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Effect of Conventional Exercises with Balance Training &Only Conventional Exercises in Patients with Osteoarthritis of Knee

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ABSTRACT: The study aimed to find out the effects of combining conventional exercises with balance exercises in improving functional abilities in OA knee patients. Thirty patients above the age of 50 years who were diagnosed as having " primary osteoarthritis '' according to the criteria of American College of Rheumatology (ACR) and who had radiologically more than stage II bilateral knee OA according to the Kellgren & Lawrence Scale were included in the study.Exercise program – First group of 15 patients (Group A) received both balance and conventional exercises, while the second group of 15 patients (Group B) received only conventional exercises for the total duration of 6 weeks. The Western Ontario and McMaster Universities Index of Osteoarthritis (WOMAC) was used in the assessment of the patients before and after 6 weeks exercise program. The results show that combining balance exercises to conventional exercises improves the functional ability of OA knee patients more than the conventional exercises alone. Based on the presented findings, exercises which aimed to improve the stability of the knee joint, through training of the neuromuscular and proprioceptive systems, attending to neutral alignment of the knee, and muscle strengthening both are necessary.

KEY WORDS: OA Knee, WOMAC Scale, BMI, Proprioceptive Exercises, Conventional Exercises.

I. INTRODUCTION

OA is the most common form of arthritis .Its prevalence increases steadily with age, and radiographic changes of OA are seen in the knees of more than 50% of the population older than the age of 65 years .After the age of 75 years virtually everyone has the evidence of OA in one joint[1]. Men and women are equally affected before the age of 45, but after age of 45 the prevalence is higher in women. [2].The prevalence of osteoarthritis among elderly is 56.6 %. Community survey data in rural and urban areas of India shows the prevalence of osteoarthritis to be in the range of 17 -60.6%.[3]

The process appears to begin in the second decade of life, but degenerative changes are not apparent until middle age, and by 55 to 65 years of age approximately 85% have roentgenologic evidence, to a variable degree of disease.The disease is twice as prevalent in the obese.[4]

The great increase in the elderly population worldwide is the most important change in the field of public health in the 21st century. It is being estimated that the number of people over the age of 65 will be doubled in the next 20 years [5]. Consequently, osteoarthritis (OA) and similar diseases that are more frequently encountered in advanced years will become much more important from both medical and economic aspects [6].

Although osteoarthritis is a disease of the joints, its effects are not just physical. Lifestyle effects include depression, anxiety, feelings of helplessness, limitations on daily activities, job limitation,difficulty in participating in everyday

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personal and family joys and responsibilities. The effects of OA of the knee joint are irreversible and ultimately the patient may choose to undergo elective knee joint arthroplasty. However the incorporation of physical therapy to minimize the chronic symptoms of OA and facilitate improved functional capabilities of the patient.[7].

Conservative treatment includes rest, external support, administration of salicylates, intra-articular injections of steroids, and exercise therapy [4].Proprioceptive deficits are greater in people with knee OA compared with people of a similar age without disease. These deficits are also seen in contra-lateral legs of people with unilateral OA who have high risk of developing bilateral OA. Proprioception deficits may result in poorly controlled, excess loading to knee during gait, initially or accelerating joint degeneration.[8]

People may accommodate for (sub) conscious proprioceptive decline by adapting their behaviour. Therefore impaired proprioception may explain why people with symptomatic OA walk more slowly and with longer double limb stance to avoid risk of joint injury and prevent worsening of disease. These compensatory mechanisms could also explain the lack of association between poor proprioception and progression of OA. [9]

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.[10]Effective control of balance thus relies not only on accurate sensory input but also on a timely response of strong muscles. Individuals with knee OA display reductions in quadriceps strength and activation as well as impairments in knee joint proprioception.[11]

Patients with more severe OA based on radiographic grading had poorer proprioception than those with less severe radiographic signs. When treating patients with knee OA, knee instability is a problem that, if left untreated, might lead to the development of neuromuscular joint stabilization strategy that could hasten progression of disease therefore knowledge of strategies that improve knee stability and function is important for development of treatment approaches that could improve outcomes in individuals with medial knee OA.[12],[13]

Pain associated with OA knee may play a role in balance impairments. The presence of pain may reflexively inhibit the muscles around knee, which could compromise effective and timely motor responses in postural control. [14]Early, the x-ray appearance is normal. Then joint narrowing gradually appears, reflecting thinning of the articular cartilage covering opposing subchondral cortices. A negative film does not rule out the disease .On the other hand; a film with typical characteristics of OA does not necessarily define this as the primary disease. [4]

However, a study is required to find out the effect of balance exercises in conjunction with conventional exercises and also to find out whether combining balance exercises along with conventional exercises is more effective than conventional exercises alone. Not much of such comparative studies has been carried out earlier, so I decided to carry out the following study.

