# EFFECTIVENESS OF CLOSED KINETIC CHAIN EXERCISES VS OPEN KINETIC CHAIN EXERCISES IN REDUCING PAIN AND IMPROVES FUNCTIONAL ACTIVITIES OF LOWER LIMB IN PATIENTS WITH UNILATERAL PATELLOFEMORAL PAIN SYNDROME – A Comparative Study

*Dissertation submitted to*

*The Tamil Nadu Dr. M. G. R. Medical University*

*Chennai*

*In partial fulfillment of the requirements for the degree of*

**MASTER OF PHYSIOTHERAPY**

**(ADVANCED PHYSIOTHERAPY IN ORTHOPAEDICS)**

**REG . NO. 27101102**

**APRIL - 2012**


## COLLEGE OF PHYSIOTHERAPY

**SRI RAMAKRISHNA INSTITUTE OF PARAMEDICAL SCIENCES**

**COIMBATORE - 641 044.**

# CERTIFICATE

This is to certify that the dissertation work entitled **Effectiveness Of Closed Kinetic Chain Exercises Vs Open Kinetic Chain Exercises In Reducing Pain And Improves Functional Activities Of Lower Limb In Patients With Unilateral Patellofemoral Pain Syndrome – A Comparative Study** was carried out by the candidate bearing the **Register No. 27101102 (April 2012)** in College of Physiotherapy, SRIPMS, Coimbatore, affiliated to The Tamilnadu Dr. M.G.R Medical University, Chennai towards partial fulfillment of the **Master of Physiotherapy** (Advanced Physiotherapy in Orthopaedics).

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Place : Coimbatore

Date :

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Date :

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This is to certify that the dissertation work entitled **Effectiveness Of Closed Kinetic Chain Exercises Vs Open Kinetic Chain Exercises In Reducing Pain And Improves Functional Activities Of Lower Limb In Patients With Unilateral Patellofemoral Pain Syndrome – A Comparative Study** Submitted By

**Reg . No. 27101102**

**APRIL - 2012**

To The Tamil Nadu Dr. M.G.R. Medical University, Chennai in Partial fulfillment of the requirement for the award of degree of **MASTER OF PHYSIOTHERAPY** was evaluated

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**INTERNAL EXAMINER** **EXTERNAL EXAMINER**

Place : Coimbatore
Date :

# ACKNOWLEDGEMENT

*First and foremost I wish to acknowledge my heartfelt gratitude to the **Lord Almighty** for his divine blessing and guidance throughout this endeavour.*

*I am especially indebted to my **Family members** for their prayerful support, inspiration, love and encouragement throughout this endeavour.*

*I express my gratitude to **Prof**. **N. Parameshwarri** M.P.T., (OBG) Principal, College of Physiotherapy, Sri Ramakrishna Hospital for providing the facilities for doing the study.*

*I wish to express a deep sense of gratitude to **Dr.G.BalaSubramanian**, M.B.B.S., M.S.(Ortho), DNB (Ortho), FRCS (Ed), FRCS (Te & Ortho), Consultant trauma and Orthopedic surgeon, Sri Ramakrishna Hospital for his guidance.*

*It is my pleasure to express my sincere thanks and gratitude to my thesis guide **Mr.K.Saravanan.**, **M.P.T.,(Ortho)** Professor, College of Physiotherapy, SRIPMS, for his inspiring timely suggestions and valuable guidance, encouragement and constant support throughout the study.*

*I extend my profound sense of gratitude **Mr.V.S. Seetharaman, M.P.T.,** Professor, **Mr.S. Santhakumar, M.P.T.,** Professor, **Mr.A.Pahinian M.P.T.,** Professor and **Mr. G. Kamban** all the **Faculty Members** for their guidance and concern in making this project a successful one.*

*I also thank to **Mr. Faith Ragland, M.P.T.,** , Professor for his support to accomplish my project.*

*I express my deep gratitude to all my **Friends** for their unending source of support and encouragement extended at every stage of my project work.*

*Last but not the least, my special thanks to **M/s. Saraswathi Computer Centre**, for their extended co-operation and guidance in execution of the project work.*

# CONTENTS

# I. INTRODUCTION

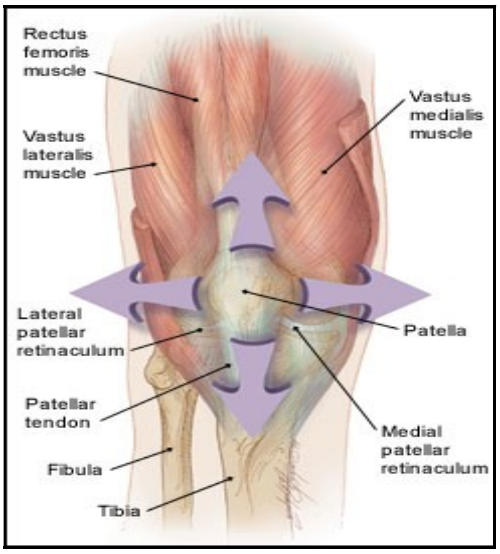
Patellofemoral pain syndrome (anterior knee pain) is one of the most common treated conditions in orthopaedic and primary care practices.

Patellofemoral pain syndrome is defined as peripatellar pain resulting from physical, biomechanical and soft tissues changes in the patellofemoral joint. Many of the structures of the anterior that compromise the patellofemoral joint can be the source of chronic that is associated with this condition.

Patellofemoral pain syndrome constitutes 16-25% of all injuries occurring in runners and 11% musculoskeletal complaints in the office settings are caused by anterior knee pain.

In general, patellofemoral pain can effect 25% of the population. It is more common in adolescents and young adults. It is very common clinical entity in active young people involved in sports and that can even dramatically end participation in sports events.

Patients suffer from pain during activities and ascending stair or hills. It is also triggered by prolonged sittings with knee flexed. One or both knees can be affected.




While theories regarding the pathophysiology of patellofemoral pain syndrome vary, identification of the resultant forces involved in dynamic and static knee positions has been fundamental to the research on this syndrome. Factors believed to contribute to production of retropatellar pain include impairments affecting the patellofemoral joint interface. Such impairments may be a consequence of overuse, over load, biomechanical and muscular causes.

**Overuse and overload causes:**

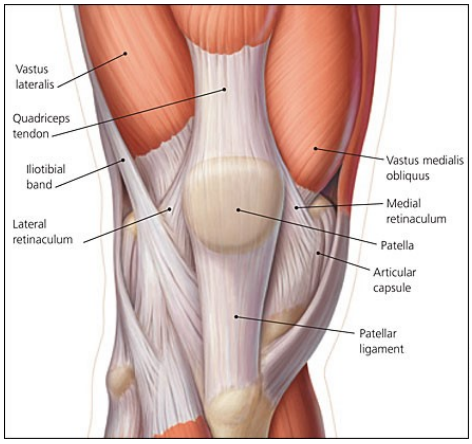
Patella not only glides superiorly, inferiorly it also, tilts and rotates medially and laterally. During all their movement patella comes in contact with femur at various points. These repetitive patellar stress along with maltracking is the major cause of anterior knee pain.

