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THE EFFECTS OF TRADITIONAL STRENGTHENING EXERCISES VERSUS FUNCTIONAL TASK TRAINING ON PAIN, BALANCE, WALKING SPEED AND FUNCTIONAL MOBILITY IN OSTEOARTHRITIS KNEE.

THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE AWARD OF

DEGREE OF DOCTOR OF PHILOSOPHY
IN THE FACULTY OF PHYSIOTHERAPY

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LIST OF FIGURES

Sr. No.	Figure	Page No.
2.1	Cartilage in normal and Arthritic knee joint	8
2.2	Anatomy of normal knee joint	12
2.3	Posterior view of knee joint	15
2.4	Flexor group of knee joint	19
2.5	Extensor group of knee joint	21
2.6	Radiograph of knee joint	30
3.1	Timed up and go test	98
3.2	Berg balance scale	109
3.3	TE program group	124
3.4	Functional task group	130

LIST OF TABLES

Sr. No.	Table	Page No.
2.1	Extensor group muscles of knee joint	18
2.2	Flexor group muscles of knee joint	20
4.1	Demographic data of the age of subjects of TE and FTT group	137
4.2	pie chart presentation of demographic data of age of the subjects of TE and FTT-group	138
4.3	Comparison Between mean of VAS scores in FTT group and TE group	140
4.4	Comparison Between mean of WOMAC scores in FTT group and TE group	143
4.5	Comparison Between mean of TUG scores in FTT group and TE group	146
4.6	Comparison Between mean of 20 Meter Walk test scores in FTT group and TE group	149
4.7	Comparison Between mean of Berg Balance Score scores in FTT group and TE group	152

LIST OF GRAPH

Sr. No.	Graph	Page No.
4.1	Comparison Between mean of VAS scores in FTT group and TE group	141
4.2	Comparison Between mean of WOMAC scores in FTT group and TE group	144
4.3	Comparison Between mean of TUG scores in FTT group and TE group	147
4.4	Comparison Between mean of 20 Meter Walk test scores in FTT group and TE group	150
4.5	Comparison Between mean of Berg Balance Score scores in FTT group and TE group	153

ABBREVIATIONS

FTT- Functional task training

TE- Traditional Exercises

VAS-Visual Analog Scale

WOMAC-The Western Ontario and McMaster Universities Osteoarthritis Index

TUG-Time Up & Go

BBS- Berg Balance Scale

ABSTRACT

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

Study design: Comparative case control study. ***Methodology:*** Fifty individuals with a diagnosis of OA Knee were selected directly from Physiotherapy outpatient door of Jaipur Physiotherapy College, MVGU, Jaipur. These individuals were randomly assigned into two groups: FTT Group [Functional task Training (n = 25)] and TE Group [Traditional Exercise (n = 25)]. FTT Group Functional tasks included sit to stand box lift, standing star exercise, walking up and down a ramp while holding a weight, ascending/descending stairs while holding a weight in the preferred hand, and walking indoors while passing a weighted ball from hand to hand. Subjects performed the exercises for one minute with (when indicated) a one-pound weight. Progressions included either an increase in weight or time to perform the activity. Subjects in the TE program performed four-way straight leg raises (4 way SLR), seated knee extension, wall slides, step ups, and ambulation on the treadmill. Two sets of ten repetitions were performed for each exercise. Weight repetition progression based on subject's tolerance. Subjects ambulated on the treadmill at their own pace for a period that did not exceed 15 minutes. Both the groups were given exercises supervised by physiotherapist on regular basis for 12 weeks. Data for measurements of Pain on VAS, Physical function on WOMAC score, Balance & mobility on BBS & TUG and walking speed on 20 meter walk test, was collected on day 1 (pretreatment session), at 6 weeks, and at week 12.***Results:*** Results indicate that both groups improved in all measures of pain, Balance, walking speed and functional outcomes. However, upon Intergroup analysis the mean changes in the score of VAS, WOMAC, TUG, BBS

&20-meter walking time was highly significant across the two testing periods (at 6 week & 12 week) for the functional task training group (FTT) with respect to Traditional Exercise Group (TE). ***Conclusion:***Functional task training on regular basisis an effective rehabilitation program for improving functional mobility, balance, walking speed and decreasing pain in OA Knee.

Key words: Functional Task Training, Traditional exercises, OA Knee, visual analogue scale (VAS), *Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC)*

TABLE OF CONTENTS

Declaration by student		ii
Certificate of guide		iii
Acknowledgements		v
List of Figures		vi
List of Tables		vii
List Of Graphs		viii
Abbreviations		ix
Abstract		x
CHAPTER	**CONTENT**	**PAGE NO**
1	**Introduction**	2
	Aims & Objective of the study	7
	Alternate Hypothesis	7
	Null Hypothesis	7
2	**Review of Literature**	8
	Introduction	9
	Diagnosis and Pathophysiology of the Disease	29
	Prevalence and Incidence of OA Contributing Factors	34
	Mechanics/Pathomechanics	44
	Rehabilitation Exercises for Knee OA	56
3	**Materials and Methods**	82
	Subjects	85
	Inclusion Criteria	85
	Exclusion Criteria	86
	Instrumentation	86
	Procedures	125
	Data Analysis	138
4	**Results**	139

5	**Discussion**	157
6	**Conclusion**	163
	Summary	165
	References	167
	List of publication from thesis	
	Curriculum vitae	
	Appendices	
	Appendix A –DRC Approval Form	
	Appendix B -Patient consent form	
	Appendix C -Demographics Questionnaire	
	Appendix D -Data Collection Form	
	Appendix E –Assessment Form	
	Appendix F - Master Chart	

Chapter 1

Introduction

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) is a degenerative articular 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). OA is characterized by degradation of the articular cartilage, resulting in an alteration of its biomechanical properties (Pearle AD, Warren RF, Rodeo SA, 2005). There are alternations of the tensile, compressive, shear properties and hydraulic permeability of the cartilage, thus increased stiffness of the subchondral bone (Flores RH, Hochberg MC, 1998). 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 (Cerhan JR, Wallace RB, el-Khoury GY, Moore TE, Long CR, 1995).

Osteoarthritis (OA) is the most common form of arthritis in the United States (Lawrence et al., 2008) in adults over the age of 45 (Hunter, McDougall & Keefe, 2009). 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 (Hinton, Davis, & Thomas, 2002). To date, no cure for the disease exists. However, evidence suggests that risk factors for the onset and progression of the disease are reducible or avoidable through lifestyle modifications such as weight loss, increased physical activity and dietary changes. Epidemiologic studies confirm that these modifications may help control the onset and progression of knee OA (Zhang, 2010).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).

According to the World Health Organization, knee OA ranks the fourth most common cause of disability in women and the eighth in men (Simmons, Mathers, & Pfleger, 2000). 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 (Arthritis Foundation, 2009).

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 articular 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 (Vad, Hong, Zazzali, Agi, & Basrai, 2002).Stiffness associated with restricted activities and ultimate deconditioning is often associated with the disease (Dixon, Hinman, Creaby, Kemp, & Crossley, 2010; Leslie, 2000). 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).

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 (Brousseau et al., 2005). Traditional exercises tend to focus on the isolation of one or more muscle groups (e.g., quadriceps) in an attempt to address the impairment. Alternately, functional task 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 (de Vreede, Samson, Van Meeteren, Duursma, & Verhaar, 2005).Functional task training involves the performance of muscular control activities as well as balance and coordinated movement strategies required 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).

In a pilot study, Blundell, Shephard, Dean, Adams and Cahill (2003) investigated 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 functional task 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 functional task 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). Exercise programs designed to help usmeet the activity and participation needs of our clients may influence their responsiveness to exercise (Fitzgerald & Oatis, 2004). Thus, creating an exercise program that focuses on functional task training at the activity level may improve exercise compliance and decrease the fear associated with traditional exercise (Campbell, 2005).

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

Aims & Objective of the study

Aims & Objective of this study is to investigate the effects of traditional exercises and selective functional task training on pain, balance, walking speed and function in old adults with OA of the knee.

Alternate Hypothesis

Functional task training will be more effective than traditional therapeutic strengthening exercise programs in decreasing pain, improving walking speed & functional mobility in old individuals with knee osteoarthritis.

Null Hypothesis

There will be no any significant difference in effect of Traditional strengthening exercises & Functional task training on Pain, walking speed & functional mobility in old individuals with knee osteoarthritis.

Chapter 2

Review of Literature

Introduction

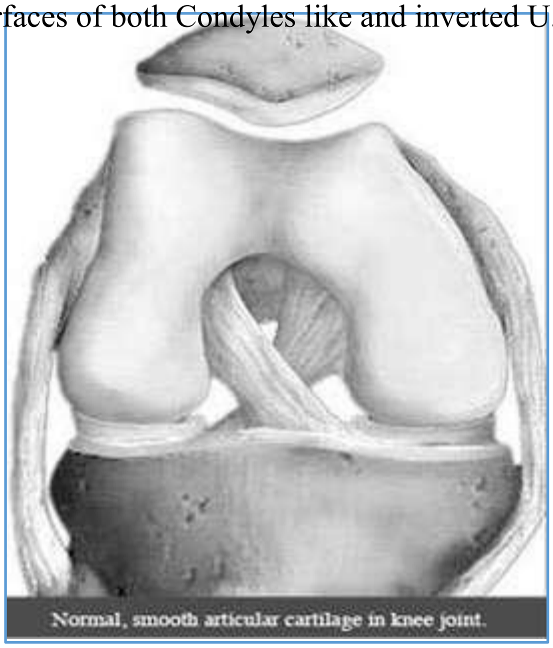
This chapter deals with anatomy, Biomechanics, epidemiology, risk factors, etiopathogenesis, signs and symptoms and management of Osteoarthritis along with basic concepts of Isotonic exercise which helps us to gain better understanding of effect of combined Isotonic exercises in unilateral Knee Osteoarthritis.

Anatomy of Knee Joint

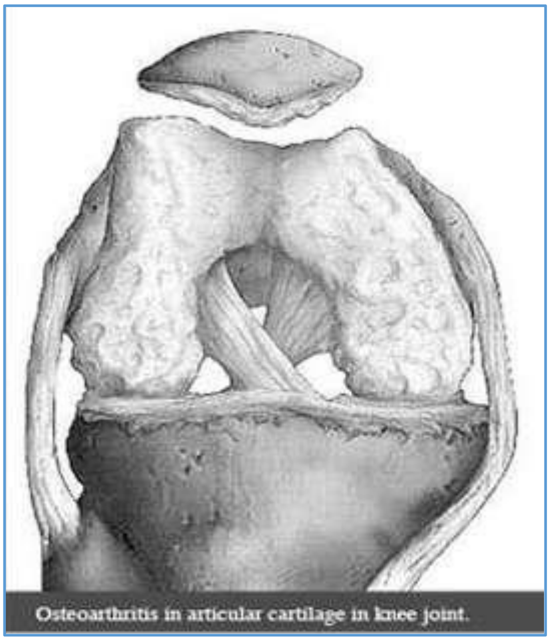
The Knee Joint was formerly described as a hinge joint. It consist of three articulation in one; two condyloid joints one between each condyle of the femur and the corresponding meniscus and condyle of tibia; and one synovial joint between the patella and femur.

Articular Surfaces

The distal femoral Condyles bearing articular cartilage are almost convex; in lateral profile both are spiral with a curvature increasing posteriorly, the lateral condyle more rapidly. The tibial proximal surfaces are also cartilage covered areas, separated by the inter Condylar region, each is gently hollow centrally and flattened peripherally where a meniscus rests. The lateral Tibial articular surface is almost circular and smaller; the medial oval with a longer anteroposterior axis. Femurotibial congruence is improved by the menisci, shaped to increase the concavity of tibial surfaces, the combined lateral tibiomeniscal surface being deeper. The distal outlines of the femoral surfaces conform to the tibiomeniscal articular surfaces. The surfaces approach congruence in full extension, the close packed position. Osseous Components of the Patellofemoral joint are the trochlear groove of the femur and the patellar facets. Patella`s articular surface is adapted to the femoral surfaces extends on to the anterior surfaces of both Condyles like and inverted U.



Normal, smooth articular cartilage in knee joint.



Osteoarthritis in articular cartilage in knee joint.

Figure 2.1 Cartilage in Normal & Arthritic Knee Joint

Fibrous capsule

The fibrous capsule is complex, partly deficient and fully augmented by expansions from adjacent tendons. Its posterior, vertical fibers are attached proximally to the posterior margins of the femoral condyles and intercondylar fossa and distally to the posterior margins of the tibial condyles and intercondylar area. Proximally on each side it blends with the attachments of gastrocnemius and is centrally strengthened by oblique popliteal ligament.

Synovial membrane

The synovial membrane of the knee is the most extensive and complex in the body. At the proximal patellar border, it forms a large suprapatellar bursa between quadriceps femoris and the lower femoral shaft. This is, an extension of the joint cavity sustained by articularis genu, which is attached to it. Along side the patella the membrane extends beneath the aponeurosis of thesti, more extensively under the medial. Distal to patella the synovial membrane is separated from the patellar ligament by the infrapatellar fat pad, covering which the membrane projects into the joint as two fringes or alar folds, these bear villi and then converge posteriorly to form the single infrapatellar fold (ligamentum mucosum) which curves posteriorly to its attachment in the femoral intercondylar fossa. At the sides of a joint the synovial membrane descends from the femur, lining the capsule as far as the menisci. Posterior to lateral meniscus the membrane forms a subpopliteal recess between a groove on the meniscal surface and the tendon of the popliteus, it is reflected across the front of cruciate ligaments, which are situated outside the synovial cavity.

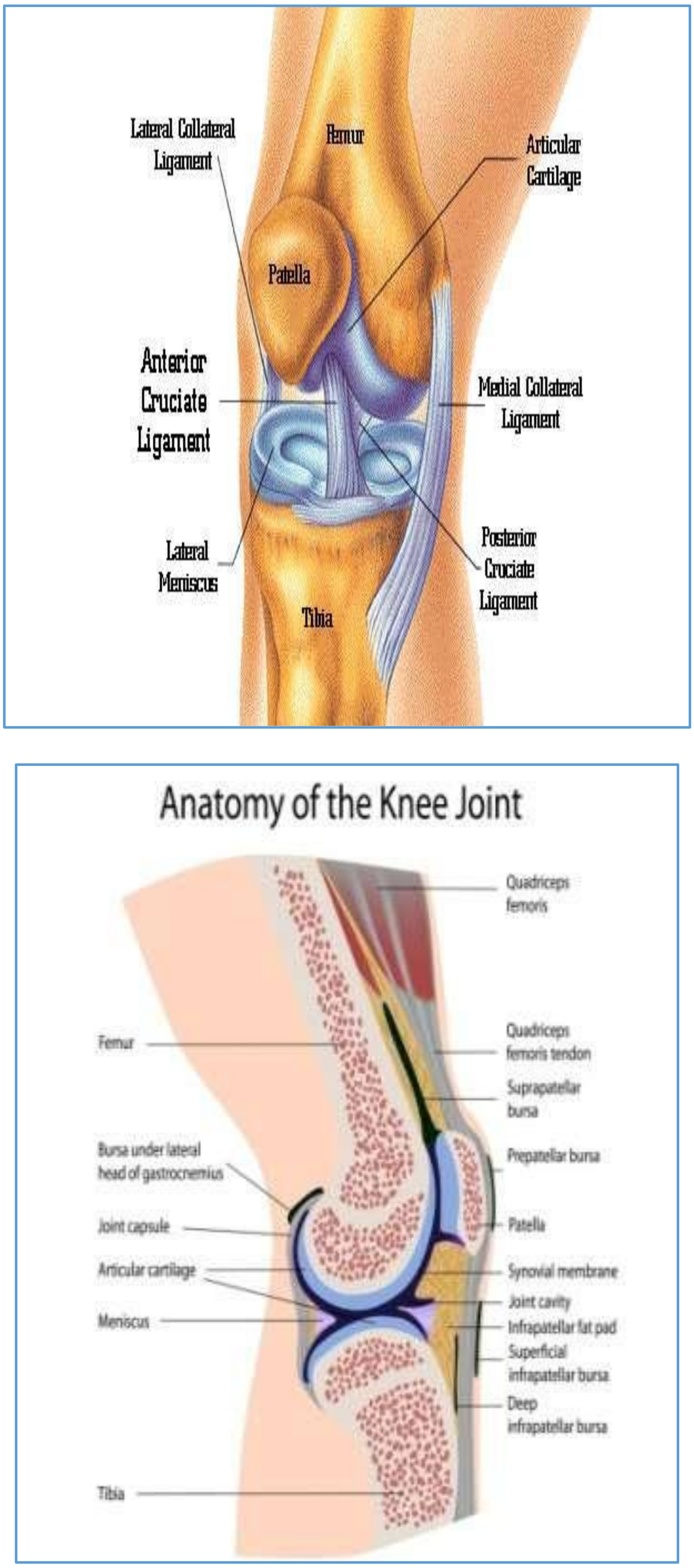


Figure: -2.2 Anatomy of Normal Knee Joint

Bursae

Bursae associated with the knee are numerous.

Anteriorly

1. Prepatellar

2. Infrapatellar

3. Subcutaneous infrapatellar

4. Suprapatellar

Laterally

1. A bursa between the lateral and the tendon of biceps femoris.
2. One between fibular collateral head of gastrocnemius and joint capsule (sometimes continuous with the joint).
3. One between fibular collateral ligament ligament and the tendon of popliteus.
4. One between the tendon of popliteus and the lateral femoral condyle.

Medially

1. A bursa between the medical head of gastrocnemius and fibrous capsule.
2. A bursa between the tibial collateral ligament and the tendons of sartorius, gracilis, and semitendinosus.
3. A bursa between tendon of semimembranosus and medial tibial condyle and also medial head of gastrocnemius.
4. An occasional bursa between the tendon of semimembranosus and semitendinosus.

5. Variable bursa in number and position, deep to the tibial collateral ligament between the capsule, femur, medial meniscus, tibia or tendon of semimembranosus.

Posteriroly, bursae are variable.

Ligaments of Knee Joint:-

*Ligamentum Patellae

The ligamentum patellae is the central portion of the common tendon of the Quadriceps femoris, which is continued from the patella to the tuberosity of the tibia.

Obliaue Pooliteal Lligament

This ligament is a broad, flat, fibrous band. It is attached above to the upper margin of the intercondyloid fossa and posterior surface of the femur close to the articular margins of the condyles, and below to the posterior margin of the head of tibia. The oblique popliteal ligament forms part of the floor of the popliteal fossa, and the popliteal artery rests upon it.

Tibial Collateral Ligament

The tibial collateral is a broad, flat, membranous band. It is attached, above, to the medialcondyle of the femur immediately below the adductor tubercle; below, to the medial condyle and medial surface of the body of the tibia.

Fibular Collateral Ligament

The fibular collateral ligament is a strong, rounded, fibrous cord, attached, above, to the back part of the lateral condyle of the femur, immediately above the groove for the tendon of the popliteus; below, to the lateral side of the head of the fibula, in front of the styloid process.

Anterior Cruciate Ligament

The Anterior Cruciate Ligament is attached to the depression in front of the intercondyloid eminence of the tibia, being blended with the anterior extremity of the lateral meniscus; it passes upward, backward, and lateral ward, and is fixed into the medial and back part of the lateral condyle of the femur. Anterior Cruciate Ligament consists of 2 major bundles-

1. Anteromedial- It is taut in flexion.

2. Posterolateral- It is taut in extension

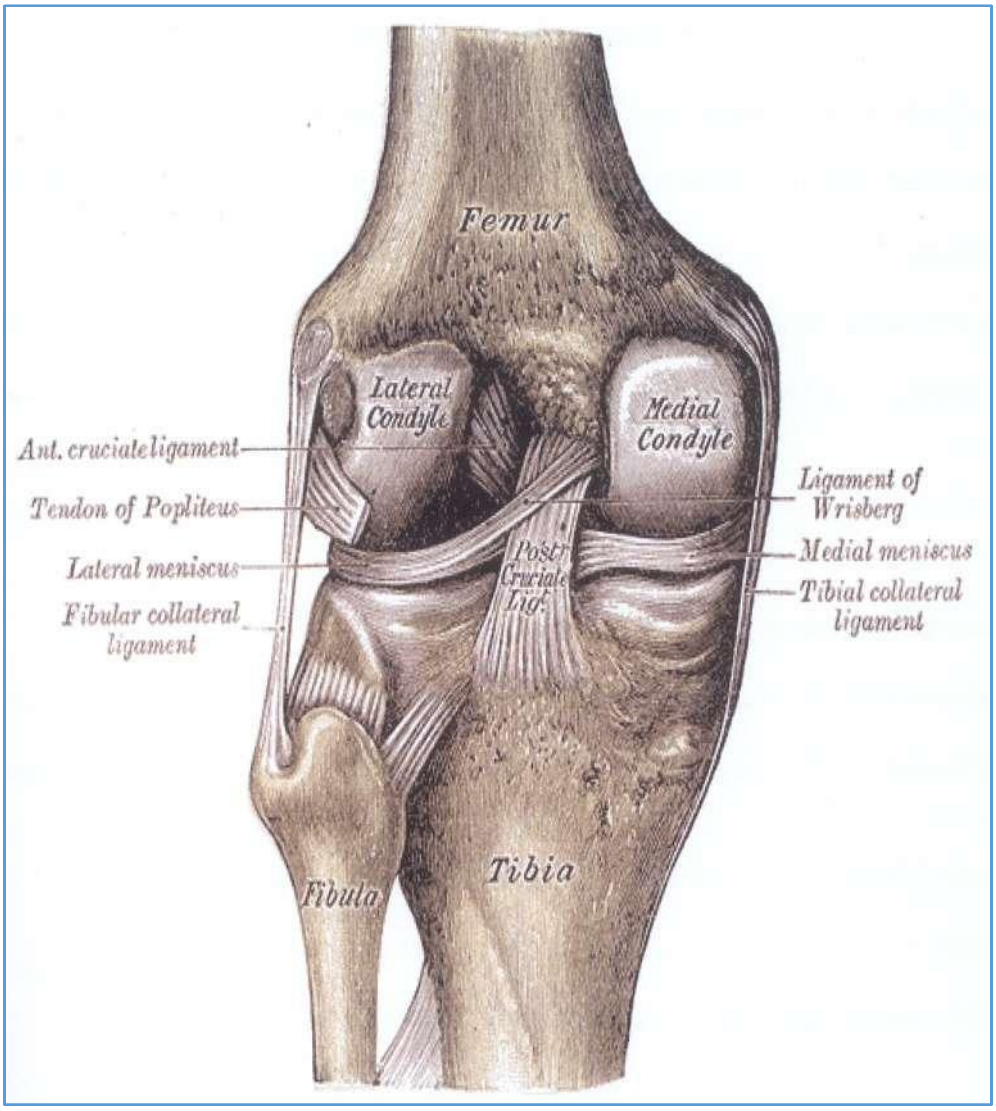


Figure: -2.3 Posterior View Of Knee joint

Posterior Cruciate Ligament

The Posterior Cruciate Ligament is attached to the posterior intercondyloid fossa of the tibia, and to the posterior extremity of the lateral meniscus; and passes upwards, forward, and medial ward, to b fixed into the lateral and front part of the medial condyle of the femur. Posterior Cruciate Ligament can be divided into posteromedial and anterolateral fiber bundles. Posteromedial are taut in extension and anterolateral are taut in flexion.

Menisci

The menisci are two crescentric lamellae, which serve to deepen the surfaces of the head of the tibia for articulation with the condyles of the femur. Each meniscus covers approximately the peripheral two-thirds of the corresponding articular surface of the tibia.

1. The medial meniscus- It is attached to the anterior intercondyloid fossa of the tibia, in front of the anterior cruciate ligament; its posterior end is fixed to the posterior intercondyloid fossa of the tibia, between the attachments of the lateral meniscus and the posterior cruciate ligament.
2. The lateral meniscus- Its anterior end is attached in front of the intercondyloid eminence of the tibia, lateral to, and behind, the anterior cruciate ligament, with which it blends; the posterior end is attached behind the intercondyloid eminence of the tibia and in front of the posterior end of the medial meniscus.

   They act to maintain the joint space by serving shock absorber when compressive forces are placed on the knee. and they improve the congruency of the joint that improves joint stability and decreased contact stress on the articular surfaces of the knee.

Transverse Ligament

The transverse ligament connects the anterior convex margin of the lateral meniscus to the anterior end

of the medial meniscus; its thickness varies considerably in different subjects, and it is sometimes absent.

Coronary Ligaments

They are merely portions of the capsule, which connect the periphery of each meniscus with the margin of the head of the tibia.

Blood Supply

Femoral, popliteal arteries (superior, middle, and inferior genicular arteries). The descending genicular artery supplies the vastus medialis and various portions of knee joint and surrounding musculature. Saphenous branch of descending genicular artery supplies medical aspect of joint. Superior and inferior genicular arteries supply cruciate ligaments

Nerve Supply

Branches of Femoral, Obturator, tibial, and common Peroneal nerves accomplish the innervation of the knee joint.

Muscles of knee joint

Extensor group

Table 2.1: - Extensor group of muscles of Knee joint.

