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Proprioceptive Impairments in OA Knee Patients

Noel Macwan, Lata D Parmar

Abstract
Context: Error in estimating Joint position sense reflects the proprioceptive inaccuracy of the concerned joint. Such an error is threat to the joint integrity.
Aim: determine extent of joint position deficit in patients with OA knees.
Design: Hospital based, observational study
Methods and Material: 94 Normal and 54 OA Knee patients were assessed to test Joint Position sense using Universal Goniometer. JPS was measured for Test angles 30°, 45° and 60° toward extension. At all angles test was performed three times in sequence. Radiologist gave K L scores.
Statistics: STATA/IC-13 and SPSS Version 16.
Results: All test angles on comparison with reproducible angles were significantly different (P-value <0.001) between right and left knees of both normals and OA patients. The Mean Range of Error in Reproducible Angles was 0.97 -5.48 on Right and 0.63-5.92 on Left in Normals, and 1.61 -8.52 on Right and 0.54 -6.59 on Left in OA patients. Inter Group comparison of various reproduced angles of Right & left normal knee to those with all KL Grades were insignificant (p>.05). Percentiles values of normal population for right and Left Knee for all reproducible angles of all test angles showed normal 'S' curve and ROC showed 50% area under the curve.
Conclusions: Caution need to be exercised before concluding on proprioception impairment in OA knee patients.

Keywords: proprioception, joint position sense, joint movement, OA knee, goniometer

Introduction

Osteoarthritis (OA) of Knee, a chronic Musculo skeletal degenerative disease, is one of the most common causes of disability in the world. [1-26] Almost 10 to 40% of the world population is affected with Osteoarthritis. [1,4,16,18,26,27] The knee is the weight-bearing joint most commonly affected by OA and is second in overall incidence. [1,7,8,15,19,24,28] The Prevalence of OA is very high in India being 32.6% in rural and 60.3% in urban population. [27,29] Due to demographic changes, the incidence of OA is rapidly increasing. It also leads to social, psychological, and economical burden on the affected population throughout the world. [1,6,9,29,30] OA is also more common in women than in men. [3,12,15,16,27,31]

For weight-bearing joints, altered loading mechanisms, increased mechanical forces and changed biomechanics are significant contributing factors for initiation and progression of OA. [1,9,11,32,33] The disease processes not only affect the articular cartilage, but involve the entire joint, ultimately, the articular cartilage degenerates with fibrillation, fissures, ulceration, and full thickness loss of the joint surface. [8,10,21,32] This leads to clinical symptoms like stiffness, decreased range of motion and pain [4,8,9,19,32,34,35] and further leads to impaired proprioception [36,37,38] and inhibits muscle activation leading to decrease in activity. This disuse results in a lowering of aerobic capacity, muscle strength and muscle mass and ultimately a decrease in functional capacity and increased dependence. [4,10,25] Reduced functional ability is already present even in the early phase of the disease. [3,10,11,15,24,33,35]

Proprioception encompasses the senses of joint position and joint motion. Proprioception involves different sensory systems of muscles, ligaments, tendons, joints, skin, and organs, muscle spindle being important of all. [3,4,10,18,19,21-23,25,28,29,37,39,40] Lenssen AF et al studied the Proprioceptive impairments in OA Knee patients using Universal Goniometer for measuring the Knee ROM. According to the author, reproducibility is better for knee flexion than knee extension. [41] Other author suggested that for knee extension measurements, the same therapist should take all the measurements for the same patient's joint. [42]

Segal NA et al stated that impaired proprioception has not been associated with structural damage at the knee longitudinally. [28] Whether proprioceptive deficits initiate joint degeneration from abnormal neuromuscular control and harmful dissipation of knee loads or whether proprioceptive deficits in patients could be a result of damage to joint receptors from OA-associated degeneration is an unresolved issue. [3,18,34] Knoop J et al. concluded that recent

literature showed that proprioceptive accuracy may play an important role in progression of OA Knee. However the role needs to be further clarified. [7]

The present study was carried out to identify and understand the proprioceptive impairments in OA Knee patients by studying joint position sense in normal and then in OA knee patients.

Subjects and Methods

The study proposed was approved by SVIEC (Institute Ethical Committee)

The study was observational, analytical study, hospital Based Study

Every Consecutive OA Knee patient diagnosed by competent authority that was referred to Physiotherapy Dept was considered.

