was perceived. Five trials were completed at each angle, in a random order. An electrogoniometer was secured to the lateral portion of the knee in order to measure angular displacement after perturbation in two specific phases: detection (displacement from leg release to movement cessation) and response (displacement from movement cessation to peak knee flexion). A three-factor ANOVA (two repeated factors (knee angle and proprioception phase) and one between factor (gender)) was performed on the average and standard deviation of the five trials for significant main effects and interactions.	

Discussion

Proprioception plays a crucial role in human movement control, which is fundamental for daily activities, exercise, and sports. To explore proprioceptive mechanisms, many techniques have been widely used in the literature, such as single limb standing or high sitting position, CSMI technobody PK-252 isokinetic balance system, isokinetic dynamometer, active angle repositioning test, digital goniometer, universal goniometer, electrogoniometer, 2D video analysis, threshold to detection of passive motion (TTDPM), joint position reproduction (JPR), active movement extent discrimination apparatus (AMEDA), but their applicability, ecological validity, test validity, and data validity differ. The TTDPM method has less relative ecological validity, but has high conceptual purity, given the prior relaxation of the stimulated musculature, and the control of other information sources. This method has been widely used in neurophysiology studies, when differentiating between the contribution of different mechanoreceptors to proprioception. Although JPR tests may have less relative test validity, the method is efficient and enables exploration of hemispheric asymmetries in sensorimotor abilities. The AMEDA method appears to have better ecological validity and relatively better test validity and data validity.

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