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Research Paper

Effect of Neuromuscular Exercises on Articular Cartilage Changes in Knee Osteoarthritis

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ABSTRACT: Background and Objective: *Osteoarthritis is a chronic degenerative disorder characterized by Cartilage loss. It is extremely prevalent in society and is a major cause of disability. It is important to treat Osteoarthritis effectively using a multi-disciplinary approach tailored to the patient's needs. Neuromuscular Exercises have been proved effective in Reducing Pain, Function. But there is a lack of literature regarding the effect of Neuromuscular Exercises on changes in Articular Cartilage. Hence the need of the study arises. The Aim of the study was to find out the effectiveness of Neuromuscular Exercises in Reducing Pain, Improving Function and changes of Articular Cartilage Thickness in subjects with Knee Osteoarthritis.*
Methods: *Prospective study design.This study Includes 66 subjects with age of 35 to 65 years having a Clinical Diagnosis of Knee Osteoarthritis were randomly allocated in two groups. In Group I (n=33) subjects were treated with Conventional Exercises whereas in Group II (n=33) subjects were received Neuromuscular Exercises. Participants were given intervention thrice a week for 16 weeks. The outcome measures of this intervention were measured in terms of VAS for Pain, WOMAC score for Function, and MRI for Cartilage Thickness.*
Results: *Independent `t` test was used to compare the mean significance difference between continuous variables of WOMAC and MRI. Paired `t` test was used to asses the Statistical difference between Pre and Post test scores of WOMAC and MRI. The ANOVA was used to compare the mean scores of VAS within the groups.Statistical Analysis of the data revealed that within the group comparison and in between groups showed significant Improvement in VAS and WOMAC. However within and between comparison of MRI there is no significant difference between the groups.*
Conclusion: *After 16 weeks of Intervention both Conventional Exercises and Neuromuscular Exercises showed significant Improvement in Reducing Pain and Improving Functional performance,but there is no significant change in Articular cartilage Thickness. However Neuromuscular Exercises were found to be more effective when compared to the Conventional Exercises for reducing Pain and Improving Function. From the findings of the current study, it can be recommended that the Neuromuscular Exercises protocol can be used for mild to moderate Knee Osteoarthritis for Pain and Functional Ability.*
Keywords: *Knee Osteoarthritis, VAS, MRI, WOMAC, Conventional Exercises, Neurouscular Exercise.*

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I. INTRODUCTION

Osteoarthritis(OA) is also known as degenerative joint disease or wear and tear arthritis or age-related arthritis[1]. Osteoarthritis usually affects large weight-bearing joints such as the knee and is predicted to be the 4th largest cause of disability by 2020(Woolf AD 2003). Osteoarthritis is a condition with multifaceted etiology and afflicts both weight-bearing and non-weight-bearing joints reporting Pain and difficulty in Functional activities with various modifiable and non-modifiable riskfactors[2].

Literature is limited on the incidence and prevalence of Osteoarthritis because of the problems that define it. The prevalence of Osteoarthritis in India was found to be 17-60% and Males are affected more than females below 45 years of age, while females are more affected after 45 yearsof age[3].

The knee is the largest synovial joint in humans, it is composed of the osseous structures, cartilage, ligaments, and synovial membrane. The latter is in the production of the synovial fluid, which provides lubrication and nutrients to the avascular cartilage. Unfortunately, cartilage is given the high use and stress of this joint and it is a frequent site for painful conditions including Osteoarthritis. Osteoarthritis is an exclusively degenerative disease of cartilage however, the latest evidence has proven that Osteoarthritis is a multifactorial entity involving multiple causative factors like trauma, mechanical forces and inflammation, biochemical reactions, and also metabolic derangements. It is also known as the cartilaginous tissue is not only that one involved. Given its lack of vasculature and innervations, the cartilage, by itself is not capable of producing inflammation or Pain at least in the early stages of the disease. Hence the source of Pain is mainly derived from the changes to the non-cartilaginous components of the joint, like the joint capsule, synovium, subchondral bone, ligaments, and the Periarticular muscles. As the disease advances these structures are affected and changes are seen including bone remodeling, Osteophyte formation, weakening of Periarticular muscles, laxity of ligaments and synovial effusion can become evident[4].

