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A Comparative Study of Isometric versus Isotonic: Osteoarthrosis Knee

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Abstract –

Objectives: To investigate the efficacy of Isotonic training in decreasing pain, and increasing balance, walking speed & functional mobility in Osteoarthritis Knee.

Study design: Comparative case control study.

Methodology: Two hundred (200) individuals with a diagnosis of OA Knee will be selected directly from Physiotherapy outpatient door CMJ University, Department of Physiotherapy, Shillong, Meghalaya. 50 will be qualified for study and are randomly assigned into two groups. Isotonic Exercise group (n = 25) and Isometric Exercise group (n = 25).

Results: Results indicate that both groups improved in all measures of pain, Balance, and functional outcomes. However, upon Intergroup analysis the mean changes in the score of VAS, WOMAC, TUG will highly significant across the two testing periods (at 6 week & 12 week) for the Isotonic training group (FTT) with respect to Isometric training Group (TE).

Conclusion: Isotonic training on regular basis an effective rehabilitation program for improving functional mobility, balance and decreasing pain in OA Knee.

Key Words – Isotonic training, Isometric training, OA Knee, visual analogue scale (VAS), Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC)

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1. INTRODUCTION

Osteoarthritis (OA) is the third most common diagnosis made by general practitioners in older patients and OA is the most common arthropathy to affect the knee. About 25% of adults aged >55 years' experience significant knee pain; half of these have radiographic changes of OA and a quarter have significant disability. Risk factors for knee OA include ageing, female gender, being overweight, prior knee injury and a positive family history. Osteoarthritis of knee joint is characterized by structural joint changes including joint space narrowing and osteophyte formation, localized tenderness over the joint and pain on passive or active motion. Pain is frequently the first symptom and is often associated with swelling. Crepitus can often be detected and muscle atrophy is seen secondary to disuse.

Osteoarthritis (OA), also known as degenerative joint disease is the most common form of arthritis and a leading cause of disability worldwide. The incidence of OA increases with age and disproportionately affects women. Osteoarthritis of the knee (OA knee) is one of the five leading causes of physical disability in non – institutionalized elderly men and women. The risk for disability attributable to OA knee is as great as that attributable to cardiovascular disease and greater than that due to any other medical condition in elderly persons. OA was considered to be primarily a degenerative disorder and a natural occurrence of "wear and tear" on joints as a result of aging. Recent research evidence is changing this views as knowledge increases regarding the pathogenesis and natural history of OA, particularly the metabolically active role of the disease and the process of remodeling and repair of damaged tissue. Current thinking is that it may be possible to arrest the progress of and potentially even reverse the disease. The primary effect of OA is pain that can lead to disability. The cause of the Pain is generally due to an inflammation of joint incongruity, but the reasons for differing Pain levels by individual patients with similar conditions is still unknown.

Because some patients with radiographic OA exhibit few symptoms, the psychological impact of the disease and its associated Pain and disability may be underestimated in the general population.

Prevalence of Osteoarthritis of the knee 1,00,000 Population in India Age Groups (Years)

Age	15-24	25-34	35-44	45-59	60-69	70-79	>80
Males	-	-	-	4644	15385	20000	6250
Females	-	-	2247	6587	14371	19608	14286

Osteoarthritis (OA) is a degenerative Particular disease which is slowly evolving that appears to originate in the cartilage by breaking down and affects the underlying bone, soft tissues, and synovial fluid (Gur H, C¸ akın N. 2003).[1] OA is characterized by degradation of the Particular cartilage, resulting in an alteration of its biomechanical properties. There are alternations of the tensile, compressive, shear properties and hydraulic permeability of the cartilage, thus increased stiffness of the subchondral bone. Individuals with knee OA must often overcome a variety of problems, such as joint pain, tenderness, limitation of movement, crepitus, occasional effusion, swelling and local inflammation. Physical disability arising from pain and loss of functional capacity reduces quality of life and increases the risks of further morbidity and mortality.

