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RESEARCH ARTICLE

EFFECT OF KINESIO TAPING WITH OPEN KINETIC CHAIN VERSUS CLOSED KINETIC CHAIN EXERCISE IN PATELLOFEMORAL PAIN SYNDROME.

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Key words:-

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Abstract

Background: Patellofemoral pain syndrome is one of the most common musculoskeletal disorder which affect an individual in third and fourth decades of life.

Objective: The objective of the study is to compare the effectiveness of open kinetic chain and closed kinetic chain exercises along with the application of Kinesio taping in subjects with patellofemoral pain syndrome.

Study design: Quasi experimental study design, Pre and Post test.

Subjects: 30 Subjects diagnosed with patellofemoral pain syndrome with age group of 20-65 years of both the genders, having 4-7 of Visual Analogue Scale score.

Intervention: 15 Subjects in Group-A received Kinesio taping with open kinetic chain exercise and 15 Subjects in Group-B received Kinesio taping with closed kinetic chain exercise.

Results: The result of the study showed significant improvement in closed kinetic chain exercise along with the application of Kinesio tape.

Conclusion: It was concluded that there was statistically significant improvement in closed kinetic chain exercise along with the application of Kinesiotaping, where there is a decrease in pain and increase in Range of motion, Muscle strength and Functional ability.

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Introduction:-

Patellofemoral pain syndrome is a collective term describing the diffuse pain in the anterior compartment of the knee aggravated with specific activities that heighten the compressive loading forces across the patellofemoral joint and is one of the most common musculoskeletal problem[2].

Bony Structure Of Patellofemoral Joint:-

The patellofemoral joint comprises of the patella and the femoral trochlea. The patella acts as a lever and also increases the moment arm of the patellofemoral joint, quadriceps and patellar tendons. The patella is the largest sesamoid bone situated within the quadriceps tendon. The anterior surface is slightly convex in shape and divided into three parts. The quadriceps tendon inserts into the rough superior third of the anterior surface of deep fascia,

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which is adherent to the bone. The middle third of the patella has numerous vascular orifices. The inferior third is the insertion point of the patellar tendon.

The posterior surface of the patella is divided into an inferior and superior portion. The inferior portion is non-articulating and represents up to a quarter of the patellar height. The remaining of the surface forms the superior portion, which is the articulating surface which is covered by hyaline cartilage. The cartilaginous posterior surface is further divided by a rounded vertical ridge. It has a large, lateral portion for articulation with the lateral condyle of the femur and a smaller, medial portion for articulation with the medial condyle of femur. The medial and lateral facets are divided into superior, middle and inferior facets. There is an odd facet located medially to the medial facet. This does not articulate with the femur until flexion exceeds 90 degrees.

With increasing knee flexion, the contact pressure moves proximally on the patella up to the superior pole and onto the quadriceps tendon. These contact pressures and tracking path within the trochlear can be affected by the osseous motion of the patella. The contact of the patella with the femur is initiated at 20 degrees of knee flexion and increased with further degrees of flexion reaching maximum of 90 degrees[19].

Patellofemoral Pain Syndrome:-

Patellofemoral pain syndrome is a common problem in third and fourth decades of life, characterized by retro patellar pain when ascending and descending stairs, squatting and sitting with flexed knees[1]. After 50 years of age the incidence and prevalence of patellofemoral joint arthritis is more rapidly in women than in men. The incidence rate of patellofemoral pain syndrome among athletes is 25%, which is higher than that of the general population. 10-19% of all athletes have patellofemoral pain and women experience this about 25% in their entire life[5].

Patellofemoral pain syndrome is caused by repetitive stress on the musculotendinous structures which surround the knee and is aggravated in athletes by cycling and running. Symptoms include pain around and anterior to patella, crepitus, tracking, swelling, instability along with stiffness. The symptoms often occur in athletes because of increased intra-articular stress on the patellofemoral joint and are often caused by abnormal biomechanics of athletes, particularly during drop landing[3].

The abnormal position and maltracking of patella could be caused by imbalanced force of muscle pull on patella leads to patellar tracking, during knee flexion and extension with over loading of the joint[7]. Weakness of vastusmedialisobliquus was suggested to cause abnormal patellar tracking in patellofemoral pain syndrome[6]. An imbalance in muscle activities of vastusmedialisobliquus and vastuslateralis muscles leads to lateral patellar tracking during knee extension. Vastusmedialisobliquus is a patellar stabilizer and the weakening of this muscle has been reported to be a predisposing factor of patellofemoral pain syndrome[44].

The quadriceps activates the dynamic patellar movement, and the vastusmedialis oblique (VMO) and vastuslateralis (VL) enable the patella to stabilize during tracking[8]. The factors causing patellofemoral pain syndrome include weakness and imbalance of quadriceps muscle, malalignment of lower limb, stiffness of soft tissue and increase in Q- Angle of quadriceps muscle[9].

Q- angle is an angle formed by a line drawn from the Anterior Superior Iliac Spine (ASIS) to mid of patella and a second line drawn from middle of patella to tibial tubercle. Increased Q-angle is a biomechanical factor observed in patellofemoral pain syndrome[11].

Q-angle creates a lateral force on patella and exposes it to lateral displacement during activation of quadriceps. An increase in Q-angle may increase a lateral pull of patella, causing patella to glide on the lateral ridge of femoral groove and produce pain[10].