Knee Osteoarthritis is categorized on clinical symptoms as well as on radiological grading. Kellgren-Lawrence (KL) grading system for Knee Osteoarthritis is the most commonly used grading system and is based on a weight-bearing anteroposterior radiograph of both knees. The higher grades indicate more severe signs of Osteoarthritis and need for surgical intervention. The non-operative treatment is usually useful for patients with KL grades 1-3[5]. The hallmark of structural changes occurring in the Osteoarthritis joint is cartilage loss[6]. Cartilage is an ultra slippery thin layer of high-quality hyaline material that covers the ends of bones that comfort the movement of the joint and it covers the patella-femoral and tibiofemoral joints of the knee[7].

Articular Cartilage is a connective tissue that covers the articulating surfaces of bones within the synovial joints. Its primary function is to absorb the mechanical shock and distribute the weight having a minimum coefficient of friction[8] Articular cartilage is composed of two different elements (Chondrocytes and extracellular matrix)[9]. Chondrocytes regulate the metabolism of the extracellular matrix through mechanically, physiochemically, and electrical stimuli whose intensity modulates cellular responses (Smith et al.,2000)[10].

The extracellular matrix is composed of a network of collagen fibrils, water, and large amounts of proteoglycans.[11] Proteoglycans (PGs) are molecules that are made up of a core protein attached to glycosaminoglycan (GAG) chains[12,13]. Aggrecan is the main PG in the articular cartilage composed of the following GAGs, chondroitin sulfate, and keratin sulphateand it is being the early sign of tissue degeneration(AlessioBricca et al,.2017). The interaction between Aggrecan and Hyaluronic acid is responsible for retaining water in the cartilage[24]. The interaction between collagen fibrils and Aggrecan makes the extracellular matrix of cartilage highly hydrophilic, which leads to high resistance may lead to compressive mechanical loads and regulating the movement of molecules in the extracellular medium[14].

Collagen together with the PGs is also responsible for resisting the deformation in the cartilage[15].During the aging process, there are changes in the structure of the extracellular matrix resulting in tissue with reduced ability to absorb mechanical stress and more susceptible to degenerative diseases.

Articular cartilage outcomes assessed by MRI were classified into morphometry (ie, thickness), morphology (ie, defects), or composition(ie, GAG assessed by delayed gadolinium-enhanced MRI of cartilage(d GEMRIC) and collagen assessed with T2-mapping in seven comparisons). Radiography, currently used to define the presence of Osteoarthritis in the joints, identifies disease only in the later stages when severe cartilage damage has occurred. There has increased that interest in the use of MRI to measure the disease severity of Osteoarthritis Knee. Cartilage Thickness measured with MRI is one such approach, which shows as a method of quantifying disease severity in Osteoarthritis.It correlates inversely with the radiographic grade of the disease, such that subjects with Knee Osteoarthritis have less Knee Cartilage Thickness than normal healthy subjects. It is possible to estimate that normal Cartilage Thickness distinguishes diseased Knee from healthy Cartilage.

To study that Cartilage alteration earlier in the disease, Magnetic Resonance Imaging (MRI) techniques have been developed. Delayed gadolinium-enhanced MRI of cartilage (d GEMRIC) also estimates the Cartilage quality by measuring the changing density of the tissue and comprising glycosaminoglycans

(Gass)[6] which are building blocks of proteoglycans and are crucial for the important viscoelastic properties of Cartilage.

Exercise that effectively reduces Pain and improves Function in patients with Knee Osteoarthritis.The mechanisms that which Exercise reduces Pain are poorly understood, and a variety of Exercise interventions, ranging from Aerobic Exercise to isolated resistance training, have been used.

The Conventional Exercise was the first-line treatment and it is safe and effectively reduces Pain and Improves Function. But Less was known about the effects of Conventional Exercise on knee joint thickness of Articular Cartilage. The effects of exercise on human Cartilage are largely unknown because investigators have been unable to examine the biochemical properties of Cartilage tissue (Ewa M Roos and Leif Dahlberg2005).