Osteoarthritis (OA) is the most common form of arthritis in the United States in adults over the age of 45. Although the etiology has not been fully delineated, there is evidence to suggest that genetics, heredity, histology and biochemistry play a strong role in its development. To date, no cure for the disease exists. However, evidence suggests that risk factors for the onset and progression ofthe disease are reducible or avoidable through lifestyle modifications such as weightloss, increased physical activity and dietary changes. Epidemiologic studies confirm that these modifications may help control the onset and progression of knee OA. Therapeutic parameters proven to be successful in treatment include patient education, physical therapy, pharmacological agents, social support, assistive devices, and participation in arthritis programs. The effects of the disease accompany secondary impairments that include alterations in gait, varus/valgus alignment deformities, muscle imbalances and other abnormalities associated with aging (Altman, Hochberg, Moskowitz & Schnitzer, 2000).[2]

According to the World Health Organization, knee OA ranks the fourth most common cause of disability in women and the eighth in men. Knee OA represents a major cause of pain and dysfunction and represents an economic burden to society. The United States spends more than$56billion per year on treatment and compensation for individuals with knee OA. Radiographs confirm the diagnosis of knee OA. Radiographic and physical findings can include crepitus, joint space narrowing, edema, increased tissue temperature, bony hypertrophy, tenderness and varus or valgus deformities. Clinical symptoms of this disease for any individual afflicted may include any or all of the following: deterioration of particular cartilage, hypertrophic changes in bone, hardening of subchondral bone and presence of osteophytes, fissures, and periositis that may serveas a mechanism of pain in individuals afflicted with OA. Stiffness associated with restricted activities and ultimate deconditioning is often associated with the disease. Individuals with knee OA report morning pain and stiffness with activities of daily living (ADL's), making it difficult to get up from a chair, walk without pain and participate in community activities such as walking (American Geriatric Society Panel on Exercise and Osteoarthritis, 2005).[3]

Considerable evidence in the literature confirms that strengthening exercises should be employed in the treatment of knee OA; however, confusion exists as to what exercises are the most appropriate and beneficial in meeting the needs of the patient with OA. Isometric training stend to focus on the isolation of one or more muscle groups in an attempt to address the impairment. Alternately, Isotonic training focuses at the activity level by strengthening and adapting postural strategies to environmental demands through functional task performance. This type of activity requires coordinated functional movements, task specific balance requirements and incorporates multiple muscle groups and joints working in multiple planes. Isotonic training involves the performance of muscular control activities as well as balance and coordinated movement strategiesrequired tfunction in an ever-changing environment such as walking up and down stairs and crossing a busy street. (devreede, et al., 2005; Shumway-Cook & Woollacott, 1995).[4]

In a pilot study, Blundell, Shephard, Dean, Adams and Cahill (2003).[5] investigat functional task specific strength training in children with Cerebral Palsy. Children performed exercises similar to everyday tasks such as walking up and down ramps, picking up objects, step-ups and sit-to-stand activities. Motor skills and isometric strength improved secondary to functional task training. Activity limitations also decreased as evidenced by an increase in walking speed, cadence, distance and the ability to rise up independently from a low chair. One can infer that task specificity training is important in addressing impairments in structure and function and improving one's activity level ability to perform age appropriate functional tasks. A study involving older women yields similar results. In their study, deVreede et al. (2005) compared functional tasks and resistance strength training exercises on activities of daily living (ADL) in a 12-week pilot study of 70-year-old healthy women. The Isotonic training group performed exercises that included a vertical and horizontal movement component for endurance, strength, rising from a chair, stepping on a platform, putting objects on a shelf, and walking while carrying an object. The

strengthening group used graded resistance elastic bands, dumbbells and cuff weights to strengthen all muscle groups in the extremities and trunk. Pre and post-test outcome measures included the Assessment of Activity Performance Scores (ADAP), timed up and go test (TUG), isometric strength tests, and leg extension power. ADAP scores were significantly greater in the functional group and isometric strength was greater in the strengthening group; however, the gains in this group were not sustained six months after training. The author's data supports that a 12- week training program consisting of functional task exercises was superior to resistance strength exercise in this population. When addressing disability in the elderly, additional evidence also suggests that Isotonic training may be more effective than resistance training in preventing functional decline by decreasing activity limitations and participation restrictions in this population (Fieo, Watson, Deary, & Starr, 2005).[6] Exercise programs designed to help us meet the activity and participation needs of our clients may influence their responsiveness to exercise. Thus, creating an exercise program that focuses on isotonic training at the activity level may improve exercise compliance and decrease the fear associated with Isometric training.

To date, few studies report the use of Isotonic training exercise approach in the 50 to 65 Years old population diagnosed with knee osteoarthritis in addressing their level of activity and participation.

2. LITERATURE REVIEW

According to RACGP (2009)[7] there is some evidence to support GPs recommending self-management education programs for treatment of OA of the hip and knee.