Muscle Quadriceps Femoris	Origin	Insertion	Nerve supply
A.Rectus Femoris	a) StraightHead: From the upper half the anterior inferior iliac spine. b)Reflected Head: From the groove above the margine of the acetabulum and the capsule of the hip joint	Base of patella	Femoral nerve
B.Vastus Lateralis	The origin is linear. The line runs along: a) Upper part of intertrochanteric line. b) Anterior and inferior borders of greater trochanter. c) Lateral lip of gluteal tuberosity. d) Upper half of lateral lip of linea aspera.	a) Lateral part of the base of patella. b) Upper 1/3 of the lateral border of patella. c)expansion to the capsule of knee joint.	Femoral nerve
C.Vastus medialis	a) Lower part of intertrochantric line .b)Spiral line. c)Medial lip of linea aspera. d)Upper ½ of lateral lip of linea aspera.	Medial 1/3 of the base and upper 2/3 of the medial border of the patella.	Femoral nerve
Vastus intermedius	Upper 3/4 of the anterior and lateral surface of the shaft of the femur.	Base of patella.	Femoral nerve

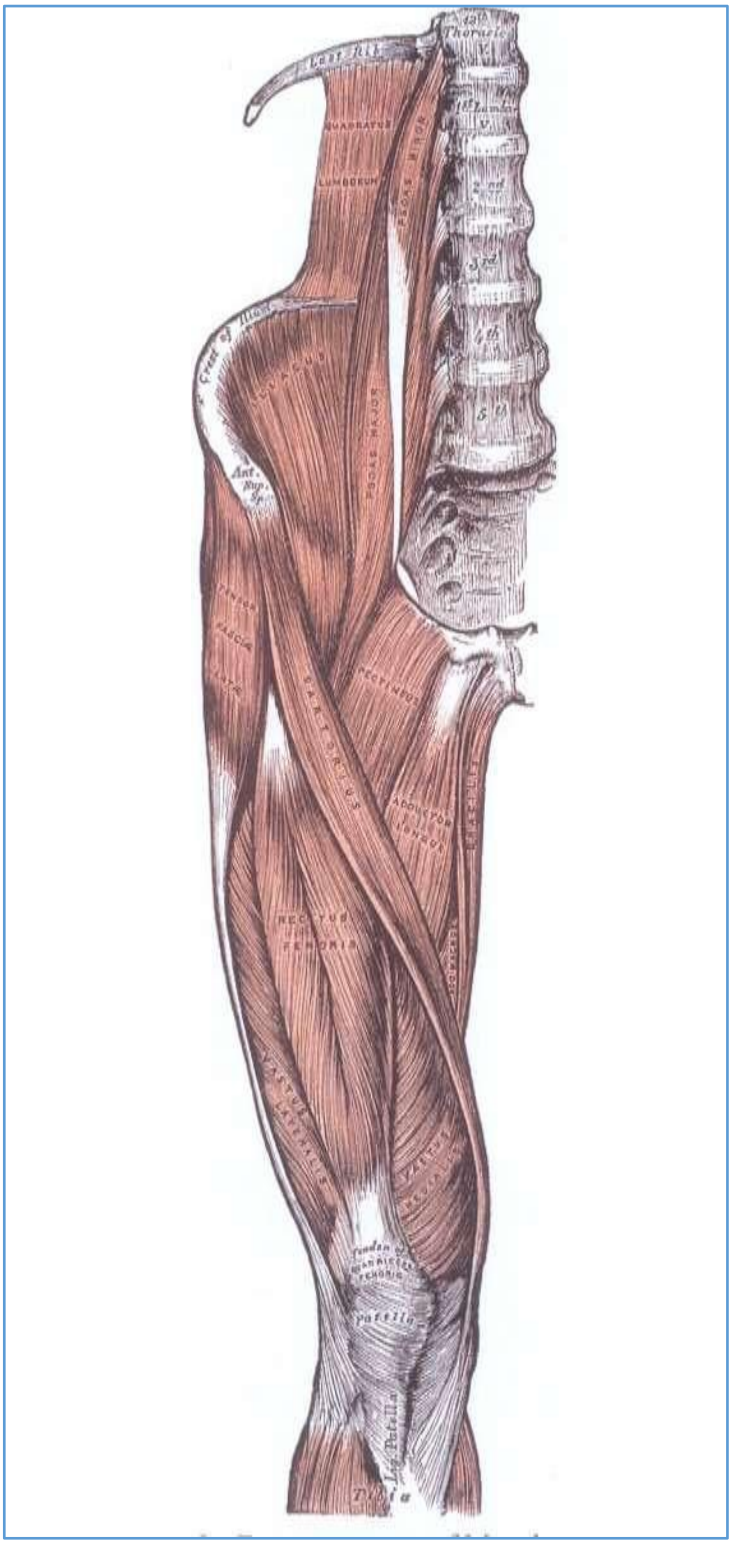


Figure: -2.4 Flexor group of muscles of knee joint

Flexor group

Table 2.2: Flexor group of muscles of knee joint.

Muscle	Origin	Insertion	Nerve supply
Bicep femoris	a) Long Head: From the inferomedial impression in the upper part of ischial tuberosity. b) Short Head: From lateral lip of linea aspera between the adductor magnus and the vastus lateralis.	The tendon is either folded around, or split by a fibular collateral ligament. It is inserted in to head of fibula.	Long head by tibial part of sciatic nerve. Short head by common peroneal nerve.
Semitendinosus	Inferomedial impression on the upper part of ischial tuberosity.	Upper part of medial surface of behind the sartorious and gracilis.	Tibial part of sciatic nerve.
Semimembranosus	Superiolateral impression on the upper part of ischial tuberosity.	Groove on the posterior surface the medial condyle of the tibia.	Tibial part of sciatic nerve.

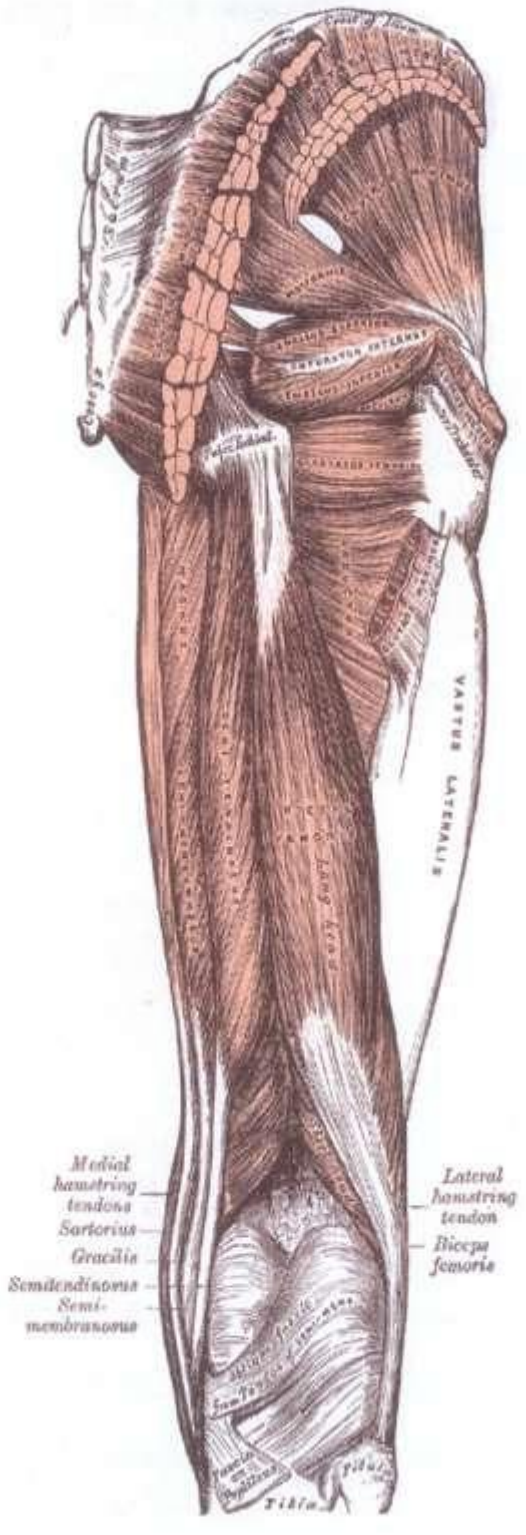


Figure 2.5 Extensor group of muscles of knee joint

Biomechanics of Knee

The Tibiofemoral joint relies on muscular, meniscal and ligamentous support to maintain biomechanical and anatomical integrity. The Patellofemoral joint mechanics depend on the properties of articular cartilage, as well as on its dynamic and static components.

The anatomic axis of femur is oblique directed inferiorly and medially from its proximal to distal end. Anatomic axis of tibia is vertical. Femoral and tibial longitudinal axis normally form an angle of 185-190 degrees medially at knee joint.

Movement

The knee joint has 2 degrees of freedom of motion. Flexion-extension and tibial rotation.

Flexion-extension is the rotation around coronal axis and in sagittal plane. Internal and external tibial rotation occurs around the longitudinal axis but in transverse plane.

In the tibiofemoral joint, surface motion occurs in three planes simultaneously but is greatest by far in the sagittal plane. In the patellofemoral joint, surface motion occurs simultaneously in two planes, the frontal and the transverse, and is greater in the frontal plane.

Extension of the knee is linked to superior patella glide, anterior translation of tibia and external rotation of the knee. This rotation is called the Screw-home mechanism or automatic rotation. Automatic rotation is aided by tension developed in cruciate ligaments. The Screw-home mechanism of the tibiofemoral joint adds stability to the joint in full extension.

Flexion of the knee is associated with internal rotation of tibia, posterior translation of tibia and inferior glide of patella. During flexion, rotation of tibia is initiated by the popliteus muscle and continues as allowed by geometry of joint surfaces.

Patella has other motion components associated with superior and inferior glide caused by quadriceps and ligamentum patellae. The normal tracking pattern of patella includes lateral shift, lateral tilt and lateral rotation as knee is extended from flexed position.

The patella aids knee extension by lengthening the lever arm of the quadriceps muscle force throughout the entire range of motion and allows a wider distribution of compressive stress on the femur.

Active tibial rotation differs from automatic rotation in that it is caused by muscular effort instead of passive elements. During voluntary rotations, the axis of rotation passes through medial compartment. During external rotation of tibia, lateral tibial plateu slides posteriorly.

Active knee flexion ranges from 125-140 degrees depending upon the amount of flexion at the hip. Active tibial rotation reaches a maximum of 20-25 degree of internal rotation and 40 degrees of external rotation. Rotation reaches a maximum range between 45 degree and 90 degree of knee flexion.

Biomechanics of Osteoarthritic Knee

The primary concept involved at the knee is that of increased stress (force per unit area) and the response of musculoskeletal system to this stress.

In most patients with osteoarthritis of the knee, there is no specific known underlying reason for the development of osteoarthritis and the resulting deformity.

When a patient with a normally aligned lower extremity stands on both legs, the line of weight bearing force goes from the center of the femoral head through the center of knee and through the center of the ankle.

In a patient with genu varum, the weight bearing line falls through the medial side of knee or medial to knee. In genu valgum, the weight bearing line falls lateral to the knee.

During normal walking, a force of about 3 times body weight is transmitted through the knee. Largest portion of this load is borne on medial side of knee. The magnitudes of force are not identical throughout the weight bearing part of gait on both plateau.

Loss of medial meniscus decreases the contact area between the femur and the tibia by approximately 50%.

The anatomical axis of the knee is angle made by intersection of a line from center of the knee down the shaft of tibia. This angle does not take into account malunions or other abnormalities in proximal femur, femoral shaft, foot or ankle.

The mechanical axis is the angle formed by intersection of a line from the center of femoral head to the center of distal femur and a line through the center of ankle to the center of proximal tibia. Normally this angle is 0 degrees. The mechanical axis does take into account abnormalities in femoral shaft, tibial shaft and ankle. Thus, mechanical angle must be used in planning any type of reconstructive procedure for osteoarthritis of knee.

Flexion deformity of knee from whatever cause also increases force per unit area.

Therefore, the largest area of contact between the tibia, meniscus and femur occurs with knee in full extension and decreases with flexion. Flexion deformity results in loads being carried across a smaller surface.

Although the tibial Plateaus are the main load bearing structures in the knee, the cartilage, menisci and ligaments also bear loads. The menisci aid in distributing the stresses and reducing the load imposed on the tibial plateaus.

Fracture of tibial plateau may increase the stress by 2 modes of action:

1. Initial disruption of articular cartilage with irregularities of articular surface thus creating points of increased stress.
2. Production of varus/valgus deformity if plateau can't be reduced and held in normal anatomic position.

Malunited fracture of tibial or femoral shaft results in malalignment that leads to shift of weight bearing line to medial or lateral side of knee creating overload on otherwise normal joint. Over a long time this may result in osteoarthritis of loaded compartment.

Once an angular deformity is present one compartment of the knee bears less weight and may eventually bear no weight at all. This means that in varus deformity, the entire load is passing through the medial side of the knee. Because of the ligamentous stays on the lateral side of the knee, the actual force increment is greater than if no deformity existed.

Osteoartritis

Osteoarthritis is a nonsystemic disease primarily affecting the weight bearing joints of the lower extremity. Individuals with knee OA must often overcome a variety of problems, such as joint pain, stiffness, limitations in motion, crepitation, instability, joint enlargement, impaired muscle strength, motor and sensory dysfunctions, and functional limitations that prevent them from participating in regular physical activity and impaired quality of life. The principal symptom associated with knee OA is articular pain, which is typically exacerbated by activity and relieved by rest. Primary risk factors for knee OA include gender, congenital malformations, and age. Secondary risk factors include obesity, inactivity, muscle weakness, and heavy physical activity (occupation or recreational) trauma, and rnalalignment (Felson, 2006).

Individuals with a history of injury to their anterior cruciate ligament or menisci were shown to develop knee OA 10 to 20 years post injury (Lohmander, Englund, Dahl, & Roos, 2007).Mechanical trauma can result in arthrological factors, such as varus/valgus deformities, leading to biomechanical modifications. Varus alignment is associated with an increase in adductor moment that is responsible for disease progression (Andriacchi, 1994; Mundermann, Dyrby, & Andriacchi, 2005) of the aforementioned factors, secondary risk factors are modifiable. Although difficult to determine which are factors for the development and progression of the disease, researchers agree that obesity is considered the primary risk factor in the progression of knee **OA** (Taylor, Heller, Bergmann, & Duda, 2004). Weight control, proper body mechanics and regular activity may minimize or at least diminish pain and disability (AGS panel on exercise & osteoarthritis, 2010; Blagojevic, Jinks, & Jordan, 2010).

Diagnosis and Pathophysiology of the Disease

Recent research suggests the nature of knee OA to be a metabolically active process rather than a condition simply characterized by "wear and tear" of the joint. (Velasquez & Katz, 2010).Currently, researchers regard OA as a metabolic or biochemical phenomenon that involves destruction and remodeling of joints. C-reactive protein, an inflammatory marker, which is evident in early knee OA, canlead to its progression (Spector et al., 1997).Progression of the disease includes the appearance of synovial hyperplasia, osteophyte formation, and capsular thickening (Osteoarthritis, 2001). Osteophyte formation often occurs at the margin of the hyaline cartilage and synovium in response to changes in knee joint loading (Jewell, Watt, & Doherty, 1998). Therefore, osteophyte formation may be the body's attempt at self-repair and redistribution of forces across the joint. This appears to represent an effort by these joint components to reform the joint and surrounding tissues in response to the histochemical changes in cartilage. Although OA was originally thought to involve the articular cartilage, it is now considered a disease of the entire joint, affecting the whole body as a functional unit (McGibbon, 2002). In addition to the breakdown of articular cartilage, there is subchondral bone remodeling with cyst formation, sclerosis, synovial inflammation, muscle atrophy, spasm and ligamentous involvement. Chondrocytes, synovial leukocytes and bone osteoblasts Iosteoclasts produce cytokines, the inflammatory mediators associated with inflammation. Inadequate repair of cartilage results from the imbalance of the catabolic and anabolic processes that drive these inflammatory cytokines. Ultimately, these changes in the biomechanical properties of cartilage result in anabnormal increase in pressure on both the cartilage andsubchondral bone (Martell-Pelletier, Boileau, Pelletier, & Roughley, 2008). Mechanoreceptors no longer provide adequate information to muscles, ligaments, tendons and joint capsules regarding cartilage load (Felson, 2006). As insult occurs to the joint, the body's response is to lay down additional bone to contend with compressional and functional forces placed on the joint. A decrease in cartilage volume accompanies a decrease in joint space, which may result in ligament laxity. As a result, loading rates are 21 % greater than those in normal individuals (Fischer, White, Yack, Smolinsky & Pendergast, 1997). These physical and histological changes along with capsular thickening, for joint stability, may mark the beginning of the disease. Confirmation of the structural and mechanical changes in the joint can be viewed radiographically. Physicians employ radiographs to establish the diagnosis and rule out other pathological processes. In 1963, the American College of Rheumatology adopted the KellgrenILawrence (KIL) classification based on radiographic evidence as the standard for grading OA severity. The KIL scale correlates with MRl's in detecting osteophytes, cartilage defects and joint effusion (Hayes et al., 2005).

Grades for Severity of Knee OA According to the Kellgren & Lawrence Scale (Kellgren et al., 1963):-

Grade **1** Doubtful joint space narrowing and possible osteophyte lipping

Grade 2 Definite osteophytes and possible joint space narrowing

Grade 3 Moderate multiple osteophytes, definite joint space narrowing and some sclerosis, and possible deformity of bone ends

Grade **4** Large osteophytes, marked joint space narrowing, severe sclerosis, and definite deformity of bone ends.

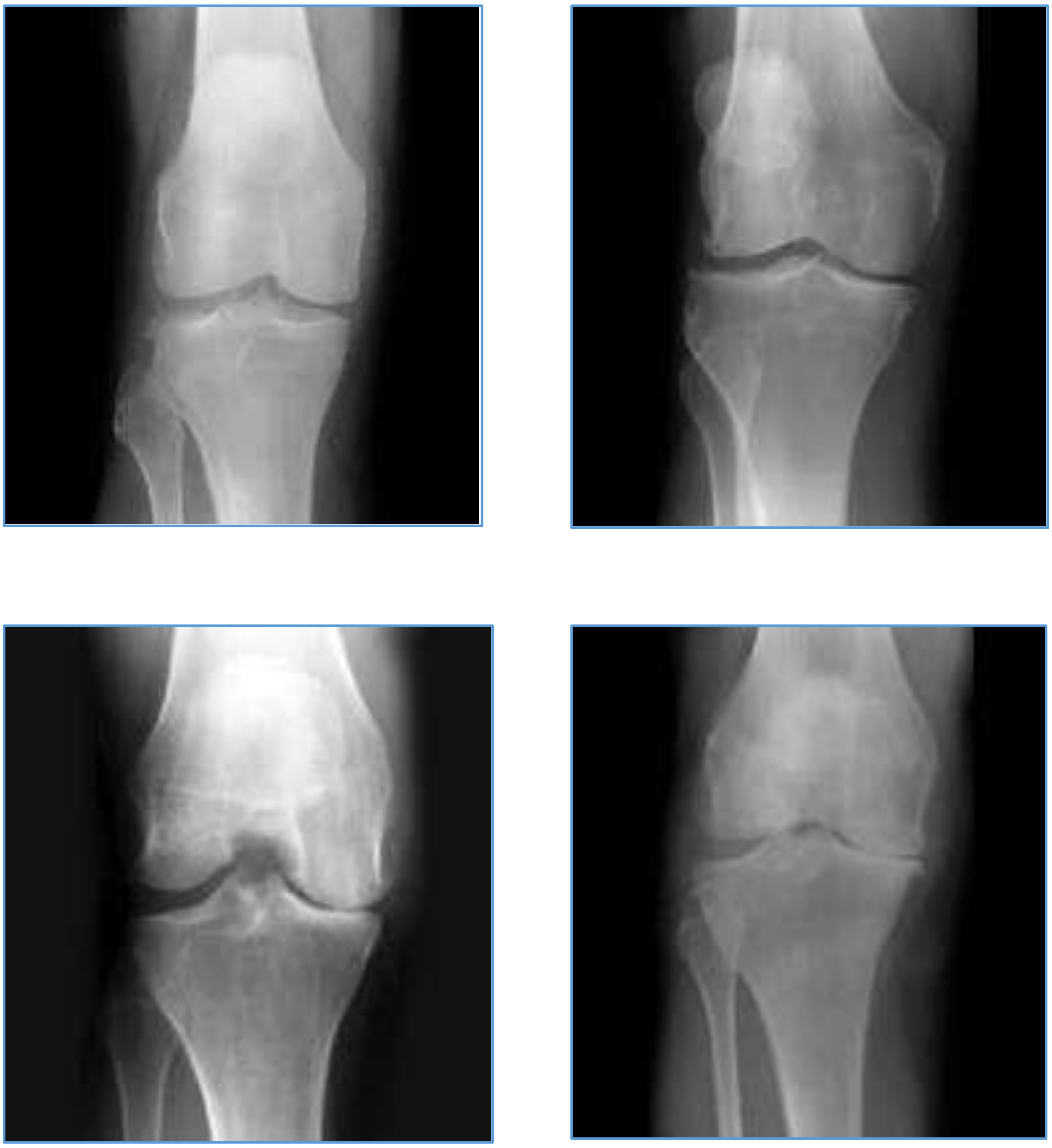


Figure 2.6 :- Radiograph of OA Knee.

Positive findings associated with knee OA may include asymmetric joint space, loss of articular cartilage, subchondral sclerosis and cysts, and osteophytic formation (Altman et al., 2000; Blagojevicy, Jinksy, Jeffery, Jordan, 2010). Although radiographs are used to confirm the diagnosis, the correlation between radiographs and symptoms is not always consistent (Leslie, 2000). The apparent progression in radiographic change does not always correspond to the degree of pain or to the level of functional ability (Blagojevic et al.,2010; Hunter et al., 2009; McAlindon et al., 1993). Thus, despite radiographic evidence, the individual may be asymptomatic (Osteoarthritis, 2001). The results of a survey administered by Peat, McCarney, a2nd Croft (2001)demonstrate that in a population of individuals (mean age, 55 years), 50% had knee pain without radiographic evidence while the other 50% had radiographic evidence without knee pain. Additionally, the presence and extent of radiographic OA does not predict its progression to a symptomatic state (Kim, Richard, Jones & Hegab, 2003).

Although radiographs are currently used to confirm a diagnosis of knee OA,Magnetic Resonance Imaging (MRI) may be superior in that it allows for direct visualization of the joint (Racunica et al., 2007),and may pick up early OA changes not viewed with radiographs (Wall & Doherty, 2003). To date, radiographs combined with clinical criteria prove to be an excellent and more cost effective alternative in the diagnosis of knee OA (Altman et al., 1986; Flores & Hochberg, 2003; Toivanen, 2007). This clinical classification criterion for idiopathic knee OA includes the presence of knee pain on most days of the month and at least one of the following: age over 50 years, morning stiffness less than 30 minutes in duration, crepitus on active joint motion. Furthermore, there should be radiographic evidence of osteophytes at joint margins. The combination of clinical and radiographic results increases the sensitivity (91%) and specificity (86%) of reaching a diagnosis of knee OA (Altman et al., 1986).

The guideline development group for the National Institute for Health and Clinical Excellence (NICE) guideline on osteoarthritis considered the following to represent a clin[redacted]an‟s working diagnosis of peripheral joint osteoarthritis:

- persistent joint pain that is worse with use
- age 45 years old and over

morning stiffness lasting no more than half an hour.

According to the NICE guideline, patients who meet the working diagnosis of osteoarthritis do not normally require radiological or laboratory investigations. This working diagnosis is quite similar to the American College of Rheumatologists‟ clinical criteria for classification of osteoarthritis of the knee. The criteria are knee pain, and at least one of the following three criteria: age >50 years, stiffness < 30 minutes, crepitus and ostephytes. Because there are several definitions of knee osteoarthritis, the populations included in studies of knee pain and studies of knee osteoarthritis overlap.

Prevalence and Incidence of OA

It is estimated that 10% of the world‟s population who are 60 years or older has significant clinical problems that can be attributed to osteoarthritis. Osteoarthritis of the knee is expected to be the fourth leading cause of disability by the year of 2020.

The estimated population prevalence varies, depending on age, gender and definition of the disease. Above the age of 55, radiologic knee osteoarthritis is an increasingly common cause of knee pain, and about 25% of individuals over 55 will report an episode of knee pain in the past year.Painful, severely disabling radiographic knee osteoarthritis affects about 1.5% of adults over the age of 55, whereas painful knee osteoarthritis associated with mild to moderate disability affects up to 10%. The prevalence of knee pain increases with age, though age is more closely correlated to knee pain in women than in men. Population studies have consistently reported a higher prevalence of radiographic knee osteoarthritis in women than in men from middle age onwards. In a Norwegian population between 24 to 76 years the overall self-reported prevalence of knee osteoarthritis was 7.1%, 7.9% in women and 6.2% in men respectively.

Osteoarthritis is a complex disorder with multiple risk factors. The risk factors can be divided

into three major categories.

1. genetic factors (heritability for knee osteoarthritis is high at 40-60%, though the responsible genes are largely unknown)
2. constitutional factors (for example aging, female sex, obesity, high bone density)
3. more local, largely biomechanical risk factors (for example joint injury, occupational/recreational usage, reduced muscle strength, joint laxity, joint malalignment)

In the Norwegian population knee osteoarthritis was significantly associated with several factors, such as fewer than 10 years` education and increased body mass index.

According to the Center of Disease Control (CDC), the prevalence of OA is dramatically increasing, and will continue to increase from previously reported numbers of 43 million to 60 million in the year 2020. The disease affects approximately 27 million people in the United States, 33% of whom are over the age of 65 (Lawrence et al., 2008; Sisto, & Malanga, 2006),and it is estimated that the number of individuals aged 65 and over will double in the next 20 years (Adelman & Daly, 2001). Sixty percent of adults over the age of 50 are afflicted with this disease (Vad et a!., 2002). The incidence of knee OA has risen by 22% from 1990 to 2005 (Flegal, Carroll, Ogden, Durtin, 2010). Ten percent of men and 13 percent of women over the age of 60 have symptomatic knee OA (Zhang & Jordan, 2010) and women have a 1.8 times greater likelihood of developing knee OA (Felson, 1997). Although knee OAis prevalent in the elderly, its presence is increasing steadily in middle-aged individuals (40 and over), and is the most frequently reported reason for orthopedic visits (Leslie, 2000). When compared to cardiovascular disease, knee OA is the most frequently encountered disability (Doherty, 2001) and is the primary reason for visits to a primary care physician in individuals over the age of 55 (Peat et al., 2001). Inactivity associated with the disease results in greater impairments and activity limitations which ultimately result in an increase in health care costs (Dunlop et al., 2010). In 2008, the annual cost for treating arthritis and its complications was almost 65 billion dollars in the United States (Zhang, 2008).

Contributing Factors

Obesity

According to the CDC (2005), obesity is a major health problem in our country. Statistics indicate obesity in the United States has doubled between 1971 and 1994 (Flegel, Carroll, Kuczmarski & Johnson, 1998). Individuals with a body mass index (BMI) greater than 30 are considered overweight, except in those individuals with a low percentage of fatty tissue (Bray, York, & Delaney, 1992). Knee OA is more common in obese individuals than in those of normal body weight (Cooper et a!., 2000; Murphy et al., 2008).Obesity is considered the primary risk factor in the incidence of and progression of knee OA(Messier, et al., 2009; Taylor, Heller, Bergmann, & Duda, 2004). Astephen, Deluzio, Caldwell, and Dunbar (2008) suggest that two thirds of the world population is at risk for developing knee OA in their lifetime.

An obese woman and man with a BMI of 30-35 kg/m2 have a four times greater, and 4.8times greater, respectively, risk of developing knee OAwhen compared to lean individuals. After a knee injury, this risk increases three fold for women, and five to six fold for men (Spector et al., 1994)[75]. Additionally, a higher body mass index (BMI) correlates with a larger concentration of inflammatory mediators, which is associated with functional decline and disease progression
(Wolfe, 1997). During walking, ground reaction forces are exerted by the contact surface on the joints. These forces are augmented in obese individuals, resulting inan increase in knee joint load. Greater muscle force is required to withstand this additional load (Browning & Kram, 2007). As a consequence, obese individuals may

chose to walk slower, since walking slower minimizes ground reaction forces and knee joint load. When compared to lean individuals, obese individuals walk with less knee flexion and generate less ankle and knee torque and power when walking at self-selected speeds (DeVita & Hortobagyi, 2003). This suggests that obese individuals may alter their gait ta minimize forces associated with a larger mass, and these alterations may result in compensatory motions at other joints (Bejek, Paroczai, Illyes, & Kiss, 2005).

In 2000, Cooper et al. conducted a prospective radiographic study involving 354 men and women with and without knee pain. In conjunction with radiographs, the subjects completed questionnaires regarding lifestyle, risk factors, medical history and leisure activities. The authors found that both obesity and knee trauma were strong predictors of incidence, as evidenced by a decrease in joint space, and that obesity is a significant variable in disease progression as these individuals demonstrated greater radiographic evidence. To determine the effect of knee OA over time, the Framingham study followed 1420 individuals with knee **OA** over a 30-year period (Felson et al., 1997). Radiographs were obtained before and after the study which demonstrated there was a higher prevalence of radiographic changes in women and that overweight individuals are at higher risk for symptomatic and radiographic knee OA (Felson et al., 1997).