Neuromuscular Exercise is aimed at improving sensorimotor control(Ability to produce controlled movement through coordinated muscle activity and Functional stability) and attaining Functional joint mobilization by addressing the quality of movement in all 3 movements planes.Researches has found that Neuromuscular Exercise feasibly and effectively relieves Pain, improves Function, alters biomechanics, and improves the muscle activation patterns of the surrounding Knee musculature in patients with Knee Osteoarthritis. Further, more Neuromuscular Exercises have been shown to improve Articular Cartilage quality in high-risk Knee Osteoarthritis These results indicate the Neuromuscular Exercises may have important implications for Knee Osteoarthritis .

Neuromuscular Exercise is a broad class of exercise program incorporating program known by terms such as Functional exercise, Proprioceptive, Kinesthesia, Balance, Agility, or Perturbation training. Our supported studies stated that stability deficits seem to be more marked in moderate Knee Osteoarthritis as compared to mild and the patients who have moderate to severe Osteoarthritis have more insufficiencies in balance control than with mild forms. These deficits are also seen in the contralateral legs of people with unilateral Osteoarthritis who have a high risk of developing bilateral Osteoarthritis.

Neuromuscular techniques are designed to improve dynamic joint stability using a series of physical activities which challenge subjects Neuromuscular system to maintain balance and coordination. Neuromuscular exercises are widely used among sports participants. Neuromuscular rehabilitation training will differ from sports performance agility training which is designed to improve the ability to change body or limb positions. In the rehabilitation sense, Neuromuscular training requires efficient changes in body positioning, utilizing balance, coordination, and speed. Speed in this definition is relative to the function required for normal daily activities, and therefore agility training is generally conducted at a walking place.

Neuromuscular Exercises are dynamic weight-bearing exercises that are having an impact on recovery Knee Osteoarthritis subjects. So the study aims to know the effectiveness of Neuromuscular Exercises on Articular Cartilage changes in Knee Osteoarthritis.

II. MATERIALS AND METHODS

Study Design: Prospective Study Design.

Ethical clearance and Informed consent: The study protocol was approved by the Ethical Committee of GSL Medical College & General Hospital(Annexure-I), the investigator has explained the purpose of the study and given the patient consent sheet. The participants were requested to provide their consent to participate in the study(Annexure-II). All the participants signed in the informed consent and the rights of the included participants will have been secured.

Study Population : Subjects clinically diagnosed as Knee Osteoarthritis by an Orthopedician.

Study Setting: The study was conducted at outpatient Department of Physiotherapy , GSL Medical College and General Hospital, Rajamahendravaram, Andhra Pradesh, India.

Study Duration : The study was conducted during the period between July 2020 and June 2021.

Sampling Method: Simple Random Sampling.

Intervention Duration : 3 Sessions a Week for 16 Weeks.

Sample Size: . A total of 150 subjects based on prevalence were screened in that 66 subjects were recruited who are willing to participate in the study. Recruited participants were explained the purpose and relevance of the study. Those willing to voluntarily be included in the study after obtaining informed consent. All the eligible Participants were randomized in either Conventional Physiotherapy or Neuromuscular Exercises Group with 33 in each group.

GROUPS	NO OF SUBJECTS	TREATMENT
GROUP I	33	Conventional Exercises
GROUP II	33	Neuromuscular Exercises

INCLUSION CRITERIA

Participants with diagnosis of Knee OA according to clinical ACR criteria.

- Subjects with age of 35-65 years
- Subjects with self-reported Knee Pain
- Subjects with morning Stiffness less than 30 min
- Subjects not engaged in any Exercise Program for 6 months
- Subjects with Knee pain more than 3 months.
- Subjects with Met k-L grading 2 and 3.