**Biomechanical factor:**

Pesplanus in which there is weakening of medial arch and compensatory medial femoral rotation; pes cavus in which there is accentuated medial arch; exaggerated Q-angle are the common biomechanical factors that results in anterior knee pain.

**Muscular factors:**

Weakness of quadriceps especially vastus medialis oblique, tight iliotibial band, tight hamstrings , tight or weakened adductors, abductors, external rotators of hip and tight calf muscles are the common muscular factors.




Several factors may create a predisposition for the development of patellofemoral pain syndrome through alteration in patellar tracking, increased patellofemoral joint forces or a combination of these biomechanical features.

Three major contributing factors for patellofemoral pain syndrome were;

a. Malalignment of lower extremity may be of pes planus, pes cavus, large ‘Q’ angle, femoral anteversion and patella alta.

b. Muscular imbalance which are responsible for paellofemoral pain syndrome may be weakness of quadriceps specifically vastus medialis oblique, tight iliotibial band, tight lateral retinaculum, tight hamstrings, weakness or tightness of the hip muscles.

c. Knee bending increases the patellar stress on femur which often produce patellofemoral pain syndrome due to overuse injury.

The symptoms are usually of gradual onset. Common symptoms include pain and stiffness on prolonged sittings with knee flexed and pain with activities that load the patellofemoral joint such as climbing or descending stairs, squatting, kneeling, rising from sitting from standing and running. Other symptoms include instability of knee, crepitance, swelling, quadriceps weakness and night pain.

The management of the patellofemoral pain syndrome should focus on implementation of a comprehensive rehabilitation program. Many therapies have been advocated for treating patellofemoral pain syndrome.

Conservative management of acute patellofemoral pain syndrome are relative rest, physical therapy and patient education. The treatment for patellofemoral syndrome includes analgesics, bracing, exercises, pain relieving modalities, patella mobilization, patellar taping and foot wear modifications. The closed kinetic chain exercise and open kinetic chain exercise are also one of the main forms of physiotherapy.

## DEFINITIONS

### Closed kinetic chain exercises

It is defined as the exercises in which the joints of extremity work together with contribution from every point. All functional movements of human body are closed chain movements like walking, eating food etc.

### Advantages of closed kinetic chain exercises

- Provides greater joint compressive forces.
- Multiple joints are exercised through weight bearing and muscular contractions.
- Velocity and torque are more controlled.
- Shear forces are reduced.
- Joint congruity is enhanced.
- Proprioceptive are re-educated.

**Open kinetic chain exercises**

It is defined as those movements, which are performed with the joints of exercising extremity moving independent of the other. This form of exercises allows isolated training for various muscles of the body.

**Advantages of open kinetic chain exercises**

- Can isolate a specific muscle group for intense strength and endurance exercises.
- Can develop strength in very weak muscles that may not function properly in a closed kinetic chain system.
- Can produce great gains in peak force production.

## 1.1 NEED FOR THE STUDY

Patellofemoral pain syndrome is a common condition seen in the young adults. Physiotherapy plays a vital role in the patellofemoral pain syndrome. Although patellofemoral Pain syndrome responds well for the treatment, but its recurrence rate is more.

Closed kinetic chain and open kinetic chain exercises plays a vital role in the prevention of recurrence of patellofemoral pain syndrome.

So this study was focused to find out the outcome measures of closed kinetic chain exercises versus open kinetic chain exercises in reducing pain and improve functional activities of lower limb in patient with unilateral patellofemoral pain syndrome.

## 1.2 STATEMENT OF THE PROBLEM

A study to find out the outcome measures of closed kinetic chain exercises versus open kinetic chain exercises in reducing pain and improves functional activities of lower limb in patients with unilateral patellofemoral pain syndrome.

## 1.3 OBJECTIVES OF THE STUDY

To find out the outcome measures of closed kinetic chain exercises in reducing pain and improve functional activities of lower limb in patients unilateral patellofemoral pain syndrome.

To find out the outcome measures of open kinetic chain exercises in reducing pain and improve functional activities of lower limb in patients unilateral patellofemoral pain syndrome.

To study the outcome measures of closed kinetic chain exercises versus open kinetic chain exercises in reducing pain and improves functional activities of lower limb in patients with unilateral patellofemoral pain syndrome.

## 1.4 HYPOTHESIS

### Null Hypothesis

There is no significant difference in decrease in pain and functional performance in using closed kinetic chain exercises than open kinetic chain exercises in unilateral patellofemoral knee pain.

# II. REVIEW OF LITERATURE

- **Amir H Bakhtiary, 2007** stated that semi-squat exercises (closed kinetic chain) are more effective than SLR exercise (open kinetic chain) in the treatment of patellofemoral knee pain.
- **Thomas Souza, DC, DACBSP 2007** stated that closed kinetic chain exercise are more effective than open kinetic chain exercises in the treatment of anterior knee pain.
- **Lieven Danneels, Damien Van Tiggelen, 2006** concluded that both open kinetic chain and closed kinetic chain programs lead to an equal long-term good functional outcome.
- **G L Fehr, A Cliquet Junior, 2006** stated that closed kinetic chain exercises and open kinetic chain exercises are more effective in treatment of patellofemoral pain syndrome. Closed kinetic chain exercises are more effective than open kinetic chain exercise.
- **R van Linschoten,2007** sports physician stated that supervised exercise therapy resulted in less pain and better functional gain in patients with anterior knee pain.

- **E M Heintjes, Research Associate,2007** stated that closed chain exercises improves functional activities in patients with patellofemoral pain syndrome.
- **Leath Jesen, MS.PT, 2005** stated that patellar mobilization and vastus medialis oblique strengthening exercise is effective for relieving pain and to enhance functional recovery for patellofemoral pain syndrome.
- **Shannon Erstad et al., 2005** stated "Exercise reduces joint pain and improves ability to do daily activities".
- **J B Miranda, 2006** stated that closed kinetic chain exercises are effective in the treatment of patellofemoral knee pain
- **K.L.Bennell, R.SHinman, B.R.Metcalf, 2005** stated "A multimodal physiotherapy program including closed kinetic chain exercises is more effective for anterior knee pain compare to open kinetic chain exercises".
- **Berger M.Y, Heintjies, Vershar JA, Koes BW, Bierma, Ziensstra SM et al., 2003** stated that exercise therapy aims to treating patellofemoral pain syndrome with pain syndrome with pain and limited function. They concluded that there is strong evidence that open and closed kinetic chain exercises were equally effective.