Statistics indicate obesity in the United States has doubled between 1971 and 1994 (Flegel, Carroll, Kuczmarski & Johnson, 1998).[8] Individuals with a body mass index (BMI) greater than 30 are considered overweight, except in those individuals with a low percentage of fatty tissue. Knee OA is more common in obese individuals than in those of normal body weight.

All the guidelines discussed the effect of strengthening exercises as part of land- based exercise programs for knee OA. Only one guideline discussed strengthening exercises separately and included specific recommendations. One good-quality Meta-analysis (MA) was documented in the four included guidelines and reported that a statistical significant effect due to quadriceps strengthening exercises on reducing pain and functional disability, compared to education and lifestyle advice, telephone support, no intervention and sham intervention, was found. In this MA, the major shortcoming was that the analysis combined studies that measured pain and disability in different ways. Thus, it is impossible to determine whether the effects were clinically important (Roos, E. M., & Toksvig-Larsen, S. 2003).[9]

One guideline reported a recommendation for range of motion (ROM) / flexibility exercises in the management of knee OA. The recommendation was based on expert opinion. The guideline developers were unable to find any published studies to determine the effect of ROM/flexibility exercises on relieving pain or improving function in knee OA. ROM/ flexibility exercises were documented in the eligible guidelines as part of an exercise program for knee OA which included aerobic, quadriceps strengthening exercises and stretching. Consequently, the reviewers were unable to formulate recommendations for or against the use of ROM/flexibility exercises in the physiotherapeutic management of knee OA.

Limited evidence supports the use of aquatic exercise as an intervention to manage patients with knee OA. Three guidelines reported the effects of aquatic exercises on pain and functional disability in knee OA patients. Only one guideline reported direct recommendations related to the use of aquatic exercises in the management of knee OA. The recommendation was based on 3 RCTs (Cynthia C. Norkin, Pamela K. Levangie 1998).[10] which examined the effect of aquatic exercises on pain and functional disability in knee OA patients. One guideline reported limited evidence for the benefit of aquatic exercises in knee OA management and a recommendation was not formulated.

Recommendations related to the use of weight-loss programs in the management of knee OA were documented in all the eligible guidelines. There is good evidence that weight-loss programs should be a core component in the management of obese and overweight knee OA patients. The recommendation for weight-loss programs in the management of knee OA was based on two RCTs and one SR. The evidence of this recommendation was evaluated as Level I since the included RCTs were of high-quality and well-designed.

Evidence was collected from three moderate-quality RCTs and one low-quality RCT for multimodal physiotherapy management of knee OA. The following recommendation was formulated by one of the eligible guidelines: “There is some evidence to support General Practitioners (GPs) recommending multimodal physical therapy (up to 3 months) in the management of knee and hip OA”.

3. OBJECTIVE OF THE STUDY

To compare the effects of Isometric versus Isotonic Quadriceps exercise training in unilateral Osteo Arthrosis (OA) of the knee Using pain rating scale and Goniometer, comparing of strength variations between isometric and isotonic exercise in knee quadriceps muscle.

4. METHODOLOGY

Source of data: Two hundred (200) individuals with a diagnosis of OA Knee will be selected directly from Physiotherapy outpatient door CMJ University, Dept of Physiotherapy, Shillaong, Meghalaya. 50 will be qualified for study and are randomly assigned into two groups. Isotonic Exercise group (n = 25) and Isometric Exercise group (n = 25)

Research Design: Experimental design of study.

Methods of Sampling: A sample of convenience of Fifty patients aged range between 50 to 65 Years diagnosed with Knee Osteoarthritis will selected and randomly assigned to two equal groups, the Isometric training group (TE group, n=25) or the Isotonic training group (FTT group, n=25).

Instruments used

1) Inch Tape

2) Stopwatch

3) 25 meter long hallway Stairs

4) 4 Pound Box

Variables

- Independent Variables
  1) Traditional Strengthening exercise Technique (TE)
  2) Isotonic training Technique (FTT)
- Dependent Variables
  1) Western Ontario and Mac Master Universities OA Index (WOMAC)
  2) Pain on VAS
  3) Timed Up and Go Test

5. RESULT ANALYSIS

All Three variables with respect to the subjects recorded were clearly insignificant at Day 1 (pretreatment session) when compared against each other namely Isometric training group (TE) or the Isotonic training group (FTT).