II. RELATED WORK

OA can cause changes that affects not only intra-capsular tissues, but also peri-articular tissues, such as ligaments, capsule, tendons and muscles leading to proprioceptive deficits in extremes of joint position and body position [26]. These effects on proprioceptive sense may induce errors in the normal coordinated patterns of the muscles, thereby causing disturbances in the functional stability. [27]Kim Benell, Rana Hinman; Curr Opin Rheumatol [23],Fitzgerald G, Piva S, Irrgang [24], Hasan BS, Mockett S Doherty M[25]M Van Der ESCH, M Steultjens, J harlaar, D knol , W lems, J Dekker[28] have done study on effect of Knee joint proprioception in OA patients. When proprioceptive acuity decreases, functional ability can only be maintained if there is sufficient muscle strength to compensate for the decrease in accuracy of modulation and activation of muscles. Thus the functional ability will be more strongly affected in presence of both proprioceptive inaccuracy and muscle weakness. Although the direct relationship between proprioception and functional ability is weak, it appears that proprioception indirectly influences functional ability through modulation of the relationship between muscle strength and functional ability. [28]Poor proprioception can be

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compensated by adequate muscle strength; in patients with poor proprioception, an increase in muscle strength would result in a bigger improvement in functional ability[28] Srinivas Mondam [29]Jun Iwamoto [30]have done study on effect of proprioceptive exercise in OA knee patients.

III. METHODOLOGY

STUDY DESIGN: Cross sectional Study
INCLUSION CRITERION:

- Age – Greater or equal to 50 yrs.
- Gender eligibility – Both Male & Female.
- Patient with normal and mildly increased BMI BMI < 40
- Ability to ambulate without any assistive devices.
- Patients having primary OA according to ACR Clinical & Radiologic Criterion for Knee osteoarthritis.
- Grade 2 or greater Kellgren & Lawrence radiographic changes.

EXCLUSION CRITERION:

- Patient diagnosed as having secondary OA, patients with active synovitis & patients who had severe knee trauma, surgical interventions & history of recent intra-articular knee injections.
- Patient having polyarthritis, RA or other systemic inflammatory arthropathies.
- Lower extremity amputations or foot deformities.
- Severe arthritis limiting activities of daily living and pending joint replacement.
- Morbid obesity (BMI > 40).
- Central or peripheral neurological dysfunction, like peripheral neuropathy with or without foot drop, severe peripheral vascular disease with claudication, spinal stenosis, chronic low back pain.
- TKR done on one limb.
- Medically unstable on examination i.e. poorly controlled BP or blood sugar, unstable coronary artery disease.

Place of Study: Physiotherapy Department of D.Y.Patil Hospital& Research centre, Nerul , Navi Mumbai.
Sample Size: 30 patients with diagnosed Primary Osteoarthritis of the knee.

EXERCISE PROGRAMME AND PLANNING:

Patients who met the inclusion criterion, are included in the study and were randomized into two groups using the one to one randomization method by allocating one patient to the conventional group and other patient to the balance along with conventional exercise group. BMI of every patient was calculated before taking the patient in the study. Those patient with normal and mildly increased BMI (BMI < 40) were included in the study. Those patients with moderate and severely increased BMI (BMI > 4) were not included in the study. All the patients participating in the study were informed about the study and approval of the ethical committee. (D. Y.Patil University, Nerul, Navi Mumbai) is obtained.Patients in both groups were informed about knee osteoarthritis and protective recommendations (ergonomic advices) for the knee were given.Exercise program – First group of 15 patients (Group A) received both balance and conventional exercises, while the second group of 15 patients (Group B) received only conventional exercises.The exercises were done under clinical supervision daily for first two weeks and then on alternate day in the rest of the 4 weeks, for the total duration of 6 weeks. In the remaining days, patient did the exercise at home.The Western Ontario and McMaster Universities Index of Osteoarthritis (WOMAC) was used in the assessment of the patients before and after 6 weeks exercise program.
CONVENTIONAL EXERCISE PROGRAM [15],[16]
1. Quadriceps isometric strengthening exercises.
2. Range of motion and active stretching exercises applied to hamstring and quadriceps muscle.
3. Hamstring muscle isometric exercises.