EXCLUSION CRITERIA

- Obese (BMI>30)
- Inability to obtain physician release for Exercise
- Unresolved Balance disorder
- Unresolved Neurological disorder
- History of Knee surgery or major Knee trauma injury
- Hip or Ankle Instability
- Excessive weakness
- Surgery or major Trauma injury
- Hip or Knee replacement
- Intra-articular joint injection

OUTCOME MEASURES

Primary Outcome Measures:

- MRI (Magnetic Resonance Imaging) was used to measure the Articular Cartilage Thickness.

Secondary Outcome Measures:

- WOMAC score was used to measure the Functional score of Knee Osteoarthritis.
- VAS (visual analog scale) was used for measuring Pain.

Measurement of Cartilage Thickness (MRI)[9] :

NORMAL CARTILAGE THICKNESS

The knee had mean cartilage thickness in the ranges 1.69 to 2.55mm respectively.

TECHNIQUE

The Achieva 1.5T has been a solid and reliable performer for Philips since the early 2000's.The Achieva (like the Intera before it) uses the F2000 magnet with a 60cm bore. Although the F2000 is not technically a zero boil-off magnet, it is nonetheless very efficient, with typical boil off of approximately 1% a month, needing refills only about every 3 years.

Achieva 1.5T systems come with a wide array of whole-body software options, powerful gradients (typically 33mT/m amplitude and 150 slew rate, but up to 66mT/m and 180 slew rate is possible), and RF channel options of 8, 16, or 32ch.

PATIENT POSITION

Patient in supine position - use dedicated knee coil

• Axials parallel to knee joint line - include whole patella and fibular head

• Coronals parallel to posterior aspect of femoral condyles include entire patella to 2 cm posterior to femoral condyle.

• Sagittal obliques parallel to medial aspect of lateral condyles include both collateral ligament.

MRI knee protocol comprises a group of MRI sequences to routinely assess the knee for internal pathologies such as meniscal, ligament and cartilage injury.

As with most MR joint imaging, PD weighted sequences with and without fat-saturation are usually the mainstay. Often a T2 FS sequence is included as a replacement to PD FS in one plane, typically coronal. A T1 weighted sequence is usually included in one plane to facilitate the assessment of any incidental marrow or soft-tissue lesions

Standard MRI knee protocol

PD weighted

Plane: sagittal, coronal, axial (optional)

Technique: PD fast-spin echo

Slice thickness: 3 or 4 mm

Purpose: detailed anatomy, fat helps to outline structures, good differentiation between fluid (high signal), hyaline cartilage (intermediate signal) and ligaments/tendons/menisci (low signal)

PD weighted (fat-saturated)

Plane: sagittal, coronal (optional), axial (optional)

Technique: PD FS fast-spin echo
Slice thickness: 3 or 4 mm
Purpose: best sagittal sequence for meniscal tear detection, fat-saturation helps reveal fluid such as marrow edema, fat pad edema, bursae, parameniscal cysts
T2 weighted (fat-saturated)
Plane: coronal, axial (optional)
Technique: T2 FS fast-spin echo
Slice thickness: 3 or 4 mm
Purpose: best coronal sequence for meniscal root tear detection, fat-saturation helps reveal fluid such as marrow edema, fat pad edema, bursae, parameniscal cysts

T1 weighted

Plane: at least one, often axial or coronal
Sequence: T1 fast-spin echo
Slice thickness: 3 or 4 mm
Purpose: to characterize T1 characteristics of any incidental bone or soft-tissue lession.

A radiology report includes complex anatomical and medical terms specifically written for healthcare providers. A radiologist (a physician specially trained in medical imaging) reviews your medical history and analyzes your diagnostic imaging. Next, the radiologist writes a report detailing the results. A typical radiology reports includes these sections:

- Name or Type of Exam
- Date of Exam
- Interpreting Radiologist – the name of the radiologist who read the diagnostic imaging exam and wrote the report.
- Clinical History – describes the patient's symptoms or existing diagnosis.
- Technique – technical details of the exam (such as "2-view x-ray" or "5mm axial images"), and if contrast was used.
- Comparison – if this exam was compared to any previous diagnostic imaging exams. Comparisons are most commonly made to exams of the same body area.
- Findings – what was "found" out from the exam, listing each area of the body that was examined in the diagnostic imaging study. Oftentimes, the radiologist will use the word "unremarkable" if an area is normal.
- Impression – this is the radiologist's "impression" or diagnosis of the diagnostic imaging exam. This section includes a summary of the results and any follow up testing (like a biopsy or additional diagnostic imaging) that the radiologist recommends.