Inclusion Criteria

- Primary OA knee patients
- Age 40 to 65yrs

Exclusion Criteria

- Secondary OA knee patients
- Any Ligament injury
- RA
- Surgeries around knee joint
- Ankle Injury

Methodology

After the approval by SVIEC, 94 normal subjects in the age range 20-30, 31-40 & 41-65 were recruited.

In a quiet environment, the participants were blindfolded and seated on a high chair with their lower legs relaxed over the edge of the seat. A Universal Goniometer (360 degrees) was attached to lateral aspect of the participant's knee using double sided sticky tape. The fulcrum, the fixed arm of the goniometer and the movable arm were aligned as per standard textbook (picture 1&2).

90 degree of knee flexion considered as 0˚ (starting position). The participants were instructed to slowly straighten their knee and told to stop when 30 degree knee extension angle was reached. At this 'test angle' for approximately five seconds the participants were asked to maintain and mentally visualize the position of their knee. They were then told to relax, and after three seconds the patients were asked to reproduce the test angle. The 'reproduced angle' was recorded. [15] The procedure was performed for 45˚ and 60˚ degrees. All the three angles were performed three times in sequence. [7]

Next all the OA knee patients referred to Physiotherapy were screened; those who satisfied the inclusion criteria and were willing to participate were included after a written consent. The same procedure as above was undertaken to study the reproducibility.

Every participant thus assessed was then referred for X- ray of knee. The radiologist was requested to give Kellgren and Lawrence (KL) score.

Pic (1)

Pic (2)

Results

Total No. of normal's: 94

Total no. of OA knee patients

B/L OA Knee: 39, RT. OA Knee: 7, LT. OA Knee: 8

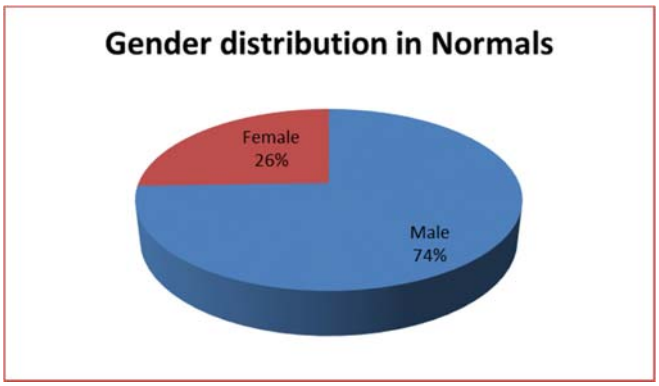


Fig: 1

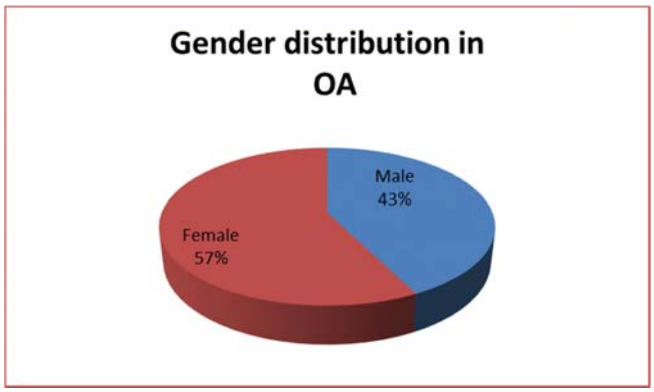


Fig: 2

Comparison of all test angles (30, 45 & 60 degrees) to reproduced angle of right and left (for Normal group age wise and for OA knee patients age 41-65years) by one sample T-Test was found to be highly significant p-value < 0.001

Table: 1 Test Angle R = 30, Age group = 41-65 right & left comparison

Normal subjects	N	Mean (Std. Deviation)	Std. Error Mean	t	df	P-value
Reported Angle R	31	3.530108E1 (4.7937883)	.8609898	6.157	30	.000
Reported Angle L	31	3.592473E1 (5.9240312)	1.0639874	5.568	30	.000

OA subjects	N	Mean Std. Deviation	Std. Error Mean	t	df	P-value
Reported Angle R	46	3.852174E1 7.3745147	1.0873129	7.837	45	.000
Reported Angle L	47	3.658865E1 6.6747099	.9736065	6.767	46	.000

Table: 2 The comparison of reproduced angles between and within the normal groups of different ages using one way ANOVA

Test Angle R = 30 (Right Knee)		N	Mean	Std. Deviation	Std. Error
Reported Angle R	20-30	31	33.193548	2.7022271	.4853343
	31-40	30	35.477778	5.6383222	1.0294121E0
	41-65	31	35.301075	4.7937883	.8609898
	Total	92	34.648551	4.6051317	.4801182

