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Effectiveness of Muscle Energy Technique in Fixed Flexion Deformity after Post ACL Surgery a Single Case Study

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Abstract:

Background: Anterior Cruciate Ligament (ACL) injury and reconstruction are common in active individuals. Postoperative complications such as fixed flexion deformity (FFD) often occur due to arthrofibrosis, posterior capsule tightness, or quadriceps inhibition. Loss of full knee extension negatively impacts gait, increases energy expenditure, and predisposes to early osteoarthritis.

Objective: To assess the effectiveness of Muscle Energy Technique in improving hamstring flexibility and reducing knee flexion contracture after ACL surgery. To evaluate the role of VMO strengthening in restoring knee extension and quadriceps control. To measure improvement in extension range, pain reduction, and function outcome following the combined 6-week intervention.

Methodology: This study was done on people aged 18–40 years who had ACL surgery and developed a fixed flexion deformity (FFD) between 5°–15°, about 4–8 weeks after surgery. Those with meniscus repair limits, re-injury, infection, or nerve problems were not included. The treatment lasted six weeks and used Muscle Energy Technique (MET) for the hamstrings and VMO strengthening exercises. Patients also received cryotherapy, stretching, and patellar mobilization as supportive therapy. Improvement was checked using a goniometer for knee movement, VAS for pain, and MMT for muscle strength.

Results: After six weeks of treatment, the patients showed clear improvement in their knee movement and overall function. The ability to straighten the knee increased by about 8° to 12°, showing better knee extension. Pain levels reduced from about 9 out of 10 before treatment to around 1 or 2 out of 10 after treatment. The strength of the quadriceps muscles also improved by at least one grade on the manual muscle test, showing better control and activation.

Conclusion: The six-week program using Muscle Energy Technique (MET) and VMO strengthening was effective in improving knee extension, reducing pain, and increasing quadriceps strength in patients with fixed flexion deformity after ACL reconstruction. MET helped release hamstring tightness, while VMO exercises improved knee control and stability. Early use of these techniques can prevent long-term extension problems and promote better functional recovery after surgery.

Keywords: Anterior Cruciate Ligament Reconstruction, Fixed Flexion Deformity (FFD) Muscle Energy Technique, (MET), VMO Strengthening

INTRODUCTION:

The Anterior Cruciate Ligament (ACL) is one of the four major ligaments of the knee joint. It connects the femur (thigh bone) to the tibia (shin bone) and plays a vital role in stabilizing the knee during movement. The Anterior Cruciate Ligament (ACL) is a band of dense connective tissue that connects the femur and

the tibia. (1) It is enveloped into the synovial membrane of the human knee joint, which by definition places the ligament intra articular but extra-synovial. The ligament originates at the medial side of the lateral femoral condyle and runs an oblique course through the intercondylar fossa distal-anterior-medial to the insertion at the medial tibial eminence. Due to its orientation within the knee joint, the ACL has (2) The ACL consists of soft connective tissues. The collagen fibrils are surrounded by connective tissue, which forms multiple fascicles within the A. The major collagen of the ACL is type I collagen whereas the loose connective tissue consists of type III collagen. (3)

The Anterior Cruciate Ligament (ACL) plays a crucial role in maintaining the mechanical stability of the knee joint. It primarily functions to prevent the forward (anterior) translation of the tibia relative to the femur, ensuring smooth and controlled knee movements during walking, running, or jumping. Along with this, the ACL provides rotational stability, particularly during twisting or pivoting motions that occur in sports such as football, basketball, and skiing. (4) This rotational control is vital for coordinated movements that involve sudden changes in direction. Works in close coordination with the Posterior Cruciate Ligament (PCL) to maintain overall knee joint stability, especially during dynamic weight-bearing activities. Additionally, the contains specialized sensory nerve endings known as mechanoreceptors, which contribute to proprioception the body's ability to sense joint position and movement. This proprioceptive feedback is essential for maintaining balance, coordination, and neuromuscular control of the lower limb. (5)

When the ACL is injured, patients often experience a sudden pop sound at the moment of trauma, indicating ligament rupture. This is immediately followed by sharp pain and rapid swelling caused by bleeding within the joint hem arthrosis. The individual typically reports a feeling of the knee giving way or collapsing during weight-bearing, reflecting the loss of ligamentous stability. This instability often makes it difficult to continue activity or even walk normally. In addition, there is usually a limited range of motion, particularly in knee extension, due to swelling, pain, and reflex muscle inhibition.(6) These symptoms not only indicate the mechanical disruption of the ligament but also the functional impairment of the knee's proprioceptive system, which together contribute to the sensation of instability and weakness that persists after injury.