The radiology report is sent to healthcare provider, who in turn provides the results.

Measurement of Function (WOMAC):

This Questionnaire is used to assess the health status of Osteoarthritis patient introduced in 1988. It is consisted of 33 items which evaluates the health and function of the patient from various aspects including: Clinical symptoms (5 questions), Severity of joint stiffness ((2 questions), Degree of pain (9 questions) and Activity of daily living (17 questions). Each question has five subscales where best situation score as never or none and the worst one names as extreme or always. Here higher scores are representative of better situation and less pain (ANNEXURE III).

Measurement of pain severity (VAS)

The VAS scale is reliable,valid,responsive and frequently used Pain outcome measure. The instrument used consists of horizontal lines 10 cm long, with anchor points of 0 (no pain) and 10 (severe pain).It is located at either end of the line.Patients are instructed to draw a vertical mark on the line indicating their Pain level.The severity of Knee Osteoarthritis was evaluated by VAS.

INTERVENTIONS

The study consists of 16 weeks of intervention which includes conventional physiotherapy(GROUP I) and Neuromuscular exercises(GROUP II). The outcome measures were measured by using VAS for pain and WOMAC for function, MRI for the Cartilage Thickness . All the eligible participants were consecutively randomized into either GROUP I or GROUP II.

GROUP I : CONVENTIONAL PHYSIOTHERAPY

The subjects were asked to perform Conventional Physiotherapy 3 times per week for 16 weeks under supervision by the physiotherapist.

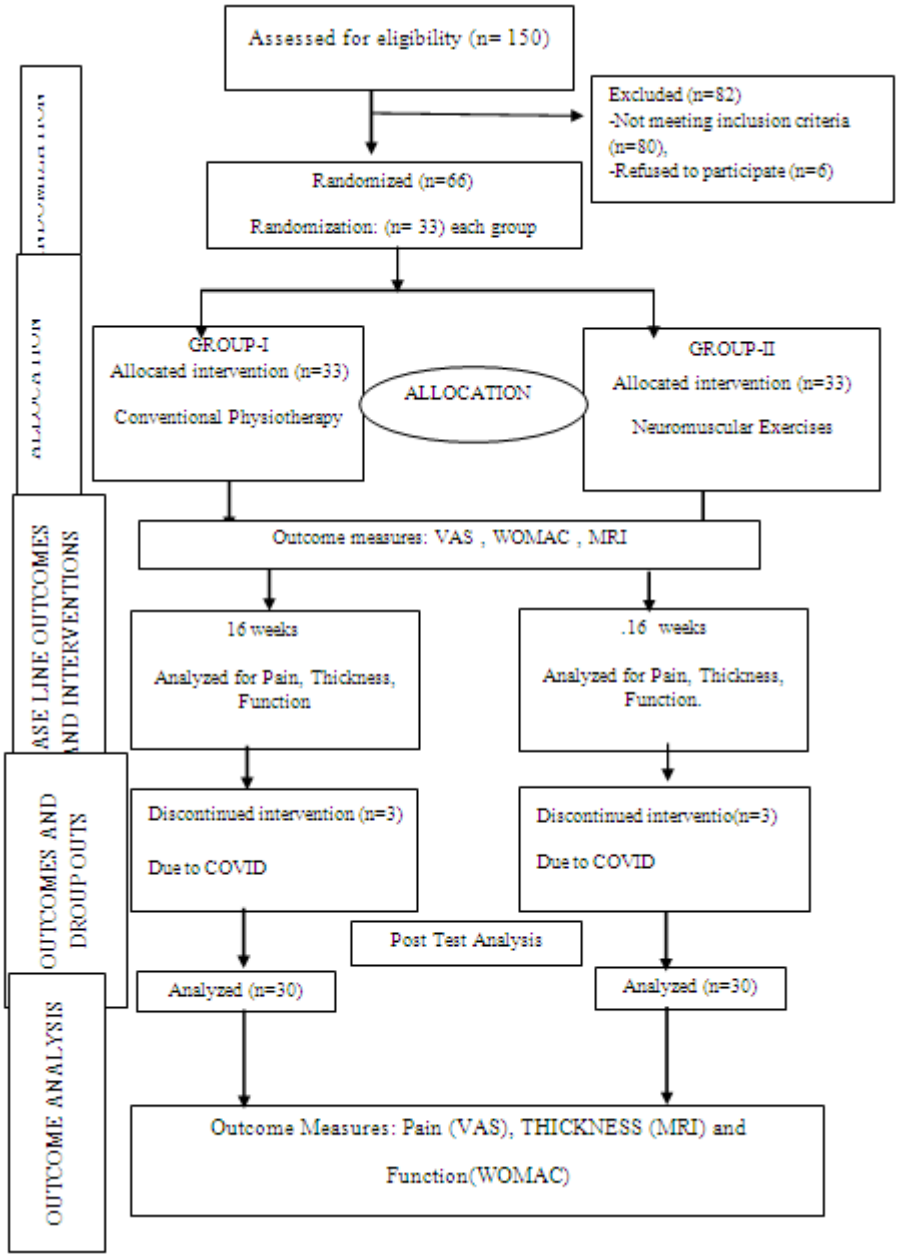
The conventional physiotherapy consists of Stretching and Strengthening exercises and Active resistance exercises.Stretching exercises consisting of Hamstring ,Quadriceps and Calf stretches were given thrice weekly