Current treatment protocols continue to employ kinetic chain exercises despite that there is greater evidence to support the use of kinetic chain exercises to produce optimal activation of the Vastusmedialisobliques. During the activation of open kinetic chain exercise the quadriceps muscle acts isolately, thus favoring the increase in the forces of the patellofemoral compression. The closed kinetic chain exercise generate co-contraction producing higher stability of the joint[12]. The open kinetic chain is a movement in which the distal end of the extremity is not fixed to

a relatively stable surface. In closed kinetic chain, movement of a joint cannot occur without causing predictable movements in the other joints of the extremity[13].

Kinesio taping is an organized wrapping technique using Kinesio tape proposed by Kase, is claimed to be able to reduce pain, swelling and muscle spasms, as well as to prevent sports injury[14]. Kinesio taping is relatively a new technique that has become popular with athletes and clinicians alike in the treatment of musculoskeletal pathologies. It is theorized that the use of Kinesio tape can enhance joint stability by providing support to or affected muscles. The tape can be worn for 3-5 days[18]. Therapeutic effects of knee taping include minimizing pain, increasing muscle strength, improving gait pattern and enhancing functional outcome of patients with sports injury, osteoarthritis and patellofemoral pain[15].

Various conservative treatments, including muscle strengthening exercise, muscle stretching, electrotherapy, knee bracing and patellar taping exist to treat patellofemoral pain syndrome¹⁶. Physical exercise have long been reported to be effective in strengthening the muscles and soft tissues. It has also been reported that a supervised physical therapy program could reduce pain and improve functions in patients with patellofemoral pain syndrome[17]. Although few investigations evaluated patellar pain related impairments in knee joint. Limited studies have detected the combination of open and closed kinetic exercises for quadriceps strengthening[32]. The purpose of this study was to compare the effectiveness of Kinesio taping with open and closed kinetic chain exercise in order to relieve pain and improve function of the knee joint activities.

Aim Of The Study:-

The aim of the study is to find out the efficacy of kinesio taping (Neutral) with open versus closed kinetic chain exercise in patellofemoral pain syndrome and to improve the knee Range of motion, muscle strength (Quadriceps) and functional activity of the joint.

Need For The Study:-

Individuals with patellofemoral pain must often overcome variety of problems such as joint pain, stiffness, limitations in joint motion, decreased quadriceps muscle strength and functional limitations, that prevent them from participating in regular activity. Many researchers compared the taping techniques in patellofemoral pain syndrome and concluded that taping is beneficial. Effect of kinesio taping (Neutral) with open versus closed kinetic chain exercise is currently unclear. Hence the need of the study is to evaluate the benefits of kinesio taping (Neutral) with open and closed kinetic chain exercises in patellofemoral pain syndrome.

Methodology:-

Study Design:-

Experimental study.

Study type:-

Comparative study.

Sample Technique:-

Convenient sampling.

Study duration :-

2Week for each subject.

Study setting:-

SRM Medical College Hospital and Research Center, Out Patient Department of Physiotherapy, Kattankulathur.

Sampling population:-

30 subjects.

GROUP A:-

Kinesio Taping (Neutral) with open kinetic chain exercise, 15 subjects.

GROUP B:-

Kinesio Taping (Neutral) with closed kinetic chain exercise, 15 subjects.

Inclusion Criteria:-

1. Both male and female.
2. Age group 20 – 65 years.
3. Visual analogue scale (score 4-7)
4. Subjects diagnosed as patellofemoral pain by clarks sign.

Exclusion Criteria:-

1. Subjects with recent fractures, surgeries in lower limb.
2. subjects with assistive devices.
3. Subjects with ligament injuries in lower limb.
4. Subjects with total Knee or Hip replacement .
5. Subjects with Open wounds or infections.
6. Subjects with Hypersensitive skin.
7. Subjects under going NSAIDS (Non Steroidal Anti Inflammatory Drugs)