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4. Active ankle pump.
5. Short arc terminal extension exercises for the knee joint.
6. Static and dynamic strengthening exercises for the hip abductors, adductors and extensor group of muscles.
7. Non-weight bearing progressive resistance exercises with weighted cuffs, with progression to closed chain exercises as patient's pain allows.
8. Isometric exercises were applied with 6 second contractions and rest period of 2 seconds. Isotonic exercises were started as 10 repetitions with half of weight of 10 RM, 10 repetitions with three fourth of this weight and 10 repetitions with whole 10 RM. 10 RM was determined again every week.

BALANCE EXERCISE PROGRAM [17]:
1. Walk forward through 6 boxes mark on the soft foam mat on one foot (In-In-Out to right –In-In-Out to left)
2. Stair up & down a regular four step staircase
3. Stand with feet approximately shoulder width apart and extend arm slightly forward and lower than the shoulder. Lift both heels off the floor and try to hold the position for 10 seconds. Followed by climbing a regular four step staircase, - up - down.
4. Standing with feet side by side, hold arm in the same position as described in the previous exercises. Place one foot on the inside of the opposite ankle and try to hold the position for 10 seconds. Followed by climbing a regular four step staircase, - up - down.
5. Repeat the exercise three with hands behind the back.
6. Perform a one legged stand with one foot raised to the back (non weight bearing knee flexes at 90 degree).Try to maintain the position for a minimum of 3 seconds. The long term goal is to decrease the knee for balance support and to hold the position for 10 seconds. However, as necessary, the hands are allowed to contact the support apparatus (a standard chair). Followed by climbing a regular four step staircase, - up - down.
7. Perform the same exercise as above, but raise one foot to the front (non weight bearing knee flexes and lifted as high as the hip). Followed by climbing a regular four step staircase, - up - down.
8. Walk heel to toe along a line marked on a medium density polyfoam mat.
9. Rising from the standard chair (without arm support).
10. With the knee straight but not hyperextended, execute single (relatively small) leg raises to the front, then back. Continued alternating front to back.

In addition, patients were instructed to stand in 6 different conditions for static exercises (exercises no 2, 3, 4, 5, 6 & 10) as follows [17]:
1. On a firm surface, eyes open, head neutral
2. On a firm surface, eyes closed, head neutral
3. On a firm surface, eyes open, head tilted back
4. On a firm surface, eyes close, head tilted back
5. On a foam surface, eyes open, head neutral
6. On a foam surface, eyes closed, head neutral.

IV. RESULT & INTERPRETATION

In this study, age of patients ranged from 50.0 to 73.0 years wherein mean age was 60.07 in Group A and 57.07 in Group B which was similar and hence the difference was not significant. 86.7% of the total cases were females in Group A which was more than 66.7% female cases in Group B but the difference was not significant.