1 set of 3 repetitions in 16 weeks. Strengthening exercises consists of static and dynamic hamstring and quadriceps exercises and VMO strengthening were given thrice weekly 3 sets of 10 repetitions .Active resistance exercises consists SLR and abductor raise and adductor raise and hamstring and quadriceps curls were given thrice weekly 3sets

GROUP II: NEUROMUSCULAR EXERCISES

The subjects were received Neuromuscular Training exercises((Ageberg E, Roos 2015) consisting of warm up, lunge, pelvic lift, step up, squat, weight transfer, limping cross, cloth underfoot, kettelball, side lying jumping jerk, elastic band and gait training and stretching were given thrice weekly with 2 sets of 12 repetitions.

FLOW CHART



STATISTICAL ANALYSIS

All Statistical analysis was done by using SPSS software version 21.0 and MS excel -2010. Descriptive data will be presented as mean +/- standard deviation and percentages. Data will be tabulated and graphically represented.

With in the Groups: Paired Student `t` Test was performed to assess the statistical difference within the groups for Pain ,Function from pre test and post test value.

Between the Groups: Independant Student `t` test was performed to assess the statistical difference in Mean value between the groups for Visual Analogue Scale Pain,WOMAC for Function and MRI for Articular Cartilage Thickness.

Multiple comparisons with in the Groups:ANOVA was performed to assess the statistical difference with in the group for VAS.

For all statistical analysis,P is <0.05 was considered as statistically significant

III. DISCUSSION

The Aim of the study was to evaluate the effectiveness of Neuromuscular training (Group II) on Pain, Function, and Cartilage Thickness in Subjects with Knee Osteoarthritis. In this study, Subjects were assessed for Knee Pain using VAS, Function by WOMAC and Cartilage Thickness by MRI respectively.

In this study Subjects were assessed for Knee Osteoarthritis underwent either Conventional Physiotherapy or Neuromuscular Exercises which are performed for 6 weeks the parameters were assessed before and after exercise training.

In this study (Group I) Conventional Physiotherapy have shown statistically significant difference within the Groups from pre test to post test values in reducing Pain and Improving Function in Subjects with Knee Osteoarthritis.

In this study (Group II) Neuromuscular Exercises have shown statistically significant difference within the Groups from pre test to post test values in reducing Pain and Improving Function in Subjects with Knee Osteoarthritis.

