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Comparative Effectiveness of Modified Agility Training and Perturbation Training in Osteoarthritis Knee: A Randomized Controlled Trial Investigating Pain, Functionality, and Joint Stability

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Abstract:

Introduction: As a modified hinge joint, the knee joint maintains static and dynamic body stability. The patellofemoral and tibiofemoral joints stabilize the knee by joining the femur, tibia, patella, and fibula. Ligamentum Patella and collateral ligaments support. Primary osteoarthritis (OA) is more common in women and thins knee cartilage. Secondary OA can occur from pathology or injury. Proprioception is impaired in knee OA, affecting balance and coordination. Physiotherapy like agility and perturbation exercises improves neuromuscular control. A knee OA study compares traditional physiotherapy with modified agility and perturbation training to improve treatment and symptoms. Understanding risk factors and symptoms helps prevention and treatment.

Material and Methods: Two groups of sixty osteoarthritis (OA) patients—20 men and 40 women—were formed. In addition to standard physiotherapy, Group B got modified agility and perturbation training. Group A received traditional physiotherapy. For three weeks, interventions were provided three times a week. VAS, TUG, and WOMAC were used to assess pain and function.

Result: According to statistical analysis, both groups' pain and functional outcomes improved dramatically. However, Group B—which got modified Agility and Perturbation training—performed better than Group A. The VAS, WOMAC, and TUG mean pre- and post-session values demonstrated significant pain reductions and functional improvements.

Conclusion: This study shows that modified Agility and Perturbation training is helpful for conservative knee OA treatment. Since it significantly reduced pain and improved functional results, the intervention showed promise as a knee OA treatment. More research is needed to determine the long-term effects and widespread use of this technique in various patient populations.

Keywords: knee joint, modified hinge joint, static stability, dynamic stability patellofemoral joint, tibiofemoral joint, ligaments, osteoarthritis, primary, secondary, cartilage thinning, proprioception, physiotherapy, agility exercises, perturbation training, risk factors, symptoms, preventive measures.

I. Introduction:

The knee joint, which is essentially a modified hinge joint, is vital for maintaining both static and dynamic stability inside the body, which is necessary for many different functions. It is made up of the femur, tibia, patella, and fibula [1]. It creates the patellofemoral and tibiofemoral joints, which help to stabilize the knee as a whole. The convex condyles of the femur fit into the concave tibial condyles, which are divided by an intercondylar notch, maintaining static stability. During extension, the fibrous capsule provides an additional layer of defence for the joint [2]. Coordination of the menisci, ligaments, muscles, and femoral condyles is