Malalignment

At the impairment level, malalignment increases the risk and progression of knee **OA** (Sharma et al., 2001; Sharma, Dunlop, Cahue, Song & Hayes, 2003); however, the association of incidence and malalignment continues to be investigated (Tanamas et al., 2009). Radiographs are utilized to assess mechanical knee joint alignment by locating the anatomic axis of the knee via the intersection of two lines, which identify the femoral and tibia1 axis. A varus angle of 1-2 degrees constitutes neutral alignment (Peat, Mallen, Wood, Lacey, Duncan, 2008). In the elderly, malalignment greater than 5 degrees is associated with greater functional deterioration (Sharma et al., 2001). Varus malalignment is associated with radiographic evidence of decreased tibiofemoral joint space width and an increased external knee adductor moment, which is a marker of OA progression (Andriacchi, 1994; Mundermann, 2005). External knee adduction moments have been linked to an increase in medial knee joint load in individuals with knee varus deformities (Hurwitz,, Sharma, & Andriacchi, 1999 ; Sharma, et al., 2001). Varus and valgus deformities increase the risk of medial and lateral **OA** progression respectively, which is augmented if an individual is overweight (Sharma, Cahue, & Dunlop, 2000). In the literature, a direct relationship between has been noted (Sharma et al., 2000; Sharma et al., 2003). An 18-month longitudinal study examining quadriceps strength and OA progression in individuals with malaligned and or lax knees utilized baseline isokinetic strength testing and radiographs to determine the presence or absence of malalignment in 237 participants. Additional radiographs were taken 18 months later to assess the progression of the disease. Those individuals with malalignment or highly lax knees showed greater predictability of OA progression. Sharma et al. (2003) conclude that quadriceps-strengthening exercises may produce negative effects on this population. Since their study did not include any strengthening intervention, the negative impact of quadriceps strengthening on knee OA progression in this population is questionable (Sharma et al., 2003). A subsequent 12-week study investigated the effects of varus malalignment (measured by using 3D motion analysis during gait) on pain and function in individuals with knee OA (Lim, Hinman, Wrigley, Sharrna, & Bennell, 2008). Measures of knee varus/valgus laxity were assessed as well as isometric quadriceps and hamstring torque measures. Each participant completed the Western Ontario and McMaster Osteoarthritis Index **(WOMAC),** which is a **24-** question self - assessment questionnaire regarding pain, stiffness and function. Bellamy, Buchanan, Goldsmith, Campbell and Stitt (1988) reported this test to be highly valid and reliable **(lCC=.88--93)** for individuals with hip or knee OA. Performance measures included the step test, stair climb test and walking speed. Quadriceps exercises were performed over a 12-week period, which consisted of seated knee extension, short arc quads, straight leg raises and isometric knee flexion exercises with ankle weights and therabands. In this study, the severity of the disease was significantly associated with the degree of malalignment. Both the groups with neutral and malaligned knees had an increase in quadriceps strength and functional measures; however, the increase in quadriceps strength was not associated with an increase in the knee adduction moment in the group with malaligned knees, which may suggest that quadriceps strength may be indicated in this population. In fact, dynamic optimization (i.e. mathematical formulae) utilizing a **3D** model for gait analysis demonstrates that during stance, the knee is stabilized in the frontal plane by the quadriceps and gastocnemius muscles. This muscular stabilization of the knee serves as a mechanism to control the knee adduction moment (Shelbourne, Torry & Pandy, 2006).

Pain is the primary reason and most significant impairment for physician's visits as well as the ultimate cause for total knee replacements (O'Reilly & Doherty, 2003).

Pain is the most common symptom in patients with knee OA and contributes to declines in functional activities such as rising from a chair, climbing stairs and completing activities of daily living (ADL's) (Sharma et al., 2003). Individuals with knee OA usually describe their pain as a deep dull ache that is aggravated with weight bearing activities such as walking. By the year 2020, an estimated three million people in the United States will have a total knee replacement procedure performed secondary to end stage knee OA (Piva et al., 2010).

Clinicians employ the use of self-report questionnaires in the assessment of pain and function in individuals with knee OA. These include the Medical Outcome Study 36-Item Health Survey Questionnaire (SF-36), the Lower- Extremity Functional Scale (LEFS), the Knee Injury and Osteoarthritis Outcome Score (KOOS) and the Western Ontario and McMasters Universities

Osteoarthritis Index WOMAC). The SF-36, LEFS and KOOS have been reported to be highly valid and reliable tools (Binkley, StratFord, Lott, Riddle, & The North American rehabilitation network, 1999; Roos & Toksvig-Larsen, 2003; Ware & Sherboume, 1992).

Current research implicates either a nociceptive or neuropathic mechanism as causative agent of OA pain (Kidd, Langford, & Wodehouse, 2007). Central sensitization, the neuropathic mechanism, is thought to result in modification of the central pain transmitting neurons arising from chronic nociceptor stimulation (Woolf & Salter, 2000). Chronic pain is associated with this central sensitization, which may lead to a hypersensitivity modulating pain transmission resulting in an active process of transmission in both the periphery and the cortex. This "plasticity" can result in excitatory inputs to nociceptive neurons, resulting in additional pain. This may explain why some individuals with **OA** experience pain in the absence of noxious stimuli (Woolf et al., 2000). Pain characteristics may provide some insights regarding the mechanism of pain. During one-on-one interviews with 52 individuals with hip OA and 92 individuals with knee OA, participants described their pain intensity, duration, and predictability. Many of the participants described their pain as having "pins and needles" and burning, indicating that the pain may be neuropathic in nature (Hawker, et al., 2008). Individuals with neuropathic pain have hypersensitivity to pressure, cold, heat and light touch (Bennett, Attal, & Backonja, 2007). Intrusive night pain is evident in the later stages of the disease (Woolhead, Gooberman, Hill, Dieppe & Hawker, 2010). Pain at night can cause sleep disturbances in individuals with OA, which may be associated with fatigue, depression, anxiety and disability (Pawlikowska et al., 1994). Night pain is associated with a greater subjective report of fatigue and a reduced sense of well being in these individuals (O'Reilly et al., 2003). Understanding OA pain from the patient's perspective may be beneficial in determining the appropriate treatments for pain. However, since pain is subjective, individuals may have different descriptors of their pain. Due to these variations, pain is difficult to measure (Woolhead, et al., 2010). Yet, an inverse relationship between pain and both strength and function has been reported in the literature (Fitzgerald, Childs, Ridge, & Irrgang, 2002). Additionally, self reports of physical function may be interpreted by the person as the pain experienced with these activities rather than the ability to actually perform the activities. Since individuals tend to report a decrease in physical function when having pain, performance-based measures should be utilized to assess physical function (Stratford et al., 2006), as these measures are more sensitive to change and less influenced by pain than self-reported measures (Piva et al., 2010). Subject-reported measures of pain and disability do not always correlate with functional performance tests. Therefore, performance measures combined with self-reported measures will yield a more accurate outcome (Stratford et al., 2006).

Medication is often utilized to diminish pain experienced in advanced stages of knee **OA.** It has been reported that administration of NSAIDS to minimize pain can result in "analgesic arthropathy" due **to** excessive knee joint loading. Given the noted inverse relationship between pain, adductor moments and external knee flexion moments (Huwitz, Sharma, & Andriachi, 1999), an excess of medication can disguise the body's recognition and response to pain. Normal cartilage homeostasis is a balance between degeneration and repair. It is well demonstrated that NSAIDS tip the balance in favor of the destructive activities, and in doing so, exacerbate the very condition for which they have been prescribed (Hauser, 2010). Although pain medication is utilized to promote wellbeing, caution is advised in that overuse may result in progression of joint degeneration. Since pain is inherently a protective mechanism, excess use of analgesics may have shortcomings. Exercises based on improving strength and decreasing activity limitations may prove to be an alternative treatment and minimize the use of this medication in the knee OA population.

Mechanics / Patho-Mechanics

Gait

Gait is an automatic phenomenon requiring an intact neuromuscular and musculoskeletal system to coordinate and integrate the kinematic, kinetic, kinesthetic factors associated with it. Pain-free walking is a basic task required for normal locomotion and is an essential component for maintaining an independent life style (Bejek, Paroczai, Illyes, Kocsis & Kiss, 2006). Individuals with OA have difficulty with walking secondary to pain, stiffness and decreased flexibility (Van Baar, Assendelft, Dekker, Oostendorp & Bijlsma, 1999; Dixon et al., 2010). Their altered gait patterns, muscle atrophy, decreased range of motion, decreased strength, loss of function, and knee joint stiffness can lead to activity limitations (Slemenda, Brandt, Heilman, Mazzuca, & Braunstein, 1997; Gignac et al., 2006) Ultimately, painful walking may cause individuals to limit not only their level of activity but also their participation level in the community. Any pathological process affecting changes in flexibility, stability, strength, power or neural input may produce alterations in temporal-distance parameters that quantify gait including velocity, cadence, step length and stride length (Perry 1992; Perry & Burnfield, 2010). In the past, clinicians relied on observational gait analysis (OGA) to report on gait characteristics, which can be subjective as personal bias, and or clinical experience may influence this assessment (Sisto, 1998). Technological advances remove the subjectivity from gait observation by utilizing instrumented gait analysis (IGA), which provides spatiotemporal information on individual gait patterns. Quantitative gait analyses have demonstrated significant gait discrepancies in patients with knee OA (Lafuente, Sanchez-Lacuesta, Soler, Poveda & Prat, 2000). During normal walking, adults ambulate at a speed that minimizes excessive energy expenditure. Healthy 40-60 year old women and men walk between 1.35mJs and 1.41 mls respectively when ambulating at a comfortable speed. These values can increase to 1.94 and 2.19 mls when individuals walk as fast as they can without running (Bohannon, 1992). Individuals with knee OA ambulate with significantly reduced walking speed, lower cadence, shorter stride length, and with a more prolonged stance phase of the gait cycle compared to age-matched controls (Adriacchi et al., 1982; Baliunas et al, 2002; Gok et al., 2002; Hurwitz et al., 2000). These adaptations may be attributed to limb avoidance secondary to pain (Al-Zahrani & Bakheit, 2001; Andriachhi, Galante, & Fermier, 1982; Baliunas et al., 2002). People with knee OA employ a re-programming mechanism of the neuromuscular system which alters normal patterns that may result in minimizing joint loading forces during gait (Robon, Perell, Fang & Guererro, 2000). Walking slower is also associated with a reduction in these joint forces. Values of approximately 25% less or greater, dependent on the parameter measured, have been reported for knee OA individuals when compared to controls (England & Granata, 2007). As the disease progresses, gait speed can be reduced as much as .55m/sec. in some individuals (Zoltan et al., 2006). Gait speed has been found to be directly proportional to single stance time and inversely proportional to double support time (Perry, 1992). Most importantly, a decrease in gait speed is associated with activity limitations (Edmund, 1997) and accounts for individual gait variations as well as force attenuation (Perry, 1992). During normal walking, the knee encounters compressive forces that are equal to three to six times an individual's body weight (Grainger & Cicuttini, 2004). This increase produces an augmented contact force at the knee joint (Kaufman, Hughes, Murray, Kai-Nan 2001). An increase in walking speed requires augmented force and duration of the knee musculature to accommodate the increase in ground reaction force associated with faster walking speeds (Andriacchi et al., 1972). Thus, muscle activation is an important contributor to all joint forces about the lower extremity throughout the gait cycle.

The gait cycle constitutes both the stance and swing phase. The stance and swing phase, periods during which one (single support) or both feet (double support) are in contact with the floor, account for 62% and 38% of the gait cycle respectively when an individual walks at a rate of 80mlmin (Perry, 1992). When the foot strikes the floor during load phase, external ground reaction forces are directed vertically through the ankle, knee and hip, causing the knee to flex. To counterbalance the external moment and minimize joint forces, the quadriceps must produce an internal moment large enough to balance the external moment to resist knee buckling and absorb the forces associated with these knee joint loads (Winter, 1991). Quadriceps weakness during this weight bearing phase may result in increased activity of the hip extensors and ankle plantarflexors to contribute to the net support moment (Oatis, 1994). It is interesting that whilesome individuals with knee OA may reduce their knee flexion at heel strike to minimize these ground reaction forces (Childs, Sparto, Fitzgerald, Bizzini, & Irrgang, 2004; Mundermann et al., 2005), others demonstrate an increase in knee flexion during the loading phase (Heiden et al., 2009), which requires a greater net internal moment to accommodate for this increased joint angle. Also, an increase in knee flexion (Baliunas et al. 2002, Childs et al., 2004) as well as extension (Munderman, 2005) has been reported in the literature and further contributes to the knee instability seen in the individual with **OA.** Knee instability (buckling, shifting, or giving out) in the OA population is associated with factors that include muscular weakness, ligament laxity, proprioception deficits, malalignment and pain (Fitzgerald, Irrgang, Piva, Irrgang, & Bouzubar, et al., 2004). These individuals adopt a "quadriceps avoidance gait" which limits the quadriceps eccentric muscle control at knee flexion, resulting in an increased knee joint load (Taylor, Bergmann, Heller, & Duda, 2004). In the event that this loss of stability is caused by the inability of the hamstrings or quadriceps muscles to generate adequate torque (Kannus & Jarvinen, 1997), muscular co-contractions stabilize the joint (Lewek, Rudolph & Synder-Mackler, 2003a). This increased muscle activity around the joint results in a "stiffness" that compensates for joint instability, but these co-contractions increase the energy expenditure associated with walking (Kuo et al., 2010). Furthermore, these contractions can increase the adductor moment (Heiden et al., 2009). In the normal knee joint, loads are disproportionately transmitted to the medial compartment (Morrison, 1968). Forces attenuated at the medial joint during gait constitute 60-80% of the total force transmitted across the **knee** joint, and are 2.5 times greater than lateral forces (Baliunas, Hurwitz, Ryals, Karrar, Case, Block et al., 2002). As the ground reaction force passes medial to the knee, the knee joint attenuates 70% of the load (Andriacchi, 1994). There is an increase in the external knee adductor moment, in both early and late stance, which results in medial compartment load distribution across the tibia1 plateau (Andriacchi, **1994;** Teichtahl, Wluka, & Cicuttini, 2003; Lim et al., 2008). As this external ground reaction **force** passes medial to the knee, In the OA population there is a larger **and** more variable external knee adductor moment associated with walking when compared to normals, at terminal stance (Hurwitz, Ryals, Case, Block & Andriacchi, 2002), resulting in an increase in pain as the forces are augmented. Therefore, co-activation augments these forces and contributes to the progression of OA in the already compromised joint (Lewek et al, 2005) and can result in an increase in energy expenditure (Kuo & Donelan, 2010) in an individual who may already be experiencing fatigue (Bouzubar, & Fawzi, 2003). Forces become greater during single limb support as the center of gravity (COG) shifts to the support leg with the trunk, and the hip adducts to maintain the center of mass over the stance foot (Oatis, 2004). A correlation has been noted between the severity of disease and single limb adduction moment during gait (Kim et al., 2003). These moments are further augmented as an individual walks faster; (Andriacchi, Ogle, & Garante, 1977; Thorp, Sumner, Block, Moisio, Schott, & Wimmer, 2006); therefore, individuals with knee OA decrease their walking speed **to** decrease these external forces (Thorpe et al., 2006). Since these external knee adduction moments are greater in magnitude than those in the sagittal plane, individuals with knee OA utilize compensatory mechanisms to decrease joint loading (Al-Zahran et al., 2002; Bejek et al., 2006; **Hurwitz** et al., 1999). Subjects with medial joint compartment involvement may reduce the load by turning their foot outward, decreasing stride length and/or leaning their trunk toward the affected extremity. This allows the load to be distributed across the entire joint for attenuation of ground reaction forces **(Hurwitz,** et al., 1999). These forces increase proportionally with overweight individuals. Body mass index (BMI) is linked with medial compartment OA and both are related to varus deformities (Sharma, et al. 2000). Since body mass is proportional to joint loading, overweight individuals may demonstrate even larger adaptations during gait (De Vita et al., 2003). Finally, the ankle and or hip can compensate for mechanical changes that result from knee pathology (Levangie & Norkin, 2002). Robon et al. (2000) found that subjects decreased plantarflexion moments during terminal stance to prevent anterior tibia1 advancement. The increase in dorsiflexion causes the tibia to displace anteriorly, therefore decreasing the in-line knee joint reaction force, thus preventing large compressive forces at the knee. Gait velocity can also be amplified by increasing the hip flexion moment during terminal stance in these individuals (Fisher et al., 1997; Robon et al., 2000). The increased hip flexor moment results in picking up rather than pushing off the foot to initiate initial swing. In both circumstances, these compensatory strategies serve to decrease knee joint forces and shorten stride length (Robon et al., 2000).

Stairs

Although stair climbing is similar to walking, the biomechanical demands are greater in this activity. A stair climbing task requires greater sagittal plane control as the moments increase threefold when walking up and down stairs (Levange & Norkin, 2005) with greater knee extensor torque and power required to perform this task (Mizner & Snyder-Mackler, 2005). Thus, the ability to efficiently ascend/descend stairs is dependent on both joint mobility and muscle strength (Perry et al., 2010). Negotiating stairs can be very challenging for individuals with knee OA (Whatling et al). Individuals with knee OA often report the need for a handrail to get up from a chair or climb a set of stairs. Women demonstrate greater knee flexion angles and larger knee external moments during both stair ascent and descent (Hughes, Kaufman, Morrey,Morrey & An, 2000), which may explain the increased incidence of OA in this gender (Felson, 1997).

When compared to level walking, the knee sustains a 12-25% greater joint load when climbing stairs (Whatling et al., 2008). Forces in single leg stance increase threefold for every one pound of body weight, therefore, obesity may adversely affect load distribution when climbing stairs (Felson, Reva, Dieppe, Hirsh & Helmick, 2000). Emphasis is placed on the knee and lower extremity muscles to advance the body forward against gravity while clearing the contralateral leg. As the body advances forward, the weight-bearing limb accepts the body weight from the contralateral limb as well as advancing the head, neck and trunk (HAT) over the limb. This requires the hip and knee extensors to load concentrically while the hip abductors maintain a level pelvis. Greater range of motion and larger internal moments are required with this activity at these joints (Kaufman, Hughes, Morrey, Morrey, &An, 2001). During weight acceptance at load phase, there are increased demands for the quadriceps muscles to absorb shock and maintain stability when accepting the body weight. Individuals with advanced knee OA ascend stairs by decreasing peak external knee flexion moments while increasing the peak hip external moments (Asay et al., **2008),** which results in a lateral trunk lean while ascending/descending stairs. This adaptive mechanism assists in unloading the medial joint compartment (Hunt, Wrigley, Hinman, & Benell, 2010). Advancing the leg during stair ascent is accompanied by a foward trunk lean, which appears to be a compensatory strategy to decrease knee joint load as it correlates with a reduction in net quadriceps moment (Asay et al., 2008). Although this strategy is effective for reducing joint forces, these compensations can alter lumbar spine biomechanics (Whatling et al., 2008). Descending stairs places a greater demand on the knee. During weight acceptance at the load phase, there are increased demands for the quadriceps muscles to absorb shock and maintain stability when accepting the body weight in order to advance the swing limb. These eccentric quadriceps muscle contractions are associated with greater muscular control which, in turn, increases compressive forces on the knee joint (Radin, Paul & Rose, 1972). It comes as no surprise that these individuals report more difficulty with this activity, as external knee flexion moments are six times greater with stair descent (Hughes et al., 2001).

Muscular Weakness

Arthrogenous muscle inhibition is a phenomenon described as muscle inhibition secondary to altered afferent input from a diseased joint. This results in a reduction in efferent motor neuron stimulation of the quadriceps (Hurley et al., 1998).

In individuals with knee OA, joint effusion may prevent full voluntary activation of muscles that cross the joint. This phenomenon has been termed arthrogenous muscle inhibition (AMI), which results from abnormal afferent information elicited from the damaged joint (Hurley & Newham, 1993). AMI reduces the number of motor units supplying the major muscle group crossing the knee, i.e., quadriceps. This decrease in full muscular activation has a direct contribution to quadriceps muscle weakness and resultant muscle atrophy (Hurley **et** at., 1993; Stevens, Mizner, & Snyder-Mackler, 2003). Lewek, Rudolph and Synder-Mackler (2003b) report that the failure of the central nervous system (CNS) to activate the quadriceps muscle suggests that abnormal afferent information is sent to the motor neuron pool. The literature identifies investigative methods for activation failure. These include twitch interpolation and burst superimposition techniques. The former represents a single supplemental stimulus (delivered via electrical stimulation) applied to a voluntary maximally contracted muscle where the latter is delivered by a stream of supplemental stimuli (delivered in the same fashion). If there is additional recruitment greater than **5%** elicited after the application of the electrical stimulus, the percent deficit is proportional to the degree of activation failure. **A** mathematical ratio that results in 1.0 implies full activation of a muscle (Lewek et al., 2003b). Hurley and Scott (1998) believe AMI may be part of the pathogenesis of degenerative joint diseases. As these muscles become weaker, the joint's ability to withstand load diminishes. This added joint stress results in knee pain and subsequent gait alterations. Individuals modify their gait pattern by decreasing walking speed, lowering cadence, decreasing stride length and increasing stance phase to compensate for knee pain and/or instability. Both normal (experimentally effused) and pathological knee joints (with effusion) exhibit full volitional quadriceps activation failure (Hurley et al., 1993). In a group of knee OA participants (mean age of 61) who reported little to no pain or joint effusion, maximal voluntary contraction (MVC), quadriceps activation or voluntary activation (VA) were 72.5% when compared to 93% in an age matched control group (Hurley et al., 1997). In the elderly, peak torque relative to body weight, was 20% less in individuals with symptomatic or radiographic evidence of knee OA (Slemenda et al., 1997). Quadriceps activation failure has been linked to a decline in physical function in individuals **45** years and older with knee OA (Fitzgerald, Piva, Irrgang, Bouzubar, & Starz, 2004), and is found to be the greatest single predictor of lower limb functional limitations, exceeding that of knee pain (Felson, 2006; Kijowski, Blakenbaker, Stanton, Fine & De Smet, 2006). These functional activity limitations are compounded in the elderly, as there is a 40 % decrease in strength of these muscles with advancing age (Jajagordar & Kendre, 2010). Addressing deficits associated with knee OA in the middle-aged population may delay or lessen the development of these activity limitations.

In 2002, Berth, Urhuch and Awiszus examined maximal voluntary contractions in knee OA patients before and after a total knee arthroscopy (TKA) and found similar results; however, after surgery, strength deficits persisted. In addition, the non-operational leg demonstrated a decrease in strength as compared to age-matched controls. After a three-year period, these investigators re-evaluated strength in the study participants. They found that although MVC's improved, quadriceps strength was still considerably lower when compared to controls. Other investigators examining this population found similar results in strength deficits (Fitzgerald, 2005; Stevens et al., 2003). Interestingly, Berth et al. (2002) found that even after an exercise intervention, their subjects employed compensatory mechanics in performing a sit-stand task one year post surgery, suggesting the need to incorporate functional training in an exercise program (Farquhar, Reisman, & Snyder-Mackier, 2008). Diminished quadriceps muscle strength has been associated with progression of the disease and may represent the initiation of knee OA on the quadrilateral limb (Zeni & Snyder- Mackler, 2010). The results of the "Chingford kneen study demonstrate that 50% of **45-64** year old obese females with unilateral OA developed incident changes in their contralateral knee over a two year period (Spector, Hart, & Deyle, 1994).

Use of primary health care among patients with knee osteoarthritis

Pain and reduced function are the main problems associated with knee osteoarthritis and are the reason patients seek health care, including physiotherapy. The annual incidence of consultations with a general practitioner for knee pain in the UK and the Netherlands is estimated to be 0.5% among people over 55 years and 1% among those over 70 years.Among people with self-reported knee pain in the UK 33% consulted their general practitioner during the past year.[148] A study carried out among primary care patients with knee osteoarthritis in Germany reported that 86% of women and 77% of men visited their general practitioner at least once during the previous half year, and 55% had visited a physiotherapist at least once. In Norway, in a population of persons with self-reported knee osteoarthritis, the mean number of physiotherapy visits was 6.0 during the previous year, and 5.6 for visits to a medical doctor**.** This might indicate variation in health service use between countries for patients with knee osteoarthritis.

Most patients with chronic knee pain are managed with medication, followed by physiotherapy and aids. Mitchell et al (80) reported that analgesics or non-steroidal anti-inflammatory drugs (NSAIDs) was received by 83% of patients with knee osteoarthritis, and that 21% of patients with knee pain who consulted their general practitioner were referred to physiotherapy. Another study, also from the UK, found that 13% of patients with knee osteoarthritis received physiotherapy. Physiotherapy was used more by patients from higher social classes in the UK , and by patients who have previously seen a hospital consultant for their knee osteoarthritis.Patients with osteoarthritis also commonly used complimentary medicine and therapies the most frequently reported complimentary therapy used was cod liver oil which was used by 38% . A survey of individuals with chronic knee pain identified a mismatch between the kind of treatments the responders preferred, the treatment they had received and the treatments that were recommended in evidence-based guidelines. Among those who expressed a treatment preference, the most popular treatment option was physiotherapy. Many individuals had no preference for a particular treatment (40%). It also appeared that many individuals with knee osteoarthritis do not discuss their pain and osteoarthritis during consultations with their general practitioner. Less than one-third of participants in this study reported that they received information on knee osteoarthritis when visiting their general practitioner. Despite the considerable health problems reported to be associated with knee osteoarthritis, many people do not seek help from health care professionals. Over 50% of those with severely disabling knee pain did not consult for it. Neither the presence of self reported co-morbidity nor the total number of co-morbid conditions was related to consultations for knee pain. A qualitative study found that the reasons for not consulting were that patients perceived that knee pain was a part of normal ageing, that little effective prevention and treatment is available and that the use of medication causes side effects and dependency. On the other hand, many patients with knee osteoarthritis might have unmet needs for information and management in primary care. The fact that many of the patients with knee osteoarthritis do not consult general practitioners or physiotherapists might indicate a mismatch between felt need (an individual"s assessment of their need for health care) and expressed need (demand for health care). It also suggests that physiotherapy is underused because guidelines recommend therapeutic exercises as a first-line management.

Rehabilitation Exercises for Knee OA

The management of knee OA typically comprises of pharmacological, non-pharmacological or surgical interventions (Royal Australian Collage of General Practitioners (RACGP), 2009; American Association of Orthopaedic Surgeons (AAOS), 2008). Physiotherapeutic interventions are a non-pharmacological form of treatment. A wide range of passive and active physiotherapeutic interventions such as self-management education programs, physical exercise, weight-loss programs, thermotherapy, electrotherapy, manual therapy, massage, acupuncture, bracing and assistive devices are commonly used to treat patients with knee OA. The reported positive cost-benefit ratios and reduced side-effects linked to physiotherapeutic interventions for knee OA compared to pharmacological and surgical interventions support the use of physiotherapy as first-line management for knee OA (Osteoarthritis Research Society International (OARSI), 2008.

Evidence for the effectiveness of physiotherapeutic interventions in knee OA is synthesized in the currently available published clinical guidelines (CGs) (AAOS, 2008; RACGP, 2009; **National Institute for Health and Clinical Excellence (NICE), 2008;** OARSI, 2008). CGs provides readily accessible, time-efficient and interpretable references for clinicians, as they summarise available literature to answer a range of clinical questions (**van der Wees*et al*., 2008).** However, CGs should be specific to the local context of the target users. Evidence-based clinical guidelines (EBCGs) often differ with respect to the guideline development methodology, evidence grading and methods used to formulate recommendations (Hillier *et al*., 2011). Selecting the most appropriate EBCGs for a specific context may thus be challenging to clinicians and may constrain the implementation of evidence into clinical practice. Synthesizing EBCGs may therefore assist clinicians in understanding the comprehensive evidence base for a specific intervention and provide succinct, composite recommendations which may facilitate the implementation of evidence into practice (van der Wees *et al*. 2008).