Procedure:-

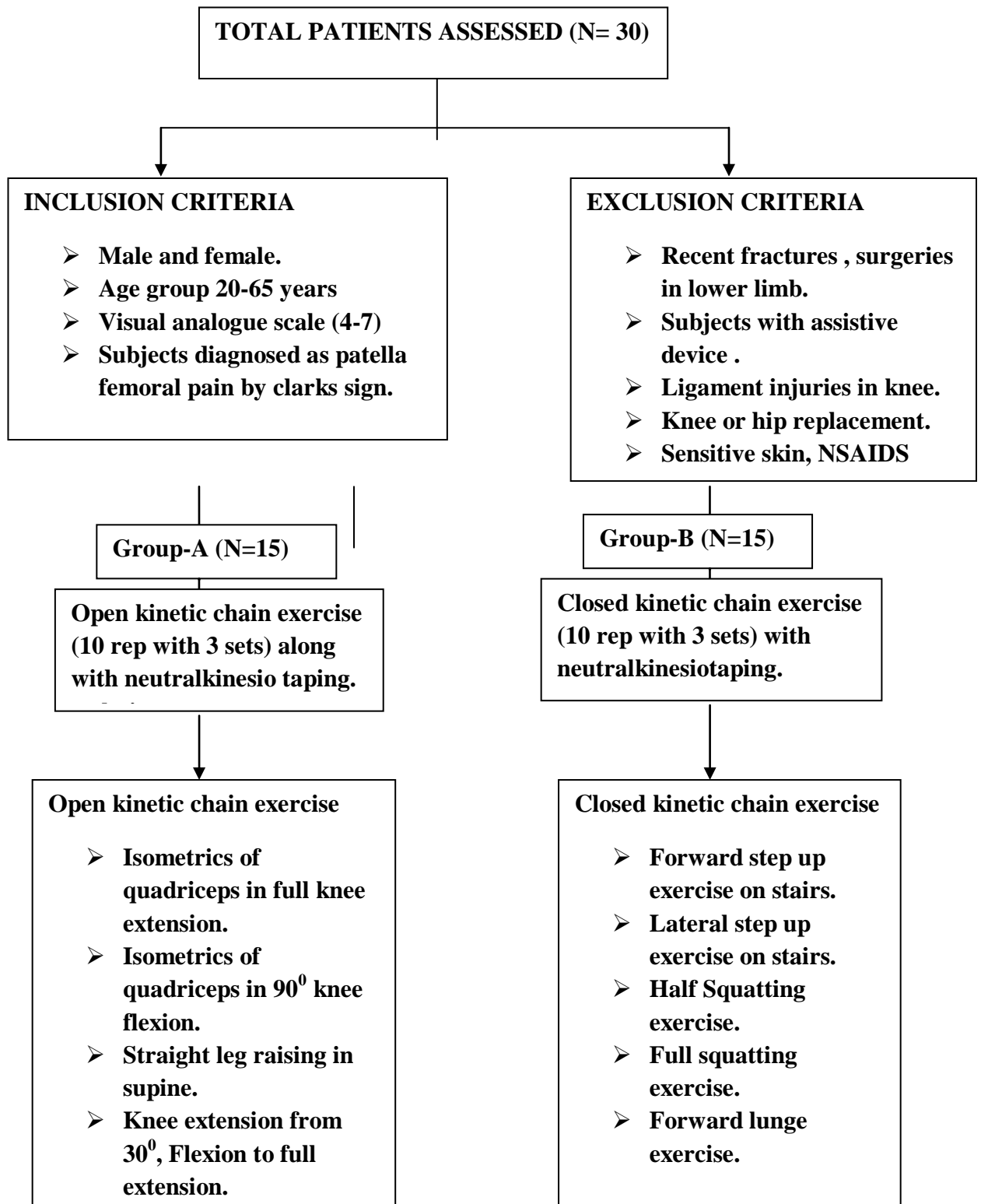
This Study was held in SRM Medical college hospital and research centre, SRM physiotherapy Department Kattankulathur. The subjects were included on basis of inclusion and exclusion criteria .30 Subjects were taken on the diagnosis of patellofemoral pain involving the patellofemoral compartment depending on clarks sign. The subjects were assessed according to the assessment chart (Annexure II) and those who satisfied the inclusion criteria were recruited in the study. The subjects were explained in detail about the procedure and informed consent was obtained.

The different types of exercise protocol were explained to the participants. Consent form and pre study information was clearly explained to each participant, prior to the study. The subjects were alternately been placed in each group. 30 subjects were allocated in to two group, i.e Group- A (Open kinetic chain exercise) and Group-B (Closed kinetic chain exercise). Each group has 15 subjects.

The participants were assessed with pre-test which includes pain by Visual analogue scale, flexion and extension of knee joint by universal goniometer, muscle strength by manual muscle testing and functional activity by Western Ontario McMaster Universities Osteoarthritis(WOMAC Index). The participants were blinded to which group they enrolled to.

The neutral Kinesio taping was applied to each patient three day once. The exercises where taught to the participants according to their group. Each exercise was asked to follow 3 sets with 10 repetition per set. The conventional physiotherapy includes interferential therapy . At the end of the session the post test was taken.

At the end of 2nd week the post test were measured to conform the improvement of pain and functional ability of both the Group. The pre and post test values of Group-A and Group-B were compared finally to find the effectiveness of neutral Kinesio taping in open and closed kinetic chain exercises. The post test values of the both groups were further compared to find the significant results of subjects with patellofemoral pain syndrome.

**Data Analysis:-**

The statistical package for social sciences (SPSS) software version 20.0 was used for data analysis. The statistical tool used in this study were paired' test, Independent t-test. Paired' test was used for analysis of pre-test and post-test means within the groups. The collected data were tabulated and analyzed using descriptive statistics. Whereas independent t-test was used for analysis of comparison between the 2 groups.

Table-1:-Pre And Post Test measures of Mean and Standard Deviation for Visual Analogue Scale, Range of Motion, Manual Muscle Testing and Western Ontario McMaster Universities Osteoarthritis (WOMAC) Index for Open Kinetic Chain (Group A).

GROUP A	MEAN	SD	T-VALUE	SIGNIFICANCE
VAS	6.07	0.884	13.748	0.001
	3.07	0.704		
ROM	112.67	6.114	9.280	0.001
	120.43	4.577		
MMT	3.60	0.507	3.095	0.005
	4.00	0.654		
WOMAC	57.27	3.654	19.285	0.001
	48.37	2.968		

Interpretation:-

Table 1 shows the mean and standard deviation changes of Visual Analogue Scale, Range of Motion, Manual Muscle Testing and Western Ontario Mc Master Universities Osteoarthritis(WOMAC) Index of the open kinetic chain (Group-A)

By this statistical analysis which shows following t’ values of 13.748 for Visual Analogue Scale, 9.280 for Range of Motion, 3.005 for Manual Muscle Testing and 19.285 for Western Ontario McMaster Universities Osteoarthritis (WOMAC) Index, which is having statistically significant difference between pre test and post test at p<0.001 level. GRAPH-1 Comparison between pre and post test for Visual Analogue Scale, Range of Motion, Manual Muscle Testing and Western Ontario McMaster Universities Osteoarthritis (WOMAC) Index among Open kinetic chain (Group-A).