- **Cowan SM, Bennell KL, Crossley KM et al., 2002** concluded that open kinetic chain exercises and closed kinetic chain exercises both showed improvement in overall function, extension strength and pain.
- **Damien Van Tigglen pt, 2000** stated that open and closed kinetic chain exercises useful in decrease in pain and improves functional activities in patients with unilateral patellofemoral knee pain.
- **Crossely K. et al., 2001** stated there is a consistent improvement in short term pain and function due to physiotherapy treatments in patient with patellofemoral pain syndrome.
- **Witvrouw E, Lysens R, Bellemans J, et al., 2000** stated that exercise program consisting of open kinetic chain exercise and closed kinetic chain exercise. Finally they concluded that closed kinetic chain exercise showed more greater improvement in range of motion, muscle strength, functional performance and pain when compare to the open kinetic chain exercises.
- **Merchant Ac., 1998** stated patellofemoral pain syndrome can be defined as anterior knee pain affecting he patella and retinaculum that excludes other intra-articular and peripetallar pathology.

- **Vanderstraeten MD, Phd , 2000** stated that exercise program consisting of open kinetic chain exercise and closed kinetic chain exercise. Finally they concluded that closed kinetic chain exercise showed more greater improvement in range of motion, functional performance and pain when compare to the open kinetic chain.
- **Stiene HA, Brosky T, et al., 1996** compared open kinetic chain exercise and closed kinetic chain exercises for patients with patellofemoral pain syndrome. They found that closed kinetic chain exercises had significant improvement for isokinetic knee extension strength compare to the open kinetic chain exercises .
- **Kujala UM, Jaakkola LH, Koskinen SK et al.,** 1993 has described the evaluation of the knee scoring scale as a specific scale for patellofemoral pain syndrome. It is a 0-100 point scale. A score of 100 is the highest score. This scale evaluate occurs pain during stair climbing, running, squatting, jumping and prolonged sitting with knee flexed knee flexion range of motion deficit etc.
- **Zientra S.M; Bernsen R.M, 1991** stated that " Exercise therapy is more effective in treating patellofemoral pain syndrome, with respect to pain reduction and functional improvement".

# III. MATERIALS AND METHODOLOGY

## 3.1 MATERIALS

- Stationary bicycle
- Couch
- Pillow
- Towel roll
- Stool
- Theraband

## 3.2 METHODOLOGY

### (A) Study Design:

30 subjects with unilateral patellofemoral pain assigned in two groups.

**Group A:**

15 subjects: closed kinetic chain exercises.

**Group B:**

15 subjects: Open kinetic chain exercises.

### (B) Study Setting:

This study is proposed to conduct in outpatient, department of physiotherapy and patient referred from department of orthopaedics and various other departments of Sri Ramakrishna Hospital, Coimbatore.

**(C) Study Duration:**

This study is proposed to be carried out for a period of 6 months.

**(D) Treatment Duration:**

Subjects in each group will receive treatment 3 days per week two session per day for each group four weeks.

**(E) Sampling:**

Unilateral patellofemoral pain syndrome patients are included in this study, according to inclusion criteria hence this will be a convenient sampling.

**(F) Inclusion Criteria:**

- 14-33 years
- both sexes.
- Moderate to chronic knee pain
- Anterior knee pain for more than 6 weeks.
- Pain on direct compression of the patella against the femoral condyles with the knee in full extension.(on initial examination)
- Pain on resisted knee extension.
- Pain with isometric quadriceps muscle contraction against suprapatellar resistance with the knee slight flexion.
- Pain on palpation of patellar facet.

**(G) Exclusion Criteria:**

- History of knee operation.
- Acute knee pain cases
- Patients age more than 35.
- Bilateral patellofemoral knee pain.
- Ligaments and meniscal injuries.
- Fracture in and around the knee joint.
- Metal implants.
- Diabetes.
- Peripheral vascular disease.
- Osteoporosis.
- Other knee problems.

## 3.3 TECHNIQUES:

**Group A:**

**Closed kinetic chain exercises:**

- Seated leg presses.
- One-third knee bends on one leg and on both legs.
- Stationary bicycling.
- Step up and step down exercises.

**Group B:**

**Open kinetic chain exercises:**

- Maximal static quadriceps muscle contractions with the knee full extension.
- Straight leg raises with the patient supine.
- Short arc movements from 10 of knee flexion to terminal extension.
- Leg adduction exercises in the lateral decubitus position.

In both training protocols the patients were instructed to perform the conventional static quadriceps, hamstring and calf muscle stretching exercises after each training session.

## 3.4 PARAMETERS

- Visual analog scale.
- Kujala knee scoring scale.

## 3.5 STATISTICAL TOOLS

Pre and post test values are collected and asses for variation in improvement and their results are analyzed using Independent 't' test.

$$t = \frac{\bar{x}_1 - \bar{x}_2}{S}\sqrt{\frac{n_1 n_2}{(n_1 + n_2)}}$$

$$S = \sqrt{\frac{\sum (x_1 - \bar{x}_1)^2 + \sum (x_2 - \bar{x}_2)^2}{n_1 + n_2 - 2}}$$

***Where,***

S = Combined Standard deviation.

$X_1$ = Difference between pre test and post test in Group A

$\bar{x}_1$ = Mean difference of the Group A.

$X_2$ = Difference between pre test and post test in Group B

$\bar{x}_2$ = Mean difference of the Group B.

$n_1$ = Number of patients in Group A

$n_2$ = Number of patients in Group B

# IV. TREATMENT TECHNIQUES

## CLOSED KINETIC CHAIN EXERCISE:

### Seated Leg Press

**Position** - Sitting with knee flexed.

**Procedure** - Elastic resistance band is placed in mid of Foot and then Quadriceps muscle is contracted and extend knee such as to push out the elastic resistive band.

**Duration** : 10-15 times.

**Partial squat exercise:**

**Position of the patient:** Standing.

**Procedure:**

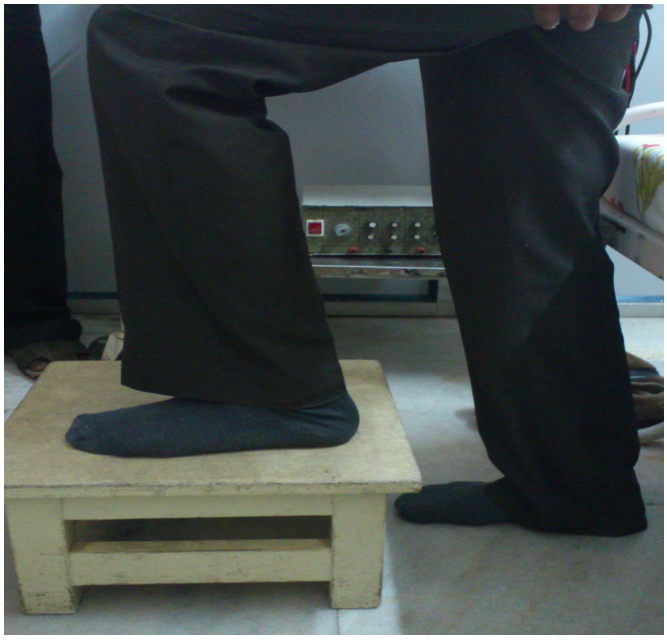
Ask the patient to simultaneously flex knees and hip to perform partial squat.