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necessary for dynamic stability. In addition to maintaining joint space and functioning as shock absorbers, the menisci also enhance joint stability by lowering contact stress on the articular surface [3,4]. The fibrous capsule, Ligamentum Patella, Tibial collateral, Fibular collateral, Oblique popliteal, Arcuate popliteal, Anterior cruciate, Posterior cruciate, Medial meniscus, Lateral meniscus, and Transverse ligament are among the ligaments that support the knee joint. The degenerative joint disease osteoarthritis (OA) is characterized by the thinning of the cartilage that covers the ends of bones. More women than males are affected by primary OA, which is more prevalent than secondary OA and frequently seen in the knee joint. People with a history of injuries, knee instability, or underlying pathology are more likely to develop secondary OA [5]. Osteophytes, or new bone growth at the joint borders, and the progressive loss of articular cartilage are two aspects of the pathophysiology of osteoarthritis (OA) in the knee. Modifications in cartilage, including a reduction in proteoglycans, result in changed biomechanics that impact nutrition and lubrication of the joints. Repetitive or prolonged weight bearing, insufficient sleep, sedentary behaviour, obesity, endocrine disorders, and metabolic disorders are the main causes of osteoarthritis (OA). Conditions such as hemophilia, diabetes, rheumatoid arthritis, infections, excessive steroid medication, obesity, and knee abnormalities can all contribute to secondary OA [6]. Non-modifiable risk factors for osteoarthritis (OA) include age and gender; modifiable risk factors include overweight, obesity, joint injuries, and occupation; and other risk factors include osteoporosis, high C-reactive protein, oestrogen deficit, and vitamin deficiencies. Reduced muscle strength, knee pain, soreness, and joint stiffness are typical indications and symptoms of osteoarthritis (OA). In patients with knee OA, proprioception—which is essential for balance, coordination, and agility—is compromised [7]. A major part of treating knee OA is physiotherapeutic intervention. Exercises that test the neuromuscular system, such as agility and perturbation, protect joints and lessen persistent discomfort. Physiotherapeutic therapies include manual therapy, bracing, biofeedback, exercises, and electro modalities. For people with knee OA, agility—which is the capacity to change direction while retaining stability—is essential. Training under perturbation improves proprioception, reducing the risk of injury and boosting output [8]. A study compares the efficacy of traditional physiotherapy versus modified agility and perturbation training for people with osteoarthritis (OA) in the knee. The objective is to identify the best exercise regimen for knee OA to improve overall management and minimize symptoms. When it comes to knee osteoarthritis (OA), pathology analysis identifies two main mechanisms at work: the gradual degeneration of articular cartilage and the emergence of new bone, or osteophytes, at the joint borders. The principal biochemical alteration is a reduction in proteoglycans, which are essential to cartilage integrity and proper function. Consequently, the breakdown process is triggered by the loss of proteoglycans, which impacts the cartilage's lubrication, stiffness, elasticity, and nutrition [9,10,11]. According to histological investigations, there are specific regions where there is softening, fibrillation, cleft creation, and penetration into subchondral bone, which ultimately leads to the development of cysts. A minor inflammatory response is triggered when cartilage fragments are released into the synovial cavity as a result of this deterioration. Primary osteoarthritis is frequently brought on by lifestyle factors such as obesity, insufficient rest, sedentary behaviour, and extended or repetitive weight-bearing activities [12]. In addition, OA is facilitated by several metabolic and endocrine diseases. Conversely, some conditions include rheumatoid arthritis, infections, hemophilia, diabetes, overuse of steroids, obesity, and anatomical abnormalities of the knee are associated with secondary osteoarthritis. It is essential to comprehend the risk factors linked to osteoarthritis to develop preventive and therapeutic methods [13]. Non-modifiable risk variables include gender and age, with women and the elderly being more vulnerable. Changes in lifestyle and work can address modifiable risk factors, such as obesity, overweight, joint injuries, and occupation [14]. Osteoporosis, vitamin deficiencies (C, D, and E), estrogen insufficiency, and high C-reactive protein levels are other possible risk factors. Common symptoms of osteoarthritis in the knee include pain, soreness, stiffness in the joint, and loss of muscle mass [15]. In patients with knee OA, proprioception—which includes joint position perception, velocity, movement detection, and force—is frequently compromised. Because of the substantial impact this impairment has on balance, coordination, and agility, proprioception is an important area of focus in knee OA treatment. Agility and perturbation exercises are a type of physiotherapeutic intervention that deliberately challenges the neuromuscular system to improve balance and improve everyday living tasks [16]. The conservative treatment of osteoarthritis in the knee is thought to require this kind of intervention. Physiotherapists use a variety of strategies to treat knee

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OA symptoms and support joint protection, including electro modalities, exercises, biofeedback, manual therapy methods (such manipulation and mobilization), and bracing [17]. To gain important insight into treatment strategies, a study comparing the efficacy of modified agility and perturbation training to traditional physiotherapy is being conducted on patients with osteoarthritis in the knee [18]. The focus on developing better exercise regimens is in line with the changing goals of osteoarthritis care, which include improving patient outcomes and quality of life.