Self-management education programs (SMEPs)

Recommendations relating to SMEPs were documented in all the eligible guidelines. Evidence for the use of SMEPs in the management of knee OA was collected from two meta-analyses (MA) (Warsi *et al*., 2004; Chodosh *et al.,* 2006), one systematic review (SR) (Devos-Comby *et al*., 2006) and six randomized controlled trials (RCTs)

(Nunez *et al*., 2006; Buszewicz *et al*., 2006; Heuts *et al*., 2005; Victor and Triggs, 2005; Maisiak *et al*., 1996; Calfas *et al*., 1992).

AAOS (2008) suggest patients with symptomatic OA of the knee be encouraged to participate in self-management educational programs, such as those conducted by the Arthritis Foundation and incorporate activity modifications into their lifestyles.

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

OARSI (2008) recommended that all patients with hip and knee OA should be given information access and education about the objectives of treatment and the importance of changes in lifestyle, exercise, pacing of activities, weight reduction, and other measures to unload the damaged joint(s). The initial focus should be on self-help and patient-driven treatments rather than on passive therapies delivered by health professionals. Subsequently emphasis should be placed on encouraging adherence to the regimen of non-pharmacological therapy.

NICE (2008) recommended that Healthcare professionals should offer all people wit[redacted]linically symptomatic OA advice on the following core treatments:

- access to appropriate information
- activity and exercise

interventions to effect weight loss if overweight or obese

Land-based exercise

Aerobic exercises:-Good evidence supporting aerobic exercises as core management for patients with knee OA was reported in the included guideline recommendations. All of the included guidelines provided evidence based on large, well-conducted SRs (Roddy et al., 2005) consisting of 13 RCTs which compared aerobic exercises to a control.

AAOS (2008) recommended that Patients with symptomatic OA of the knee should be encouraged to participate in low-impact aerobic fitness exercises.

RACGP (2009) recommended that there is good evidence to support GPs recommending land-based exercise for people with OA of the knee.

OARSI (2008) recommended that Patients with knee OA should be encouraged to undertake, and continue to undertake, regular aerobic, muscle strengthening and range of motion exercises.

NICE (2008) recommended that Exercise should be a core treatment for people with OA, irrespective of age, co morbidity, pain severity or disability. Exercise should include:

- Local muscle strengthening
- General aerobic fitness

Strengthening exercises

All the guidelines discussed the effect of strengthening exercises as part of land-based exercise programs for knee OA. Only one guideline (AAOS, 2008) 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 (Roddy *et al*., 2005).

According to AAOS (2008) Quadriceps strengthening for patients with symptomatic OA of the knee is recommended.

The Royal College of Physicians in the UK has published an extensive clinical practice guideline for osteoarthritis produced by the National Institute for Health and Clinical Excellence (NICE). The first recommendation in the guideline is: “Exercise should be a core treatment for people with osteoarthritis, irrespective of age, comorbidity, pain severity or disability “. The guideline explicitly recommends acupuncture not to be used, stating that there is not enough consistent evidence of clinical or cost-effectiveness to allow a firm recommendation on the use of acupuncture for the treatment of osteoarthritis. TENS is recommended as an adjunct to core treatment for pain relief. Nevertheless, the guideline points out that clinical judgement is important and patients themselves have to take part in treatment decisions by assessing the benefit they might obtain from these interventions. Finally, the guideline does not specify whether exercise should be provided by the NHS or whether the healthcare professional should provide advice and encouragement to the patient to obtain and carry out exercise themselves. Exercise has been found to be beneficial but the clinician needs to make a judgment in each case on how to ensure effective patient participation. This will depend on the patient"s individual needs, circumstances, self motivation and the availability of local facilities[161].

Range of motion/ Flexibility exercises

One guideline (AAOS, 2008) 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.

Aquatic-based exercises

Limited evidence supports the use of aquatic exercise as an intervention to manage patients with knee OA. Three guidelines (RACGP, 2009; ORASI, 2008; NICE,

2008) reported the effects of aquatic exercises on pain and functional disability in knee OA patients. Only one guideline (RACGP, 2008) reported direct recommendations related to the use of aquatic exercises in the management of knee OA. The recommendation was based on 3 RCTs (Cochrane *et al*., 2005; Hinman *et al*., 2007; Fransen *et al*., 2007) which examined the effect of aquatic exercises on pain and functional disability in knee OA patients. One guideline (NICE, 2008) reported limited evidence for the benefit of aquatic exercises in knee OA management and a recommendation was not formulated.

One Cochrane review on the effect of aquatic exercise has also been published recently. This review found that aquatic exercise has some beneficial short-term effects for patients with hip and knee osteoarthritis. Following this review, at least two randomised controlled trials have compared aquatic exercise to land based exercise in patients with knee osteoarthritis. One study that involved exercise for 8 weeks showed that only landbased exercise improved pain and muscle strength compared with the control group.

However, aquatic exercise had significantly fewer adverse effects compared with a land-based programme. The other study found that 18 weeks of water-based and land-based exercises both reduced knee pain and increased knee function, but water exercise was superior to land-based exercise in relieving pain before and after walking during the last follow-up. In conclusion, both land based and water based exercise seems to be beneficial for patients with knee osteoarthritis and patient preferences and availability has to inform practice.

Weight-loss programs

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 (NICE, 2008). The recommendation for weight-loss programs in the management of knee OA was based on two RCTs and one SR (Christensen *et al*., 2005; Christensen *et al*., 2007; Roddy *et al*., 2005). The evidence of this recommendation was evaluated as Level I since the included RCTs were of high-quality and well-designed.

According to AAOS (2008) Patients with symptomatic OA of the knee, who are overweight (as defined by a BMI>25), should be encouraged to lose weight (a minimum of five percent (5%) of body weight) and maintain their weight at a lower level with an appropriate program of dietary modification and exercise.

RACGP (2009) there is good evidence to support GPs recommending weight reduction for obese patients with OA of the knee.

OARSI (2008) Patients with hip and knee OA, who are overweight, should be encouraged to lose weight and maintain their weight at a lower level.

NICE (2008) Interventions to achieve weight loss should be a core treatment for obese or overweight knee OA patients.

Multimodal physiotherapy

Evidence was collected from three moderate-quality RCTs (Deyle *et al*., 2000 and 2005; Hay *et al*., 2005) and one low-quality RCT (Deyle *et al*., 2000) 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*" (RACGP pg.25, 2009).

Thermotherapy

Three guidelines directly addressed the effect of thermotherapy in the management of knee OA (RACGP, 2009; OARSI, 2008; NICE, 2008). No result was found in the AAOS guideline. Evidence for thermotherapy was collected from one SR (Brosseau *et al*., 2003); two RCTs (Yurtkuran *et al*., 1999; Clarke *et al.*, 1974) and one comparative study (Martin *et al*., 1998).Modest evidence exists to support the use of hot and cold therapy for symptom relief in patients with knee OA.

Strategy 1: Applying ice massage for 20 min × 5 times/week for two weeks showed clinically significant improvement in quadriceps strength in knee OA patients.

Strategy 2: Applying ice three times per week for three weeks showed some improvement on pain in knee OA patients.

Electrotherapy

Transcutaneous Electrical Nerve Stimulation (TENS): The use of TENS in the management of knee OA was recommended by three of the eligible guidelines.

Evidence for efficacy documented by OARSI was collected from one Cochrane SR (Osiri *et al*., 2000), a SR (Brosseau *et al*., 2004) and one MA (Bjordal *et al*., 2007). Consequently, the short-term effect (2 to 4 weeks) of TENS on pain in knee OA patients was found to be clinically significant based on the evidence included in the guideline. Additionally, two low-quality RCTs (Paker *et al*., 2006; Adedoyin *et al*., 2005) were included. One RCT (Paker *et al*., 2006) compared intra-articular injection of hylan (three injections once weekly for three weeks) to TENS (applied five times per week for 20min at 150 Hz for three weeks). The study reported no benefits for the intra-articular injection of hylan in reducing pain and stiffness and improving function and Lequesne index at 6-month follow-up compared to TENS, in knee OA patients. The second RCT provided evidence that TENS or interferential current (two times weekly for 20 min) in association with 20min exercises showed no benefit compared to 20min exercises alone. All the groups showed improvement in WOMAC over time. Finally, NICE (2008) reported one SR (Osiri *et al.,* 2000) and three RCTs (Cheing *et al.,* 2002; Cheing and Hui-Chan, 2004; Paker *et al.,* 2006) which examined the effects of TENS in knee OA.

For TENS, low level laser and acupuncture, new systematic reviews have been published since the search was carried out in our overview. One extensive review by Bjordal et al included 36 RCT and assessed the short term effect of physical agents, including acupuncture on pain relief in knee osteoarthritis. Supporting our conclusion that there is moderate quality evidence that TENS, low level laser and electro-acupuncture reduce pain, this review concluded that these modalities offer clinically relevant short term pain relief. However, the optimal treatment doses for these modalities are unclear. Despite this new evidence, the role of acupuncture in the management of chronic knee pain is still unclear and the findings of new randomised trials of acupuncture have caused debate. An updated systematic review suggested that acupuncture can reduce pain and disability in people with chronic knee pain[168]. Combining five studies in 1334 patients, acupuncture was superior to sham acupuncture for both pain and function (weighted mean difference in WOMAC pain subscale score = 2.0, 95% CI 0.57-3.40, range 0–20, and for WOMAC function subscale score = 4.32, 95% CI 0.60-8.05, range 0-68). The differences were still significant at long-term follow-up. A trial by Foster and colleagues assessed the effects of adding acupuncture to a course of advice and exercise delivered by physiotherapists. The addition of acupuncture provided no additional improvement in pain scores. One implication of these findings might be that there is little point in recommending acupuncture to people with chronic knee pain who already exercise. However, acupuncture might be recommended to people who do not exercise.

LASER: One guideline reported a recommendation for the use of LASER in the management of knee OA patients (RACGP, 2009). Weak evidence from a low-quality RCT (Tascioglu *et al*., 2004) was reported for the use of LASER in the management of knee OA. No effects were reported on WOMAC pain, stiffness or disability scores, compared to placebo LASER treatment at three-week and six-month follow-up. One MA (Brosseau *et al*., 2006) and two RCTs (Tascioglu *et al*., 2004; Yurtkuran *et al*., 2007) were included in NICE. No benefit was reported for the use of LASER in the management of knee OA patients.

Ultrasound (US): One moderate-quality RCT (Robinson *et al*., 2005) reported no benefit of US compared to placebo. Assessment was performed immediately after the treatment and at three-month follow-up. Zhang *et al.* (2010) reported in the updated OARSI guideline that US had no effect on pain in knee OA patients (ES 0.06; 95% CI: -0.39 - 0.52).

Pulsed Short-Wave Diathermy (SWD) : One guideline (RACGP, 2009) suggested that there is no benefit for the use of pulsed SWD in the management of patients with knee OA. These results were confirmed by Zhang *et al*. (2010) in the updated OARSI (2008). Evidence for electrotherapy was collected from seven SRs (Osiri *et al*., 2000; Brosseau *et al*., 2006; Bjordal *et al*., 2007; McCarthy *et al*., 2006; Hulme *et al*., 2002; Robinson *et al*., 2006) and six RCTs (Adedoyin *et al*., 2005; Paker *et al*., 2006; Cheing *et al*., 2002; Cheing and Hui-Chan, 2004; Tascioglu *et al*., 2004; Yurtkuran *et al*., 2007). Cumulative data showed a small effect for function (ES=0.33: 95% CI 0.07-0.59) and no significant efficacy for pain reduction (ES=0.16: 95% CI -0.08-0.39).

Manual therapy: The effects of manual therapy in patients with knee OA were discussed in one guideline (NICE, 2008). The guideline development group stated the following recommendation: "*Manipulation and stretching should be considered as an adjunct to core treatment in the management of hip and knee OA*." (NICE, 2008; Page 96). This recommendation was based on five RCTs (Bennell *et al*., 2005; Deyle *et al*., 2000 and 2005; Tucker *et al*., 2003; Moss *et al*., 2007).

Massage: One recommendation related to the use of massage in the management of knee OA was found in the included CGs (RACGP, 2009). There is weak evidence to support GPs recommending massage therapy for treatment of OA of the knee.

Braces and assistive devices: Recommendations related to the use of braces and assistive devices in the management of knee OA were documented in all the eligible guidelines. Evidence was collected from two SRs (Brouwer *et al*. 2008; Reilly *et al*., 2006) and four RCTs (Keating *et al*., 1993; Kirkley *et al*., 1999; Toda *et al*., 2001; Maillefert *et al*., 2001).

AAOS (2008) recommended that Lateral heel wedges should not be prescribed for patients with symptomatic medial compartmental OA of the knee. Unable to recommend for or against the use of a brace with a valgus directing force for patients with medial uni-compartmental OA of the knee. Unable to recommend for or against the use of a brace with a varus directing force for patients with lateral uni-compartmental OA of the knee.

OARSI (2008) recommended walking aids can reduce pain in patients with knee OA. Patients should be given instruction for the optimal use of a cane or crutch in the contra lateral hand. Frames or wheeled walkers are often preferable for those with bilateral disease. In patients with knee OA and mild/moderate varus or valgus instability, a knee brace can reduce pain, improve stability and diminish the risk of falling. Every patient with knee OA should receive advice concerning appropriate footwear, and that insoles can reduce pain and improve ambulation. Lateral wedged insoles can be of symptomatic benefit for some patients with medial tibio-femoral compartment OA.

NICE (2008) recommended that Healthcare professionals should offer advice on appropriate footwear (including shock absorbing properties) as part of core treatment for people with knee QA. Bracing/joint supports/insoles as an adjunct to core treatment of knee OA patients who have biomechanical joint pain or instability, should be considered. Assistive devices (for example walking sticks and tap turners) should be considered as adjuncts to core treatment for knee OA patients who have specific problems with activities of daily living. Healthcare professionals may need to seek expert advice in this context (for example from occupational therapists or disability equipment assessment centers).

Acupuncture: All the guidelines examined the effect of acupuncture in patients with knee OA. Evidence for acupuncture was collected from one MA (Manheimer *et al*., 2007) and ten RCTs (Ezzo *et al*., 2001; White *et al*., 2007; Kwon *et al*., 2006; Moe *et al*., 2007; Vas *et al*., 2007; Yamashita *et al*., 2006;Witt *et al*., 2005; Foster *et al*., 2007; Yurtkuran *et al*., 2007 ; Vas *et al*., 2006). Conflicting evidence was noticed by the AAOS. Therefore, they performed a *de novo* SR to the published SRs and confirmed that the conclusions were conflicting. Additionally, the AAOS further performed a MA which clarified that the effects of acupuncture on pain and functional disability were dependant on the study designs of the included studies (AAOS, 2008). Conversely, NICE (2008) stated a clear, yet negative recommendation for the use of electro-acupuncture in the management of knee OA patients. Evidence for clinical or cost-effectiveness was not sufficient to formulate firm recommendations for the use of acupuncture in the management of knee OA (NICE, 2008).There is modest evidence for the use of acupuncture in the management of knee OA pain.

Patellar taping: Two of the included guidelines reported recommendations for the use of patellar taping as part of the management program for knee OA. The strength of the recommendations was based on one SR, documented in the AAOS, which concluded that the effect of medially-directed taping is statistically significant and possibly clinically important immediately and four days after taping when compared to sham taping. We suggest patients with symptomatic OA of the knee use patellar taping for short-term relief of pain and improvement in function . The effect lasted for three weeks when compared to no taping group (Warden *et al*., 2008). Evidence for patellar taping was collected from one SR (Warden *et al*., 2008) and four RCTs (Hinman *et al*., 2003; Cushnaghan *et al*., 1994; Hinman *et al*., 2003 B; Quiltyet *et al*., 2003).

Several practice guidelines recommend exercise for individuals with knee **CIA.** The Ottowa Panel (Brousseau et al., 2005) , European League Against Rheumatism (EULAR) (Pendleton et al., 2003), American Academy of Orthopedic Surgeons (Voelker, 2009) and American College of Rheumatology (Altman, Hochberg, Moskowitz, & Schnitzer, 2000) reviewed numerous randomized controlled studies regarding knee OA and developed exercise recommendations for treatment. Although recommendations vary, they all agree that exercise is an integral component in the treatment of knee OA. However, insufficient data exists to determine the frequency, duration and intensity of the exercise program. To date, only the Ottowa Panel (2005) has evaluated the specific exercises in relation to their outcomes, particularly for the management of pain and improvement in function. The goal of an exercise program for knee OA is to minimize pain and improve function; however, systematic reviews of physical therapy interventions suggest this cannot be accomplished utilizing a specific approach (Jamtvedi et al.,2008). **The** literature supports strengthening, aerobic, flexibility, stability, mobility, proprioceptive and balance exercises in the treatment of individuals with knee OA (Devis-Corn by, Cronan, & Roesch, 2006; Deyle, 2000; Fitzgerald, 2000; Huang et al., 2003; Hurley et al., 2002; Gur et al., 2002; McCarberg & Hers, 2001 ; Pendleton, et al., 2000). These types of exercises have been recommended with only moderate noted benefits in decreasing pain and improving function (vanBaar et al., 2001). Additionally, long term beneficial effects have not been extensively studied (Dunlop et al., 2010) and those that have indicate that the positive effects of exercise diminish and ultimately disappear over time (Pisters, Veenhof, deBakker, Schellevis & Dekker, 2007). Given that low levels of physical activity correlate with functional decline in the OA population, it is important that the activities associated with rehabilitation continue long after the completion of the rehabilitation program. Recognizing the need to maintain physical function in this population, Dunlop et al. (2010) examined factors associated with aspects that would improve or control OA over a period of time. Longitudinal data, taken from the **OA** initiative study, included baseline measurements of the chair stand test, the 20 meter walk and completion of the PASE, which is a 26 question self administered physical activity questionnaire. Questions are based on ADL1s1 purposeful exercise, sport activities and walking. They merged initial intake data from the OA initiative study (which included **2274,45-79** year old participants) with data one year post and found that physically active adults had greater petforrnance outcomes in function as evidenced by significant improvements in both the 20 meter walk and chair stand test. These findings suggest a correlation between a healthy active lifestyle and performance maintenance outcomes. Additionally, functional task training, where activities are designed to mimic ADL's may encourage a more active lifestyle, and therefore decrease functional limitations (Pisters et al., **2007).**

Rehabilitation exercises that are designed to improve muscle strength are based on exercises that address the individuals' impairment rather than their functional limitations as defined by their activity and participation level. Isotonic, isokinetic and isometric strengthening exercise programs, which address impairments, have been utilized in knee **OA** protocols with positive significant in strength gains (Huang et al., 2003); however, ADL's involve the integration of cognitive, perceptual and motor functions influenced by the variability of the individual's dynamic environment. (Mulder, 1991). Thus, impairment-based exercises (e.g. quadriceps strengthening) may not effectively improve functional performance levels. Additionally, the inability to coordinate complex musculoskeletal control must also take into consideration environmental demands for effective performance of the task (Shumway-Cook & Woollacott, 1995). Functional task training, task specificity and functional training have long been utilized in stroke rehabilitation (Carr & Shepherd, 1982). Practicing motor tasks in the context of the environment for which it is to be carried out has been found to promote motor learning. The theoretical framework supporting functional task training suggests that functional improvement necessitates practice of the actual task and that motor neuron pools are organized according to specific tasks, not specific muscles (Platz, 2004). The extent and efficiency of the motor skill transfer is enhanced by the performance of that task-specific activity (Schmidt & Lee, 2005), which increases muscle performance and sensorimotor integration, resulting in optimal functional performance (Ageberg & Roos, 2010).

An article often cited in evidence-based practice literature (Brousseau et al., 2005; Kelley et al., 2004; Krohn & Fitzgerald, 2006; Pisters et al., 2007) includes a longitudinal study that addressed the entire lower extremity in its treatment approach for knee OA (Deyle et al., 2000). Exercises were tailored for subjects with knee OA according to the individual's abilities. Significant improvements were noted for both self-reported (WOMAC) and functional performance (six-minute walk test) in the exercise group, which were sustained one year after the study. Since benefits were sustained for one year after the study, individual tailoring of an exercise program that addresses functional limitations appears to be optimal (Fitzgerald & Kelley, 2004). In 2001, McGibbon, Puniello, and Krebs examined the issue of practice organization in a cohort of 60 year-olds with **OA** who participated in either a strength training or functional task training program. While strength and walking speed increased in both groups, the functional task training group demonstrated a reduction of compensatory hip involvement associated with knee **OA;** whereas the strengthening group demonstrated an exaggerated compensatory gait pattern. This finding further supports previous findings that in an effort to decrease knee joint load, individuals with knee OA utilize compensatory strategies to augment work done at their ankle or hip (Levange et al., 2002; Robon et al., 2002). In a subsequent study by McGibbon, Krebs, and Moxley Scarbourough (2003), a group of fifteen 62-85 year old participants with lower extremity arthritis were randomized to either a functional task training group or strength-training group. The functional task group performed various ADL's (e.g. rising from a chair, holding objects while walking, picking up laundry baskets and walking around obstacles, etc.), while the strength training group utilized graded elastic bands and performed extremity and trunk strengthening exercises. Environmental demands were addressed by varying the floor surface and step height in the functional task group. Both groups improved in strength; however, the functional task group demonstrated greater gains, 15.6% and 25.6% respectively. Gait speed also increased significantly in both groups. Normal gait involves greater work at the ankle and knee than at the hip (Perry et al., 2010).

The strength-training group increased their hip power, while the functional task group improved their walking speed by increasing ankle and knee power, indicating a return to more normal gait. The functional task group also demonstrated a significant decrease in double support time. Another important finding in this study was the reduction in knee torque during the chair rise test for the functional task group. This finding suggests this group was more functionally efficient in translating their anterior momentum into a more vertical one by decreasing trunk flexion which decreased hip and knee joint flexion. This is consistent with reductions of knee and hip torque. Since this activity was one of the tasks practiced in this group, it is

evident that the extent and efficiency of the transfer of the task is enhanced by the performance of that task specific activity
(Schmidt & Lee, 2005) .

Although the literature is limited for functional task training in knee OA, the available data does support the benefits of functional task training. As previously mentioned, deVreede et al. (2005) found significant improvements in fitness sores of 70 year old women who petformed functional task exercises compared with an age-matched group assigned to a traditional strengthening exercises. Whitehurst, Johnson, Parker, Brown, and Ford (2005) found similar results in their 12-week study of functional task exercises with an elderly population. The exercises included wall squats, single leg balance, star exercise, modified pushups and walking over obstacles while carrying bags. The environment was varied by obstacle height, changing directions and walking backward. Outcome measures were significant for the get up and go test (TUG), standing reach, sit and reach and self-report of physical function. In 2008, Milton, Porcari, Foster, Gibson, and Undermann modified the exercise program of Whitehurst et al. (2005) and added a control group to their study who were instructed to carry out their usual exercise regimen. Their results also indicated that the functional task group demonstrated significant improvements in performance tests.

In a pilot study of **45-65** year old knee OA subjects, who were randomized to either a functional task training or traditional exercise group, Stutz-Doyle (2009) found the functional task training group demonstrated a significant increase in quadriceps muscle strength and gait velocity as well as greater improvements in **TUG** scores.

An exercise program tailored to the individual's diagnosis, lifestyle, habits and co-morbidities may well provide a rehabilitative program that may be more positively embraced and adhered to for a longer period (Pisters, et al., 2010).

Although well documented as initially successful, strengthening exercise programs are often abandoned and the initial successful results are minimized (vanBaar, et **al.,** 2001). Non-compliance with home exercise programs is an issue in people with knee OA secondary to several psychometric variables such as age, culture, fear and motivation (Campbell et al., 2005). Some older adults with knee OA believe that exercise and activity will exacerbate the pain and symptoms associated with this condition (Wilcox et al., 2006). Furthermore, exercise that requires additional equipment and special scheduling constraints may present obstacles in the course of rehabilitation. Activities that are part of a person's lifestyle or personal history may be more readily adopted and adhered to over time (Veenhorf et al, 2006). Since there is limited information regarding the benefit of functional task training programs in the OA population over strength training exercises , further investigation is warranted in the knee OA population; therefore, the purpose of this study was to investigate whether functional task training would be more effective in decreasing pain, improving strength and increasing functional mobility in this population.

Our overview of physiotherapy interventions for patients with osteoarthritis of the knee included 23 systematic reviews. As far as I am aware, only one extensive overview of the effectiveness of exercise therapy had been published earlier. Only a few comparisons were graded as high quality evidence in the overview and for the other interventions and outcomes the quality of evidence was assessed as moderate, low or very low. Exercise was covered in nine reviews, but there was no evidence to support type, frequency and dose of optimal exercise programme. Many of the reviews concluded that both aerobic and strengthening exercise, as well as individual and group exercise are effective in patients with knee osteoarthritis. The conclusions were based on indirect comparisons and subgroup analysis, and should be interpreted with caution. We need head to head comparisons in which participants are randomised to different exercise modalities. Since we published the overview, a Cochrane review on exercise for osteoarthritis of the knee has been updated. The updated review now includes 32 randomised controlled trials, compared to 17 in the previous version. No new head to head comparison was identified. On the basis of indirect comparisons, the new analysis suggested that both pain and physical function were significantly influenced by the number of direct supervised sessions of exercise, suggesting that more than 12 sessions, either as home visits, monitored classes or individual clinic-based treatments was associated with better outcome. The optimal exercise frequency and intensity is still to be documented, as well as information about who will benefit the best and who will not. Overall, the treatment effects based on the meta-analysis were considered small (SMD 0.40, 95% CI 0.30 to 0.50 for pain, and SMD 0.37, 95% CI 0.25 to 0.49 for physical function). The effect estimates are, however, comparable to estimates for non-steroidal anti-inflammatory drugs. One Cochrane review on the effect of aquatic exercise has also been published recently. This review found that aquatic exercise has some beneficial short-term effects for patients with hip and knee osteoarthritis. Following this review, at least two randomised controlled trials have compared aquatic exercise to land based exercise in patients with knee osteoarthritis. One study that involved exercise for 8 weeks showed that only landbased exercise improved pain and muscle strength compared with the control group. However, aquatic exercise had significantly fewer adverse effects compared with a land-based programme. The other study found that 18 weeks of water-based and land-based exercises both reduced knee pain and increased knee function, but water exercise was superior to land-based exercise in relieving pain before and after walking during the last follow-up. In conclusion, both land based and water based exercise seems to be beneficial for patients with knee osteoarthritis and patient preferences and availability has to inform practice.

For TENS, low level laser and acupuncture, new systematic reviews have been published since the search was carried out in our overview. One extensive review by Bjordal et al included 36 RCT and assessed the short term effect of physical agents, including acupuncture on pain relief in knee osteoarthritis. Supporting our conclusion that there is moderate quality evidence that TENS, low level laser and electro-acupuncture reduce pain, this review concluded that these modalities offer clinically relevant short term pain relief. However, the optimal treatment doses for these modalities are unclear. Despite this new evidence, the role of acupuncture in the management of chronic knee pain is still unclear and the findings of new randomised trials of acupuncture have caused debate. An updated systematic review suggested that acupuncture can reduce pain and disability in people with chronic knee pain. Combining five studies in 1334 patients, acupuncture was superior to sham acupuncture for both pain and function (weighted mean difference in WOMAC pain subscale score = 2.0, 95% CI 0.57-3.40, range 0–20, and for WOMAC function subscale score = 4.32, 95% CI 0.60-8.05, range 0-68) . The differences were still significant at long-term follow-up. A trial by Foster and colleagues assessed the effects of adding acupuncture to a course of advice and exercise delivered by physiotherapists. The addition of acupuncture provided no additional improvement in pain scores. One implication of these findings might be that there is little point in recommending acupuncture to people with chronic knee pain who already exercise. However, acupuncture might be recommended to people who do not exercise.