In this study both Groups (Group I and Group II) have shown no statistically significance difference with in the Group and from pre test to post test values in Subjects with Knee Osteoarthritis.

The Conventional exercises training can help to reduce Pain and Improvement in Function in Osteoarthritis . The Pain intensity is reduced due to increase in the power of the quadriceps muscles and stretching of the hamstring muscles,these causes decreasing muscle spasm and improves circulation, which is responsible for Muscle Function performance.The Strengthening Exercises and Active Resisted Exercises lead to increase in daily living activities and Improved Functional performance .Our study supported by previous study done by **Bennel *et.al* ,** reported that Conventional physiotherapy was effective in Improvement of Pain and Function.[22]

Our study supported by previous study done by **Patchava Apparao *et . al,*** reported that Strengthening of Hamstrings and Quadriceps muscles helps in relieving Pain improves Muscle Strength and Functional performance and also Static and Dynamic training shown significant Improvement in Functional performance and reduced joint Pain after Conventional Physiotherapy in Subjects with Knee Osteoarthritis. And also reported that Conventional Physiotherapy was not effective in Cartilage changes after 8 weeks of study.[3]

The Neuromuscular group is mainly based on the Sensorimotor system. Sensorimotor dysfunction also may play a role in the development and progression of degenerative Knee disease.Based on biomechanical and Neuromuscular principles that aims to improve Sensorimotor control and achieve compensatory Functional stability. It is the ability to produce controlled movement through coordinated Muscle activity, and Functional stability (also called dynamic stability) is the ability of the joint to remain stable during physical activity[20].

Eva Ageberg *et.al*, reported that after 11 weeks ,it is found that NEMEX programme is as effective on reducing Pain and Improvement of Function. **Pritzker *et.al***, reported that moderate exercises not only increases the blood flow to the various connective tissues of the joint but also keeps joints lubricated. These Neuromuscular Exercises which facilitates catabolism and anabolism in tissues and maintains homeostasis. As the strengthening of knee tissues through regular exercises is of paramount importance. Frequent movements of joint can relive the symptoms of Pain due to increase circulation of tissue fluid in joint. Weight bearing exercise has several benefits including improved blood circulation and also decreased tissue stagnation in the joint. Synovial fluid produced by synovial membrane in the joint which responds to exercises,thus requiring regular exercises to stay lubricated nourished.[35]

Regular Exercises facilitates diffusion of nutrients through the Cartilage and moderate exercises likely Improves the Pain reduction and Functional Activity. And also reported that long term moderate exercises will have impact on Articular Cartilage health and reduces degeneration of Knee Joint.

These moderate activities such as treadmill training, squats, one legged knee bend, lunges, pelvic lifts are likely more beneficial in terms of pain and function.[35] But there is no improvement in Articular Cartilage Thickness after 16 weeks of study.It may be Improved due to long term protocol more than 16 weeks of Intervention. so study duration can be increased in further studies for Articular Cartilage changes.

This present study shows that individually both Conventional Physiotherapy and Neuromuscular Exercises were found to be effective in Pain reduction and Function.

When coming to Comparison between the Conventional and Neuromuscular Exercises are effective in VAS and WOMAC. The result of the study shows that Neuromuscular training is more effective than

Conventional Exercises to improve the Pain, and Functional Ability of OA knee patients. But there is no effectiveness in Cartilage changes.None of the groups is superior to other on reducing degenerative changes of Articular Cartilage with Knee Osteoarthritis.

Hence we can conclude that subjects with Knee Osteoarthritis can achieve significant results of Pain and Function using Neuromuscular Exercises Programme.

IV. LIMITATIONS

- Less sample size
- Lack of Control group in the present study.
- No blinding of evaluators of outcomes.
- Lack of follow up in the present study.
- Medications and activities of daily living were not taken in to account.
- Home exercises were not monitored.

