

Effect of Proprioceptive Training Using Biofeedback (Equiboard) on Pain, Function and Proprioception in Osteoarthritic Knee - An Interventional Study

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ABSTRACT

Background: Knee osteoarthritis is a prevalent musculoskeletal condition affecting older people causing pain, physical disability and reduce quality of life. It commonly referred to as “wear and tear” of joint but it is the disease of entire joint involving cartilage, joint lining, ligament and bone. Community survey data in rural and urban areas of India in 2007 shows the prevalence of osteoarthritis to be range from 17% to 60.6%, prevalence rate is 32.6% in rural and 60.3% in urban population.

Common sign and symptoms of osteoarthritis of knee include knee pain, tenderness, joint stiffness and decrease muscle strength. In addition, individual with osteoarthritis knee often exhibit poor neuromuscular control, slower walking speed, decreased functional ability and increased susceptibility to fall.

The proprioception sense originates from the stimulation of mechanoreceptors in joint capsule and ligaments. Mechanoreceptor dysfunction could result from a combination of factors related to knee osteoarthritis such as articular mechanoreceptors compromised by osteoarthritis and degeneration of joint structure. A recent development in rehabilitation is exercising in gaming or virtual reality environment, thus providing a novel form of immersive biofeedback.

Methodology: This study was conducted on 22 patients with knee osteoarthritis, who fulfilled inclusion and exclusion criteria. They were divided into 2 groups. Both groups underwent conventional physiotherapy and interventional group underwent proprioceptive training using biofeedback in addition. Both groups were assessed before and after the treatment for pain,

proprioception and function by using NPRS, joint position sense error and WOMAC respectively.

Result: At the end of the 8 weeks, patient in both the groups showed reduction in pain and improvement in joint position sense error and function. Here interventional group showed statistically significant improvement than control group. ($p < 0.05$)

Conclusion: Proprioceptive training along with conventional physiotherapy helps in reducing pain and improving function and proprioception in patients with osteoarthritis of knee.

Key words: Osteoarthritis, knee joint, proprioceptive training

INTRODUCTION

Knee osteoarthritis is a prevalent musculoskeletal condition affecting older people causing pain, physical disability and reduce quality of life [1] Community survey data in rural and urban areas of India in 2007 shows the prevalence of osteoarthritis to be range from 17% to 60.6%, prevalence rate is 32.6% in rural and 60.3% in urban population. [2,3]

It is commonly referred to as “wear and tear” of joint but it is the disease of entire joint involving cartilage, joint lining, ligament and bone. [4] It has multifactorial origins and may be present in various joint where biomechanical, metabolic and morphologic changes take place. It is characterized by a loss of normal configuration, crackling during movement, bone deformities, formation of bone spurs,

the presence of inflammatory process, the accumulation of synovial fluid, weakness of quadriceps and sensorimotor loss.^[5]

Proprioception is defined as a conscious or unconscious perception of position and movement of an extremity or joint in space. Knee proprioception derives from the integration of afferent signals from the proprioceptive receptors in different structure of the knee like tendons, ligaments, meniscus, joint capsule and muscle.^[6]

Proprioception impairments might be mediated by disruption of the mechanoreceptors in the diseased joint structures or changes in muscle receptors secondary to muscle changes associated with osteoarthritis. So, proprioception deficits may result in poorly controlled excess loading to the knee during gait, initially or accelerating joint degeneration.^[7]

Biofeedback can be defined as the instrument to make convert physiological process more exert.^[8] Due to visual biofeedback, visual receptors were recruited to provide feedback and enhance sensorimotor mapping of movements of knee joint.^[9] One such device is Equiboard Sport by Techno Concept.^[10]

Concurrent feedback is given by the means of different games. All the games involve a task to complete by shifting weight in sagittal and coronal plane and in multiple direction, by combined movement in sagittal and coronal plane.^[11]

MATERIAL AND METHODS

Ethical clearance for this study was obtained by institution ethical committee prior to the study. 34 patients referred from the orthopedic OPD were screened for the eligibility. Patients having neurological and vestibular disorder, any previous knee surgery, Amputation, Diabetes, Systemic inflammatory arthropathy such as Rheumatoid arthritis, and gout, any musculoskeletal problem in hip and ankle joint were excluded from the study. From that 27 patients between the age 55 to 70 with bilateral grade II/III were included in

the study. The whole procedure and purpose of the study were explained to all patients. Written informed consent was taken from all the patients prior to the study. Total 22 patients were divided into 2 groups by convenience sequential sampling. **GROUP A: CONTROL GROUP** (n = 11) patients in the control group were given conventional treatment of knee osteoarthritis. **GROUP B: INTERVENTIONAL GROUP** (n=11) patients in the interventional group were given conventional treatment and proprioceptive training for knee osteoarthritis.