Two other updated reviews add evidence to our overview. One review showed that pulsed electromagnetic field did not seem to reduce pain or improve function, based on moderate quality evidence. However, a more recent systematic review suggested that pulsed electromagnetic field provided a small reduction in pain leaving the conclusion open. Finally, the role of braces, orthosis and tape in knee osteoarthritis was unclear in our review, but an updated systematic review evaluating the effects of patellar medial-directed taping compared with no tape showed a significant reduction in knee pain . Only three percent of the patients in our study received tape.

The Royal College of Physicians in the UK has published an extensive clinical practice guideline for osteoarthritis produced by the National Institute for Health and Clinical Excellence (NICE).
The first recommendation in the guideline is: “Exercise should be a core treatment for people with osteoarthritis, irrespective of age, comorbidity, pain severity or disability “. The guideline explicitly recommends acupuncture not to be used, stating that there is not enough consistent evidence of clinical or cost-effectiveness to allow a firm recommendation on the use of acupuncture for the treatment of osteoarthritis. TENS is recommended as an adjunct to core treatment for pain relief. Nevertheless,

the guideline points out that clinical judgement is important and patients themselves have to take part in treatment decisions by assessing the benefit they might obtain from these interventions. Finally, the guideline does not specify whether exercise should be provided by the NHS or whether the healthcare professional should provide advice and encouragement to the patient to obtain and carry out exercise themselves[56]. Exercise has been found to be beneficial but the clinician needs to make a judgment in each case on how to ensure effective patient participation. This will depend on the patient‟s individual needs, circumstances, self motivation and the availability of local facilities. Because physiotherapy practice is complex, it is challenging to measure physiotherapy performance. Treatment might differ both within and across sessions and within different contexts. Almost all physiotherapists in our study used exercise in treatment sessions, and they provided different types of exercises. The two most important aims of the treatment were to reduce pain and to increase muscle strength. According to the findings from our overview, and to new evidence and guidelines, no specific type or dose of exercise can be recommended. The Norwegian physiotherapists also seem to adhere closely to the first recommendation in the NICE guideline.

Following our study on physiotherapy performance, one other survey of physiotherapists` use of therapeutic exercise in patients with clinical knee osteoarthritis has been published. The survey was carried out among therapists in the UK, and the researchers collected data through a clinical vignette. In response to the vignette 99% of the therapists stated that they would use exercise, and 9% would use exercise alone for the specific patient. Strengthening exercise was favoured over aerobic exercises. The findings are comparable to our findings showing that almost all physiotherapists used exercise, 11% used exercise only through 12 sessions, and strengthening exercise were most frequently used. However, patients in the UK would probably receive fewer treatment sessions than patients in our study. We found that most patients would receive 12 sessions or more whereas Holden et al found that only 9% of the therapists would offer six sessions or more. The authors suggested that physiotherapists in the UK should deliver more sessions to optimise the benefits of exercise. This variation between the UK and Norway might be due to reimbursement procedures and contextual factors.

Patient participation is one element of high quality care and evidence-based physiotherapy (1;35). The NICE guideline gives the following recommendation; "the clinician needs to make a judgement in each case on how to effectively ensure patient participation. This will depend on the patient"s individual needs, circumstances, self-motivation and the availability of local facilities". The expectations and wishes about participation in decisions might vary between patients with knee osteoarthritis. In our study 92% of the therapists reported that the goals for the treatment were defined in collaboration with the patients, and these findings indicate patient participation. It has been suggested that individual differences should be considered more carefully when prescribing exercise for patients with knee osteoarthritis. For some patients, the major problem might be pain, and for other patients, it might be muscle weakness or perhaps loss of motion. In our study, the most frequently reported clinical problems were related to pain (100%), muscle weakness (85%) and limited range of motion (85%). Some patients might not want to exercise for several reasons, and some patients might even get more pain by doing some types of exercise. Which type of treatments, especially exercise, should be provided for the different problems and symptoms is still unclear. Factors that determine the acceptability of and motivation for exercise in patients with knee osteoarthritis, and the barriers that limit its use vary among patients. Four types of patients have been identified: 'long-term sedentary' who had never exercised; 'long-term active' who continued to exercise; 'exercise retired' who used to exercise, but had stopped because of their symptoms, and because they believed that exercise was damaging their joints; and 'exercise converted' who had recently started to exercise, and referred a gym because of the supervision and social support they received there. The findings from this qualitative study might help us to understand individual differences that might be considered more carefully when prescribing exercise to patients with knee osteoarthritis and to tailor exercise programmes. Although 34% of the patients in our study needed more activity, as assessed by the therapists, we have no additional information about patients` preferences or motivation for exercise.

The Norwegian therapists provided different types of information to the patients. The effects of advice and information about exercise and weight reduction provided by physiotherapists to patients with knee osteoarthritis are unclear. However, professional advice and guidance with continued support can encourage people from the general population to be more physically active. Long-term adherence to exercise is required to maintain the benefits of exercise in knee osteoarthritis, and because long-term adherence requires regular motivation, supervision andmonitoring, physiotherapists should include such guidance in all treatment sessions. Although many physiotherapists gave advice about physical activity, only 15% of the physiotherapists reported having provided this in more than 80% of the sessions. We found that only 58% of the patients that the physiotherapists categorized asoverweight were given information and advice about weight reduction. There aremany plausible explanations why many physiotherapists did not focus on weightreduction. They might not have enough knowledge or skills on how to address theproblem, the topic might be too intimate or they may prefer to provide advice onphysical activity instead. Still, physiotherapists should contribute to the positiveoutcomes of weight reduction by supervision and guidance, perhaps in cooperationwith a dietician.

Chapter 3

Materials & Methodology

Materials and Methodology

3.1 Source of data

A sample of 50 patients who were diagnosed with OA Knee and who fulfilled the inclusion criteria were referred to outpatient physiotherapy department of "Jaipur physiotherapy college" MVGU, Jaipur andafter obtaining informed consent they were recruited for this study.

3.2 Research Design

Experimental design of study.

3.3 Methods of Sampling

A sample of convenience of **Fifty** patients aged range between 50 to 65 Years diagnosed with Knee Osteoarthritis was selected and randomly assigned to two equal groups, the Traditional exercise group (TE group, n=25) or the Functional task training group (FTT group, n=25)

3.4 Inclusion Criteria

- Age group between 50**-** 65 years
- had knee pain of four months or longer
- able to walk100 feet without resting and without an assistive device,
- able to ascend & descend 9 stairs
- able to lift a **4** pound box fromthe floor and stand up
- not taking anti-inflammatory medication

- Diagnosis of knee OA based on radiographic results obtained byphysician report.

3.5 Exclusion Criteria

- neurological disease
- uncontrolled low or high blood pressure
- uncontrolled cardiopulmonary or respiratory condition,
- inability to rise from and return to a chair without assistance,
- any additional musculoskeletal diseases, trauma or surgeries,
- Currently actively participating in an exercise program.

3.6 Instruments used

- Inch Tape
- Stopwatch
- 25 meter long hallway
- Stairs
- 4 Pound Box

3.7 Variables

Independent Variables

- Traditional Strengthening exercise Technique (TE)
- Functional task training Technique (FTT)

Dependent Variables

Western Ontario **and** MacMaster Universities **OA** lndex **(WOMAC)**

-
- Pain on VAS
- Timed Up and Go Test
- 20 meter Walk Test

Berg Balance Scale

The Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC)

The WOMAC is a self reported (verbal or visual analogue scale) 24-item questionnaire that focuses on pain (5 questions), stiffness (2 questions) and functional limitations (17 questions) related to knee osteoarthritis on separate visual analogue scales. The Likert version of the WOMAC is rated on an ordinal scale of 0 to 4, with lower scores indicating lower levels of symptoms or physical disability. The ordinal 0 = non, 1 = slight, 2 = moderate, 3 = severe and 4 = extreme. Each subscale is summated to a maximum score of 20, 8, and 68, respectively and the sum scores ranged between 0-96.

This index assesses level of pain for 5 activities (walking on level ground, walking up and down stairs, sleeping, sitting, and standing) using the WOMAC pain scale, with a maximum score of 20 points. For each of these actions, pain scores between 0 and 4, with 0 indicating no pain, 1 indicating mild pain, 2 indicating mild pain, 3 indicating severe pain, and 4 indicating extreme pain, and total scores can range from 0 to 20, with higher scores indicating greater pain.

This index that assesses the severity of knee stiffness consists of 2 items “after first awakening in the morning” and “after sitting, lying or resting later in the day”. The ordinal 0 = non, 1 = slight, 2 = moderate, 3 = severe and 4 = extreme and total scores can range from 0 to 8, with higher scores indicating greater stiffness.

A self-reported physical function as measured by (WOMAC) uses 17 questions concerning the degree of difficulty performing activities of daily living (e.g., ascending and descending stairs, standing up, bathing, and general house work) to assess a person‟s physical function. In the Likert version of the WOMAC, the participant is asked to indicate on a scale from 0 (none) to 4 (extreme) the degree of difficulty due to knee OA. The individual scores for the 17 items were added to generate a summary score that could range from 0 to 68, with higher scores indicating poorer function. The WOMAC is a widely used, reliable, valid and responsive measure of outcome in people with Knee OA.

Description of WOMAC scale:

INSTRUCTIONS TO PATIENTS

In Sections A, B, and C questions are asked in the following format. Please mark your answers by putting an " *X*" through the horizontal line.

EXAMPLES:

1. If you put your " *X*" at the left-hand end of the line as shown below, then you are indicating that you feel **no** pain.

No Pain ______________________________ 1 Extreme I Pain

2. If you put your "*X*"at the right-hand end of the line as shown below, then you are indicating that you feel **extreme** pain.

No1 Pain I ty- Extreme h. Pain

3. Please note:
   a) that the further to the right you place your " *X*", the **more** pain you feel.
   b) that the further to the left you place your " *X*", the **less** pain you feel.
   c) **please do not** place your " *X*" **past either end of the line.**

You will be asked to indicate on this type of scale the amount of pain, stiffness or disability you have felt during the last 48 hours.

Think about your ______________ (study joint) when answering the questions. Indicate the severity of your pain and stiffness and the difficulty you have in doing daily activities that you feel are caused by the arthritis in your (study joint).

Your study joint has been identified for you by your health care professional. If you are unsure which joint is your study joint, please ask before completing the questionnaire.

WOMAC OSTEOARTHRITIS INDEX VERSION VA3.1

WOMAC VA3.1 QUESTIONNAIRE WOMA

Section **A**

PAIN

Think about the pain you felt in your ____________ (study joint) caused by your arthritis during the <u>last 48 hours.</u>

(Please mark your answers with an "*X*".

QUESTION: **How much pain have you had . . .**

	Study Coordinator Use Only
1. when walking on a flat surface? No Pain I ________ Extreme Pain	____
2. when going up or down stairs? No Pain 1 ________ Extreme Pain	PAIN1 ____
3. at night while in bed? (that is - pain that disturbs your sleep) No Pain 1 ________ Extreme Pain	PAIN2
4. while sitting or lying down? No Pain ________ Extreme Pain	PAIN3 ____
4. while standing? No Pain 1 ________ Extreme Pain	PAIN4 ____ PAIN5 ____

WOMACVA3.1 QUESTIONNAIRE WOMB

Section B

STIFFNESS

Think about the stiffness (not pain) you felt in your__________ (study joint) caused by your arthritis during the last 48 hours.

Stiffness is a sensation of decreased ease in moving your joint.

(Please mark your answers with an "X".)

	Study Coordinator Use Only
6. How **severe** has your stiffness been **after you first woke up** in the morning? No I______________________________________I Extreme Stiffness Stiffness	______ STIFF6
7. How **severe** has your stiffness been after sitting or lying down or while resting **later in the day?** No 1______________________________________I Extreme Stiffness Stiffness	STIFF7 ______

WOMAC VA3.1 QUESTIONNAIRE WoMc1-3

Section C

DIFFICULTY PERFORMING DAILY ACTIVITIES

Think about the difficulty you had in doing the following daily physical activities caused by your arthritis in your __________ (study joint) during the last 48 hours. By this we mean **your ability to move around and take care of yourself.** (Please mark your answers with an " X ".)

QUESTION: **How much difficulty have you had ...**

8. when going down the stairs?

No Difficulty |________________| Extreme Difficulty

9. when going up the stairs?

No Difficulty |________________| Extreme Difficulty

10. when getting up from a sitting position?

No Difficulty |________________| Extreme Difficulty

11. while standing

No Difficulty |________________| Extreme Difficulty

12. when bending to the floor?

No Difficulty |________________| Extreme Difficulty

13. when walking on **a** flat surface?

No Difficulty |________________| Extreme Difficulty

Study Coordinator Use Only

PFTN8 ______

PFTN9 ______

PFTN10 ______

PFTN11 ______

PFTN12 ______

PFTN13 ______

WOMACVA3.1 QUESTIONNAIRE WOMc2-3

DIFFICULTY PERFORMING DAILY ACTIVITIES

Think about the difficulty you had in doing the following daily physical activities caused by your arthritis in your__________ (study joint) during the last 48 hours. By this we mean **your ability to move around and take care of yourself.** (Please mark your answers with an " X ".)

QUESTION: **How much difficulty have you had ...**

	Study Coordinator Use Only
14. getting in or out of a car, or getting on or off a bus? No Difficulty ________________________ Extreme Difficulty	______
15. while going shopping? No Difficulty ________________________ Extreme Difficulty	PFTN14 ______
16. when putting on your socks or panty hose or stockings? No I ________________________ I Extreme Dificulty Dificulty	PFTN15 ______
17. when getting out of bed? No I ________________________ I Extreme Difficulty Difficulty	PFTN16
18. when taking off your socks or panty hose or stockings? No I ________________________ ! Extreme Difficulty Difficulty	PFTN17 ______
19. while lying in bed? No I Difficulty ________________________ Extreme I Difficulty	PFTN18 ______
	PFTN19 ______

WOMACVA3.1 QUESTIONNAIRE wOMc3-3

DIFFICULTY PERFORMING DAILY ACTIVITIES

Think about the difficulty you had in doing the following daily physical activities caused by your arthritis in your _________ (study joint) during the last 48 hours. By this we mean **your ability to move around and take care of yourself.** (Please mark your answers with an "X".)

QUESTION: How much difficulty have you had ...	Study Coordinator Use Only
20. when getting in or out of the bathtub? No Difficulty I ______________ Exteme Difficulty	PFTN20 ______
21. while sitting? No Difficulty I ______________ Extreme Difficulty	PFTN21 ______
22. when getting on or off the toilet? No Difficulty ______________ Extreme Difficulty	PFTN22 ______
23. while doing heavy household chores? No Difficulty I ______________ Extreme I Difficulty	PFTN23 ______
24 while doing light household chores? No Difficulty ______________ Extreme Difficulty	PFTN24 ______

Visual Analogue scale (VAS):

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 differences in pain experience.

INFORMATION POINT:

Visual Analogue Scale (VAS)

A Visual Analogue Scale (VAS) is a measurement instrument that tries to measure a characteristic or attitude that is believed to range across a continuum of values and cannot easily be directly measured. For example, the amount of pain that a patient feels ranges across a continuum from none to an extreme amount of pain. From the patient's perspective this spectrum appears continuous – their pain does not take discrete jumps, as a categorization of none, mild, moderate and severe would suggest. It was to capture this idea of an underlying continuum that the VAS was devised.

Operationally a VAS is usually a horizontal line, 100 mm in length, anchored by word descriptors at each end, as illustrated in Fig. 1. The patient marks on the line the point that they feel represents their perception of their current state. The VAS score is determined by measuring in millimetres from the left hand end of the line to the point that the patient marks.

How severe is your pain today? Place a vertical mark on the line below to indicate how bad you feel your pain is today.

No pain |________________________________| Very severe pain

Figure 1 Effects of the interpersonal, technical and communication skills of the nurse on the effectiveness of treatment.

There are many other ways in which VAS have been presented, including vertical lines and lines with extra descriptors. Wewers & Lowe (1990) provide an informative discussion of the benefits and shortcomings of different styles of VAS.

As such an assessment is clearly highly subjective, these scales are of most value when looking at change within individuals, and are of less value for comparing across a group of individuals at one time point. It could be argued that a VAS is trying to produce interval/ratio data out of subjective values that are at best ordinal. Thus, some caution is required in handling such data. Many researchers prefer to use a method of analysis that is based on the rank ordering of scores rather than their exact values, to avoid reading too much into the precise VAS score.

Further reading

Wewers M.E. & Lowe N.K. (1990) A critical review of visual analogue scales in the measurement of clinical phenomena. *Research in Nursing and Health* 13, 227–236.

NICOLA CRICHTON

Timed 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.

Description of Timed Up and Go (TUG) Test

Name:___________________________ MR: ______________________

Date:________

1. Equipment: arm chair, tape measure, tape, stop watch.

2. Begin the test with the subject sitting correctly (hips all of the way to the back of the seat) in a chair with arm rests. The chair should be stable and positioned such that it will not move when the subject moves from sit to stand. The subject is allowed to use the arm rests during the sit – stand and stand – sit movements.

3. Place a piece of tape or other marker on the floor 3 meters away from the chair so that it is easily seen by the subject.

4. Instructions: "On the word GO you will stand up, walk to the line on the floor, turn around and walk back to the chair and sit down. Walk at your regular pace.

5. Start timing on the word "GO" and stop timing when the subject is seated again correctly in the chair with their back resting on the back of the chair.

6. The subject wears their regular footwear, may use any gait aid that they normally use during ambulation, but may not be assisted by another person. There is no time limit. They may stop and rest (but not sit down) if they need to.

7. Normal healthy elderly usually complete the task in ten seconds or less. Very frail or weak elderly with poor mobility may take 2 minutes or more.

8. The subject should be given a practice trial that is not timed before testing.

9. Results correlate with gait speed, balance, functional level, the ability to go out, and can follow change over time.

Normative Reference Values by Age

Age Group	Time in Seconds (95% Confidence Interval)	
60 – 69 years	8.1	(7.1 – 9.0)
70 – 79 years	9.2	(8.2 – 10.2)
80 – 99 years	11.3	(10.0 – 12.7)

Cut-off Values Predictive of Falls by

Group	Time in Seconds
Community Dwelling Frail Older Adults 2	> 14 associated with high fall risk
Post-op hip fracture patients at time of discharge3	> 24 predictive of falls within 6 months after hip fracture
Frail older adults	> 30 predictive of requiring assistive device for ambulation and being dependent in ADLs

Timed Up And Go Test

Sitting OnStandard Height

Get Up From A Standard Height

Starting Walk

Ready To Walk

Turn Around

Walk Back To The Chair And Sit Down

20 Meter Walk Test

20-meter walk test, is performed by patients with mild to moderate knee osteoarthritis (OA) at a self-selected pace. Pick a stretch of hallway at least 25 meters in length.Place one piece of tape on the ground. This will be the starting line.Using the Redi-measure wheel, measure out a 20- meter course down the hallway. Mark the other end with another piece of tape; this will be the finish line.To ensure accuracy, re-measure the course in the reverse direction. Practice trials and a standardized protocol should be used in administration of the 20-meter walk test. Changes in walk time between −1.59 seconds (walking slower) and 0.15 seconds (walking faster) should be considered within the range of normal variability of 20-meter walking speed. (Motyl et al. BMC Musculoskeletal Disorders 2013).

Description of 20-Meter Walk Test Protocol

Equ[redacted]ment required performing the test:

- Stopwatch
- Bright colored tape
- 25 meter long hallway
- Redi-measure wheel (in meters)

Setting up the course:

- Pick a stretch of hallway at least 25 meters in length. Ideally, this area would not be highly travelled.
- Place one piece of tape on the ground. This will be the starting line.
- Using the Redi-measure wheel, measure out a 20- meter course down the hallway.
- Mark the other end with another piece of tape; this will be the finish line.
- To ensure accuracy, re-measure the course in the reverse direction.

Performing the test:

- The participant should be wearing comfortable, soft soled shoes for this test.
- If the participant reports any significant discomfort, or does not agree to participate in the explained test, they should not be forced.

- Participants may use a cane or other walking aid to walk the 20-meter course if they feel it is necessary. However, keep in mind that many participants only use their walking aids while outside of the home, so do not assume they will need it just because they brought an aid to the clinic.
- Read the participant the following script:

Script 1

"Now I am going to observe how you normally walk. If you use a cane or other walking aid, and you feel you need it to walk a short distance, then you may use it. This is our walking course. I want you to walk to the other end of the course, at your usual speed, just as if you were to walk
down the street to go to the store. Walk 3 – 4 steps past the other end of the tape before you stop. I will walk slightly behind you. I will now demonstrate the walk to you"

- Demonstrate the walk. Do not walk at your normal pace, rather, walk at a relaxed, leisurely pace all the way past the other end of the course. Exaggerate how far to walk by taking at least 3 or 4 steps past the finish line.
- Return back at your normal speed.

- Ask the participant if they feel safe performing the test, if so, assist them to the starting line.
- Be sure to get their toes as close as possible to the edge of the course.
- The examiner should only have a stopwatch. Read the following to the participant:

"When I want you to start, I will say ready, begin. Ready? Begin!"

- Press the start/stop button on the stopwatch as soon as the participant starts to move across the starting line.
- Follow the participant all the way down to the other end of the course. The examiner should be positioned slightly behind and to the side of the participant, keeping a close eye on the participant‟s feet.
- The test is over when the participants first foot completely crosses the line. If the participant‟s foot lands on the line, do not stop the timer until one heel completely crosses the finish line.
- Inform the participant that you are to go to the other end of the course and record the walking time. If they require a chair, provide one.

- NOTE: If the participant begins the test and is obviously not walking at their normal pace (e.g. running or jogging please read the following to the participant: “Please stop the test. Is this how you normally walk down the street going to the store? If so we will begin again. If not, please remember to walk at your normal walking pace.” and then have participant start the test again.
- After recording the walk information, read the following script to the participant:

Repeating the Walk Test

“Now I want you to repeat the walk. Remember to walk at your usual pace and walk all the way past the other end of the course before you stop. I will be walking with you.”

- If the participant feels safe performing the test, assist them to the starting line.
- Be sure to get their toes as close as possible to the edge of the course.
- The examiner should only have a stopwatch.
- Read the following to the participant:

"When I want you to start, I will say „Ready? Begin!‟ Ready? Begin!"

- Press the start/stop button on the stopwatch as soon as the participant starts to move across the starting line.
- Follow the participant all the way down to the other end of the course. The examiner should be positioned slightly behind and to the side of the participant, keeping a close eye on the participant‟s feet.
- The test is over when the participant‟s first foot completely crosses the line. If the participant‟s foot lands on the line, do not stop the timer until one heel completely crosses the finish line.

Repeat the walk test two more times. Assist the participant to their seat and record all information.

Berg Balance Scale

The Berg Balance scale is a functional performance test that examines 14 common movement tasks such as sit-to-stand, stand-to-sit, standing with eyes closed, tandem walking, single leg stand, reaching, picking up an object form the floor, alternating foot on stool, looking over the shoulders and turning 360 degrees. The BBS is scored on a 0-4 point ordinal scale where 0 indicates the inability to perform the task and 4 indicates the ability to perform the task independently. Therefore, a total score of 56 indicates maximal independence. Piotrowski & Cole et al. (1994) report a test-retest reliability of 1CC=.90 in the elderly. Noren et al. (2006) reported interrater reliability of ICC=.97 in patients with peripheral arthritis. Validity is reported to have moderate to high correlations with other performance measures such as the TUG, and gait speed (Hayes & Johnson, 2003).

Description of Berg Balance Scale

The Berg Balance Scale (BBS) was developed to measure balance among older people with impairment in balance function by assessing the performance of functional tasks. It is a valid instrument used for evaluation of the effectiveness of interventions and for quantitativedescriptions of function in clinical practice and research. The BBS has been evaluated in several reliability studies. A recent study of the BBS, which was completed in Finland, indicates that a change of eight (8) BBS points is required to reveal a genuine change in function between two assessments among older people who are dependent in ADL and living in residential care facilities.

Description:

14-item scale designed to measure balance of the older adult in a clinical setting.

Equipment needed:

Ruler, two standard chairs (one with arm rests, one without), footstool or step, stopwatch or wristwatch, 15 ft walkway.

Completion:

Time: 15-20 minutes

Scoring:

A five-point scale, ranging from 0-4. "0" indicates the lowest level of function and "4" the highest level of function. Total Score = 56.

Berg Balance Scale

Sit-To-Stand

Standing With Eyes Closed

Tandem Walking

Single Leg-Stand

Picking Up An Object Form The Floor

Looking Over The Shoulders

Turning 360 Degrees

Alternating Foot On Stool

Alternating Foot On Stool

Interpretation:

41-56 = low fall risk

21-40 = medium fall risk

0 –20 = high fall risk

A change of 8 points is required to reveal a genuine change in function between 2 assessments.

Berg Balance Scale

Name: ___________________________________ Date: ____________________

Location: _________________________________ Rater: ____________________

ITEM DESCRIPTION	SCORE (0-4)
Sitting to standing	________
Standing unsupported	________
Sitting unsupported	________
Standing to sitting	________
Transfers	________
Standing with eyes closed	________
Standing with feet together	________
Reaching forward with outstretched arm	________
Retrieving object from floor	________
Turning to look behind	________
Turning 360 degrees	________
Placing alternate foot on stool	________
Standing with one foot in front	________
Standing on one foot	________
Total	________

GENERAL INSTRUCTIONS

Please document each task and/or give instructions as written. When scoring, please ~~record the~~

lowest response category that applies for each item.

In most items, the subject is asked to maintain a given position for a specific time. Progressively

more points[redacted]re deducted if:

- the time or distance requirements are not met
- the subject‟s performance warrants supervision
- the subject touches an external support or receives assistance from the examiner

Subject should understand that they must maintain their balance while attempting the tasks. The

choices of which leg to stand on or how far to reach are left to the subject. Poor judgment will

adversely influence the performance and the scoring.

Equipment required for testing is a stopwatch or watch with a second hand, and a ruler or other

indicator of 2, 5, and 10 inches. Chairs used during testing should be a reasonable height. Either

a step or a stool of average step height may be used for item # 12.

Berg Balance Scale

SITTING TO STANDING

INSTRUCTIONS: Please stand up. Try not to use your hand for support.

( ) 4 able to stand without using hands and stabilize independently

( ) 3 able to stand independently using hands

( ) 2 able to stand using hands after several tries

( ) 1 needs minimal aid to stand or stabilize

( ) 0 needs moderate or maximal assist to stand

STANDING UNSUPPORTED

INSTRUCTIONS: Please stand for two minutes without holding on.

( ) 4 able to stand safely for 2 minutes

( ) 3 able to stand 2 minutes with supervision

( ) 2 able to stand 30 seconds unsupported

( ) 1 needs several tries to stand 30 seconds unsupported

( ) 0 unable to stand 30 seconds unsupported

If a subject is able to stand 2 minutes unsupported, score full points for sitting unsupported. Proceed to item #4.