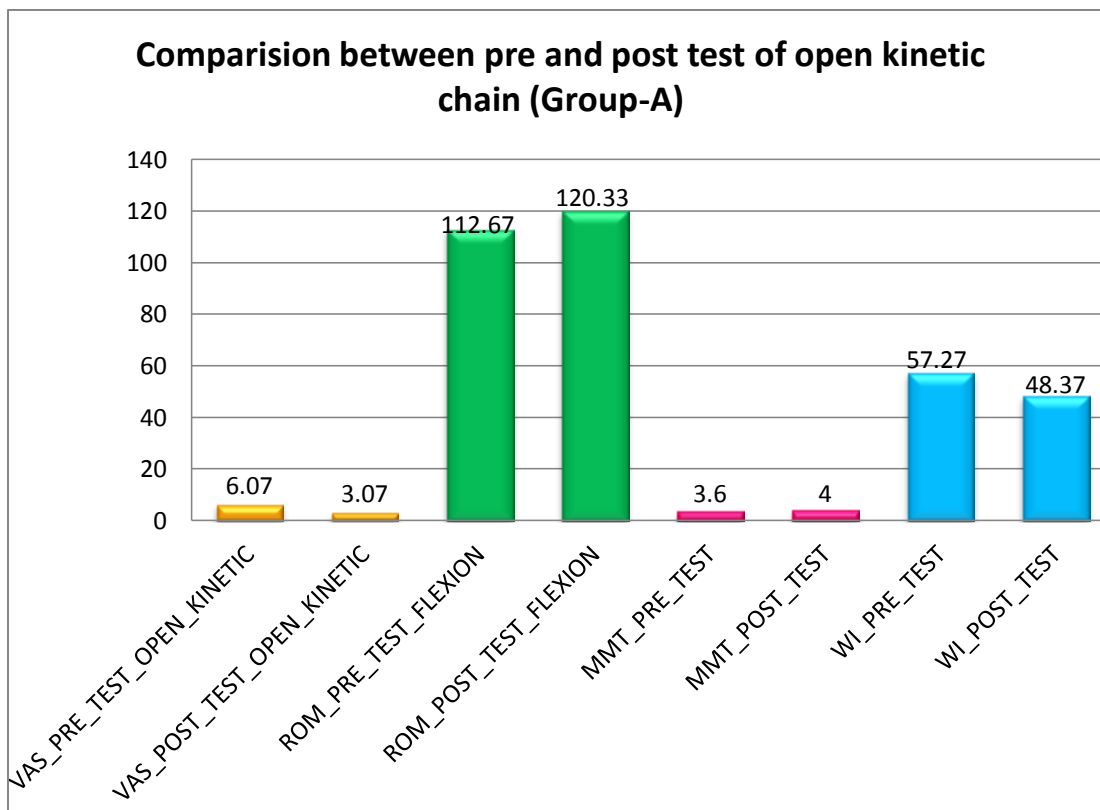


Table-2:-Pre and Post Test Measurements of Mean and Standard Deviation for Visual Analogue Scale, Range of Motion, Manual Muscle Testing and Western Ontario McMaster Universities Osteoarthritis (WOMAC) Index for Closed Kinetic Chain (Group-B).

GROUP A	MEAN	SD	T-VALUE	SIGNIFICANCE
VAS	6.33	0.617	35.133	0.001
	1.73	0.704		
ROM	113.67	5.164	19.000	0.001
	126.33	4.806		
MMT	3.40	0.507	4.349	0.001
	4.40	0.704		
WOMAC	60.27	7.170	19.742	0.001
	43.67	3.936		

Interpretation:-

Table 2 shows the mean and standard deviation changes of Visual Analogue Scale, Range of Motion, Manual Muscle Testing and Western Ontario Mc Master Universities Osteoarthritis (WOMAC) Index of the closed kinetic chain (Group-B).

By this statistical analysis which shows following ‘t’ values of 35.133 for Visual Analogue Scale, 19.000 for Range of Motion, 4.349 for Manual Muscle Testing and 19.748 for Western Ontario McMaster Universities Osteoarthritis (WOMAC) Index which is having statistically significant difference between pre and post test at p<0.001 level.

Graph-2:- Comparison between pre and post test for Visual Analogue Scale, Range of Motion, Manual Muscle Testing and Western Ontario McMaster Universities Osteoarthritis (WOMAC) Index among Closed kinetic (Group-B)