Demographic Data: Fifty individuals were included in this study, twenty five in each group TE and FTT. The mean age in years of Experimental group (FTT group) was 59.2 and of control group (TE group) was 57.56.

Table 1: Demographic data of the Age of subjects of TE & FTT Group

Group	FTT Group		TE Group		P-value
	FT (Mean value)	T SD value	TETE (Mean value)	SD value	
Age in years	59.2	3.851	57.56	3.489	0.074

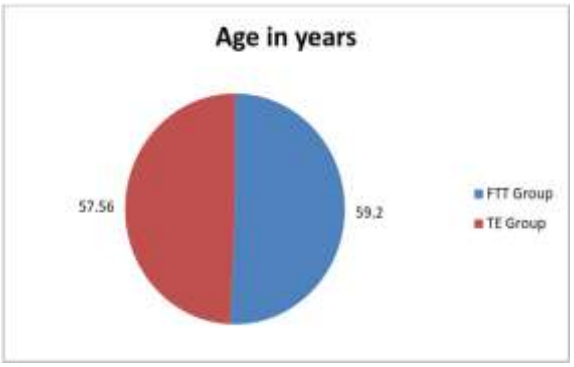

Figure 1: Pie chart presentation of Demographic data of the Age of subjects of TE & FTT Group

- **Pain on VAS scale**

Knee pain was recorded on (VAS) which is a 10 cm horizontal line, 0 represented no pain while 10 represented extremely intense pain. VAS was given to all participants and was asked to place a vertical mark along the line where they feel pain. The distance from left extreme point of the line (no pain at all) to the participants mark was measured and recorded. VAS provides a reliable method for measuring pain and is sufficiently sensitive to detect distinct difference in pain experience.

Intergroup Analysis of VAS Score (Comparison between the changes in mean scores of VAS): On Day 1 (pretreatment session), the mean of VAS score of FTT Group was 6.4 ± 1.040 & mean of VAS score of TE Group was 6.52 ± 0.770. The p–value of the difference between the two by paired t-test was found to be 0.574 which is not statistically significant.

At the end of Week 6, the mean of VAS score reduced in both the groups. In FTT Group it was reduced to 3.4 ± 0.500 and in TE Group it reduced to 4.56 ± 0.650.The P value of the difference between the two by paired t-test was found to be 0.000 which is highly significant. At the end of Week 12, the mean of VAS score again reduced in both the groups. In FTT Group, it reduced to 1.64 ± 0.489 and in TE Group it reduced to 3.32 ± 0.690. The P value of the difference between the two by paired t-test was found to be 0.000 which is highly significant.

This comparative analysis is demonstrated in Table & Figure

Table 2: Comparison between mean of VAS scores in FTT group and TE group

Group	FTT Group		TE Group		P-value
	FTT (VA)	S (SCALE)	TE (VA)	S (Scale)	
	Mean value	SD value	Mean value	SD value	
Day1	6.4	1.040	6.52	0.770	0.574
Week 6	3.4	0.500	4.56	0.650	0.000*
Week 12	1.64	0.489	3.32	0.690	0.000*

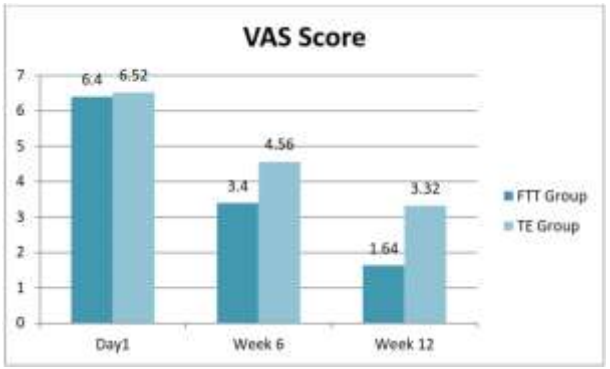

Figure 2: Comparison between mean of VAS scores in FTT group and TE group

- **WOMAC**

Intergroup Analysis of WOMAC Score : On Day 1 (pretreatment session), the mean of WOMAC score of FTT Group was 52.20±1.581 & mean of WOMAC score of TE Group was 52.00±1.223. The p–value of the difference between the two by paired t-test was found to be 0.519, which is not statistically significant.

At the end of Week 6, the mean of WOMAC score reduced in both the groups. In FTT Group it reduced to 22.76±1.128 and in TE Group it reduced to 31.72±1.369. The P value of the difference between the two by paired t-test was found to be 0.000 which is highly significant.