SITTING WITH BACK UNSUPPORTED BUT FEET SUPPORTED ON FLOOR OR ON A STOOL

INSTRUCTIONS: Please sit with arms folded for 2 minutes.

( ) 4 able to sit safely and securely for 2 minutes

( ) 3 able to sit 2 minutes under supervision

( ) 2 able to able to sit 30 seconds

( ) 1 able to sit 10 seconds

( ) 0 unable to sit without support 10 seconds

STANDING TO SITTING

INSTRUCTIONS: Please sit down.

( ) 4 sits safely with minimal use of hands

( ) 3 controls descent by using hands

( ) 2 uses back of legs against chair to control descent

( ) 1 sits independently but has uncontrolled descent

( ) 0 needs assist to sit

TRANSFERS

INSTRUCTIONS: Arrange chair(s) for pivot transfer. Ask subject to transfer one way toward a seat with armrests and one way toward a seat without armrests. You may use two chairs (one with and one without armrests) or a bed and a chair.

( ) 4 able to transfer safely with minor use of hands

( ) 3 able to transfer safely definite need of hands

( ) 2 able to transfer with verbal cuing and/or supervision

( ) 1 needs one person to assist

( ) 0 needs two people to assist or supervise to be safe

STANDING UNSUPPORTED WITH EYES CLOSED

INSTRUCTIONS: Please close your eyes and stand still for 10 seconds.

( ) 4 able to stand 10 seconds safely

( ) 3 able to stand 10 seconds with supervision

( ) 2 able to stand 3 seconds

( ) 1 unable to keep eyes closed 3 seconds but stays safely

( ) 0 needs help to keep from falling

STANDING UNSUPPORTED WITH FEET TOGETHER

INSTRUCTIONS: Place your feet together and stand without holding on.

( ) 4 able to place feet together independently and stand 1 minute safely

( ) 3 able to place feet together independently and stand 1 minute with supervision

( ) 2 able to place feet together independently but unable to hold for 30 seconds

( ) 1 needs help to attain position but able to stand 15 seconds feet together

( ) 0 needs help to attain position and unable to hold for 15 seconds

REACHING FORWARD WITH OUTSTRETCHED ARM WHILE STANDING

INSTRUCTIONS: Lift arm to 90 degrees. Stretch out your fingers and reach forward as far as you can. (Examiner places a ruler at

the end of fingertips when arm is at 90 degrees. Fingers should not touch the ruler while reaching forward. The recorded measure is

the distance forward that the fingers reach while the subject is in the most forward lean position. When possible, ask subject to use

both arms when reaching to avoid rotation of the trunk.)

( ) 4 can reach forward confidently 25 cm (10 inches)

( ) 3 can reach forward 12 cm (5 inches)

( ) 2 can reach forward 5 cm (2 inches)

( ) 1 reaches forward but needs supervision

( ) 0 loses balance while trying/requires external support

PICK UP OBJECT FROM THE FLOOR FROM A STANDING POSITION

INSTRUCTIONS: Pick up the shoe/slipper, which is in front of your feet.

( ) 4 able to pick up slipper safely and easily

( ) 3 able to pick up slipper but needs supervision

( ) 2 unable to pick up but reaches 2-5 cm(1-2 inches) from slipper and keeps balance independently

( ) 1 unable to pick up and needs supervision while trying

( ) 0 unable to try/needs assist to keep from losing balance or falling

TURNING TO LOOK BEHIND OVER LEFT AND RIGHT SHOULDERS WHILE STANDING

INSTRUCTIONS: Turn to look directly behind you over toward the left shoulder. Repeat to the right. (Examiner may pick an object

to look at directly behind the subject to encourage a better twist turn.)

( ) 4 looks behind from both sides and weight shifts well

( ) 3 looks behind one side only other side shows less weight shift

( ) 2 turns sideways only but maintains balance

( ) 1 needs supervision when turning

( ) 0 needs assist to keep from losing balance or falling

TURN 360 DEGREES

INSTRUCTIONS: Turn completely around in a full circle. Pause. Then turn a full circle in the other direction.

( ) 4 able to turn 360 degrees safely in 4 seconds or less

( ) 3 able to turn 360 degrees safely one side only 4 seconds or less

( ) 2 able to turn 360 degrees safely but slowly

( ) 1 needs close supervision or verbal cuing

( ) 0 needs assistance while turning

PLACE ALTERNATE FOOT ON STEP OR STOOL WHILE STANDING UNSUPPORTED

INSTRUCTIONS: Place each foot alternately on the step/stool. Continue until each foot has touched the step/stool four times.

( ) 4 able to stand independently and safely and complete 8 steps in 20 seconds

( ) 3 able to stand independently and complete 8 steps in > 20 seconds

( ) 2 able to complete 4 steps without aid with supervision

( ) 1 able to complete > 2 steps needs minimal assist

( ) 0 needs assistance to keep from falling / unable to try

STANDING UNSUPPORTED ONE FOOT IN FRONT

INSTRUCTIONS: (DEMONSTRATE TO SUBJECT) Place one foot directly in front of the other. If you feel that you cannot place your foot directly in front, try to step far enough ahead that the heel of your forward foot is ahead of the toes of the other foot. (To score 3 points, the length of the step should exceed the length of the other foot and the width of the stance should approximate the subject"s normal stride width.)

( ) 4 able to place foot tandem independently and hold 30 seconds

( ) 3 able to place foot ahead independently and hold 30 seconds

( ) 2 able to take small step independently and hold 30 seconds

( ) 1 needs help to step but can hold 15 seconds

( ) 0 loses balance while stepping or standing

STANDING ON ONE LEG

INSTRUCTIONS: Stand on one leg as long as you can without holding on.

( ) 4 able to lift leg independently and hold > 10 seconds

( ) 3 able to lift leg independently and hold 5-10 seconds

( ) 2 able to lift leg independently and hold L 3 seconds

( ) 1 tries to lift leg unable to hold 3 seconds but remains standing independently.

( ) 0 unable to try of needs assist to prevent fall

( ) TOTAL SCORE (Maximum = 56)

3.8 PROCEDURE

Exercise Protocols

Two exercise programs were utilized in this study. The TE program consisted of exercises that targeted the level of impairment (muscle strength), while the FTT program concentrated on exercises concerned with the body as a whole. The intensity of exercise was monitored based on the Borg Perceived Exertion Scale. The resistance load was equated with a moderately intense rating **(#3)** on the scale. As perceived exertion decreases, resistance time was increased, thus ensuring the tailoring of the individual's needs to the increase in resistance (Topp, Woolley, Hornyak , Khuder, & Kahaleh, 2002). Subjects in the TE program were performed four-way straight leg raises (**4** way SLR"s), seated knee extension, wall slides, step ups, and ambulation on the treadmill. All exercises were supervised by the principal investigator. Three sets of eight repetitions were performed for each exercise. Weight repetition progression based on subject's tolerance. Subjects ambulated on the treadmill at their own pace for a period that did not exceed 15 minutes. Functional tasks included sit to stand box lift, standing star exercise, walking up and down a ramp while holding a weight, ascending/descending stairs while holding a weight in the preferred hand, and walking indoors while passing a weighted ball from hand to hand. All exercises were supervised by the principal investigator. Subjects performed the exercises for one minute with (when indicated) a one pound weight. Progressions included either an increase in weight or time to perform the activity.

TE program group

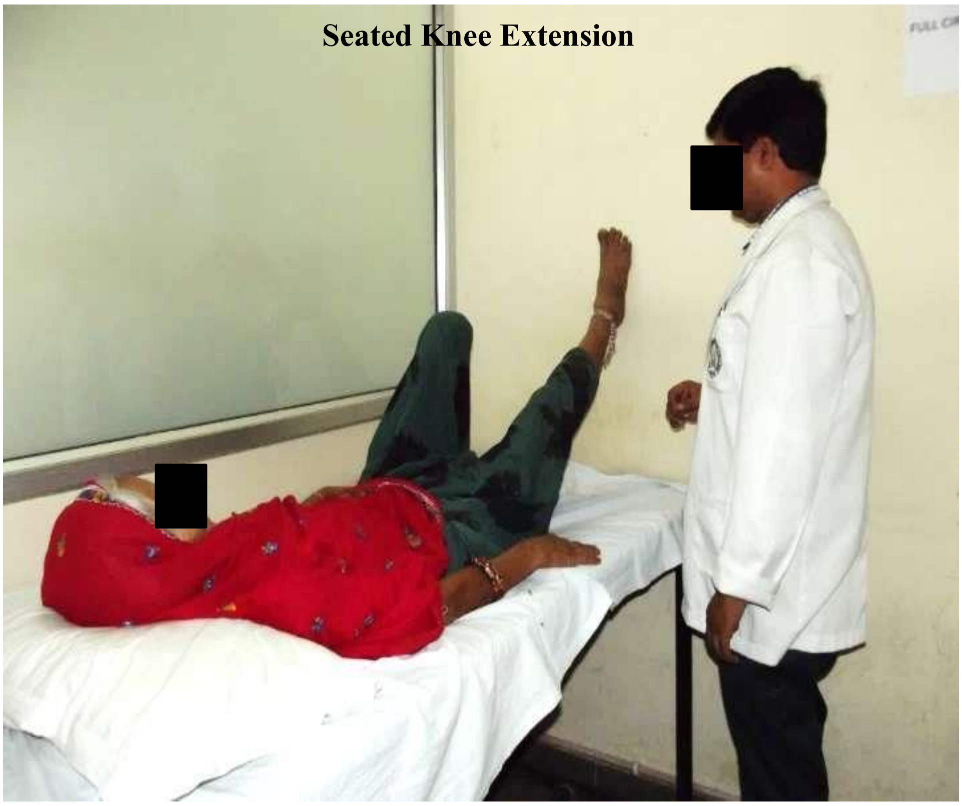
Four-Way Straight Leg Raises (4 Way SLR's)

Four-Way Straight Leg Raises (4 Way SLR's)

Four-Way Straight Leg Raises (4 Way SLR's)

Four-Way Straight Leg Raises (4 Way SLR's)

Seated Knee Extension



wall slides starting position

wall slides endi[redacted]ition

step ups starting position

Step Ups

Step Ups

step ups ending position

Ambulation On The Treadmill

Functional tasks group

Sit To Stand Box Lift

Sit To Stand Box Lift

Walking A Ramp While Holding A Weight

Walking Down A Ramp with Weight

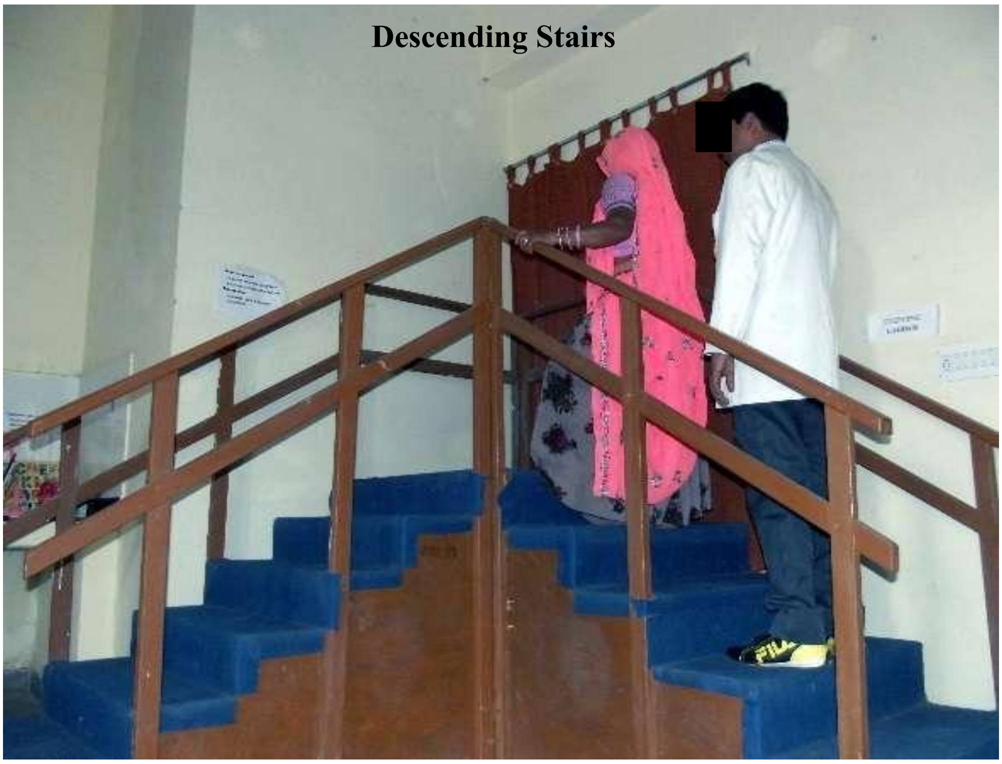
20 Meter Walk Test starting position

20 Meter Walk Test ending position

Walking Indoors While Passing A Weighted Ball From Hand To Hand

Walking Indoors While Passing A Weighted Ball From Hand To Hand

Descending Stairs



Ascending Stairs

3.9 DATA COLLECTION

On the first day of the study, the subjects were read and signed the informed consent. The principal investigator was answered any questions the participants had regarding the study. The subjects were randomly assigned to either the TE or FTT group bythe Researcher. Performance measure tests were measured at **baseline (Day-1), six week and twelve-week periods.**

3.10 DATA ANALYSIS

Data obtained on first day (Baseline), on the completion of six week & on the completion of twelve week were interpreted and SPSS statistical software was used for data analysis. In this study ***Paired t- test*** was used for all the five variables, namely VAS, WOMAC, Timed up and Go Test, 20 Meter Walk Test and Berg Balance scale. The variables with respect to the subjects recorded were clearly insignificant at Day 1 (pre treatment session) when compared against each other namely Traditional exercise group (TE) or the Functional task training group (FTT).

Chapter 4

Results

Results

All five variables with respect to the subjects recorded were clearly insignificant at Day 1 (pre treatment session) when compared against each other namely Traditional exercise group (TE) or the Functional task 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.

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

Table 4.1 Demographic data of the Age of subjects of TE & FTT Group.

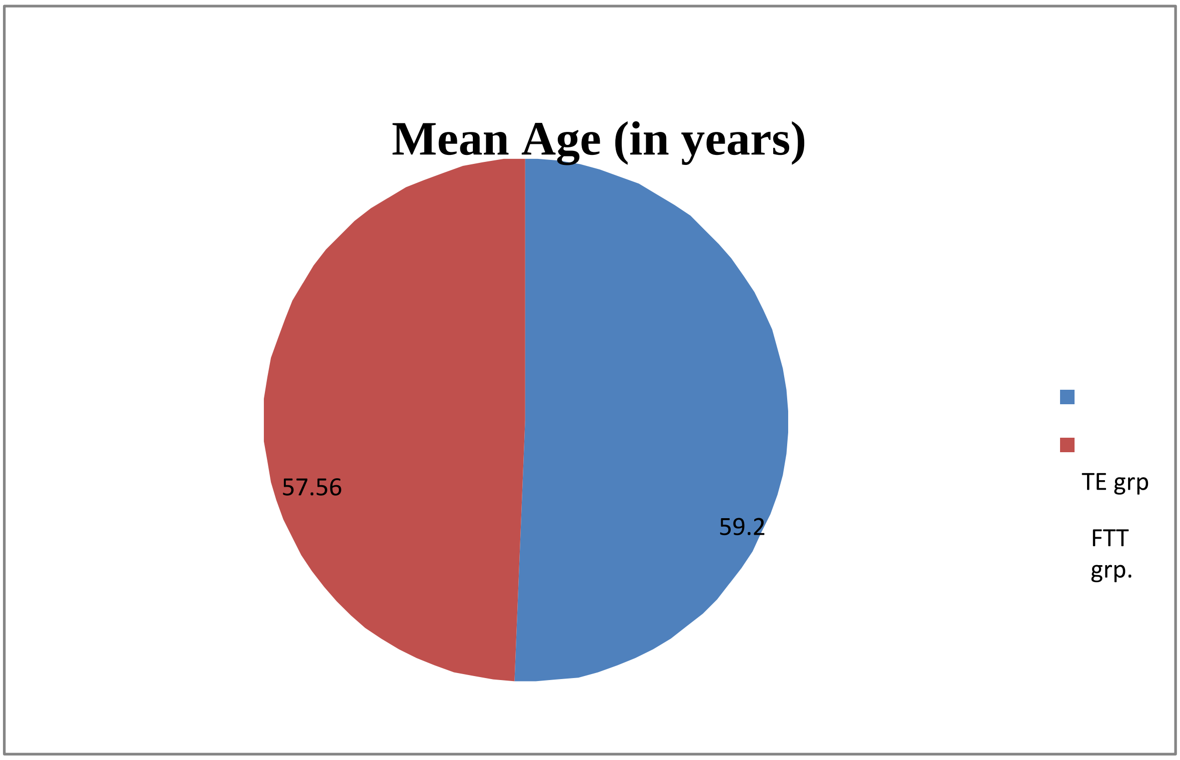


Table 4.2.: Pie chart presentation of Demographic data of the Age of subjects of TE & FTT Group.

Pain on VAS scale

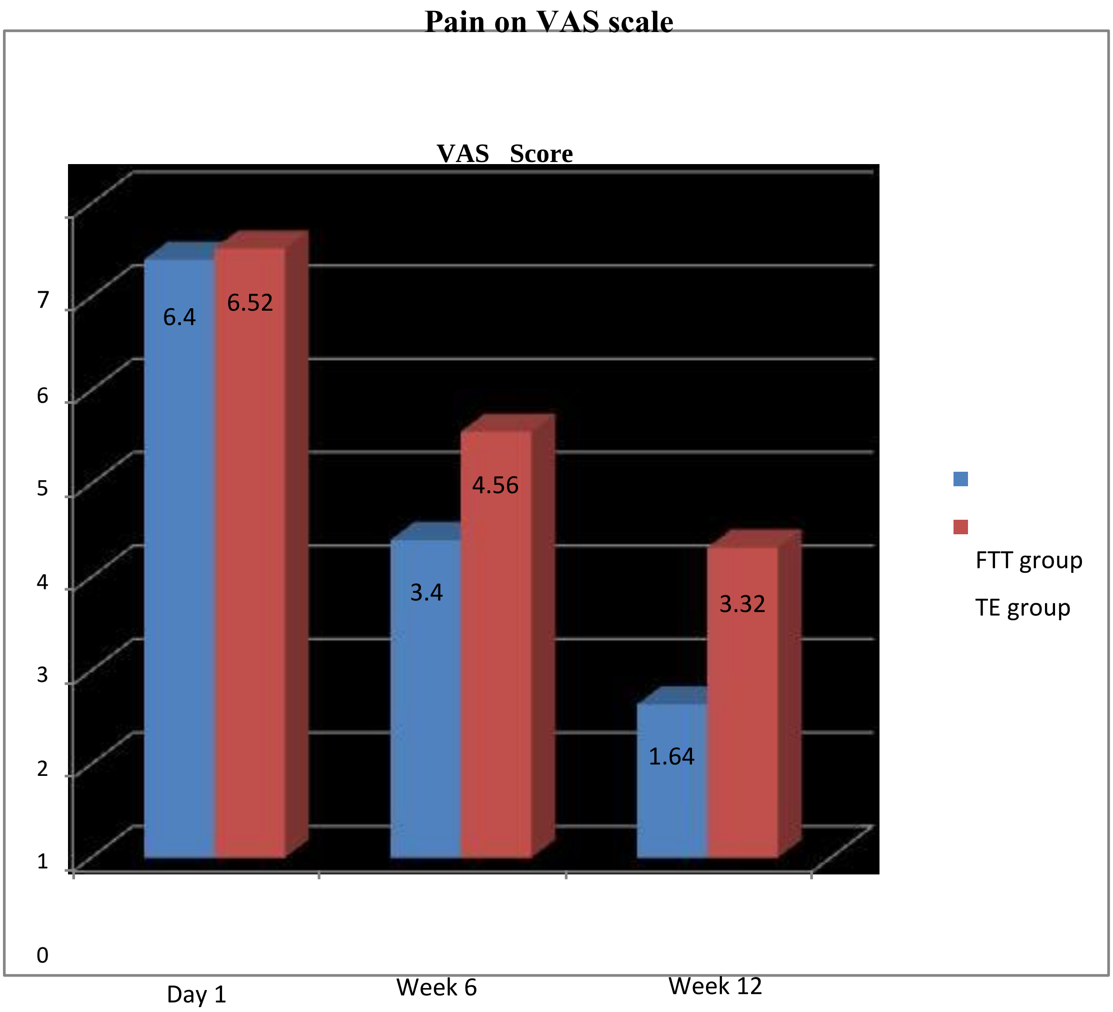
Intergroup Analysis of VAS Score (Comparison between the changes in mean scores of VAS): On **Day 1** (pre treatment session) , the mean of VAS score of **FTT Group** was 6.4 ± 1.040 & mean of VAS score of **TE Group**was 6.52 ± 0.770. The p–value of the difference between the two by paired t-test was 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-3.3 & Graph-3.1

Group	FTT (VAS SCALE)		TE (VAS Scale)		P-value
	(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*

Table 4.3. **Comparison between mean of VAS scores in FTT group and TE group.**



Graph 4.1.: **Comparison between mean of VAS scores in FTT group and TE group.**

WOMAC

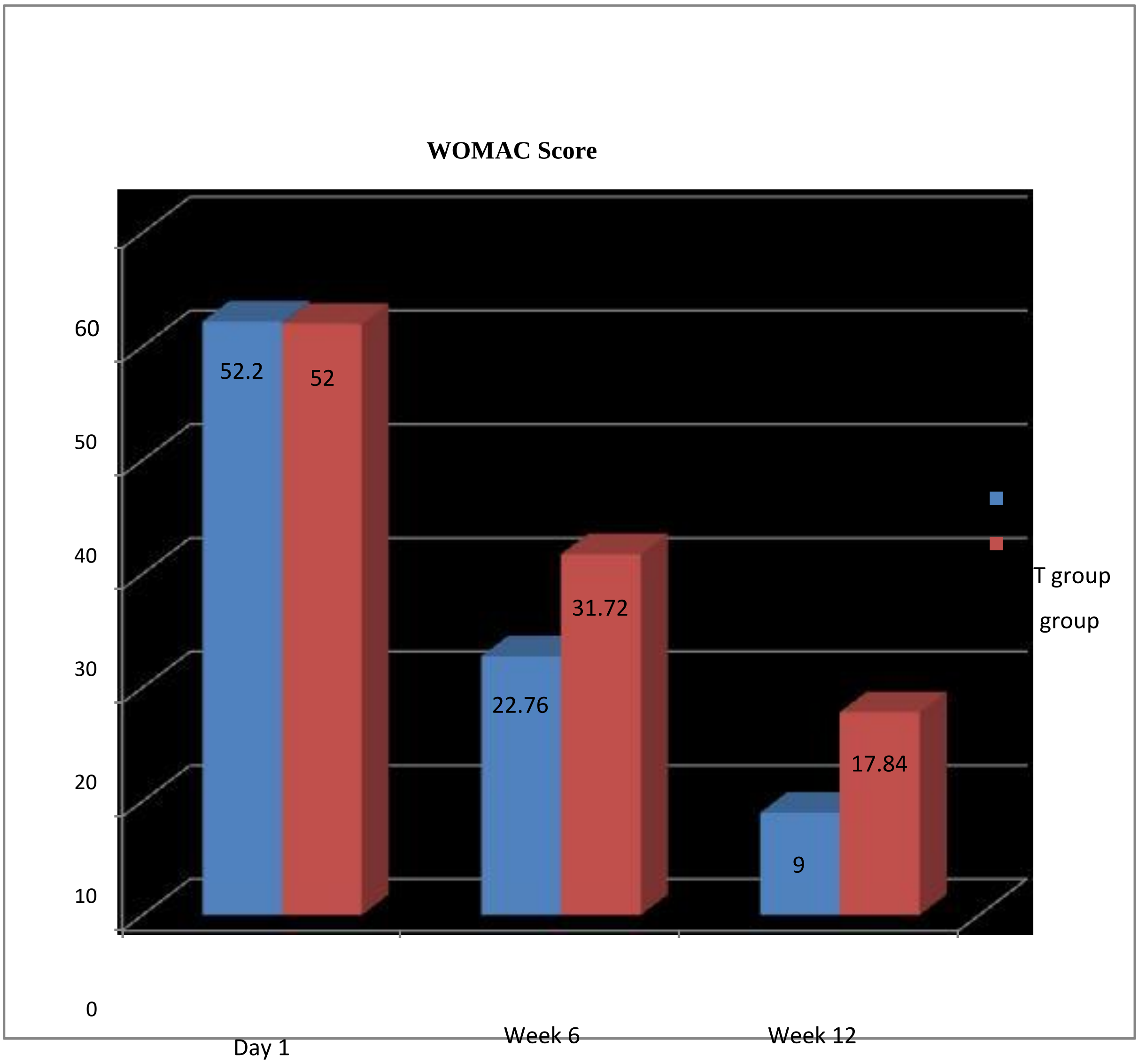
Intergroup Analysis of WOMAC Score: On **Day 1** (pre treatment session) , the mean of WOMAC score of **FTT Group**was 52.20±1.581 & mean of WOMAC score of **TE Group** was 52.00±1.223. The p–value of the difference between the two by paired t-test was found to be 0.519, which is not statistically significant.

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-3.4 & Graph-3.2.