ANOVA

		Sum of Squares	df	Mean Square	F	P-value
Reported Angle R	Between Groups	99.456	2	49.728	2.418	.095
	Within Groups	1830.403	89	20.566		
	Total	1929.859	91			

Test Angle R = 30 (Left Knee)		N	Mean	Std. Deviation	Std. Error
Reported Angle L	20-30	31	34.129032	3.6144539	.6491751
	31-40	30	34.755556	4.4143039	.8059379
	41-65	31	35.924731	5.9240312	1.0639874E0
	Total	92	34.938406	4.7593951	.4962012

ANOVA

		Sum of Squares	df	Mean Square	F	P-value
Reported Angle L	Between Groups	51.469	2	25.734	1.140	.325
	Within Groups	2009.849	89	22.583		
	Total	2061.318	91			

The same was true for right & left of normal for all test angles p-value > 0.05

Table 3: shows Inter Group comparison of test angle to reproduced angle of right and left (Normal age matched and OA Knee)

Test Angle R = 30

	Group	N	Mean	Std. Deviation	Std. Error Mean	t	df	P-value
Reported Angle R	Normal	31	3.530108E1	4.7937883	.8609898	-2.143	75	.035
	OA Knee	46	3.852174E1	7.3745147	1.0873129			
Reported Angle L	Normal	31	3.592473E1	5.9240312	1.0639874	-.449	76	.655
	OA Knee	47	3.658865E1	6.6747099	.9736065			

Test Angle R = 45

	Group	N	Mean	Std. Deviation	Std. Error Mean	t	df	P-value
Reported Angle R	Normal	31	4.817204E1	2.1376189	.3839277	-.560	75	.577
	OA Knee	46	4.860870E1	3.9617332	.5841257			
Reported Angle L	Normal	31	4.873118E1	2.9469625	.5292901	1.613	76	.111
	OA Knee	47	4.748227E1	3.5818979	.5224735			

Test Angle R = 60

	Group	N	Mean	Std. Deviation	Std. Error Mean	t	df	P-value
Reported Angle R	Normal	31	6.150538E1	2.0707325	.3719145	-.177	74	.860
	OA Knee	45	6.160741E1	2.7185194	.4052530			
Reported Angle L	Normal	31	6.255914E1	2.1246126	.3815917	3.510	75	.001
	OA Knee	46	6.054348E1	2.6780855	.3948622			

Inter Group comparison of various reproduced angles of Right & Left Knee to those of OA knee KL Grade 1-4 for all test angles no statistical difference was found

Table 4: Normal Limits

Test Angle R = 60	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean	
					Lower Bound	Upper Bound
Reported Angle R	91	61.2893	2.2874908	.2397942	60.812984	61.765770
Reported Angle L	91	61.4945	2.4105543	.2526948	60.992483	61.996528

Test Angle R = 45		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean	
						Lower Bound	Upper Bound
Reported Angle R	Normal	92	47.8623	2.8293560	.2949808	47.276376	48.448262
Reported Angle L	Normal	92	48.0652	3.2958475	.3436159	47.382667	48.747768

Test Angle R = 30		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean	
						Lower Bound	Upper Bound
Reported Angle R Normal		92	34.648	4.6051317	.4801182	33.694855	35.602246
Reported Angle L	Normal	92	34.938	4.7593951	.4962012	33.952763	35.924049