**Duration:** 10-15 times.

**Stationary bicycling:**

It's performed once daily for 5 inches height of seat adjusted. So that the knee should be at nearly full extension at bottom of pedal stroke, progression is given by increasing the duration or resistance of cycling according to patient tolerance.

**Step up and step down exercise:**



**Position of the patient: standing.**

**Procedure:**

Ask the patient to step up and step down on the stool .

**Duration :** 15-20 times.

## OPEN KINETIC CHAIN EXERCISES

### Maximal static quadriceps with knee full extension:

**Position of the patient:**

Supine lying or long sitting

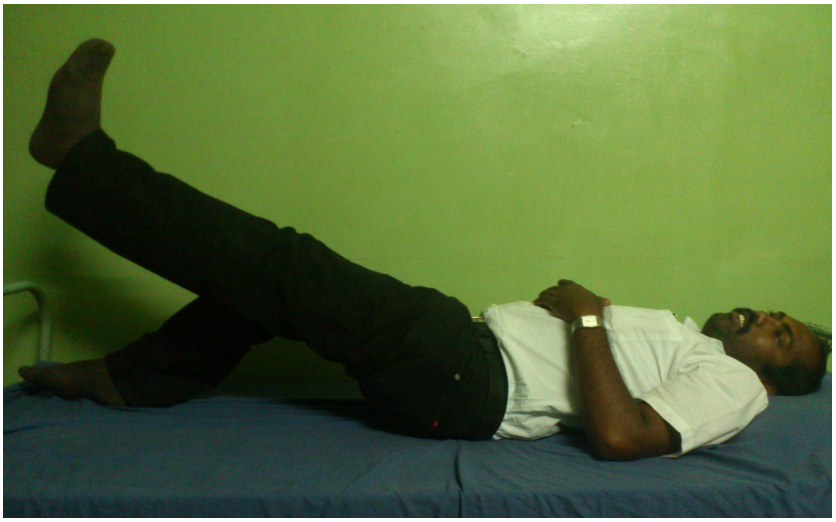
**Procedure:**

Ask the patient to leg straight and hold roll of towel under the knee.

**Hold time :** 10-20 seconds

**Duration :** 5-10 times

**Straight leg raising:**



**Position** - Supine Lying

**Procedure** - Knee should be extended with a heel on the Floor.

One of the hip and knee should be flexed to stabilize the pelvis.

Leg is lifted to about 45 degrees of hip flexion.

Hold for a count of 5-10, and then lower the leg.

**Duration :** 5-10 times

**Short arc movement:**

**Patient position:** Supine lying.

**Procedure:**

Ask the patient to flex the knee to 10 degree and place the towel roll under the knee and ask the patient to extend the knee fully(terminal knee extension).

**Duration :** 5-10 times.

**Leg adduction exercise:**

**Position of the patient:** Side lying

**Procedure**:

The patient must be in side lying and place the top foot on the ground in front of the bottom leg then move the bottom leg up and down with a flexed foot.

**Duration:** 2 sets of 15 repetitions.

In both training protocols the patients were instructed to perform the

- Quadriceps stretching.
- Hamstring stretching.
- Calf stretching.

These exercise were done after each training session. All subjects were instructed to perform three repeittions of a 30 seconds static stretch of these mucle groups.

## QUADRICEPS STRETCH

1. Lie on your side with one hand supporting your head.
2. Bend your upper leg back and grab your ankle with your other hand.
3. Stretch your leg back by pulling your foot toward your buttocks. You will feel the stretch in the front of your thigh. If this causes stress on your knees, do not do this stretch.
4. Hold each stretch 15 to 30 seconds.
5. Repeat 2 to 4 times for each leg

## HAMSTRING STRETCH

1. Sit on the floor with your right leg extended out straight and your toes pointing up. If your knee is uncomfortable, try putting a rolled washcloth or small towel under your knee to keep it slightly bent.
2. Bend your left leg so that your left foot is next to the inside of your right thigh.
3. Lean forward from the hips, and reach for your right ankle. Do not try to touch your forehead to your knee.
4. Hold each stretch 15 to 30 seconds.
5. Repeat 2 to 4 times for each leg.

## CALF STRETCH

1. Place your hands on a wall for balance. You can also do this with your hands on the back of a chair, a countertop, or a tree.
2. Step back with your left leg; keep the leg straight, and press your left heel into the floor.
3. Press your hips forward, bending your right leg slightly. You will feel the stretch in your left calf.
4. Hold each stretch 15 to 30 seconds.
5. Repeat 2 to 4 times for each leg.

## V. DATA ANALYSIS AND INTERPRETATION

The calculation were tabulated for easier statistical calculations and better comprehension. The pre test values and post test values obtained by using visual analog scale and Kujala knee questionnaire were as follows :

**VISUAL ANALOG SCALE (Group A)**

| S.No. | Pre test | Post test | $X_1$ | $\left(X_1 - \overline{X_1}\right)$ | $\left(X_1 - \overline{X_1}\right)^2$ |
|---|---|---|---|---|---|
| 1 | 8 | 2 | 6 | 0.8 | 0.64 |
| 2 | 8 | 2 | 6 | 0.8 | 0.64 |
| 3 | 9 | 3 | 6 | 0.8 | 0.64 |
| 4 | 7 | 4 | 3 | -2.2 | 4.84 |
| 5 | 9 | 2 | 7 | 1.8 | 3.24 |
| 6 | 8 | 2 | 6 | 0.8 | 0.64 |
| 7 | 7 | 4 | 3 | -2.2 | 4.84 |
| 8 | 9 | 3 | 6 | 0.8 | 0.64 |
| 9 | 7 | 3 | 4 | -1.2 | 1.44 |
| 10 | 8 | 2 | 6 | 0.8 | 0.64 |
| 11 | 8 | 4 | 4 | -1.2 | 1.44 |
| 12 | 7 | 3 | 4 | -1.2 | 1.44 |
| 13 | 9 | 3 | 6 | 0.8 | 0.64 |
| 14 | 9 | 3 | 6 | 0.8 | 0.64 |
| 15 | 8 | 2 | 6 | 0.8 | 0.64 |