Group	FTT (WOMAC SCALE)		TE (WOMAC Scale)		P-value
	(Mean value)	SD value	(Mean value)	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*

Table 4.4.: **Comparison between mean of WOMAC scores in FTT group and TE group.**



Graph 4.2.: **Comparison between mean of WOMAC scores in FTT group and TE group.**

Time Up and Go Test

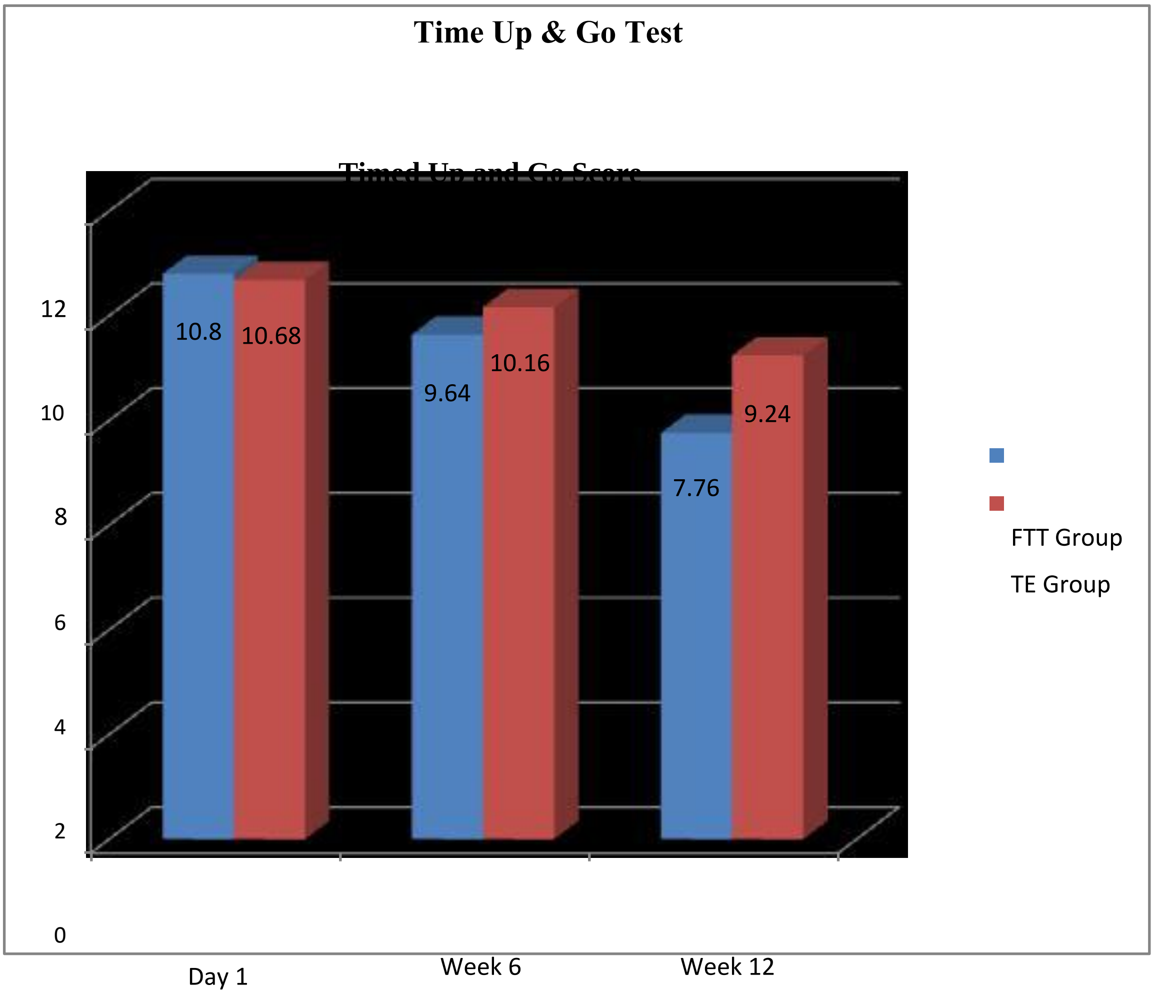
Intergroup Analysis of TUG Test: On **Day 1** (pre treatment session) , the mean of TUG score of **FTT Group** was 10.80±0.645 & mean of TUG score of **TE Group** was 10.68±0.748. The p–value of the difference between the two by paired t-test was found to be 0.327 which is not statistically significant.

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-3.5 &Graph-3.3.

Group	FTT (TUG in sec)		TE (TUG in sec)		P-value
	(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***

Table 3.5.: **Comparison between mean of TUG scores in FTT group and TE group.**



Graph 3.3.: **Comparison between mean of TUG scores in FTT group and TE group.**

20 Meter Walk Test

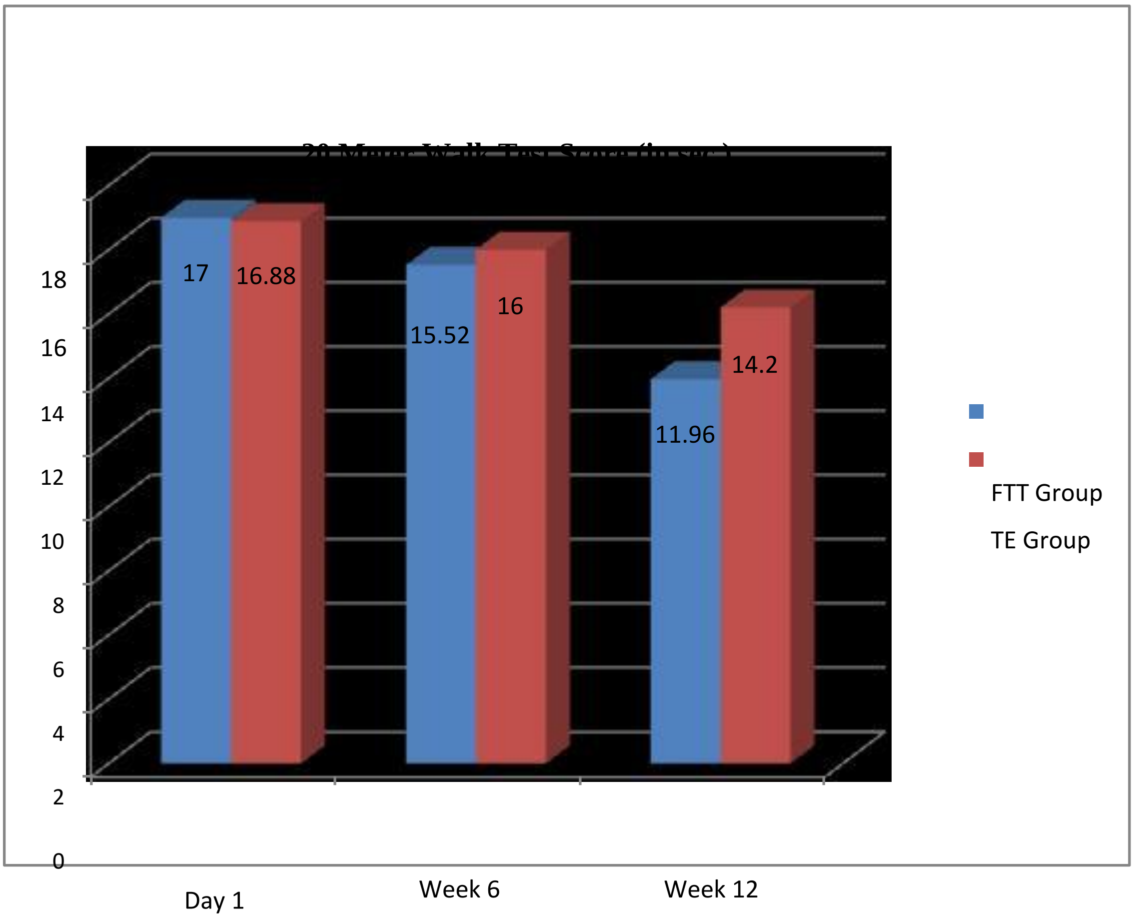
Intergroup Analysis of 20 Meter Walk Test: On **Day 1** (pre treatment session) , the mean of 20 m walk test score of **FTT Group** was 17.00±0.763 & mean of 20 m walk test score of **TE Group** was 16.88±0.665. The p–value of the difference between the two by paired t-test was found to be 0.524 which is not statistically significant.

At the end of **Week 6**, the mean of 20 m walk test score reduced in both the groups. In **FTT Group**it reduced to 15.52±0.653 and in **TE Group** it reduced to 16.00±0.577. The P value of the difference between the two by paired t-test was found to be 0.003 which is highly significant.

At the end of **Week 12**, the mean of 20 m walk test score reduced in both the groups. In **FTT Group**, it reduced to 11.96±0.538 and in **TE Group**it reduced to 14.2±0.500. 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-3.6& Graph-X.

Group	FTT (20m Walk Test in sec)		TE (20m Walk Test in sec)		P-value
	(Mean value)	SD value	(Mean value)	SD value	
Day1	17.00	0.763	16.88	0.665	0.524
Week 6	15.52	0.653	16.00	0.577	0.003*
Week 12	11.96	0.538	14.2	0.500	0.000*

Table 4.6.: Comparison between mean of 20 Meter Walk Test in FTT group and TE group



Graph 4.4.: **Comparison between mean of 20 Meter Walk Test in FTT group and TE group.**

Berg Balance Scale

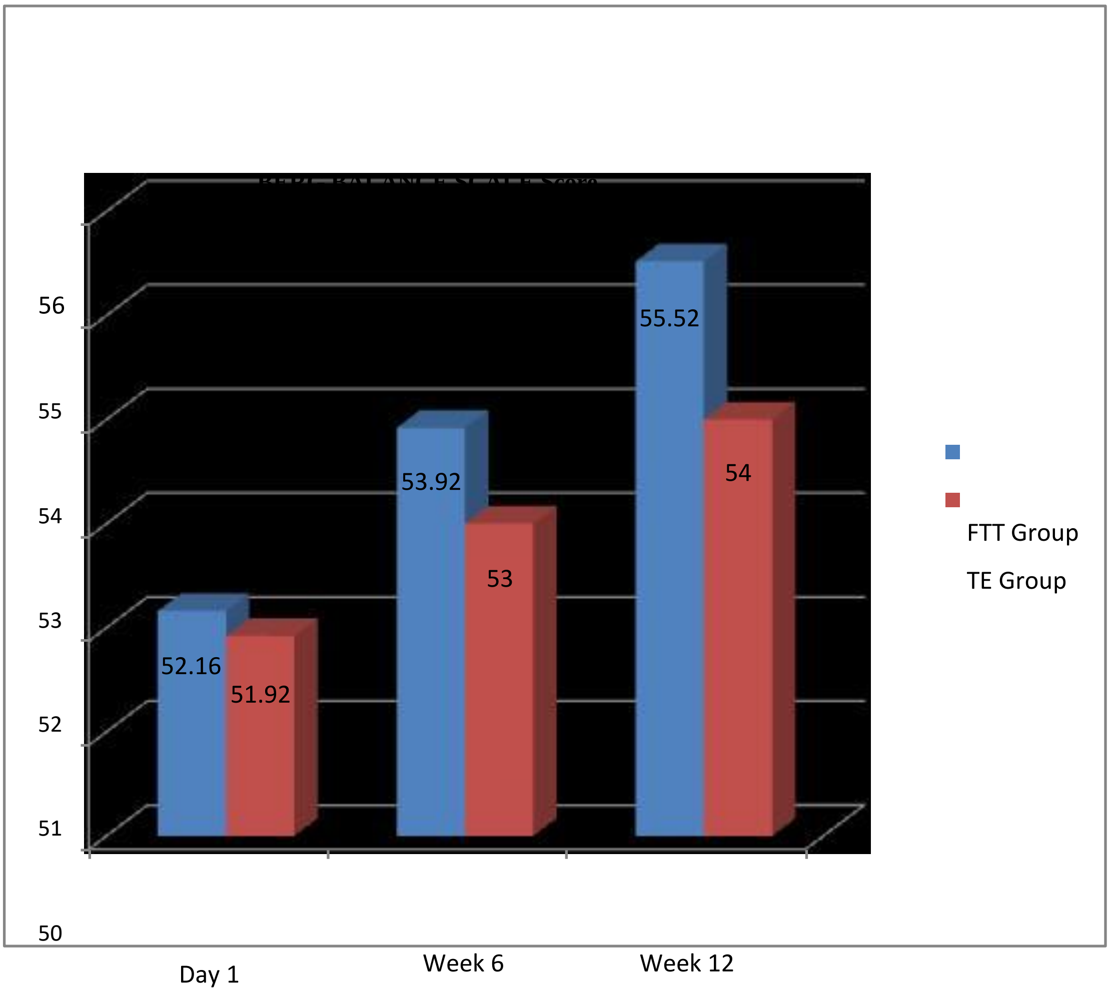
Intergroup Analysis of Berg Balance Scale Test: On **Day 1** (pre treatment session) , the mean of Berg balance scale of **FTT Group** was 52.16±0.553 & mean of Berg balance scale of **TE Group** was 51.92±0.4000. The p–value of the difference between the two by paired t-test was found to be 0.056 which is not statistically significant.

At the end of **Week 6**, the mean of Berg balance scale increased in both the groups. In **FTT Group**it increased to 53.92±0.493 and in **TE Group** it increased to 53.00±0.408. 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 Berg balance scale further increased in both the groups. In **FTT Group**, it increased to 55.52±0.509 and in **TE Group**it increased to 54.00±0.408. 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-X & Graph-X.

Group	FTT (BBS)		TE (BBS)		P-value
	(Mean value)	SD value	(Mean value)	SD value	
Day1	**52.16**	**0.553**	**51.92**	**0.4000**	**.056**
Week 6	**53.92**	**0.493**	**53.00**	**0.408**	**0.000***
Week 12	**55.52**	**0.509**	**54.00**	**0.408**	**0.000***

Table 4.7.: **Comparison between mean of Berg Balance Scale in FTT group and TE group.**



Graph 4.5.: **Comparison between mean of Berg Balance Scale in FTT group and TE group.**

Chapter 5

Discussion

Discussion

In this study, two types of Exercises technique were utilized to examine if any significant differences existed in measurement of pain (as measured by the VAS score), physical function (as measured by the WOMAC self-assessment scores), Balance and mobility on Timed Up & Go Test & Berg balance scale and walking speed on 20 meter walk test. Results indicate that both groups improved in all measures of pain, Balance, functional outcomes & walking speed.

However the effect on Pain measured by VAS, Physical function measured on WOMAC score, Balance & mobility measured on BBS & TUG and walking speed measured by 20 meter walk test, which was highly significant across the two testing periods (at 6 week & 12 week) for the functional task training group (FTT) upon intergroup analysis. This shows that FTT exercise technique gives early and highly significant relief in Pain & stiffness and provides good balance, functional mobility and walking speed which display parity with those reported by Deyle et al., (2005).
The demographic characteristics of the sample recruited for this study are consistent with those of individuals with knee OA observed in the current literature regarding age in both the group.

Pain, Stiffness and Function

Regardless of the training module, both groups demonstrated decrease in pain over time. Both the TE and FTT group demonstrated significant decreases over time for pain from baseline to the completion of the study with a larger, but significantly different decline in the FTT group. In this study, the VAS total score demonstrated a decrease by 50% and 75% for the TE and **FTT** group, respectively.

Both the group of study shows decrease in total score of WOMAC but FTT group gives better result than TE group. Overall, the results from this study are consistent with those found in the literature and suggest that regardless of group assignment, strengthening exercises decrease pain, stiffness, and improve self-reported function in individuals with knee OA (Deyle et al., 2005; Fransen & McConnell, 2001; Hinman, Heywood, & Day, 2007; Jamtvedt et al., 2008; van Baar et al., 1998). Change scores ranging from 17% to 26% from baseline are determined to reflect a minimally important clinical improvement (Barr, et al., 1994). In this study, the WOMAC total score demonstrated a decrease by 71% and 83% for the TE and **FTT** group, respectively, which display parity with those reported by Deyle et al., (2005). Since individuals tend to report a decrease in physical function when having pain, performance-based measures should be utilized in addition to self reported questionnaires to assess physical function (Stratford et al., 2006), as these measures are more sensitive to change and less influenced by pain than self-reported measures (Piva et al., 2010).

20 m walking speed test (time)

Regardless of group assignment, the FTT group walked significantly faster than the TE group after six weeks of task practice, which may have resulted from improved muscle activation and timing associated with task specific training. There was significant change from six weeks to twelve weeks; and the decrease in time to perform 20 meter walk test from baseline to six weeks was substantial. Interestingly, the literature suggests that dual-task practice supports that object manipulation with body transfer has been found to increase gait velocity more effectively than walking alone (Silsupadol, 2008). Given that 20 meter walk time ranged from an average of 16.88 sec. at baseline to 14.2 sec. on 12 week for the TE group and an average of 17 sec. at baseline to 11.96 sec. on 12 week for the FTT group, one can see that there was a substantial difference in velocity for the functional task training group. Since a velocity change of 10 cm/s is considered substantial and clinically meaningful (Jaeschke, Singer & Guyatt, 1989), the noted decrease in time of 30% demonstrates significant improvement for the **FTT** group. Consistent with the significant difference in velocity, it is noted that the FTT group demonstrated a decrease in double support time indicating that they spent more time on one leg. Since external knee adduction moments are greater during single leg stance (Hurwitz et al., **1999;** Al-Zahran et al., 2002; Bejek et at., **2006),** and an increase in adductor moment is associated with greater pain, (Hurwitz, Ryals, Case, Block & Andriacchi, 2002), a decrease in double support time may indicate less knee pain for the subjects in the FTT group.

Timed Up and Go (TUG)

The TUG scores were significantly different over time for both groups in the study; however, a greater change was observed for those subjects in the FTT group. This change was significant for both groups. The TE group improved their time by ***19.4%*** **(1.44** seconds), while the FTT group improved by 30% (3.076 seconds). Mean TUG scores have been reported between six and 11.2 seconds in community dwelling women without any **known** pathology. Published studies report that times of 8.5 seconds to 14 seconds indicate pre-clinical functional ability limitations (Fried, Young, Rubin, & Bandeen, 2001) and that a decrease of 1.5 seconds reflects a minimally clinically significant change (Piva et al., 2002). Therefore, improvements in TUG scores for the **FTT** group may indicate clinical significance. Even though both groups started out at approximately the same times at baseline, there was a substantial improvement in the FTT group. Since greater knee extensor torque is associated with a chair rising activity (Krebs et al., **2007), and** both groups performed relatively similarly on strength measures, what can account for this difference? The author postulates that the difference appears to be related to the type and intensity of exercise performed in the FTT group. Specifically, activities practiced by this group required greater repetitions of functional tasks, such as sit to stand with a weighted box, which may transfer better to pedormance secondary to task specific training. In fact, Mc Gibbons et al. (2003) found that a sit to stand task translated to greater forward momentum. Faster rise times noted for the FTT group may indicate improvements in postural stability required to accommodate to larger changes in the center of gravity associated with this activity. These findings further support the plausibility of task-specific training in transfer to task performance.

Berg Balance Scale

In this study, both groups were not at risk for falls at the beginning of the study, and both groups consisted of high functioning individuals. The BBS has been noted to be less sensitive to change in individuals with high levels of balance abilities (Bogle & Newton, 1996). Despite this fact, there was an observed significant improvement in the FTT group. Balance is a complex, multifactoral phenomenon involving the vestibular, visual and somatosensory systems, so manipulating the task and environment, as was done with the functional task training group, may help to cope with the constraints of knee OA. Effective and timely muscle control is necessary to maintain balance, and static as well as dynamic control is required for both simple and challenging tasks (Hinman et al., 2002). Several studies demonstrate the relationship between
knee pain and balance (Hinman et al., 2002; Jadelis et al., 2001) while others indicate that poor muscle strength and decreased proprioception are greater contributors to balance deficits (Bennell & Hillman, 2005). Jadelis et al. (2001) found that when subjects had greater muscle strength, pain did not influence balance performance. Postural control is a function of the afore mentioned physiological systems and together, they may be able to compensate for imbalances caused by pain or muscle weakness. However, a combination of pain, muscle weakness, and or proprioception deficits may be better predictors of balance deficits associated with knee OA. One can also suggest that the repetition of the star exercise contributed to proprioceptive acuity and increased stability in the FTT **group** as it involves standing on one leg while reaching out with the other leg to touch all points of an outlined star.

Perturbations associated with this leg movement provide challenges to this static task, thus requiring a coordination of movements that are shaped **by** environmental constraints. Since both group scores were relatively high at the initiation of the study, and both groups approached maximal scores on the BBS, this leads the author to question if the BBS is the best tool to assess balance deficits in this highly functional **group.** Further reflection on balance scores may suggest that balance may not be the primary consideration in this cohort.

Limitations

There are several limitations to this study. The first limitation of this study is small sample size. A small sample size of 50 subjects, 25 each group (TE group, n=25 and FTT group, n=25) can not cover the whole population of OA. Therefore, the results should be interpreted with caution.

Secondarily the BMI (Body mass index) criteria were not taken for the selection of subjects for this study. Weight limit criteria should have included as the inclusion criteria for the selection of the subjects because there is strong correlation between weight of the patient and severity of the OA disease.

Thirdly we included the subjects for this study on the basis of Diagnosis of knee OA based on radiographic results obtained byphysician report but did not included the grading of severity of OA. We should have taken the Grades for Severity of Knee OA According to the Kellgren & Lawrence Scale, and then the outcome of the study might be more accurate.

Additionally, there may be some methodological limitations, which represent threats to internal and external validity. First, compensatory equalization of treatments can occur when research investigators favor one experimental group over the other. Since the principal investigator supervised both exercise groups, this cannot be ruled out. Next, the FTT group performed exercises similar to the testing protocol, which may have accounted for a testing effect in this group. However, given the design of the study, this is what was investigated. Lastly, the small and limited geographic range from which the subjects were recruited, may limit the generalizability of findings. Additionally, performance tests utilized in this study may not have been sensitive enough to detect subtle changes in this highly functional age group. Future tests should include more challenging performance tests such as walking while changing directions and negotiating obstacles. Confounding variables include not controlling for bilateral knee involvement and weight loss as a result of the exercise program.

Future studies should address larger populations with more sensitive performance measures as well as dual task performance. Longitudinal studies should be used to determine the effectiveness and adherence to this exercise program in the knee OA population, as morphological changes in pain may influence exercise adherence.

Chapter 6

Conclusion

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. In addition to this the observed group effect for walking speed in favor of the FTT may have been key in improving functional stability. Further in TUG test although both groups demonstrated significant changes in time to rise from a chair, walk for few minutes, walk back to the chair and sit down, the observed change was greater in the functional task training group. Taken together, the data may suggest that increases in strength alone at the impairment level may not result in improved task performance. 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. The existence of such a threshold may simply augment strength reserves without enhancing function (Bean, Vora, & Frontera, **2004).** It is necessary to recognize if deficits at the impairment level are causative in limiting activities, so that if strength is an issue, dealing with the impairment at a more functional level may be more effective in the long term. Effectiveness of strengthening exercises can be maximized by introducing flexibility, coordination, balance, and mobility, which may transfer to an overall improvement in function. Repetition and task practice not only improves strength but reduces activity limitations associated with the impairment of decreased muscle strength. Ultimately, the inability to participate in activities at a social level has an impact on the quality of life in individuals with knee OA. Addressing the impairments and activity limitations associated with this disease in middle-aged individuals may delay and/or prevent the disabilities encountered in the elderly. One can also suggest that the repetition of the star exercise contributed to proprioceptive acuity and increased balance and stability in the FTT **group** as it involves standing on one leg while reaching out with the other leg to touch all points of an outlined star.

The data from this study support that functional task training is a better option in improving walking speed in this 50-65 year old population with knee OA. An exercise program tailored to the individual's diagnosis, lifestyle, habits and co-morbidities may well provide a rehabilitative program that may be more positively embraced and adhered to for a longer period (Pisters et al., 2010).

Chapter 7

Summary

Summary

The outcome of this study shows that FTT exercise technique gives early and highly significant relief in Pain & stiffness and provides good balance, functional mobility and walking speed in individuals with OA knee. Findings in this study provide evidence to support that FTT is an effective therapeutic approach in the rehabilitation in individuals with **knee** OA.

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RESEARCH ARTICLE

The Effects of Functional Task Training versus Progressive Resistance exercises on OA Knee.

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Abstract

Aims & Objectives: To investigate the efficacy of functional task training in decreasing pain, and increasing functional mobility in Osteoarthritis Knee.Study design: Comparative case control study. Methodology: Thirty subjects with a diagnosis of OA Knee were selected directly from Physiotherapy outpatient door of Jaipur Physiotherapy College, MVGU, Jaipur. These individuals were randomly assigned into two groups: FTT Group [Functional l task Training (n = 15)] and PRE Group [Progressive Resistance Exercise (n = 15)]. FTT Group Functional tasks included sit to stand box lift, standing star exercise, walking up and down a ramp while holding a weight, ascending/descending stairs while holding a weight in the preferred hand, and walking indoors while passing a weighted ball from hand to hand. Subjects performed the exercises for one minute with (when indicated) a one-pound weight. Progressions included either an increase in weight or time to perform the activity. Subjects in the PRE program performed three exercises (two exercises for quadriceps strengthening and one for hamstrings strengthening), for the first 6 weeks all the exercises were given with 1kg weight and for the next 6 weeks exercises were given with 1.5kg weight. Patients were instructed to do each exercise Twenty five to thirty repetitions in one set and single set is done by patient in one treatment session. Both the groups were given exercises supervised by physiotherapist on regular basis for 12 weeks. Data for measurements of pain on VAS scale, Balance & mobility on Step Test & Walking speed Test was collected on day 1 (pre treatment session), at 6 weeks, and at week 12. 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, Step Test & Walking Speed Test was highly significant across the two testing periods (at 6 week & 12 week) for the functional task training group (FTT). Conclusion: Functional task training on regular basis is an effective rehabilitation program and is better than PRE for improving functional mobility, balance and decreasing pain in OA Knee.

Introduction:-Osteoarthritis (OA) most commonly affects the knee joint (Zhang and Jordan, 2010)1Knee OA is defined as a clinical syndrome of joint pain accompanied by varying degrees of functional limitation and reduced quality of life (The Royal Australian College of General Practitioners (RACGP), 2009).2Osteoarthritis (OA) is a degenerative articular 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).3The prevalence of symptomatic knee OA in developed countries is estimated at five per cent for adults between the ages of 26 and 45 years; 17% for adults above the age of 45 years; and 12.1% for adults over the age of 60 years (American Academy of Ortho paedicSurgeons (AAOS), 2008).4 Knee OA has a significant impact on function and quality of life. Recurrent knee pain isthe primary symptom affecting crucial functional activities, including walking (Zhang and Jordan, 2010). Other kneeOA-associated symptoms such as stiffness and muscle weakness further impairs function and has an impact on societal, recreational and occupation-related activities (Walsh and Hurley, 2008). Management of chronic knee OA symptoms primarily includes pharmacological, physiother apeutic and surgical interventions (RACGP, 2009).2 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 (Brousseau et al., 2005).5Traditional exercises tend to focus on the isolation of one or more muscle groups (e.g., quadriceps) in an attempt to address the impairment. Alternately, functional task training focuses at the activity level by strengthening and adapting postural strategies to environmental demands through functional task performance.

In a pilot study of 45-65 year old knee OA subjects, who were randomized to either a functional task training or traditional exercise group, Stutz-Doyle (2009) found the functional task training group demonstrated a significant increase in quadriceps muscle strength and gait velocity as well as greater improvements in TUG scores as compared to traditional exercise group.6Since there is limited information regarding the benefit of functional task training programs in the OA population over strength training exercises/Progressive resistance exercise (PRE), further investigation is warranted in the knee OA populatio n; therefore, the purpose of this study was to investigate whether functional task training would be more effective in decreasing pain, and increasing balance & functional mobility in this population.

Material & Methods:- Evaluation of the study subjects:-A sample of 30 patients who were diagnosed with OA Knee and who fulfilled the inclusion criteria were referred to outpatient physiotherapy department of Jaipur physiotherapy college, MVGU, Jaipur and after obtaining informed consent they recruited for this study. A sample of 30 patients was assigned in two groups, the Progressive Resistance exercise group (PRE) or the Functional task training group (FTT).

Inclusion Criteria:-Both Male & female patients age ranged between 50- 65 years, had knee pain of four months or longer, able to walk100 feet without resting and without an assistive device, able to ascend & descend 9 stairs, able to lift a 4 pound box from the floor and stand up, not taking anti-inflammatory medication and diagnosis of knee OA based on radiographic results obtained by physician report.

Exclusion Criteria:-Neurological disease, uncontrolled low or high blood pressure, uncontrolled cardiopulmonary or respiratory condition, inability to rise from and return to a chair without assistance, any additional musculoskeletal diseases or surgeries and currently actively participating in an exercise program.