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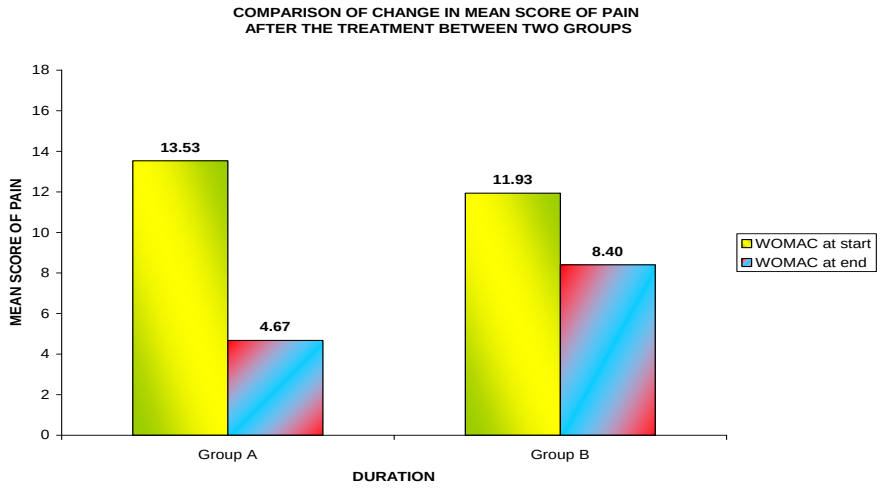
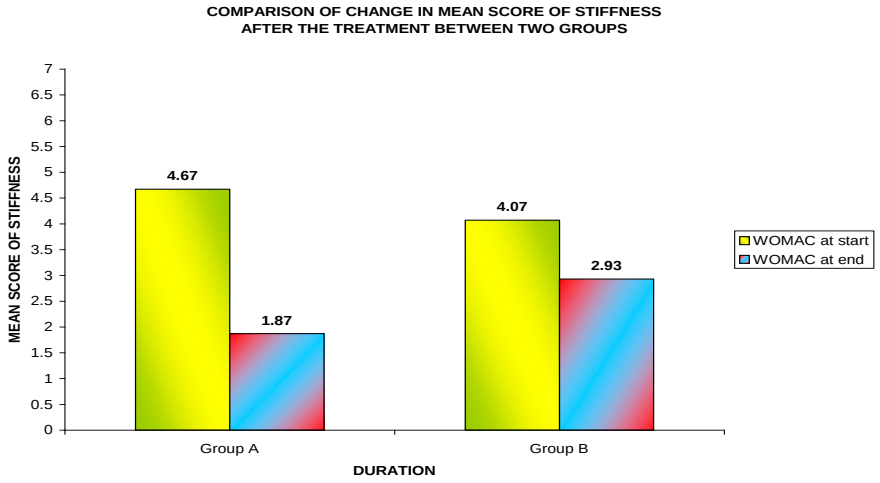
COMPARISON OF CHANGE IN MEAN SCORE OF PAIN AFTER THE TREATMENT BETWEEN TWO GROUPS:



Graph : 1 - the mean score of pain at start, among Group A was 13.53 which was similar if compared to 11.93 among Group B, therefore there was no significant difference.At the end, Mean score of pain showed significant fall from start in both the groups i.e. by 65.5% in Group A and by 29.6% among Group B. The change was statistically higher in Group A than Group B and the difference was significant.

COMPARISON OF CHANGE IN MEAN SCORE OF STIFFNESS AFTER THE TREATMENT BETWEEN TWO GROUPS:



Graph:2- Mean score of stiffness was 4.67 in Group A and 4.07 among Group B which was similar and so no significant difference was assessed. WOMAC at end states that Mean score of stiffness had a significant decrease from start among both the groups i.e. by 60.0% in Group A and by 28.0% among Group B. The change when compared was statistically more among Group A than Group B hence the difference was significant.

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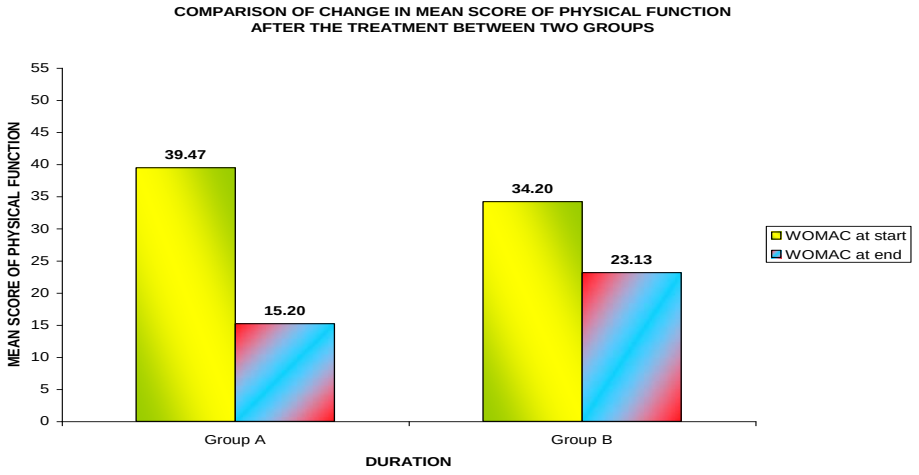
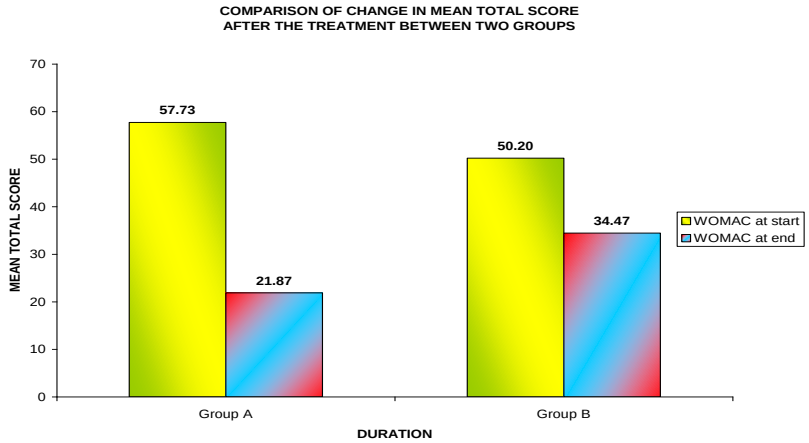
COMPARISON OF CHANGE IN MEAN SCORE OF PHYSICAL FUNCTION AFTER THE TREATMENT BETWEEN TWO GROUPS:



Graph: 3- Mean score of Physical function in Group A was 39.47 which was more than mean score 34.20 in Group B but the difference was not significant statistically. At the end, Mean WOMAC score of Physical function had a reduced significantly from start among both the groups i.e. by 61.5% in Group A and by 32.4% among Group B. If compared the change it was statistically more among Group A than Group B hence the difference was significant.

COMPARISON OF CHANGE IN MEAN TOTAL SCORE AFTER THE TREATMENT BETWEEN TWO GROUPS:



Graph: 4 Mean total score in Group A was 57.73 which were more than 50.20 among Group B but the difference was not significant statistically. WOMAC at end states that mean total score showed significant fall from start among both the groups i.e. by 62.1% in Group A and by 31.3% among Group B. The change if compared was statistically higher among Group A than Group B hence the difference was significant.

V. DISCUSSION

The study aimed to find out the effects of combining conventional exercises with balance exercises in improving functional abilities of OA knee patients. The results show that combining balance exercises to conventional exercises

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improves the functional ability of OA knee patients more than the conventional exercises alone. It has been suggested that functional ability is also affected by poor proprioception. [18]

Knee joint proprioception encompasses the sense of joint position and the sense of motion.These senses are partially derived from neural inputs arising from mechanoreceptors in joints,muscles, tendons and associated tissue(39).Joint mechanoreceptors have the ability to detect the actual joint position and joint motion.Sensory feedback through knee joint mechanoreceptors, i.e. proprioception,modulates and activates knee muscles[19].

Also it has been shown that patients with poor proprioception show more limitation in functional ability but this relationship is rather weak, and in patients with poor proprioception, muscle weakness has a stronger impact on limitations in functional ability than in patients with accurate proprioception.WOMAC at end states that mean total score showed significant fall from start among both the groups i.e. by 62.1% in Group A and by 31.3% among Group B. The change if compared was statistically higher among Group A than Group B hence the difference was significant.

The above mentioned results show that knee joint proprioception is essential for accurate modulation and activation of muscles, thus providing adequate neuromuscular control of knee joint position and joint movement, and ultimately the performance of physical tasks.When proprioceptive acuity decreases, functional ability can only be maintained if there is sufficient muscle strength to compensate for the decrease in accuracy of modulation and activation of muscles.This implies that functional ability will be more strongly affected in the presence of both proprioceptive inaccuracy and muscle weakness [20].

Chronological age is the strongest determinant of the onset and progression of Degenerative Joint Disease. This create abnormal mechanical stress, abrading the articular cartilage that is responsible for distributing joint loads to the subchondral bone. Chemical mediators are released from damaged cell, initiating the acute inflammatory response. Increased arterial vasodilatation and synovial membrane permeability permit degrading enzymes and growth factors to infiltrate the synovial fluid. Repair of minor articular defects may be possible; however, excessive damage to the cartilage diminishes its capacity to distribute stress. Therefore joint loads are ransmitted to subchondral bone, stimulating bone resorption and remodelling. New subchondral bone formation alters the joint surface and causes mal-alignment [21].