On first visit, a complete orthopedic assessment was done which include the descriptive data for age, sex, height, weight, duration of symptoms, chief complain, previous surgery, medications. Active and passive range of motion and manual muscle testing were documented. Pre intervention NPRS, joint position sense error and WOMAC score were taken at the first day. After completing eight weeks of treatment, post intervention NPRS, joint position sense error and WOMAC score were taken.

Various methods have been used in order to measure the conscious sub modalities of Proprioception like; JPS, kinesthesia. Joint position sense is generally defined as the ability to assess the limb position without the assistance of vision. A reliable method for the estimation of JPS is the measurement of the reproduction of a specific target position, the difference between target position and the estimate position being used. (Intra-rater and Interrater reliability are > 0.60)^[12]

The participants were blindfolded and seated on a high chair with their lower legs relaxed over the edge of the seat. A Universal Goniometer was attached to lateral aspect of the participant's knee using double sided sticky tape. 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 (photograph 1). 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. The procedure was performed for 45° and 60° degrees. All the three angles were performed three times in sequence (photograph 2-3). [13]

Each patient was treated once daily, 3 days a week and for 8 weeks. Both control and interventional group were given progressive muscular strengthening program. All exercises are performed thrice daily and 10 repetition of each exercise. Exercises are performed once in department and twice at home. Conventional treatment included quadriceps setting exercise, short arc terminal knee extension, straight leg raise, hip abductor strengthening in side lying, hamstring curls in prone lying,

quadriceps strengthening in high sitting, hamstring and gastrocnemius muscle stretching, close chain exercise- partial squats and short wave diathermy. Group B was given proprioceptive training using biofeedback along with the conventional treatment. Equiboard, biofeedback rehabilitation software was installed in the computer. Equiboard was charged beforehand and was connected to the computer software by a wireless Bluetooth device (photograph-4). Patients were made to stand on the Equiboard barefooted. A safety frame was placed around the board so that the patient can hold on it. Patients were made to play different types of games (photograph-5). The red dot (ball), in each game represent the angular position of the Equiboard and the patient has to maintain his balance with the feedback position of the ball (photograph-6).



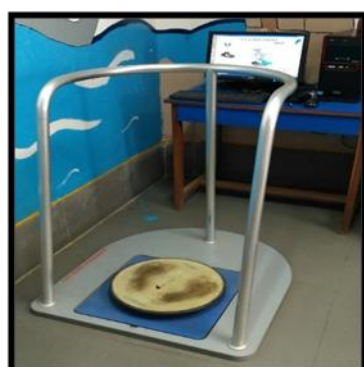
Photograph-1



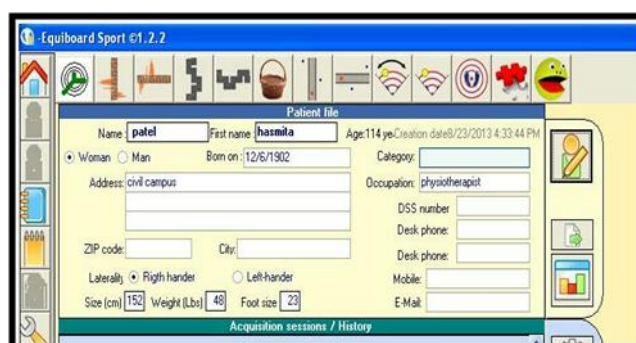
photograph- 2



photograph-3



Photograph- 4



photograph -5



Photograph – 6

RESULTS

Data of 22 patients were analyzed using statistical package for social science version 16 (SPSS v.16) and Microsoft Excel 2010. Total 27 patients were included in the study. 2 patients from group-A and 3 patients from group-B discontinued the treatment. So, total 22 patients, 11 patients in group-A and 11 patients in group- B completed the study and data analysis was

performed on the Numeric Pain Rating Scale(NPRS),WOMAC score and Joint Position Sense Error(JPSE).

Mann – Whitney U test was applied to compare the baseline characteristics of the patients in both groups. No statistically significant difference was found between both the groups. Wilcoxon Signed Ranked test was applied for the analysis of pre and post treatment outcome measures within the group. Within group analysis showed statistically significant difference ($p < 0.05$) in NPRS and WOMAC score for both the groups (table-1). Within group analysis showed statistically significant difference ($p < 0.05$) in JPSE on both the sides for both the groups (table-2).

Mann- Whitney U test was applied for between group analysis of all the outcome measures. Between group comparison showed statistically significant difference in all the outcome measures ($p < 0.05$).