V. RECOMMENDATIONS FOR FURTHER RESEARCH

- Sample size can be increased with inclusion of more number of subjects to generalize the effects of these techniques in larger population.
- In the present study the gender distribution showed more number of females affected with Osteoarthritis of Knee than the male subjects. Hence in future study can do individual like male and female.
- The Duration of the study can be increased to more than 16 weeks.

VI. CONCLUSION

The present study concluded that 16 weeks of Interventions of Conventional and Neuromuscular Exercises were shown statistically Improvement on Reducing Pain, Improving Functional performance and there is no statistical Improvement in articular Cartilage Thicknesss. However,Analysis between the groups are effective and more Percentage of improvement was found in subjects received Neuromuscular Exercises when compared to Conventional Exercises.

From the findings of the current study, it can be recommended that the Neuromuscular Exercises protocol can be used to treat mild to moderate Knee Osteoarthritis.

REFERENCES

[1]. Lespasio MJ, Piuzzi NS, Husni ME, Muschler GF, Guarino AJ, Mont MA. Knee osteoarthritis: a primer. The Permanente Journal. 2017;21.

[2]. Patchava Apparao C, Swamy G, Subramaniam S. Effectiveness of Functional Task Exercises versus Agility and Perturbation Training in Osteoarthritis Knee Subjects.

[3]. Patchava A, Ganni S, Sudhakar S, Ganapathy SCh SS, Satya Prakash T, Geetha MR. Effectiveness of stabilization exercises and conventional physiotherapy in subjects with knee osteoarthritis. International Journal of Research in Pharmaceutical Sciences. 2017;8(4):542-8.

[4]. Mora JC, Przkora R, Cruz-Almeida Y. Knee osteoarthritis: pathophysiology and current treatment modalities. Journal of pain research. 2018;11:2189.

[5]. Shi W, Jiang Y, Zhao X, Zhang H, Wang Y, Li T. The Influence of Posterior Tibial Slope on the Mid-term Clinical Effect of Medial-pivot Knee Prosthesis.

[6]. Roos EM, Dahlberg L. Positive effects of moderate exercise on glycosaminoglycan content in knee cartilage: a four- month, randomized, controlled trial in patients at risk of osteoarthritis. Arthritis & Rheumatism. 2005 Nov;52(11):3507-14.

[7]. Kubakaddi S, Ravikumar KM, Harini DG. Measurement of cartilage thickness for early detection of knee osteoarthritis (KOA). In2013 IEEE Point-of-Care Healthcare Technologies (PHT) 2013 Jan 16 (pp. 208-211). IEEE.

[8]. Novelli C, Costa JB, de Souza RR. Effects of aging and physical activity on articular cartilage: a literature review. Journal of Morphological Sciences. 2017 Jan 16;29(1):0

[9]. Burstein D, Bashir A, Gray ML. MRI techniques in early stages of cartilage disease. Investigative radiology. 2000 Oct 1;35(10):622-38

[10]. Trattnig S. Overuse of hyaline cartilage and imaging. European journal of radiology. 1997 Nov 1;25(3):188-98.T

[11]. Aigner T, Vornehm SI, Zeiler G, Dudhia J, Von der Mark K, Bayliss MT. Suppression of cartilage matrix gene expression in upper zone chondrocytes of osteoarthritic cartilage. Arthritis & Rheumatism: Official Journal of the American College of Rheumatology. 1997 Mar;40(3):562-9.

[12]. Linsenmayer TF, Hay ED. Cell biology of extracellular matrix. InCollagen 1991 (p. 7). Plenum Press New York.

[13]. Wight TN, Heinegård DK, Hascall VC. Proteoglycans. InCell biology of extracellular matrix 1991 (pp. 45-78). Springer, Boston, MA.

[14]. Säämämen AM, Kiviranta I, Jurvelin J, Helminen HJ, Tammi M. Proteoglycan and collagen alterations in canine knee articular cartilage following 20 km daily running exercise for 15 weeks. Connective tissue research. 1994 Jan 1;30(3):191-201.

[15]. Roughley PJ, White RJ. Age-related changes in the structure of the proteoglycan subunits from human articular cartilage. Journal of Biological Chemistry. 1980 Jan 10;255(1):217-24.