ACL injuries are likely to happen during deceleration and acceleration motions with excessive quadriceps contraction and reduced hamstrings co-contraction at or near full knee extension. Higher loading during the application of a quadriceps force when combined with a knee internal rotation moment compared with an external rotation moment was noted. (7) The ACL loading was also higher when a valgus load was combined with internal rotation as compared with external rotation. However, because the combination of knee valgus and external rotation motions may lead to impingement, these combined motions cannot be excluded from the noncontact ACL injury mechanisms. Further, excessive valgus knee loads applied during weight-bearing, decelerating activities also increased loading. (8)

Most of the injuries were sustained at foot strike with the knee close to full extension. Noncontact mechanisms were classified as sudden deceleration prior to a change of direction or landing motion, while contact injuries occurred as a result of valgus collapse of the knee. Hamstring flexibility parameters revealed a statistically higher level of laxity in the injures (9)

Graft shearing may occur as a result of impingement between the distal portion of the graft and the anteroinferior portion of the intercondylar notch, which may become trapped between the femur and tibia, particularly during complete knee extension... Ultimately it may rupture (10) The most common cause of impingement is incorrect positioning of the tibial fixation tunnel, too anteriorly, in front of the intersection of Blumensaat's are not due to the tibia being too anterior overall because of postoperative thickening of the posterior capsule which may cause anterior tibial translation (11) One of the most common complications of ligament plasty is arthrofibrosis, which involves the development of fibrous scar tissue within and around the synovium in at least one compartment of the joint. This may also develop diffusely (12) Long-term complications include knee instability, early onset osteoarthritis, and donor-site morbidity, which may contribute to persistent functional limitations even after apparently successful reconstruction. Proper postoperative physiotherapy, early mobilization, and adherence to rehabilitation protocols are crucial in minimizing these complications and promoting optimal recovery (13)

After ACL reconstruction surgery, one of the complications can be a fixed flexion deformity (FFD) Knee extension loss inability to fully straighten the knee is a well-documented of the knee complication following ACL reconstruction. A systematic review noted that "loss of the ability to fully straighten the knee is a potential complication of rupture and treatment in both conservative and surgical settings. (14) In particular, one study found that when rigid anatomic hamstring grafts were fixed with the knee in flexion, a mean flexion deformity of 10.9° resulted; conversely, when the graft was fixed with the

knee fully extended, full extension was reliably restored. (15) Loss of extension, even a few degrees, has meaningful functional consequences: impairments in gait, increased energy cost, quadriceps overload, and predisposition to early osteoarthritis. Given the importance of full knee extension for function, mobility and long-term joint health, interventions to restore extension range are critical components of rehabilitation after ACL reconstruction. (16)

Fixed flexion deformity (FFD, sometimes called flexion contracture) refers to the condition in which the knee cannot fully extend, remaining in a flexed posture even at rest. While many studies of come from total knee arthroplasty literature, the underlying mechanisms—such as posterior capsule tightening, soft-tissue contracture, arthrofibrosis, muscular inhibition—are relevant to the post-ACL setting. (17) In the ACL reconstruction context, extension loss may arise from multiple causes: graft impingement/tensioning error (as shown above), intra-articular scar formation, posterior capsular contracture, arthrogenic muscle inhibition (AMI) of the quadriceps, hamstring over-activity, or simply neglect of terminal extension in early rehab. Accordingly, the rehabilitation strategy must address not just strength and flexion but specifically terminal extension motion. One manual-therapy adjunct used in other joint-stiffness scenarios is MET, which may be applied to knee extension deficits. (18)

Muscle Energy Technique is a manual therapy method originally developed in osteopathic practice, now used widely by manual therapists and physiotherapists. In MET the patient actively contracts a muscle (or muscle group) against an isometric or near-isometric resistance provided by the therapist, followed by a period of relaxation and then a passive stretch of the target muscle or group. The cycle may be repeated several times. (19) One commonly used subtype is post-isometric relaxation. For example, a muscle is brought to the barrier of motion, then isometrically contracted at ~20-50% effort for ~5-10 seconds, followed by a brief relaxation and then passive stretching to a new barrier. The claim is that this yields improved muscle length (flexibility), improved joint range of motion, and reduced soft-tissue stiffness (20) During treatment, the therapist positions the affected joint or muscle near its restriction barrier and instructs the patient to perform an isometric contraction for several seconds, followed by relaxation and a gentle passive stretch. This process is repeated several times to progressively restore mobility and function. MET is considered safe, non-invasive, and effective in addressing conditions such as restricted joint movement, muscle shortening, and postural imbalance (21)