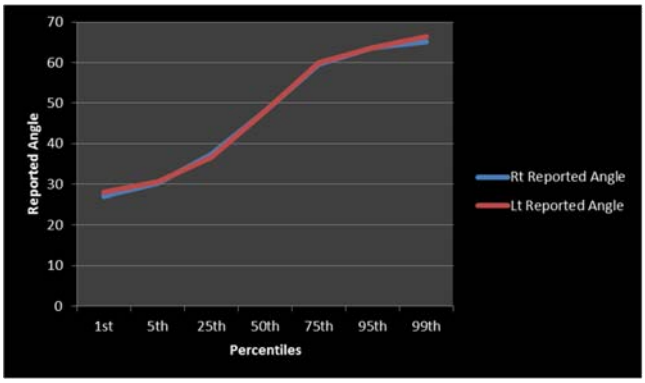
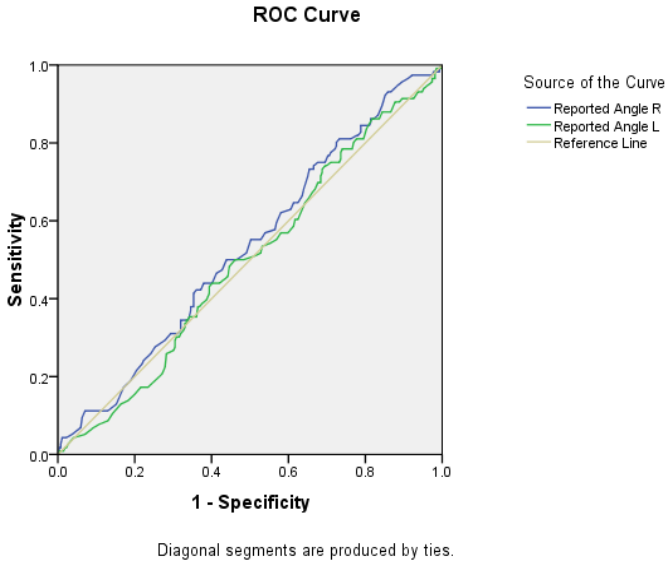


Fig: 3 Percentiles of normal population for right and left knee for all reproducible angles for all test angles.

Table: 5 Area under the Curve

Test Result Variable(s)	Area
Reported Angle R	.532
Reported Angle L	.497

ROC-



ROC- Fig: 4

Discussion

Several studies show that Knee OA is a major public health issue especially in elderly population with increased age worldwide. [12,13,14,16,17,27,30,31] Many studies have been done to study Joint Proprioception in Osteoarthritis using various methods. [3,8,10,18,19,21-25,28,34,35,36,39]

Universal goniometer was used in this study, of total 94 normals studied, 74% were males and 26% were females. Angles of 30, 45, 60 degrees were studied in various age groups of 20-30, 31-40, and 41-65.

All the test angles on comparison with reproducible angles were found to be significantly different (P-value < 0.001) between right and left knees. This finding was similar in the OA patients also (Table 1). However comparison of Reproducible angles by ANOVA within the groups and between the groups in normal was not statistically different for both right and left, except for left 60^0(Table 2).

According to the author of one study, the limits of agreement (LOA) ratios revealed that small changes in an individual's measurements cannot be detected, i.e., a relatively large difference in an individual's kinesthetic measurements would be required to confidently state that a real change had taken place. [37]

The different starting positions of 20-degrees & 40-degrees position have been used in one study and the threshold detection of passive movements (TDPM) variables from the 20-degree starting position were found to be more reliable than those from the 40-degree position, probably it being within the working range of the knee during ordinary weight-bearing activities/exercise. [37] In other study, subjects were measured from a starting position of 30° flexion, measurements were made while the knee moved toward extension, i.e., toward the end of the range of motion. [6]

Accordingly higher reliability and/or higher sensitivity in detecting movements, in proprioceptive variables close to the end range of motion has been reported compared with in the mid range of motion even in uninjured subjects, explained by an increased afferent impulse generation near the terminal joint position, which is required to protect the joint from injury. [37]

Kumar A (2012) [29], similar to the present study used three angles 30, 45, & 60 degrees to assess joint position sense (JPS) with electronic goniometer both in normals and OA knee patients. The results of normal subjects of the said study are comparable to the present study with regards to mean error of perception (the perceived errors of angles varied from 0.79 to 7.39 in the said study), the present study it was minimum 0.63 & 5.92 maximum, but the author of said study measured flexion angles. However the results with regards to OA knees the mean error quoted by the author varied from 6.63 to 12.55, which in the present study was found almost similar to normal (Minimum 0.54-8.52 max.).

T-test was done for comparison between the normal and OA knee subjects, found no significant difference between mean of reproducibility, both on right and left sides for all angles except one (Table 3). Kumar A (2012) found the JPS error to be significantly different between two groups (normal and OA) at all the preset angles ($p < 0.05$). This was strongly in contrast to the present study. [29]

Several studies [6,7,8,19,25,29,33,34] report that the patients with osteoarthritis show poorer joint position than those of similar age with no joint disease. [33] The various possible reasons hypothesized are that fatigue and painful muscles may give rise to poor proprioception. [38] Another possibility is that the generally increased pain sensory input via the Gate Control results in an overruling of the mechanoreceptor input and a general decrease in proprioception. [38] A study stated that laxity of the capsule and ligaments caused by loss of cartilage and bone height, lytic enzymes released around the joint may damage the receptors end organ within the capsule decreasing proprioception perception. [29]