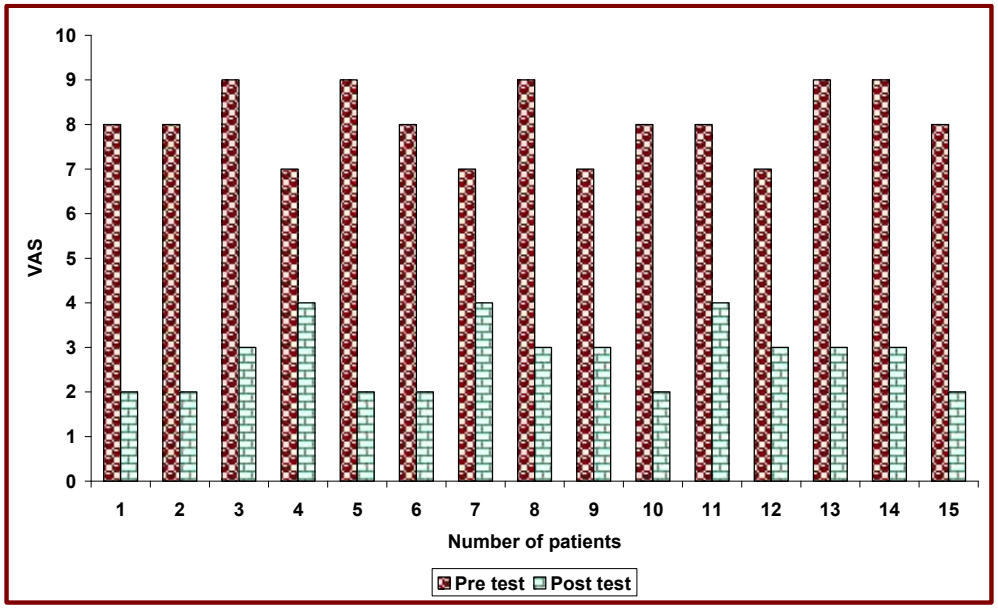
Mean : 5.2

## VISUAL ANALOG SCALE (Group B)

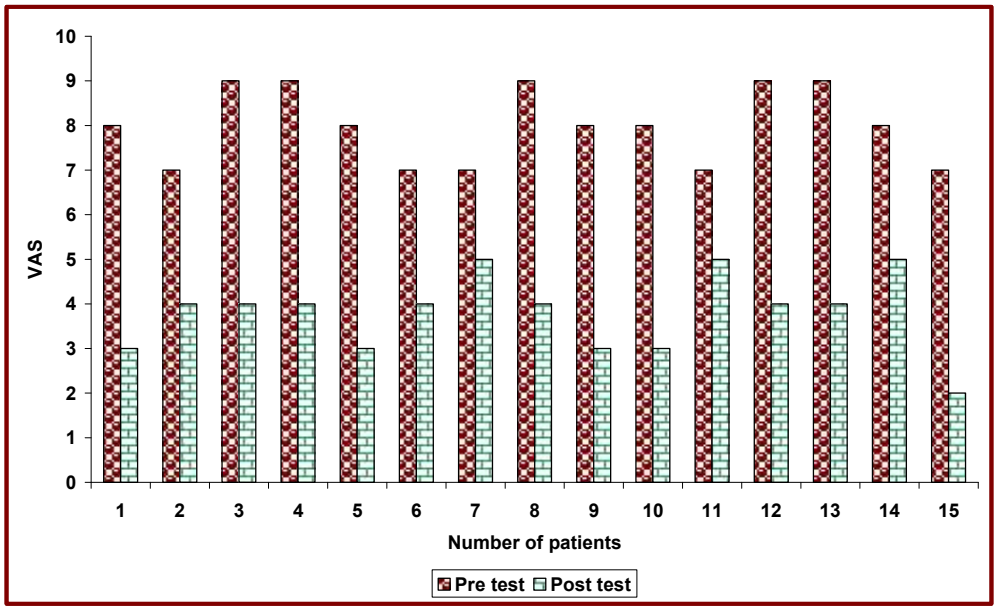
| S.No. | Pre test | Post test | $X_2$ | $\left(X_2 - \overline{X_2}\right)$ | $\left(X_2 - \overline{X_2}\right)^2$ |
|---|---|---|---|---|---|
| 1 | 8 | 3 | 5 | 0.8 | 0.64 |
| 2 | 7 | 4 | 3 | -1.2 | 1.44 |
| 3 | 9 | 4 | 5 | 0.8 | 0.64 |
| 4 | 9 | 4 | 5 | 0.8 | 0.64 |
| 5 | 8 | 3 | 5 | 0.8 | 0.64 |
| 6 | 7 | 4 | 3 | -1.2 | 1.44 |
| 7 | 7 | 5 | 2 | -2.2 | 4.84 |
| 8 | 9 | 4 | 5 | 0.8 | 0.64 |
| 9 | 8 | 3 | 5 | 0.8 | 0.64 |
| 10 | 8 | 3 | 5 | 0.8 | 0.64 |
| 11 | 7 | 5 | 2 | -2.2 | 4.84 |
| 12 | 9 | 4 | 5 | 0.8 | 0.64 |
| 13 | 9 | 4 | 5 | 0.8 | 0.64 |
| 14 | 8 | 5 | 3 | -1.2 | 1.44 |
| 15 | 7 | 2 | 5 | 0.8 | 0.64 |

Mean : 4.2
S.D. : 1.13
't' value : 2.184

## VISUAL ANALOG SCALE (Group A)




## VISUAL ANALOG SCALE (Group B)



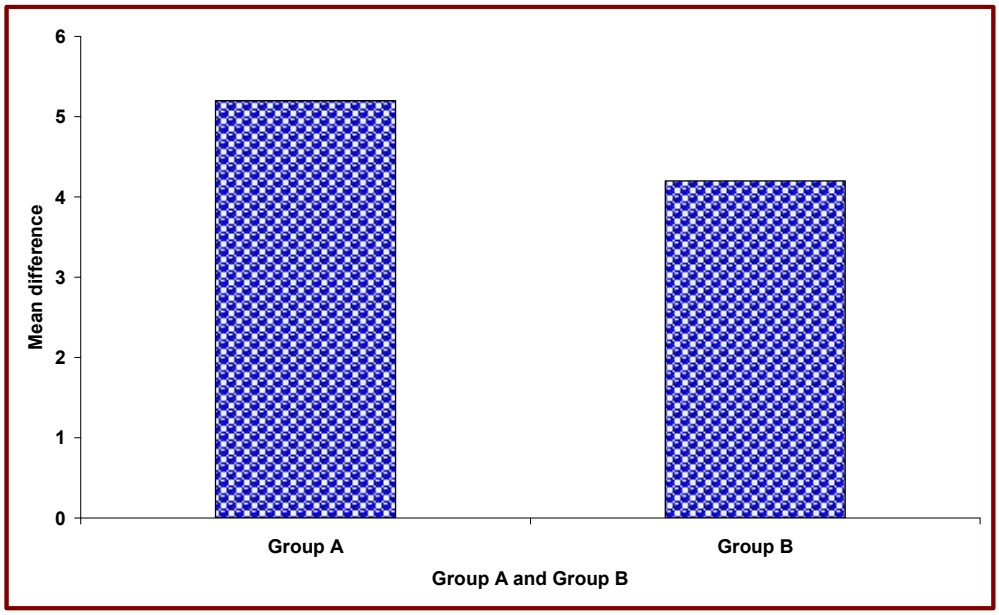
## MEAN DIFFERENCE BETWEEN

## GROUP A AND GROUP B (VAS)

| VISUAL ANALOG SCALE | | | | |
|---|---|---|---|---|
| | **Mean value** | **S.D** | **Calculated 't' value** | Table 't' value |
| Group A | 5.2 | 1.13 | 2.184 | 2.048 |
| Group B | 4.2 | | | |