II. Background Study

Osteoarthritis (OA) is a common degenerative joint disease marked by the growth of osteophytes, changes in joint structure, and a progressive degeneration of articular cartilage. The knee joint is more vulnerable among the other afflicted joints, resulting in substantial morbidity, a decreased quality of life, and a greater financial strain on healthcare systems. The knee joint's capacity to function properly depends on both its static and dynamic stability. The interaction of the menisci, ligaments, muscles, and tibia with the patella, fibula, and femur adds to the knee's overall stability. These structural elements experience pathological alterations in the setting of OA, which result in discomfort, stiffness, and decreased joint function. There are two types of osteoarthritis: primary and secondary. Primary osteoarthritis (OA) is a common age-related knee joint condition that affects more women than males. Conversely, people who have a medical history of joint trauma, instability, or underlying diseases are more likely to develop secondary OA. The main site of biomechanical alterations in OA disease is the gradual degradation of articular cartilage. Decreases in collagen and proteoglycans, which are crucial for cartilage integrity, cause changes in biomechanics that eventually contribute to joint degeneration. Furthermore, the development of osteophytes plays a role in other structural alterations. Age, gender, and other non-modifiable characteristics are risk factors for osteoarthritis (OA), as are modifiable ones like obesity, joint traumas, and work. Comprehending these risk variables is crucial for devising preventive measures and implementing efficient management [19]. A key component of the conservative treatment of knee OA is the use of physiotherapeutic treatments. Exercises that test the neuromuscular system, such as agility and perturbation exercises, are acknowledged elements of therapeutic regimens. The goals of these interventions are to lessen chronic pain, increase overall functional capability, and improve joint stability. Even with the current understanding of OA and its treatment, more study is necessary to determine the efficacy of particular therapies. In this study, the effects of combined Modified Agility and Perturbation training and Conventional Physiotherapy against Conventional Physiotherapy alone on patients with knee OA are compared. This study aims to provide important insights into the optimization of treatment options for patients with osteoarthritis of the knee by examining the effects of different interventions on symptoms and overall function of the knee [20].

III. Material and Methods

- **A. Equipment for Study:**
    a. Stopwatch for Wobble Board
    b. Inch Tape, Data Collection Sheet, Study Criteria:
    c. Criteria for Inclusion:
    d. Ages 40-55.
    e. Female and male participants participate.
    f. Patients with knee osteoarthritis.
    g. The Kellgren and Lawrence scale graded participants as Grade 2 and 3.

B. Exclusion Criteria:

a. Balance-impaired patients.
b. Total knee replacement patients.
c. Former knee pain patients**.**
d. People with ligament damage.

C. Method

This study uses experimental methods. Comparison: The study is comparative. The research lasts a year. The sample size is 60 participants (X ± SD), with 30 in each group. Calculations use the formula:

- 1 SD: Standard deviation in the first group.
- SD 2: Standard deviation in the second group.
- Simple random sampling selects participants.

The study is held in Krishna College of Physiotherapy, KIMSDU, Karad. Pre- and post-tests are analysed using the paired t-test. The data is analysed using SPSS-25. KIMSDU, Karad's protocol committee and Institutional Ethics Committee reviewed the study protocol for approval. Then, osteoarthritis patients were approached and informed of the study's goal, receiving signed consent. Participants who met inclusion and exclusion criteria were chosen for the study. Participants were

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divided into two groups using easy sampling and simple random sampling. Group A was conventional and Group B experimental. Treatments were given three times a week for three weeks. Participants were properly informed and consented to the study. Systematic baseline and pre-treatment assessments were done. The cohort was then split into two treatment groups: Traditional physiotherapy was given to Group A. Modified Agility and Perturbation training and Conventional Physiotherapy were used in Group B.

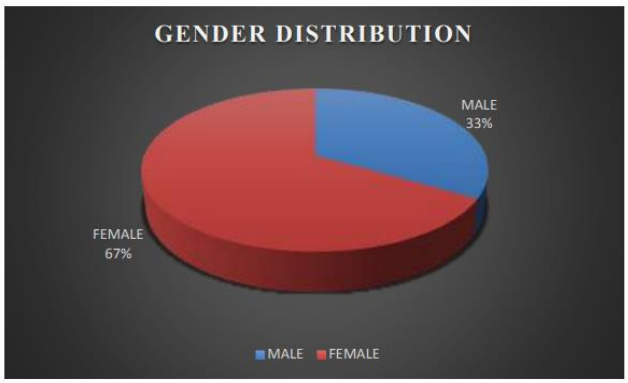
IV. Result & Discussion

This research sought to evaluate the effects of modified agility and perturbation training on patients suffering from knee osteoarthritis. The prevalence rates of this degenerative joint illness are significant in India, with 32.6% of people living in rural areas and 60.3% in urban areas. One of the most frequent types of arthritis and a major contributor to disability worldwide is osteoarthritis. It is characterised by primary and secondary classes and involves the degeneration of smooth cartilage at the ends of bones. More common than its secondary counterpart, primary osteoarthritis typically presents with major complaints in one compartment, with the medial compartment being more affected. Knee discomfort, tenderness, stiffness in the joint, and weakness in the muscles are common symptoms.