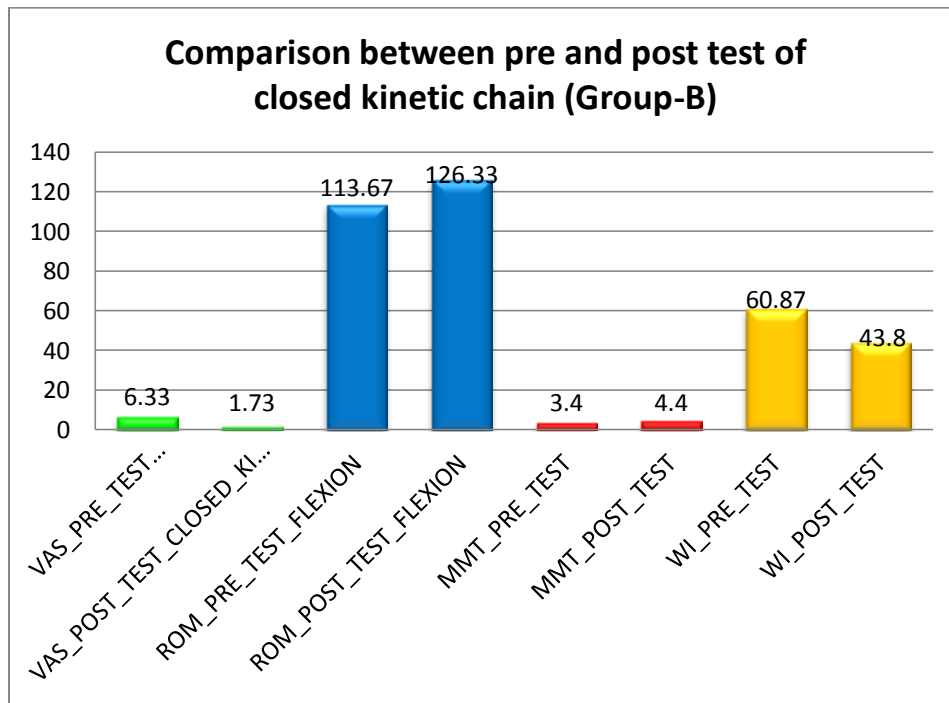


Table-3:- Comparison of post test measurements of Visual Analogue Scale, Range of Motion, Manual Muscle Testing and Western Ontario McMaster Universities Osteoarthritis (WOMAC) Index between Open kinetic chain (Group-A) and Closed kinetic chain (Group-B).

POST TEST	GROUP-A		GROUP-B		T- VALUE	SIGNIFICANCE
	MEAN	S.D	MEAN	S.D		
VAS	3.07	0.704	1.73	0.704	5.189	0.001
ROM	120.43	4.577	126.33	4.806	5.064	0.001
MMT	4.00	3.654	4.40	0.507	3.095	0.005

WOMAC	48.37	2.968	43.67	3.936	7.542	0.001
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Interpretation:-

Table-3 shows the comparison of mean values for the two groups.

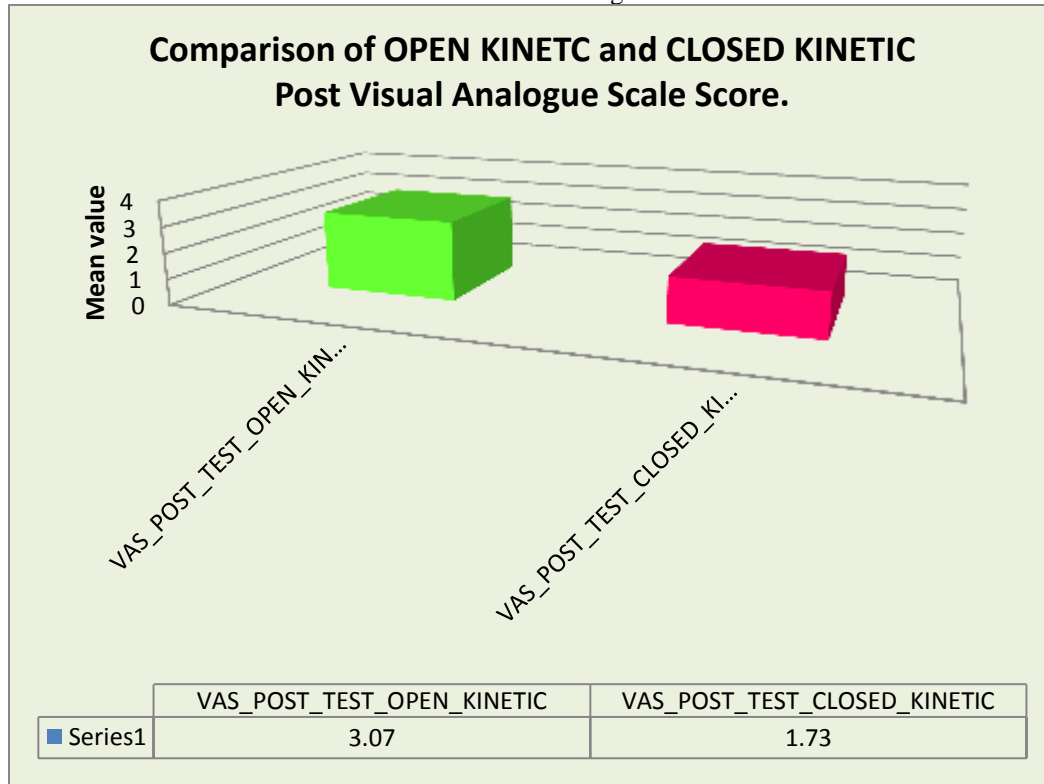
On comparing the post test Visual Analogue Scale Score between Open kinetic chain (Group-A) and Closed kinetic chain (Group-B) with mean difference of 3.07 and 1.73, it shows there is statistically significant reduction of pain in Group-B.

On comparing the post test Range of Motion between Open kinetic chain (Group-A) and Closed kinetic chain (Group-B) with mean difference of 120.43 and 126.33, it shows there is statistically significant increase of motion in Group-B.