## MEAN DIFFERENCE BETWEEN

## GROUP A AND GROUP B (VAS)



## KUJALA KNEE QUESTIONNAIRE (GROUP A)

| S.No. | Pre test | Post test | $X_1$ | $\left(X_1 - \overline{X_1}\right)$ | $\left(X_1 - \overline{X_1}\right)^2$ |
|---|---|---|---|---|---|
| 1 | 54 | 88 | 34 | -4.3 | 18.49 |
| 2 | 42 | 82 | 40 | 1.7 | 2.89 |
| 3 | 54 | 82 | 28 | -10.3 | 106.09 |
| 4 | 38 | 80 | 42 | 3.7 | 13.69 |
| 5 | 34 | 85 | 51 | 12.7 | 161.29 |
| 6 | 36 | 83 | 47 | 8.7 | 75.69 |
| 7 | 43 | 71 | 28 | -10.3 | 106.09 |
| 8 | 42 | 71 | 29 | -9.3 | 86.49 |
| 9 | 58 | 80 | 22 | -16.3 | 265.69 |
| 10 | 38 | 70 | 32 | -6.3 | 39.69 |
| 11 | 34 | 84 | 50 | 11.7 | 136.89 |
| 12 | 32 | 84 | 52 | 13.7 | 187.69 |
| 13 | 54 | 82 | 28 | -10.3 | 106.09 |
| 14 | 38 | 86 | 48 | 9.7 | 94.09 |
| 15 | 36 | 80 | 44 | 5.7 | 32.49 |

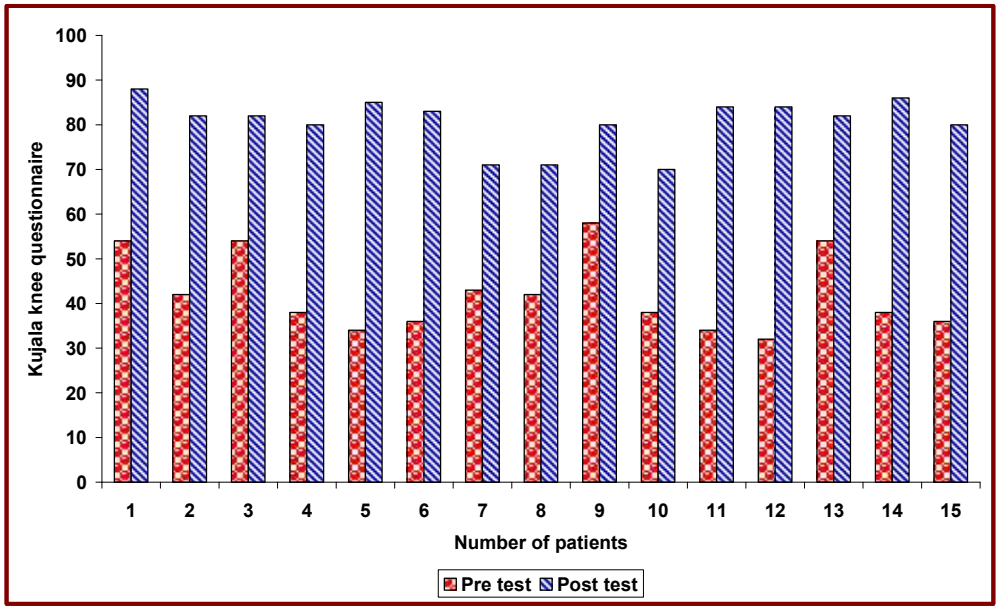
Mean : 38.3

## KUJALA KNEE QUESTIONNAIRE (Group B)

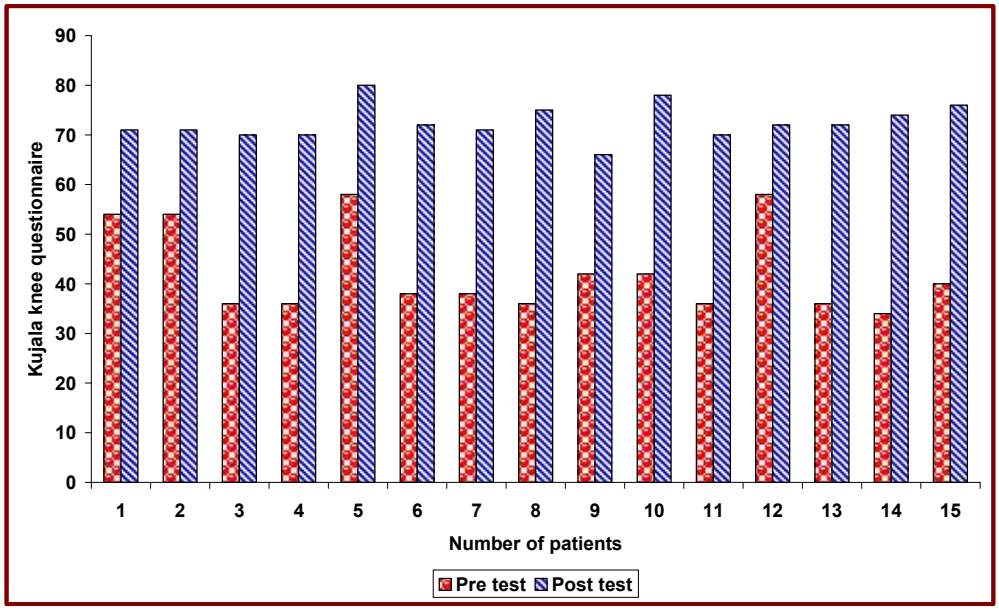
| S.No. | Pre test | Post test | $X_2$ | $\left(X_2 - \overline{X_2}\right)$ | $\left(X_2 - \overline{X_2}\right)^2$ |
|---|---|---|---|---|---|
| 1 | 54 | 71 | 17 | -13 | 169 |
| 2 | 54 | 71 | 17 | -13 | 169 |
| 3 | 36 | 70 | 34 | 4 | 16 |
| 4 | 36 | 70 | 34 | 4 | 16 |
| 5 | 58 | 80 | 22 | -8 | 64 |
| 6 | 38 | 72 | 34 | 4 | 16 |
| 7 | 38 | 71 | 33 | 3 | 9 |
| 8 | 36 | 75 | 39 | 9 | 81 |
| 9 | 42 | 66 | 24 | -6 | 36 |
| 10 | 42 | 78 | 36 | 6 | 36 |
| 11 | 36 | 70 | 34 | 4 | 16 |
| 12 | 58 | 72 | 14 | -16 | 256 |
| 13 | 36 | 72 | 36 | 6 | 36 |
| 14 | 34 | 74 | 40 | 10 | 100 |
| 15 | 40 | 76 | 36 | 6 | 36 |