A. Gender Distribution

Male	Female	Total
20	40	60

Table .1: Gender distribution



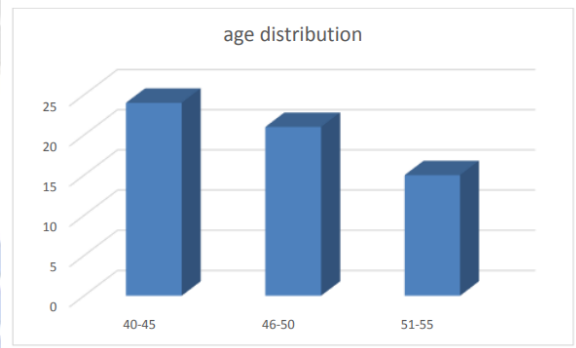
Graph 1. Gender Distribution

Twenty men and forty females were included in the study cohort for the purpose of this research. A total of sixty people who had been diagnosed with osteoarthritis were included in the study.

B. Age Distribution

AGE	40-45	46-50	51-55
	24	20	16

Table .1: Age Distribution

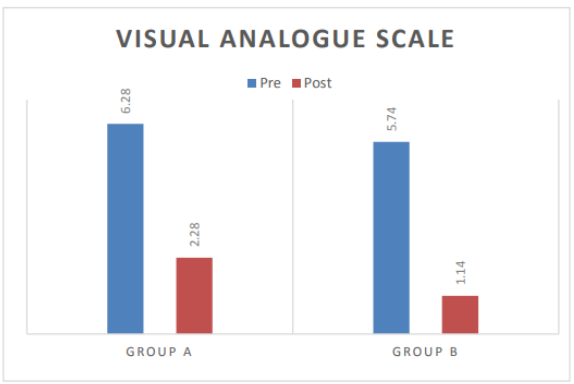


Graph 2. Age Distribution

C. VAS Scale

Groups	Pre interventional Mean±SD	Post interventional Mean± SD	p-Value	t Value	Inference
Group A	6.28±0.8831	2.28±1.43	<0.0001	14.807	Extremely significant
Group B	5.74±1.729	1.147±1.183	<0.0001	12.190	Extremely significant

Table 3. Comparison of the VAS score's PRE and POST interventional values inside Group



Graph 3. Comparison of the VAS score's PRE and POST interventional values within the group

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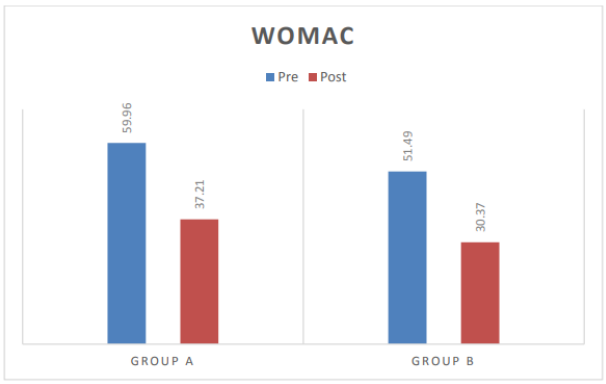
A comparison of the mean and standard deviation for PRE and POST values between groups A and B is shown by an analysis of the data in the table. The pre-session values for group A were 6.28±0.88 and the post-session values were 2.28±1.43. <0.0001 was the extremely significant p-value obtained from the paired t-test. Comparably, in group B, the pre-session values were 5.74±1.72 and the post-session values were 1.14±1.18. The paired t-test p-value was similarly found to be <0.0001, indicating extremely significant results.

D. WOMAC

Groups	Pre interventional Mean±SD	Post interventional Mean±SD	p-Value	t Value	Inference
Group A	59.96± 10.016	37.21±9.039	<0.0001	23.358	Extremely significant
Group B	51.490±8.897	30.379±6.404	<0.0001	17.229	Extremely significant

Table 4. Comparison of the group's WOMAC score's PRE and POST interventional values