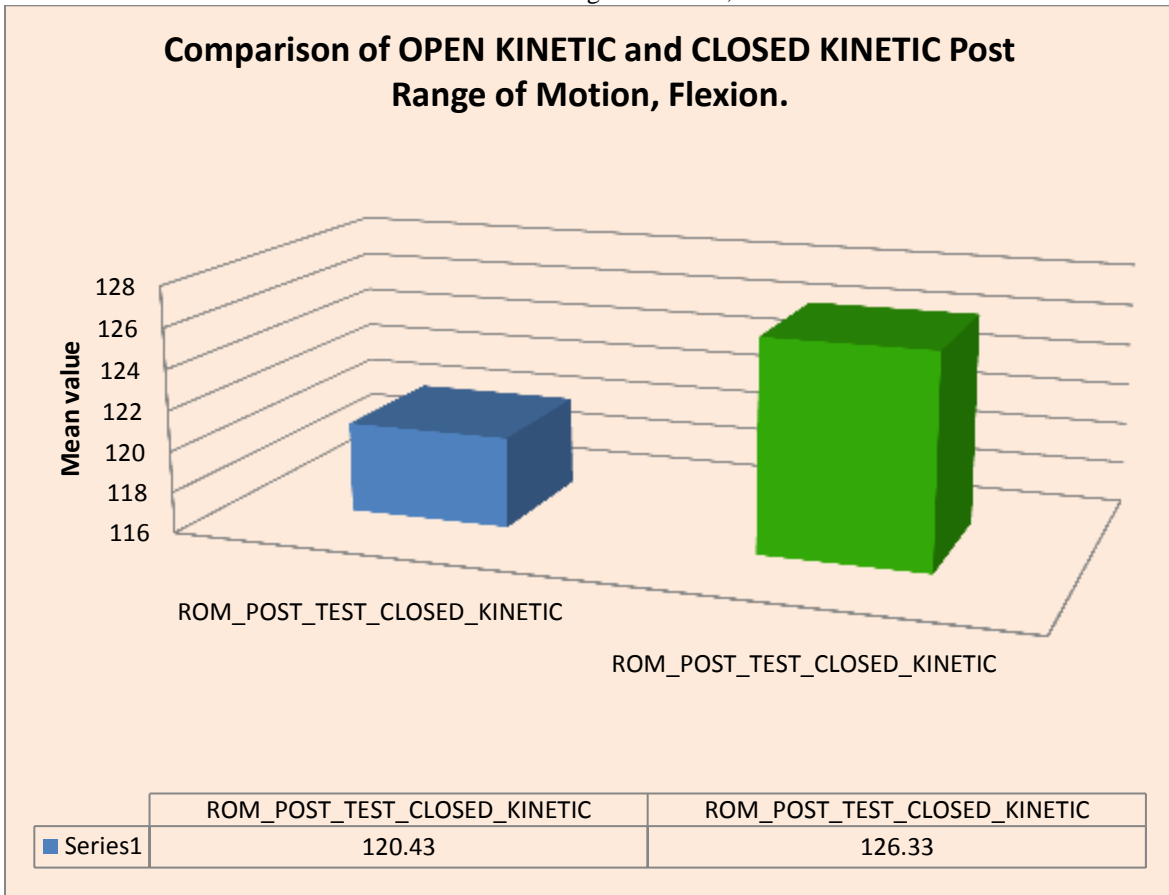
On comparing the post test Manual Muscle Testing between Open kinetic chain (Group-A) and Closed kinetic chain (Group-B) with mean difference of 4.00 and 4.40, it shows there is statistically significant increase in strength in Group-B

On comparing the post test Western Ontario McMaster Universities Osteoarthritis (WOMAC) Index between Open kinetic chain (Group-A) and Closed kinetic chain (Group-B) with mean difference of 48.37 and 43.67, it shows there is statistically significant increase in functional activity in Group-B.

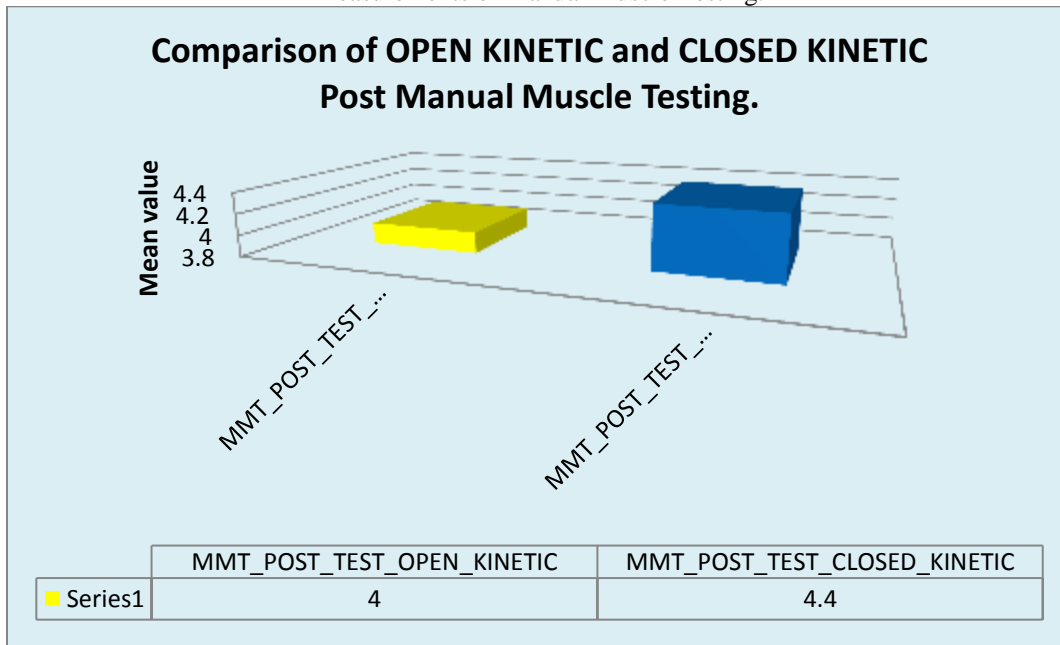
Graph-3:- Comparison of Open Kinetic Chain (Group-A) and Closed Kinetic Chain (Group-B) Post test measurements of Visual Analogue Scale Score.