Mean : 30
S.D. : 9.719
‘t’ value : 2.335

## KUJALA KNEE QUESTIONNAIRE (Group A)




## KUJALA KNEE QUESTIONNAIRE (Group B)



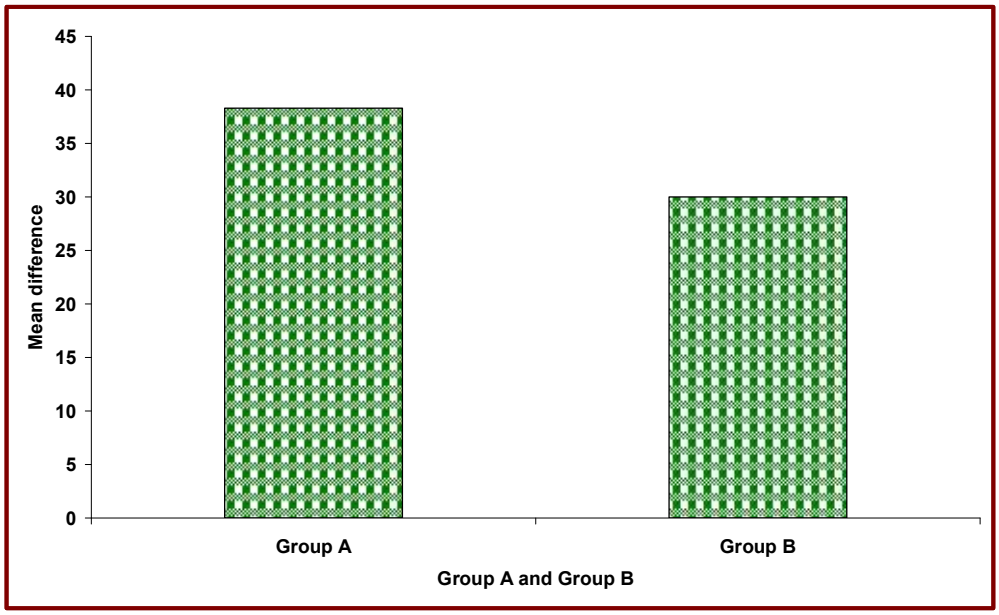
## GROUP A AND GROUP B (KUJALA KNEE)

## QUESTIONNAIRE

| KUJALA KNEE QUESTIONNAIRE | | | | |
|---|---|---|---|---|
| | **Mean value** | **S.D** | **Calculated 't' value** | Table 't' value |
| Group A | 38.3 | 9.719 | 2.335 | 2.04 |
| Group B | 30 | | | |

## MEAN DIFFERENCE BETWEEN GROUP A AND GROUP B

## (KUJALA KNEE) QUESTIONNAIRE



# VI. DISCUSSION

This was comparative study conducted to evaluate and to compare the effectiveness of Closed Kinetic Chain exercises versus Open Kinetic Chain exercises in treatment of patients with patellofemoral pain syndrome.

In patellofemoral pain syndrome limitation of movement is due to pain and muscle guarding rather than stiffness, once the pain is relieved the patient will be able to perform normal functional activity.

Pain was found to decrease effectively in group A when compared to group B. The independent 't' test the 't' value is 2.184. This 't' value greater than the one tail table value 2.048 with 28 degrees of freedom at p=0.05 respectively. Hence we can reject the null hypothesis and accept the alternative hypothesis. Therefore treatment given in group A reduces pain effectively than treatment given in group B.

The functional improvement of knee also found to increase effectively in group A when compared to group B. In functional improvement the independent 't' test the 't' value is 2.335. This 't' value greater than the one tail table value 2.048 with 28 degrees of freedom at p=0.05 respectively. Therefore treatment given in group A increases functional improvement of knee effectively than treatment given in group B.

Hence we can reject the null hypothesis and accept the alternate hypothesis.

## LIMITATIONS AND RECOMMENDATION

- ✓ The study was a short term study.
- ✓ The study has a small sample size.
- ✓ Functional performance can be measured using variety of scales such as lower extremity functional scale (LEFS), functional index questionnaire and modified functional index questionnaire.
- ✓ Similar study can be performed using patients gait pattern.
- ✓ Quadriceps strengthening can be measuring using EMG studies.
- ✓ Multiple groups can be included for the study.
- ✓ studies aimed to find out the outcome of closed kinetic chain exercises with other treatment such as cross friction massage, quadriceps retraining, ultrasound therapy, patellar mobilizations, patellar taping can be conducted for further research.

# VII. CONCLUSION

The literature review and statistical analysis done from the data collected from the study have shown that the closed kinetic chain exercises helps in early pain relief and improves functional activities effectively in patellofemoral pain syndrome when compared to the open kinetic chain exercises.

Hence the alternate hypothesis of this study is accepted and stated as **"There is a significant difference between the closed kinetic chain exercises than open kinetic chain exercises in reducing pain and improves functional activities of lower limb in patients with unilateral patellofemoral pain syndrome."**

When compared closed kinetic chain exercises are more effective than open kinetic chain exercises in patients with unilateral patellofemoral pain syndrome.

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# APPENDICES

## APPENDIX - I

## ASSESSMENT CHART

## SUBJECTIVE ASSESSMENT

Name :

Age :

Sex :

Occupation :

Address :

IP/ OP Number :

Date of evaluation :

Chief complaints

## HISTORY

Past medical history :

Present medical history :

Onset :

Duration :

Surgical history :

Drug history :

Personal history :

## ASSOCIATED PROBLEMS

### Vital signs

Temperature :

Pulse rate :

Respiratory rate :

Blood pressure :

## PAIN ASSESSMENT

Side : left / right

Site :

Type of pain :

Duration of pain :

Aggravating factors :

Relieving factors :

Grading of pain :

## VISUAL ANALOGUE SCALE (VAS)

**OBJECTIVE ASSESSMENT**

**ON OBSERVATION**

Built :

Posture :

Postural changes :

Swelling :

Muscle wasting :

Deformity :

Gait :

External appliances :

Walking aids :

**ON PALPATION**

Tenderness :

Warmth :

Trophical changes :

Swelling :

Crepitation :

Synovial thicking :

Edema : pitting/non-pitting

**ON EXAMINATION**

**Motor Evaluation**

**Range of Motion**

| JOINT | MOVEMENT | RANGE OF MOTION |
|---|---|---|
| Hip | Flexion<br>Extension<br>Abduction<br>Adduction<br>Medial rotation<br>lateral rotation | |
| Knee | Flexion<br>Extension | |
| Ankle | Dorsiflexion<br>Plantar flexion | |