Table-1: shows pre and post NPRS and WOMAC score of group –A and group- B

Outcome	NPRS				WOMAC			
	PRE	POST	Z-VALUE	p VALUE	PRE	POST	Z-VALUE	p VALUE
Group-A	6.27 ± 0.90	4.54 ± 1.29	-3.066	0.002	37.00 ± 9.16	28.00 ± 9.12	-2.96	0.003
Group- B	7.09 ± 0.94	3.81 ± 0.98	-3.071	0.002	44.81 ± 8.12	27.90 ± 6.31	-2.94	0.003

Table-2: shows pre and post JPSE of right and left side of group –A and group- B

Outcome	JPSE-LT				JPSE-RT			
	PRE	POST	Z-VALUE	p VALUE	PRE	POST	Z-VALUE	p VALUE
Group-A	13.69 ± 0.67	11.23 ± 0.88	-2.94	0.003	13.54 ± 0.72	11.05 ± 0.61	-2.95	0.003
Group- B	13.48 ± 0.92	9.60 ± 0.66	-2.94	0.003	12.89 ± 0.88	9.60 ± 0.72	-2.94	0.003

Table-3: shows difference of NPRS, WOMAC and JPSE of group-A and group-B.

OUTCOME MEASURE	GROUP - A (MEAN±SD)	GROUP - B (MEAN±SD)	U- VALUE	p VALUE
DIFFERENCE OF NPRS	2.09 ± 0.53	3.27 ± 0.46	8.00	0.001
DIFFERENCE OF WOMAC	9.00 ± 1.14	16.90 ± 2.62	0.00	0.001
DIFFERENCE OF JPSE (LT)	2.45 ± 0.63	3.78 ± 0.70	8.50	0.001
DIFFERENCE OF JPSE (RT)	2.48 ± 0.57	3.42 ± 0.77	20.00	0.007

DISCUSSION

At the end of 8 weeks, the patients in the both control group and experimental group showed reduction in pain and improvement in function and proprioception. But interventional group showed statistically significant improvement than control group ($p < 0.05$).

Thus, the study result shows that proprioceptive training along with conventional treatment is more effective than conventional treatment alone on outcome of pain, function (WOMAC) and proprioception (JPSE).

The findings of this study are similar to Da- Hon Lin et al, who did a study on Comparison of proprioceptive functions

between computerized proprioception facilitation exercise(CPFE) and closed kinetic chain exercise(CKCE) in patients with knee osteoarthritis on eighty one patients a randomized control trial. They compared one group who received CPFE along with the exercise and another group received CKCE. They concluded that both CPFE and CKCE were effective in improving joint position sense and functional score. Da- hon Lin et al state that, the CPFE facilitated the proprioceptive receptors in muscle spindles, tendons, and knee joints over the long term. Visual receptors were recruited to provide feedback and enhance sensorimotor mapping of the movements of the knee joint. Therefore, we can conclude that the CPFE emphasized sensory proprioceptor facilitation of the knee joint.^[9]

The reduction in pain and improvement in function in the control group can be attributed to the strengthening exercises which were performed in both groups. Resisted exercise may restore muscle strength and joint mechanics while improving physical function. It may also normalize muscle firing pattern and joint biomechanics leading to reduction in joint pain and cartilage degradation.^[13]

Patients with osteoarthritis showed poorer joint position sense than those of a similar age group without joint disease. Some loss of proprioception might be expected as a result of laxity of the joint capsule and ligaments caused by loss of cartilage and bone height. It is also possible that lytic enzymes released around the joint may cause damage to receptor end organs within joint capsule.^[14]

Though loss of joint position sense may be a consequence of the process of osteoarthritis, it may equally be a primary factor in the initiation of joint damage.^[14,15] Proprioceptive training increases the state of readiness of the knee joint & decrease chances of re-injury upon return to daily activities.^[16]

Another study was done by the same scientist in 2009 on, Efficacy of 2 non-

weight bearing interventions, proprioception training versus strength training, for patients with knee osteoarthritis: a randomized clinical trial on One hundred eight patients were randomly assigned to the proprioceptive training, strength training or no exercise (control) group for an 8-week intervention. From this study they concluded that proprioceptive training group led to greater improvements in proprioceptive function, while ST resulted in a greater increase in knee extensor muscle strength. Both group statistically significantly improved WOMAC score ($p < 0.05$) after 8 week intervention.^[17]

Diracoglu et al, studied effect of kinesthesia and balance exercise in osteoarthritic knee. They found that balance and strength training brought significant improvement in proprioception reflecting weakness as a factor of diminution of proprioception. As a consequence of the insufficient working of the proprioceptive system, neuromuscular control cannot be maintained so, protective muscle activities cannot be performed, and joint stabilization cannot be provided. In this condition, the joint is vulnerable to external traumatic stimulations.^[18]

Rehabilitation of OA that focus in muscle strength endurance and flexibility when combined with kinesthesia and balance demonstrate that improve dynamic muscle strength and functional status and suggest using proprioceptive exercise in a rehabilitation protocol.^[19]

Thus, proprioceptive training along with other therapeutic exercise brought significant more improvement in pain, function and proprioception in patients of group - B as compare to group - A.

CONCLUSION

It can be concluded from present study that proprioceptive training using biofeedback (Equiboard) along with conventional physiotherapy helps in reducing pain and improving function and proprioception in patients with osteoarthritic knee.

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