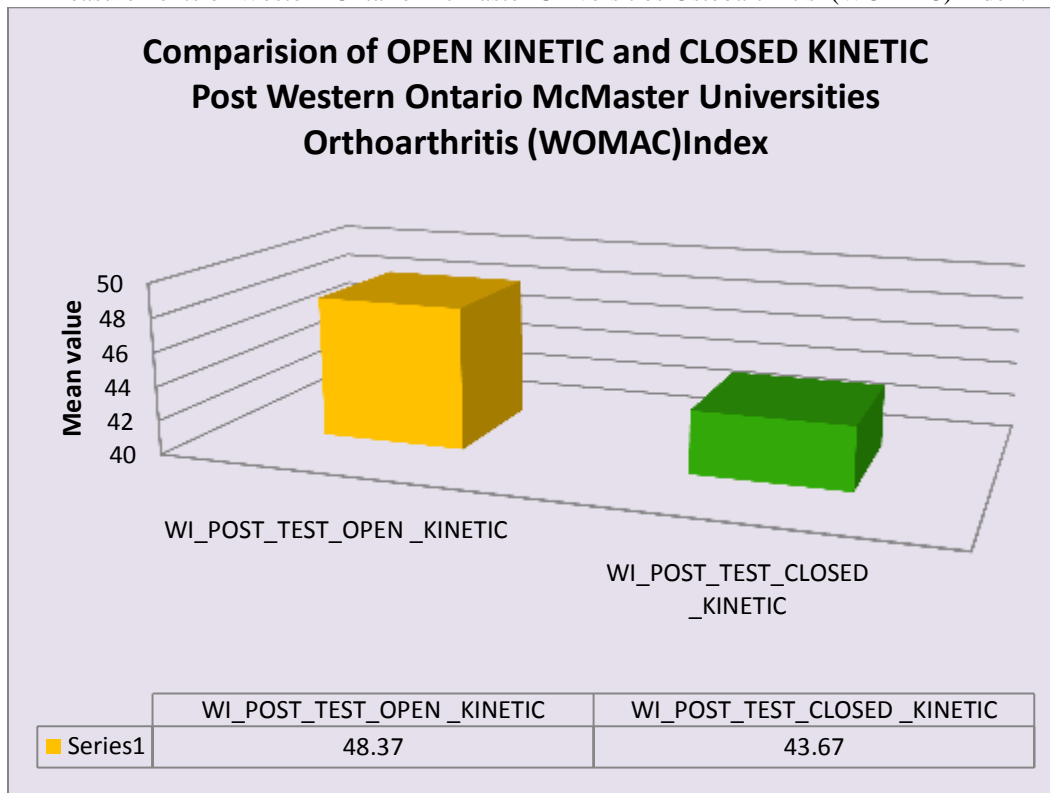
Graph-4:- Comparison of Open Kinetic Chain (Group-A) and Closed Kinetic Chain (Group-B) Post test measurements of Range of Motion, Flexion.



Graph-5:- Comparison of Open Kinetic Chain (Group-A) and Closed Kinetic Chain (Group-B) Post test measurements of Manual Muscle Testing.



Graph-6:-Comparison of Open Kinetic Chain (Group-A) and Closed Kinetic Chain (Group-B) Post test measurements of Western Ontario McMaster Universities Osteoarthritis (WOMAC) Index.



Results:-

According to table-1:

The pre test mean value of Visual Analog Scale in Open kinetic chain exercise (group-A) was 6.07 and post test value was 3.07. There is statistically significant difference in Group-A(Open kinetic chain exercise) between pre and post test of visual analog scale at $p < 0.001$.

The pre test mean value of Range of motion in Open kinetic chain exercise (group-A) was 112.67 and post test value was 120.43. There is statistically significant difference in Group-A(Open kinetic chain exercise) between pre and post test of Range of motion at $p < 0.001$.

The pre test mean value of Manual muscle testing in Open kinetic chain exercise (group-A) was 3.60 and post test value was 4.00. There is statistically significant difference in Group-A(Open kinetic chain exercise) between pre and post test of Manual muscle testing at $p < 0.005$.

The pre test mean value of Western Ontario McMaster Universities Osteoarthritis (WOMAC) Index in Open kinetic chain exercise (group-A) was 57.27 and post test value was 48.67. There is statistically significant difference in Group-A (Open kinetic chain exercise) between pre and post test of Western Ontario McMaster Universities Osteoarthritis (WOMAC) Index at $p < 0.001$.

According to table 2:-

The pre test mean value of Visual analog scale in Closed kinetic chain exercise (group-B) was 6.33 and post test value was 1.73. There is statistically significant difference in Group-B (Closed kinetic chain exercise) between pre and post test of Visual analog scale at $p < 0.001$.

The pre test mean value of Range of motion in Closed kinetic chain exercise (group-B) was 113.67 and post test value was 126.33. There is statistically significant difference in Group-B (Closed kinetic chain exercise) between pre and post test of Range of motion at $p < 0.001$.