**Muscle power**

| Muscle Power | | LEFT | | RIGHT | |
|---|---|---|---|---|---|
| **HIP** | Flexors<br>Extensors<br>Abductors<br>Adductors<br>Internal rotators<br>Internal Rotators | | | | |
| **KNEE** | Flexors<br>Extensors | | | | |
| **ANKLE** | Plantar flexors<br>Dorsi flexors'<br>Eveators<br>Invertors | | | | |

**MUSCLE GIRTH MEASUREMENT (in Cm)**

| Muscle | Right | Left |
|---|---|---|
| Thigh | | |
| Calf | | |

**Kujala knee questionnaire**

Walking

Squatting

Kneeling

Stair climbing

**Flexibility**

Hamstrings :

Quadriceps :

Calf muscle

**Gait**

Type of gait :

Walking Aids/ External appliances :

Step Length :

Stride length :

Cadence :

**SENSATIONS**

Superficial :

Deep :

**Functional Activities**

Walking :

Running :

Stair Climbing :

Squatting :

**Special Test**

Vastus medialis coordination test

Eccentric step test

**INVESTIGATION :**

**DIAGNOSIS** :

**PROBLEM LIST** :

**AIMS** :

**MANAGEMENT** :

**HOME PROGRAM** : Calf stretch, Squats, isometric quads, knee flexion, extension, abduction and adduction exercises

**APPENDIX II**

**FOLLOW UP CHART**

Name :

Age :

Sex :

Diagnosis :

| **Parameters** | **Baseline assessment** | **1st week** | **2nd week** | **3rd week** | **4th week** | **5th week** | **6th week** |
|---|---|---|---|---|---|---|---|
| VAS | | | | | | | |
| Knee flexion range | | | | | | | |
| Kujala knee questionnaire | | | | | | | |

**Treatment Plan : Group A/ Group B**

**APPENDIX III**

**SPECIAL TEST TO CONFIRM UNILATERAL PATELLOFEMORAL PAIN SYNDROME**

**1. Vastus Medialis Coordination test**

Position of the patient : Supine lying

Position of the therapist : Standing

Test : The patient lies supine while the examiner places a fist under the patient's knee.

The patient is asked to slowly extend the knee without pressing into the examinar's fist or lifting the leg away from the fist while trying to achieve full extension.

The test is considered positive if the patient cannot fully extend if the patient cannot fully extend the knee or has difficulty achieving full extension smoothly or tries to use the hip flexors or extensors to accomplish the task.

## 2. Eccentric step test

***Position of the patient*** *:* ***Standing***

Test : The patient stands on a 15 cm (6 inch) high step or stool while keeping the hand on the hips. The patient steps down, first leading with the injured legs ( this tests the good leg first) as slowly ad smoothly as he or she can .

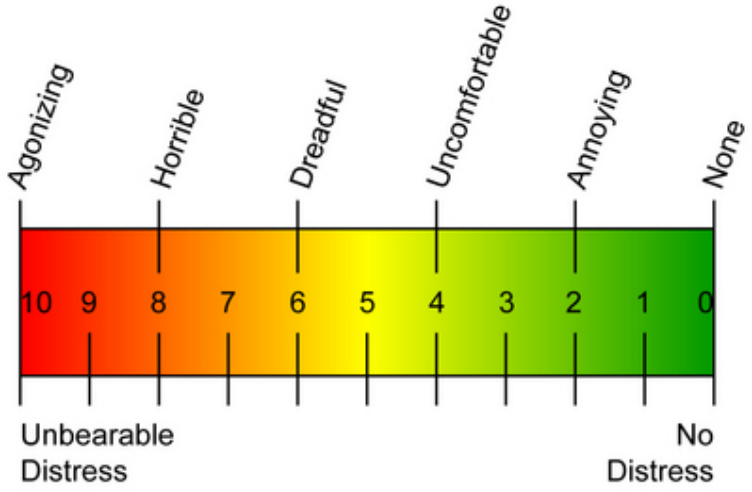
The test is considered positive if pain is felt by the patient during the test.

## APPENDIX - IV

## VISUAL ANALOGUE SCALE:

The visual analogue scale used to determine the severity of pain experienced by the patients.

It is used to quantify the nature of pain. It attempts to represent measurement quantities in terms of straight line placed horizontally or vertically on a paper. The end points on the line are labeled descriptive terms of anchor the extremities of the scale commonly the line are 10cm in length.




*Task* _____

*Date* _____ *Start* _____ *End* _____

**APPENDIX - V**

Functional assessment tool for patellofemoral joint disorders (from kujala et al, with permission from the arthroscopy Association of North America)

ANTERIOR KNEE PAIN (Sheet code: _____)

Name: _____Date: _____

Age: _____

Knee: L/R

Duration of symptoms: _____ years _____ months

For each question, circle the latest choice (letter), which corresponds to your knee symptoms.

**1. Limp**

(a) None (5)

(b) Slight or periodical (3)

(c) Constant (0)

**2. Support**

(a) Full support without pain (5)

(b) Painful (3)

(c) Weight bearing impossible (0)

**3. Walking**

(a) Unlimited (5)

(b) More than 2 km (3)

(c) 1-2 km (2)

(d) Unable (0)

**4. Stairs**

(a) No difficulty (10)

(b) Slight pain when descending (8)

(c) Pain both when descending and ascending (5)

(d) Unable (0)

**5. Squatting**

(a) No difficulty (5)

(b) Repeated squatting painful (4)

(c) Painful each time (3)

(d) Possible with partial weight bearing (2)

(e) Unable (0)

**6. Running**

(a) No difficulty (10)

(b) Pain after more than 2 km (8)

(c) Slight pain from start (6)

(d) Severe pain (3)

(e) Unable (0)

**7. Jumping**

(a) No difficulty (10)

(b) Slight difficulty (7)

(c) Constant pain (2)

(d) Unable (0)

**8. Prolonged sitting with the knees flexed**

(a) No difficulty (10)

(b) Pain after exercise (8)

(c) Constant pain (6)

(d) Pain forces to extend knees temporarily (4)

(e) Unable (0)

**9. Pain**

(a) None (10)

(b) Slight and occasional (8)

(c) Interferes with sleep (6)

(d) Occasionally severe (3)

(e) Constant and severe (0)

**10. Swelling**

(a) None (10)

(b) After severe exertion (8)

(c) After daily activities (6)

(d) Every evening (4)

(e) Constant (0)

**11. Abnormal painful kneecap (patellar) movements (subluxations)**

(a) None (10)

(b) Occasionally in sports activities (6)

(c) Occasionally in daily activities (4)

(d) At least one documented dislocation (2)

(e) More than two dislocations (0)

**12. Atrophy of thigh**

(a) None (5)

(b) Slight (3)

(c) Severe (0)

**13. Flexion deficiency**

(a) None (5)

(b) Slight (3)

(c) Severe (o)

Reference: Kujala UM, Jaakkola LH, Koskinen SK, Taimela S, Hurme M, Nelimarkka O: **Scoring of patellofemoraldisorders.** *Arthroscopy* 1993, **9:**159-163.