Outcome measures:-Visual Analogue scale (VAS):-Knee pain was recorded on (VAS) which is a 10 cm horizontal line, 0 represented no pain while 10 representedextremely intense pain. VAS was given to all participants and was asked to place a vertical mark along the linewhere they feel pain. VAS provides a reliable method for measuring pain and is sufficiently sensitive to detect distinct differences in pain experience.7

Walking speed test:-This was a 5 meter walking time. Subjects were asked to walk for a total of 8 meters in order to minimize the influence of acceleration and deceleration at the onset and conclusion of task, the 5 meter time was recorded during the middle of 8 meter.8

Step test:-In this test subjects were asked to stand on the osteoarthritic limb, while opposite knee was kept over the stool of height 15 cm. subjects stood on the osteoarthritic limb, while steeping the opposite foot on and off the step as many times a possible over 15 sec. The number of repetitions were taken the participants could place the foot on the step and return it to the floor was noted.9

Procedure:-

Exercise Protocols:-The PRE program consisted of exercises that targeted the level of impairment (muscle strength), while the FTT program concentrated on exercises concerned with the body as a whole. The intensity of exercise was monitored based on the Borg Perceived Exertion Scale. The resistance load is equated with a moderately intense rating (#3) on the scale.

Subjects in the PRE program performed three exercises (two exercises for quadriceps strengthening and one for hamstrings strengthening), For the first 6 weeks all the exercises were given with 1kg weight and for the next 6weeks exercises were given with 1.5kg weight. Weight cuff were tied at end of the leg in all the exercises. For quadriceps strengthening, Knee extension in high sitting position and short arc knee extension in supine lying position with weight cuff were given. For Hamstring strengthening, Patient prone lying knee flexion with weight cuff was given. Patients were instructed to do each exercise Twenty five to thirty repetitions in one set and single set is done by patient in one treatment session. Patients were allowed to take break if they complain of tiredness or discomfort.10

Functional tasks (FTT) included sit to stand box lift, standing star exercise, walking up and down a ramp while holding a weight, ascending/descending stairs while holding a weight in the preferred hand, and walking indoors while passing a weighted ball from hand to hand. All exercises were supervised by the Physiotherapist. Subjects performed each exercise for one minute with (when indicated) a one pound weight. Progressions included either an increase in weight or time to perform the activity.11

Data collection:-Performance measure tests were completed at Day 1 (Pre treatment session), six week and twelve week periods.

Statistical Analysis:-SPSS statistical software 21version was used for data analysis. Comparison between the two groups was done on Paired t- test.

Result:-In this study Paired t- test was used for all the three variables, namely VAS, Walking speed Test and Step Test. The variables with respect to the subjects recorded were clearly insignificant at Day 1 (pre treatment session) when compared against each other namely Progressive Resistance exercise group (PRE) or the Functional task traininggroup (FTT).

VAS:-Intergroup analysis:-The intergroup analysis with respect to the variable VAS is reflected in (table1. figure- 1). The overall data which was analyzed revealed significant improvement on the effective variable in both the groups. There was an insignificant difference between FTT Group and PRE Group at Day-1 (Pre-Test) with t value=0.326699, p<0.05.

There was a significant difference between FTT Group and PRE Group at Week 6 ((table1. figure- 1.) with t value=2.82137, p<0.05. There was a significant difference between FTT Group and PRE Group at Week 12((table1. figure- 1.) with t value=9.88929, p<0.05.

Table- 1. Comparison of VAS scale between FTT Group and PRE Group

VAS FTTGROUP (N=15)		PRE GROUP (N=15)			t-VALUE
MEAN	S.D	MEAN	S.D		
6.666667	1.046536	6.8	0.676123404	1 DAY	0.326699
4.066667	0.883715	6.066667	0.703732	6 WEEK	2.82137**
1.533333	0.63994	3.6	0.910259	12 WEEK	9.88929**

** Significant <0.05 level

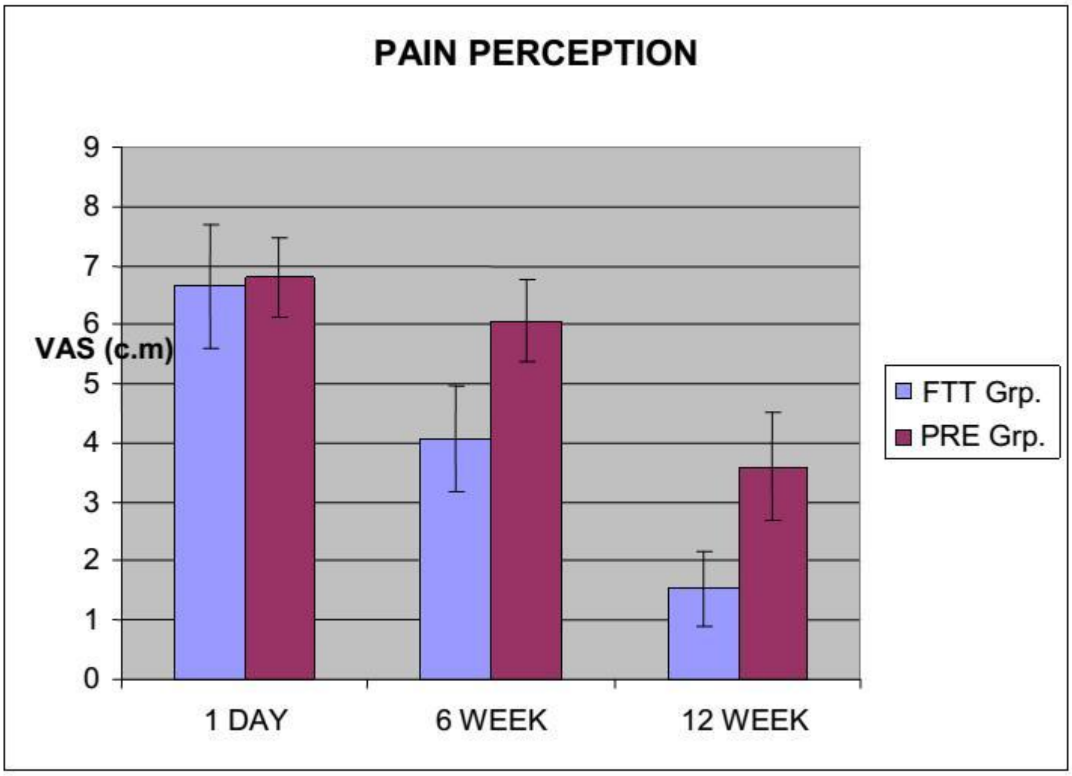

Fig.-1 Comparison of VAS scale between FTT Group and PRE Group

Step Test- Intergroup analysis:- The inter group analysis with respect to the variable step test is reflected in (Table 2., figure 2.). The overall data which was analyzed revealed significant improvement on the effective variable in both the groups. There was an insignificant difference between FTT Group and PRE Group at Day 1 (Pre-Test.) with t value=0.168525, $p<0.05$. There was insignificant difference between FTT Group and PRE Group at Week 6 (table 2. figure 2.) with t value=0.000447, $p<0.05$. There was a significant di fference between FTT Group and PREGroup at Week 12 (table 2. figure 2.) with t value=2.5854, $p<0.05$.

Table: 2. Comparison of Step test between FTT Group and PRE Group

Step test FTT GROUP (N=15)		PRE GROUP (N=15)			t-VALUE
MEAN	S.D	MEAN	S.D		
3.461538	0.518875	3.307692308	0.480384461	1 DAY	0.168525
4.538462	0.518875	3.923077	0.493548	6 WEEK	0.000447
6.615385	0.50637	4.769231	0.438529	12 WEEK	2.5854**

** Significant at <0.05 level

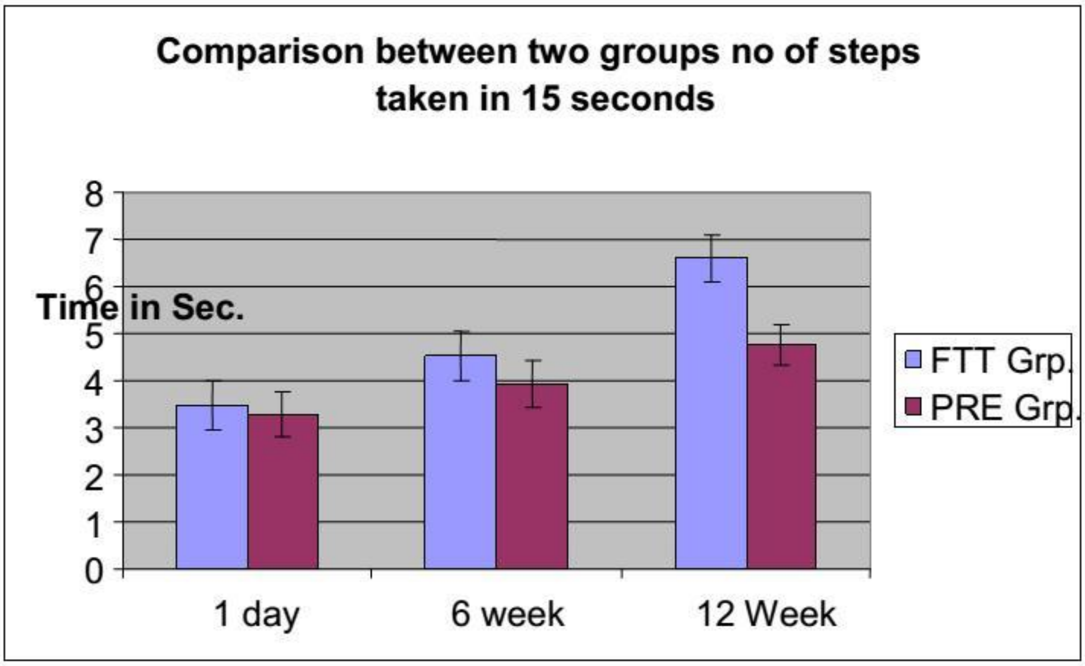

Fig.-2 Comparison of Step Test between FTT Group and PRE Group

Walking speed Test - Intergroup analysis

The intergroup analysis with respect to the variable, walking speed is reflected in (table 3. figure 3.). The overall data which was analyzed revealed significant improvement on the effective variable in both the groups. There was an insignificant difference between FTT Group and PRE Group at 1 Day (Pre-Test) with t value=0.145, $p<0.05$.

There was insignificant difference between FTT Group and PRE Group at Week 6 (table 3. figure 3.) with t value=0.02, $p<0.05$. There was significant difference between FTT Group and PRE Group at Week 12 (table 3. figure 3.) with t value=4.68, $p<0.05$.

Table: 3. Comparison of Walking speed test between FTT Group and PRE Group

Walking speed FTT GROUP (N=15)		PRE GROUP (N=15)			t-VALUE
MEAN	S.D	MEAN	S.D		
5.266667	1.032796	5.2	1.082325539	1 DAY	0.375649
4.2	1.014185	4.666667	0.816497	6 WEEK	0.055144
3.133333	0.351866	3.933333	0.703732	12 WEEK	0.001464**

** Insignificant at 0.05 level

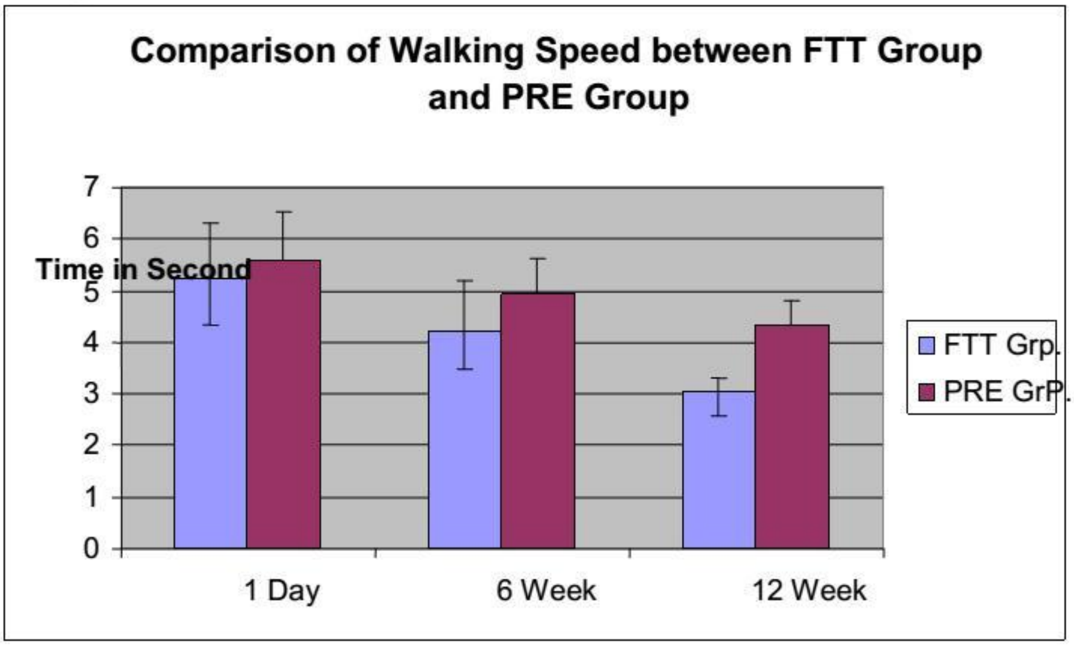

Fig.: 3. Comparison of Walking speed test between FTT Group and PRE Group.

Discussion:-In this study, two types of Exercises technique were utilized to examine if any significant differences existed in measurement of pain (as measured by the VAS score), Balance and functional outcomes on Walking speed test & Step test. Resultsindicate that both groups improved in all measures of pain, Balance and functional outcomes (walking time). However the effect on Pain measured by VAS, walking speed test score & stair climbing test score which was highly significant across the two testing periods (at 6 week & 12 week) for the functional task training group (FTT). This shows that FTTexercise technique gives early and highly signi ficant relief in Pain and provides good balance & functional mobility which display similarity with those reported by Deyle et al..12

Overall, the results from this study are consistent with those found in the literature and suggest that regardless of group assignment, strengthening exercises decrease pain, stiffness, and improve self-reported function in individuals with knee OA (Deyle et al., 2005; Hinman, Heywood, & Day, 2007; Jamtvedi et al., 2008;).12,13,14.

Singh K K et al.,(2016) reported that Functional task training on regular basis is an effective rehabilitation program for improving functional mobility, balance and decreasin g pain and stiffness in OA Knee.[15]

McGibbons et.al. (2003) found that a sit to stand task translated to greater forward momentum. Faster rise times noted for the FTT group mayindicate improvements in postural stability (Balance) required accommodate to la rger changes in the center ofgravity associated with this activity. These findings further support the possibility of task-specific training in transfer to task performance.[16]

Whitehurst, Johnson, Parker, Brown, and Ford (2005) found similar results in their 12-week study of functional task exercises with an elderly population. The exercises included wall squats, single leg balance, star exercise, modified pushups and walking over obstacles while carrying bags. The environment was varied byobstacle height, changing directions and walking backward. Outcome measures were significant for the get up and go test (TUG), standing reach, sit and reach and self-report of physical function.17Sibel eyigor2003 did study on isokinetic against PRE in OA knee patients and found that both programs are equally effective in decreasing pain and improvement in function (walking time) and no statistically significant differences could be found in two groups.18Campbell 1982 documented that dynamic stability of the knee joint depends on the appropriate strength ratio of quadriceps and hamstrings.19 Since greater knee extensor torque and power are required when ascending/descending stairs (Mizner et al., 2005)20and the FTT group spent more time performing this activity, the noted improvements may be a result of greater power associated with the additional time spent in task performance which is supporting the result of our study.Conclusion:-In this study both groups improved in all measures of pain, balance and functional out comes. However Functional Task training group benefited by significant relief in Pain, achieved good balance & functional mobility than Traditional exercise group. Functional task training is an effective rehabilitation program for improving functional mobility and decreasing pain in OA Knee.

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Curriculum Vitae

Krishna Kumar Singh, MPT (Ortho)

Principal & Professor - Jaipur Physiotherapy College,

Maharaj Vinayak Global University, Jaipur, Rajasthan.

ACADEMIC QUALIFICATION

- **2006**, MPT, All India Institute of Physical Medicine & Rehabilitation, Mumbai, under Mumbai University, Mumbai, India.

ACADEMIC EXPERIENCE

- 10 year & 3 month of Post PG teaching experience from 06/10/2007 to till date.

ACADEMIC ACHIEVEMENTS

- **Award –** Best Academician Award 2016, in 1st International Physiotherapy Conference, Rajasthan

  Best Academician Award 2015, by Jaipur Physiotherapy Network, Rajasthan.

- **Resource Person -** "Spinal Orthosis" in 1st International Physiotherapy Conference, Rajasthan

PUBLICATION

- International Journal of Advanced Research (IJAR), ISSN No. 2320-5407 *"The Effect of functional Task Training versus Progressive Resistance Exercises on O. A. Knee"*
- International Journal of Therapies & Rehabilitation Research, EISS No. 2278-0343 *"The Effect of Traditional Strengthening exercises V/s Functional Task training on Pain, Balance and Functional Mobility in Knee Osteoarthritis"*
- In Indian Journal of Physical Therapy and Rehabilitation-ISSN No. 2248-9460, Vol-2, Issue-1 "*Effect of Core Stabilization exercise on Spinal Reposition Sense in Asymptomatic Male Subjects"*

Appendix A

DRC Approval Form

MAHARAJ VINAYAK GLOBAL UNIVERSITY

sity Campus:
Dhand,Amer, Jaipur-Delhi HighwayNo. 11C
Jaipur-302001,
Ph. : 01426-284175, 284176,284407
www.mvgu.ac.in

DRC Approval Letter

Scholar's Name Mr. Krishna Kumar Singh

Registration No.: MVGU13PB1PT2

Dear Scholar,

I am pleased to inform you that your synopsis has been approved in Department of Research Committee (DRC) meeting held on dated : 09/09/2014.

Particulars are as follows:-

Name of Scholar: Krishna Kumar Singh

Faculty: Physiotherapy

Subject: Orthopaedics

Approved Title: "The Effects of Traditional Strengthening Exercises versus Functional Task Training on Pain, Balance, Walking Speed and Functional Mobility in Osteoarthritis Knee"

Name of Supervisor: Dr. Vinod Kathju

We also expect that you shall abide by rules, regulation and ordinance of Maharaj Vinayak Global University, Jaipur. Submit the following documents time to time in the university.

1. Lab attendance certificate (If applicable).
2. Progress report at every six month interval.
3. Two research articles published in as ISSN referral Journal.
4. Three hard and one soft copies of summary.
5. Two conference /seminar certificate.
6. Plagiarism Certificate by Supervisor.
7. Migration Certificate.
8. Five hard bound copies of thesis along with soft copy in PDF format.

Note: you are further informed that during verification of documents submitted by you being is founds false the admission will be cancelled automatically.

Head of the Department

Principal
Jaipur Physiotherapy College
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Appendix B

Patient consent form

I, ……………………………………………………… have been explained in details about the research project on "**The effects of traditional strengthening exercises versus functional task training on pain, balance, walking speed and functional mobility in Osteoarthritis Knee"** a comparative study doing by **Krishna Kumar Singh**. The benefits and possible risks of the treatment as well as procedure and duration of study have been explained to me. I had an opportunity to ask any question about my participation and all the questions have been answered to my satisfaction. I recognized that my participation is voluntary and I may withdraw any time.

___________________ ___________________________

(Patient"s signature) Krishna Kumar Singh (Investigator)

Date ___________

Appendix C

Demographics Questionnaire

Please complete the following questions which will determine your eligibility for the study. The principal investigator will discuss the results with each participant**.**

Name:

YES / NO

1. Are you presently walking with a cane, crutch or walker or any other assistive device?

2. Have you ever been diagnosed with a neurological disease?

3. Have you been experiencing knee pain (either off and on or constant) for at least four months?

4. Do you have an uncontrolled cardiopulmonary or respiratory condition?

5 Do you have a history of uncontrolled low or high blood pressure?

6. Do you suffer from any condition that may affect your balance? U

7. Are you presently taking over the counter nonsteroidal anti-inflammatory drugs?

8. Are you currently engaged in any exercise program (1, 2-3X/week.)?

9. Did your physician perform x-rays that confirmed knee osteoarthritis?

10. Are you able to stand on one foot, lift something from the floor, carry a weighted object, climb stairs and walk with a bag (weighing approximately one (1) pound for a period of 15 minutes?

11. Can you rise up from and return down to a chair without support or any assistive device?

12. Can you change positions (e.g. from lying down to sitting) without assistance from another person or support device of any sort?

13. Do you have any history of additional musculoskeletal diseases or surgeries?

Borg Perceived Exertion Scale

The Borg Perceived Exertion Scale gives you an idea of how hard you exercise feels.

The amount **of** resistance should equal a moderately intense rating on this scale.

Resistance should be increased or decreased according to the individual's tolerance.

0	Nothing at all
.5	Extremely weak
1	Very weak
1.5	
2	Weak
2.5	
3	Moderate
4	
5	Strong
6	
7	Very strong
8	
9	
10	Extremely strong
11 ■	
	Absolute maximum

0 "Nothing at all" means that you don't feel any exertion whatsoever; e.g. no muscle fatigue, no breathlessness or difficulties breathing.

1 "Very weak" means very light. **As** taking a shorter walk at your own pace.

3 "Moderate" is somewhat but not especially hard. It feels good and not difficult to go on.

5 "Strong". The work is hard and tiring, but continuing isn't terribly difficult. The effort and exertion is about half as intense as "Maximal".

7 "Very strong" is quite strenuous. You can go on, but you really have to push yourself and you are very tired.

10 "Extremely strong-Maximal" is an extremely strenuous level. For most people this is the most strenuous exertion they have ever experienced.

Appendix D

Assessment Form

Date of Examination:-

1. Identification data

   Name-

   Age-

   Sex-

   Address-

   Occupation-

2. Chief complaints:-
3. [redacted]etailed history of knee pain
   - Detailed previous history
   - Any history of knee surgery
   - History of recent surgery to knee

     Treatment history
4. [redacted] Observatio
   - Bony deformity
   - Colour of skin
   - Any obvious muscle atrophy
   - Swelling

     Scar

Appendix E

Data Collection Form

1. Subject number
2. Group- FTT/TE
3. Disease duration/ Date of Onset of Symptoms-
4. Pain intensity on visual analog scale (VAS)

   0 day (Baseline) ____

   6 week ____

   12 week ____

5. WOMAC Score

   0 day ____

   6 week ____

   12 week ____

6. Time up & Go Test Score (TUG)

   0 day ____

   6 week ____

   12 week ____

7. Berg Balance Scale (BBS)

   0 day ____

   6 week ____

   12 week ____

8. 20 Meter walking speed (Time)

   0 day ____

   6 week ____

   12 week ___

Appendix F

Master Chart

Group	Base line Data (On day 1)						At the end of Six week					At the end of Twelve Week				
	Age in years	VAS	WOMAC	TUG	20m Walk test	BBS	VAS	WOMAC	TUG	20m Walk test	BBS	VAS	WOMAC	TUG	20m Walk test	BBS
A1	64	8	55	12	18	52	4	25	11	16	54	2	10	9	13	55
A2	63	7	54	11	18	53	4	24	10	15	54	2	9	8	12	55
A3	62	6	52	11	17	53	3	23	9	15	54	1	8	7	12	56
A4	60	6	52	11	17	52	3	22	9	15	53	1	7	7	12	55
A5	55	5	50	10	16	53	3	22	9	15	54	1	8	8	11	56
A6	58	6 52		11	17	52	4	22	9	15	53	2	8	7	12	55
A7	54	6	51	10	16	52	3	22	9	15	54	2	9	8	12	55
A8	55	5	50	10	16	52	3	22	9	15	54	1	10	8	11	56
A9	55	6	52	11	17	52	4	22	9	15	54	2	8	7	12	56
A10	64	7	53	11	17	53	3	23	10	16	54	2	8	8	12	55
A11	63	7	53	11	18	52	4	24	10	16	54	2	10	9	12	55
A12	60	6	52	10	17	52	3	22	10	15	54	2	8	8	12	56

A13	58	5	50	10	16	53	3	22	9	15	55	1	9	7	11	56
A14	63	8	54	11	18	51	4	24	10	16	53	2	9	8	12	55
A15	64	8	55	12	18	52	4	25	11	17	54	2	10	8	13	55
A16	56	6	52	11	17	52	3	22	10	16	54	2	9	7	12	56
A17	55	5	50	10	16	51	3	23	9	15	55	1	9	7	12	56
A18	55	6	53	11	18	52	4	23	10	15	54	2	10	8	12	56
A19	56	6	52	11	17	52	3	22	10	15	54	1	8	8	12	56
A20	55	5	50	10	16	53	3	21	9	15	54	1	9	7	11	56
A21	55	6	51	10	16	52	3	22	10	16	54	1	10	7	12	56
A22	59	7	52	11	17	52	4	22	10	16	54	2	9	8	12	55
A23	63	7	52	11	17	52	3	22	10	16	54	2	9	8	12	56
A24	64	8	53	11	17	52	3	23	9	16	54	2	10	8	12	55
A25	64	8	55	12	18	52	4	25	10	17	53	2	11	9	13	55
Mean	59.2	6.4	52.20	10.80	17	52.16	3.4	22.76	9.64	15.52	53.92	1.64	9.0	7.76	11.96	55.52

TE Group	Base line Data (On day 1)						At the end of Six week					At the end of Twelve Week				
	Age in Yrs.	VAS	WOMAC	TUG	20m Walk test	BBS	VAS	WOMAC	TUG	20mWalk test	BBS	VAS	WOMAC	TUG	20m Walk test	BBS
B1	64	8	54	12	18	51	5	35	11	17	52	4	20	10	15	53
B2	56	6	50	10	16	52	4	30	10	15	53	2	18	10	14	54
B3	59	7	53	11	18	52	4	33	10	17	53	3	19	10	15	54
B4	58	7	52	10	17	52	4	32	10	16	53	3	18	9	14	54
B5	55	6	50	10	16	52	3	31	9	15	53	2	17	9	14	54
B6	52	6	52	11	17	52	4	32	10	16	53	3	18	10	14	54
B7	53	6	51	10	17	52	4	31	10	16	52	2	16	9	14	53
B8	54	7	52	11	17	52	5	32	10	16	53	3	17	10	14	54
B9	55	6	51	10	16	52	5	31	9	16	53	3	17	9	15	54
B10	54	6	52	11	17	52	5	32	10	16	53	4	18	9	14	54
B11	53	6	53	11	17	52	5	33	10	16	53	3	19	9	14	54
B12	58	6	52	10	17	52	4	31	10	16	53	4	18	9	14	54
B13	55	5	50	10	16	53	4	30	9	16	54	3	17	8	14	55
B14	58	6	51	10	16	52	5	31	10	16	53	3	17	9	14	54
B15	63	7	54	12	17	52	5	32	11	16	53	4	18	10	14	54

B16	64	8	55	12	18	51	6	32	11	17	53	4	19	9	15	54
B17	60	6	51	10	17	52	5	30	10	16	53	4	17	9	14	54
B18	58	6	50	10	16	52	4	30	9	15	53	4	17	8	14	54
B19	59	7	52	10	17	52	5	32	11	16	53	4	18	9	15	54
B20	58	7	52	11	17	52	5	30	11	16	53	3	16	9	14	54
B21	56	6	51	10	16	52	4	31	10	15	53	3	17	9	13	54
B22	58	7	52	11	17	52	5	32	11	16	53	4	18	10	14	54
B23	56	6	52	11	17	52	4	32	11	16	53	3	18	9	14	54
B24	59	7	53	11	17	52	5	33	10	16	54	4	19	9	14	55
B25	64	8	55	12	18	51	5	35	11	17	53	4	20	10	15	54
Mean	57.56	6.52	52	10.68	16.88	51.92	4.56	31.72	10.16	16	53	3.32	17.84	9.24	14.2	54