The pre test mean value of Manual muscle testing in Closed kinetic chain exercise (group-B) was 3.40 and post test value was 4.40. There is statistically significant difference in Group-B (Closed kinetic chain exercise) between pre and post test of Manual muscle testing at $p < 0.001$.

The pre test mean value of Western Ontario McMaster Universities Osteoarthritis (WOMAC) Index in Closed kinetic chain exercise (group-B) was 60.87 and post test value was 43.67. There is statistically significant difference in Group-B (Closed kinetic chain exercise) between pre and post test of Western Ontario McMaster Universities Osteoarthritis (WOMAC) Index at $p < 0.001$.

According to table-3:-

The post test value of Visual analog scale in Open kinetic chain exercise (Group-A) was 3.07 and post test value of Closed kinetic chain exercise (Group-B) was 1.73. There is statistically significant difference between Group-A and Group-B of Visual analog scale at $p < 0.001$.

The post test value of Range of motion in Open kinetic chain exercise (Group-A) was 120.43 and post test value of Closed kinetic chain exercise (Group-B) was 126.33. There is statistically significant difference between Group-A and Group-B of Range of motion at $p < 0.001$.

The post test value of Manual muscle testing in Open kinetic chain exercise (Group-A) was 4.00 and post test value of Closed kinetic chain exercise (Group-B) was 4.40. There is statistically significant difference between Group-A and Group-B of Manual muscle testing at $p < 0.005$.

The post test value of WOMAC Index in Open kinetic chain exercise (Group-A) was 48.37 and post test value of Closed kinetic chain exercise (Group-B) was 43.67. There is statistically significant difference between Group-A and Group-B of Western Ontario McMaster Universities Osteoarthritis (WOMAC) Index at $p < 0.001$.

Discussion:-

Open and closed kinetic exercises have been used by investigators as a rehabilitation protocol for patients with patellofemoral pain syndrome. The aim of the current study was to compare the effectiveness of Open and closed kinetic chain exercise along with Kinesio taping (Neutral) in subjects with patellofemoral pain syndrome.

The result of the current study revealed that both Group-A and Group-B demonstrated a significant increase in overall functions as measured by reduction of WOMAC Index (Western Ontario and McMaster Universities Osteoarthritis) and reduction in pain measured by Visual analogue scale. Although both Groups revealed a significant reduction in the reported pain after undergoing closed and open kinetic chain exercise protocol, the issues of specificity of training and reports lead one to expect that the closed kinetic chain would demonstrate more functional benefits during various activities than the open kinetic chain group. Since the Closed kinetic chain exercises contain more eccentric muscle work, and because it is known that eccentric exercise develops more tension in the muscle and there by obtains a greater training effect. This may be the primary factor in improving function and reducing pain more significant than the Open kinetic chain group.

Many researchers compared the taping techniques in patellofemoral pain syndrome ; Many researchers concluded that taping techniques is beneficial in patellofemoral pain syndrome.

McConnell et al., concluded that the mechanism of pain relief by taping may be by relieving pressure on the damaged lateral facet of the patellofemoral joint and improving tracking of patella and function of the quadriceps mechanism.

Gigante A et al.,(2001) stated that patellar taping may increase afferent fiber input which increase the alpha motor neuron excitability via the spinal cord by coetaneous stimulation.

Hence this study evaluate the benefit of Neutral taping along with the open and closed kinetic chain exercises, improving knee range of motion and muscle strength in patellofemoral pain subjects.

The statistical results of the study for Group-A and Group-B shows that there is an marked increase in Range of Motion and Manual muscle testing values and a significant reduction in visual analogue scale and (Western Ontario

and McMaster Universities Osteoarthritis) WOMAC Index from pre treatment to post treatment in duration of 2 week study. The above exposed statement suggests that both the open kinetic chain and closed kinetic chain exercise can be employed to treat the patellofemoral pain syndrome.

In another study **Bockrath K et al.**, (1993) stated Neutral taping is effective in placing the patella in neutral. The underlying goal of taping is multifaceted and intended to correct the position of patella, increase vastusmedialis oblique activation and stretch the tight lateral structures of patella leading to pain reduction and facilitating strengthening exercises of the quadriceps⁴³. **Stiene et al.**, reported excellent results related to the pain and functionality after treating individuals reporting patellofemoral pain, and concluded that after an eight week treatment, the Closed kinetic chain exercises were more effective than the Open kinetic chain exercises in the functional recovery of individual bearers of patellofemoral disorder.

Hence the current study concluded that Neutral taping of patella is a simple, safe way of providing pain relief which can be followed by open and closed kinetic chain exercise, it can also be implemented to the usual orthopaedic rehabilitation of patients with patellofemoral pain syndrome.

Conclusion:-

The result of the present study shows that, there was a significant improvement in functional ability and reduction of pain in both open and closed kinetic chain exercise program along with the application of Neutral Kinesio taping in subjects with patellofemoral pain syndrome. However the closed kinetic chain exercises showed more significant improvement than the Open kinetic chain exercise in reducing pain and improving functional activities in two weeks treatment programme.

Limitations:-

1. The sample size was small.
2. The duration of the study was short.
3. No long term follow up of subjects.

Recommendations:-

1. Further studies can be done with larger sample size. This would provide a more apparent results and more statistically significant difference may achieve.
2. Further studies can consider increasing the treatment period so that the rehabilitation may have a longer effect.
3. Further studies can compare the study between male and females.
4. Further studies can apply a different exercise protocol.

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