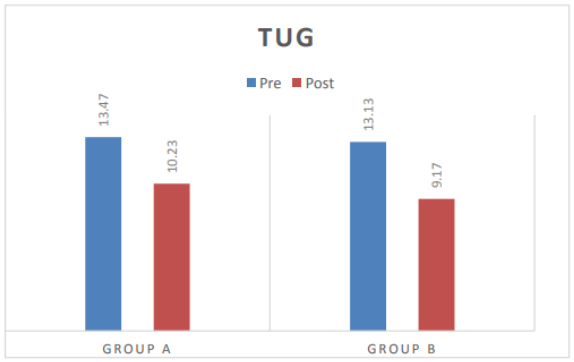
Graph 4. Comparison of the group's PRE and POST interventional values for the WOMAC score

A comparison of the mean and standard deviation for PRE and POST values within groups A and B can be seen by analyzing the table that is currently displayed. The pre-session values for group A were 59.96±10.01, while the post-session values were 37.21±9.03. The paired t-test yielded a p-value of less than 0.0001, which is very significant. Similar results were found for group B, where the pre-session values were 51.49±8.89 and the post-session values were 30.37±6.40. A paired t-test p-value of less than 0.0001 indicated extreme significance.

E. Time Up & GO-TO Test

Groups	Pre interventional Mean±SD	Post interventional Mean±SD	p-Value	t Value	Inference
Group A	13.473±2.041	10.233±1.887	<0.0001	14.305	Extremely significant
Group B	13.137±2.144	9.173±1.177	<0.0001	13.455	Extremely significant

Table 5. Comparison of the TUG score's PRE and POST interventional values within the group



Graph 5. Comparison of the TUG score's PRE and POST interventional values within the group

A comparison of the mean and standard deviation for PRE and POST values within groups A and B is shown by analysis of the accompanying table. The pre-session values for group A were 13.47±2.04 and the post-session values were 10.23±1.88. The paired t-test produced a p-value of less than 0.0001, which is very significant. In a similar vein, group B's pre-session values were 13.13±2.14 and post-session values were 9.17±1.17, with a paired t-test p-value of <0.0001, signifying maximum significance.

Conservative control is essential to halting more harm, particularly in the case of the elderly, whose low proprioception frequently raises their risk of falling. Elderly people can choose a lower-intensity option with modified agility and perturbation training, which has been suggested as an intervention to prevent injuries during activities of daily living. Effective therapies are critical because patients with osteoarthritis in the knee often experience periods of knee instability during regular activities. Agility and perturbation training may help improve knee stability, according to prior research, which makes it especially important for people with osteoarthritis. This study looked into how well patients with osteoarthritis in their knees responded to modified

Agility and Perturbation training. The study involved sixty participants, 20 of whom were male and 40 of whom were female. The study's inclusion criteria included being between the ages of 40 and 55 and having a clinical diagnosis of osteoarthritis knee (Grades 2 and 3 on the Kellgren and Lawrence Scale). References were made to earlier research that demonstrated the superiority of Agility and Perturbation training over dynamic resistance workouts in enhancing knee function. Two groups were compared as part of the study design: Group B underwent a mix of Modified Agility and Perturbation training and Conventional Physiotherapy treatment, whereas Group A received conventional physiotherapy treatment. Before the treatment, a pre-assessment was carried out, which included the Timed Up and Go (TUG) test, WOMAC score, and Visual Analogue Scale (VAS). For three weeks, the treatment sessions were conducted three times a week, with ten repetitions of the exercises. Significant improvements in VAS, WOMAC, and TUG ratings were found in both groups after statistical analysis, which included paired t-tests. These findings suggest a decrease in pain and an improvement in functional outcomes. Compared to Group A, Group B, who received modified Agility and Perturbation training, showed remarkably large improvements. According to the study's findings, modified agility and perturbation training can significantly improve knee stability, lessen discomfort, increase proprioception and balance, and generally improve the quality of life for those with osteoarthritis in their knees. For people with osteoarthritis, this exercise programme could be added to their regular workouts to help with pain and functional outcomes.

V. Conclusion

After a comprehensive statistical analysis and interpretation of the study's findings, it can be concluded that modified Agility and Perturbation training has produced significant clinical and statistical improvements in osteoarthritis knee patients on a number of measures, such as the Timed Up and Go test, WOMAC, and VAS. Consequently, this leads to improved functional results. As a result, the study provides strong evidence in favour of the claim that training in modified agility and perturbation produces notable clinical and statistical improvements in pain management in patients with osteoarthritis of the knee. This means that the alternative theory is supported.

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