At the end of Week 12, the mean of WOMAC score reduced in both the groups. In FTT Group, it reduced to 9.00±0.957 and in TE Group it reduced to 17.84±1.067. The P value of the difference between the two by paired t-test was found to be 0.000 which is highly significant.

This comparative analysis is demonstrated in Table & Figure

Group	FTT Group		TE Group		P-value
	FTT (WOMAC) (Mean value)	C (SCALE) SD value	TE (WOMAC) (Mean value)	AC (Scale) SD value	
Day1	52.20	1.581	52.00	1.443	0.519
Week 6	22.76	1.128	31.72	1.369	0.000*
Week 12	9.00	0.957	17.84	1.067	0.000*

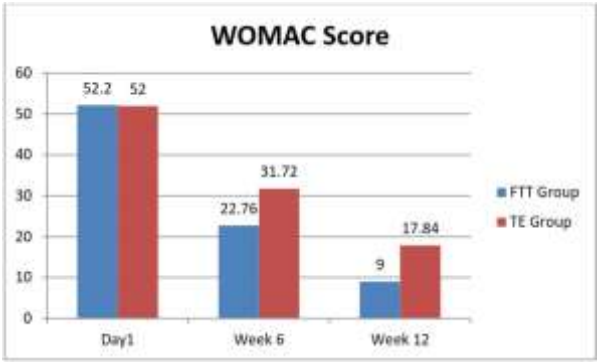

Figure 3: Comparison between mean of WOMAC scores in FTT group and TE group.

- **Time Up and Go Test**

The Timed Up and Go Test assesses balance and mobility in older adults and has established reliability of ICC=.99 (Podsiadlo & Richardson, 1991). It requires the subjects to get up from a standard height arm chair and walk 3.0 meters to a designated finish line, turn around, walk back to the chair and sit down. Time to complete the test is recorded in seconds. Shumway and Cook (2000) report a score greater than 13.5 seconds is associated with predictability for falls in the elderly. Piva et al. (2004) have investigated reliability for this test and reported intertester reliability between ICC=.94 and ICC=.99 and intratester reliability between 1CC=.72 and ICC=.98 in patients with knee OA.

Intergroup Analysis of TUG Test: On Day 1 (pretreatment session), the mean of TUG score of FTT Group was 10.80±0.645 & mean of TUG score of TE Group was 10.68±0.748. The p–value of the difference between the two by paired t-test was found to be 0.327 which is not statistically significant.

At the end of Week 6, the mean of TUG score reduced in both the groups. In FTT Group it reduced to 9.64±0.637 and in TE Group it reduced to 10.16±0.687. The P value of the difference between the two by paired t-test was found to be 0.001 which is highly significant.

At the end of Week 12, the mean of TUG score reduced in both the groups. In FTT Group, it reduced to 7.76±0.663 and in TE Group it reduced to 9.24±0.597. The P value of the difference between the two by paired t- test was found to be 0.000 which is highly significant.

This comparative analysis is demonstrated in Table & Figure.

Group	FTT Group		TE Group		P-value
	FTT (TUG in sec)		TE (TUG in sec)		
	(Mean value)	SD value	(Mean value)	SD value	
Day1	10.80	0.645	10.68	0.748	0.327
Week 6 9.	64	0.637	10.16	0.687	0.001*
Week 12 7	.76	0.663	9.24	0.597	0.000*

Figure 4: Comparison between mean of TUG scores in FTT group and TE group

6. CONCLUSION

The common trend of the treatment of OA knee is to provide strengthening exercises of quadriceps & hamstring muscles. Exercises for knee OA concentrate on increasing strength with the assumption that functional improvement will follow. In this study, the FTT group demonstrated a decrease in Pain level by (75%) when compared to the TE group (50%), which thus could account for the functional ability differences seen between groups. The FTT group performed exercises which required the subject to change directions, stand on one foot, and negotiate around other individuals and objects and may have resulted in greater task performance and muscular strength as completion of these activities required strength, coordination, balance, postural control, stability, mobility as well as the environmental demands associated with those tasks. Conversely, the TE group who practiced strengthening exercises with minimal gait training on the treadmill practiced more under a part practice model, which may have led to the observed findings. There is a nonlinear relationship between impairment and function. Improvements in strength beyond a certain threshold fail to enhance functional performance.

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