The process of degenerative joint disease, with the associated inflammation and decreased joint space, results in disruption of normal neuromuscular control mechanism necessary for joint stabilization. Abnormal afferent information in the arthritic joint is believed to be responsible for phenomenon of arthrogeneous muscle inhibition (AMI), which is the inability to achieve full voluntary muscle activation. Although, the presence of AMI has not been directly linked to proprioceptive deficits, the presence of AMI in arthritic patients illustrates a disruption in the neuromuscular control mechanism. Aberrations in the muscle activity necessary for dynamic restraint may contribute to excessive forces on the capsules, ligaments and articular surfaces. Gait abnormalities demonstrated by patients with DJD may represent motor coordination deficits or attempt to augment proprioceptive information [21].

Deficits in proprioception also occur with the normal aging process and may impair the dynamic mechanism for knee stability. Diminished proprioception is also identified as a contributing factor to the loss of balance and is a predictive measure for falls in the elderly. Regular physical activity appears to attenuate the decline in proprioception with age, suggesting disuse atrophy as a possible causative factor. However, patients with DJD demonstrate greater decrements in joint sensibility when compared to age matched controls because the loss of proprioceptive acuity appears to occur early in the diseased joint, the mechanism for dynamic joint stabilization is also compromised [21].

Sensory denervation of the knee precedes the pathological changes occurring throughout the joint. Disruption of the proprioception and dynamic restraint mechanism may precipitate DJD by changing ones weight-bearing patterns. The loss of joint afferents disrupts normal neuromuscular coactivation, reducing the shock absorbing capacity of dynamic structures and distributing excessive joint forces to the soft tissue restraints, articular surface, and subchondral bone.

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Proprioception from capsuloligamentous tissue is lost early in the degenerative process, and a neurological deficit initiates or at least accelerates degenerative changes in the pathological joint [21].

Unequal redistribution of joint loads causes the articular surface to detoriate, diminishing the joint space height and altering the balance of tension on the surrounding soft tissue. Inadequate tension on capsuloligamentous structures may be responsible for the deficits in proprioception demonstrated by patients with hypermobility syndrome [21]. With respect to the relationship between the severity of structural damage in OA, as defined radiographically, and the severity of functional limitation, the results are not entirely negative. Several studies have shown a positive relationship between radiographic severity and functional limitation [21].

From the Framingham study among subjects who had no symptoms of knee OA but a Kellgren-Lawrence (K-L) radiographic grade of OA severity3, the odds of functional limitation (as defined by difficulty in climbing stairs) increased 3-fold and the odds of encountering difficulty in walking a mile nearly 2-fold, relative to persons with a K-L grade of 0 or 1[31]. Similarly, in the Rotterdam study, after adjustment for hip and knee pain, radiographic evidence of hip OA, obesity, and age, the presence of grade 3 radiographic severity was associated with an approximately 2.5-fold increase in the risk of locomotor disability in both men and women[31].

Considering the results of this study, both the null and alternate hypothesis were rejected and not only the patients muscle strength seems to be essential in reducing the functional ability, as muscle strengthening exercises would not be effective for every patient . Exercise therapy is more successful when the aim is not only improving muscle strength, but also to improve other factors of the stabilization process.

Based on the presented findings, exercises which aimed to improve the stability of the knee joint,through training of the neuromuscular and proprioceptive systems, attending to neutral alignment of the knee, and muscle strengthening are both necessary. Exercises should focus on the training of daily activities relevant to the patient, e.g. walking, stair climbing or other transfers. Hence this form of exercise therapy in combination with joint stability exercises and muscle strength exercises should be more effective than exercise therapy primarily focused on muscle strengthening.

VI. CONCLUSION

The balance exercises in conjunction with conventional exercises is more effective mode of treating patients with knee osteoarthritis than treatment with conventional exercises alone , as measured by the reduction in the total WOMAC score after the treatment regimen .Patients had improvement in the physical functional ability associated with performing activities of daily living, along with reduction in pain and stiffness.

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BIOGRAPHY

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Ethical Clearance:
The study is approved by D. Y. Patil University, Nerul, Navi Mumbai,Maharashtra, India.

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