Hurley et al reported that in patients with knee OA, articular damage may reduce quadriceps motoneurone excitability, which decreases voluntary quadriceps activation thus contributing to quadriceps weakness and diminishing of proprioceptive acuity. [10, 29] However, impaired position sense was not associated with muscle weakness in four (small) cross-sectional studies in a total of 146 knee OA patients. [7]

OA-related inflammation has been hypothesized as a potential cause of proprioceptive impairments but this causal relationship has not been studied yet. [7] Moreover it is said people may accommodate for (sub) conscious proprioceptive decline by adapting their behavior. [34] One study suggests that the presence of fluid in the joint may contribute to the proprioceptive deficits, also that proprioceptive acuity declines with age. [8]

The results from some studies indicate that in patients with knee OA poor proprioception is not limited to the affected osteoarthritic joint but is also found across the elbow joint, it is well established that patients with knee OA have decreased proprioception across both the affected knee and the contralateral knee. [7, 33]

In the present study reproducibility were statistically not significant between the Normal's and OA knee patient's, reason, the so-called central sensitization, and a similar picture observed in patients with OA. [19] Conversely, if a sensitization of pain input leads to a lower threshold for transmitting pain higher into the Central Nervous System (CNS) [19, 38], a lower threshold of the synapses transmitting mechanoreceptor inputs may also lead to a higher degree of accuracy in proprioception. More data are needed to clarify these issues of possible central mechanisms behind changes in proprioception. [38]

Moreover, according to a study in healthy subjects, inter- and intra rater agreement parameters were better than in subjects with OA, indicating a lower measurement error for the procedure in healthy subjects than in OA subjects. Measurement error for healthy subjects was 0.4°, whereas it was 2.2° in subjects with OA.[6] indicating considerable difference in result between 2 measurements is likely to be an expression of general proprioceptive inaccuracy.[6]

The present study also did not find any association between the mean difference of error and severity of OA as assessed by KL grades (p-value >.05). Subjective assessment of pain and physical function, as measured by the WOMAC, is influenced by many psychological factors, traits, and emotions. Therefore, a weak relationship between structural articular damage, pain, and impaired proprioception is not surprising. [34]

The modest association of JPS with function loss and pain worsening may not relate to OA progression at all, but rather to poor motor control and muscle function. [34]

Some studies as quoted by author Knoop et al. showed a significant difference in JPS between KL grade 1 and grade 3 and between grade 2 and grade 4. [7] However, radiographs are considered as insensitive measure of structural joint damage, also radiograph damage is weakly related to functional loss and pain in OA. In addition the author states that because OA is a slowly progressive condition, therefore despite a relatively long follow up it may still have been too short to see changes in structural damage and proprioception. [34]

In early stages of disease when overlapping protective strategies function well, proprioception deficits may not emerge as identifiable risk factors for disease. Perhaps it is only when disease is further advanced and all protective strategies are impaired that proprioception deficits play a critical role. [34] Proprioceptive acuity declines with age, and it declines more in arthritic knees of OA subjects than in those of age- and sex matched control subjects. Although it is

unclear whether proprioceptive deficits in knee OA may contribute to and/or result from knee. [8]

Many studies have measured proprioception in patients with knee OA; however, information on the reproducibility of the methods used to assess proprioception is rarely provided. The studies providing information on reproducibility all have used a different method for the measurement of knee joint proprioception: weight bearing or non–weight bearing, start position flexion or extension, and a velocity of angular displacement of 0.1°/second to 5°/second. All these factors could have influenced the reproducibility. [6]

There are several ways of measuring proprioceptive acuity. One often used is the threshold detection of passive movement, but passive movements do not reflect real life movement or function. The author of one study estimated people's ability to replicate limb position using active movement because this maximizes sensory input to the central processing systems and replicates normal movement. [34] This was similar to the present study where the participant replicated the desired test angle. The technique does require concentration and cognitive skills by the subjects and if these skills are compromised, this will interfere with the accurate estimation of proprioception. [34]

In the present study Percentiles of normal population for right and left knee for all reproducible angles for all test angles was computed, the result, 'S' shaped curve (fig 1) confirms that data is normal. After calculating the normal limits (Table 4) ROC was obtained which shows about 50% area under the curve (Table 5, fig.2). This mean that the prediction of abnormality lacks strength, there is 50 % chance on either side. The present study is therefore inconclusive on impairment of proprioception in OA knee patients.

Conclusion

Caution need to be exercised before concluding on proprioception impairment in OA knee patients.

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