AIM: The aim of this study is effectiveness of muscle energy technique among individuals with fixed flexion deformity

METHODOLOGY

This study was done on people aged 18–40 years who had ACL surgery and developed a fixed flexion deformity (FFD) between 5°–15°, about 4–8 weeks after surgery. Those with meniscus repair limits, re-injury, infection, or nerve problems were not included. The treatment lasted six weeks and used Muscle Energy Technique (MET) for the hamstrings and VMO strengthening exercises. Patients also received cryo therapy, stretching, and patellar mobilization as supportive therapy. Improvement was checked using a goniometry for knee movement, VAS for pain, and MMT for muscle strength.

STUDY DESIGN

The study was conducted in the outpatient physiotherapy department. All treatments and assessments were done in the rehabilitation area under the supervision of qualified physiotherapist. Basic clinic equipment such as a goniometry, VAS scale, and cry therapy unit were used. All participants gave their consent before starting the study, and ethical approval was obtained.

SAMPLE SIZE

Sample size = 1.

Inclusion Criteria:

1. Age 18–50 years
2. Prior primary ACL reconstruction auto graft or allograft on the affected knee..
3. Persistent fixed deformity clinical fixed-flexion deformity or loss of full extension defined as loss of terminal extension $\geq 5-10^\circ$ or flexion $\leq 90^\circ$ despite standard physiotherapy for at least 4–6 weeks post-op.
4. Time from index ACL surgery: ≥ 6 weeks and ≤ 12 months (sub-acute to chronic but before late degenerative change) reported within the first

Exclusion criteria

1. Infection (wound infection, septic arthritis) or ongoing systemic infection.
2. open wounds
3. Acute deep vein thrombosis (DVT)
4. Prior manipulation under anesthesia (MUA) or arthroscopic/open lysis of adhesions for the same index surgery unless you plan to study those subgroups separately.
5. Gross knee instability or confirmed graft failure on exam/imaging. reconstruction; instability needs different management.
6. Significant concomitant articular cartilage defects or advanced osteoarthritis in the affected knee.
7. Multi ligament injuries requiring major additional reconstruction
8. Previous ACL reconstruction (revision surgery)
9. Osteoarthritis
10. acute inflammation,

CASE REPORT

Name: xyz

Age/Sex: 35 / male

Occupation:

Date of Assessment:

Diagnosis: Post-ACL Reconstruction with Fixed Flexion Deformity (FFD)

Chief Complaint:

Difficulty in fully straightening the knee. Pain and stiffness around the knee joint.
Discomfort during walking, squatting, or climbing stairs.

History of Present Illness:

Onset: gradual/after surgery.

Duration: weeks/months post-surgery.

Nature of pain: dull/aching/pulling pain at the back of the knee.

Aggravating factors: walking, prolonged standing,

Relieving factors: rest, ice, or medication.

Associated symptoms: feeling of tightness in hamstrings, weakness in quadriceps.

History of Surgery:

Type of graft: hamstring/patellar tendon graft.

Post-op rehabilitation followed: yes/no.

Complications: stiffness, swelling, or delayed mobilization.

Past Medical and Surgical History:

Any previous knee surgery, trauma, or infection.

Any systemic illness (Diabetes, DVT, etc.).

Personal History:

Activity level before injury (sports, occupation).

Sleep, appetite, bowel/bladder habits.

Observation:

Posture of limb: knee held in slight flexion.

Swelling or muscle wasting (especially quadriceps).

Surgical scar: healed / hypertrophic

Gait pattern: limping / short stride / incomplete knee extension.

Palpation:

Temperature: normal / raised.

Tenderness: posterior knee / patellar tendon / joint line.

Muscle tone: hamstring tightness / quadriceps inhibition.

RANGE OF MOTION	NORMAL	EFFECTED SIDE	UNAFFECTED SIDE	END FEEL
KNEE FLEXION	0-135	0-120	130	FIRM
KNEE EXTENSION	0	-15	0	HARD

Muscle group	Affected side	Unaffected side
quadriceps	3/5	4/5
Hamstrings	3/5	4/5
Gluteus maximus	4/5	4/5
Gastrocnemius	4/5	4/5

Muscle Length Tests:

Hamstring flexibility test: tight

Rectus femoris test (Ely's test): limited.

Special Tests:

Anterior Drawer Test / Lachman Test: for ACL integrity.

Patellar mobility test: reduced.

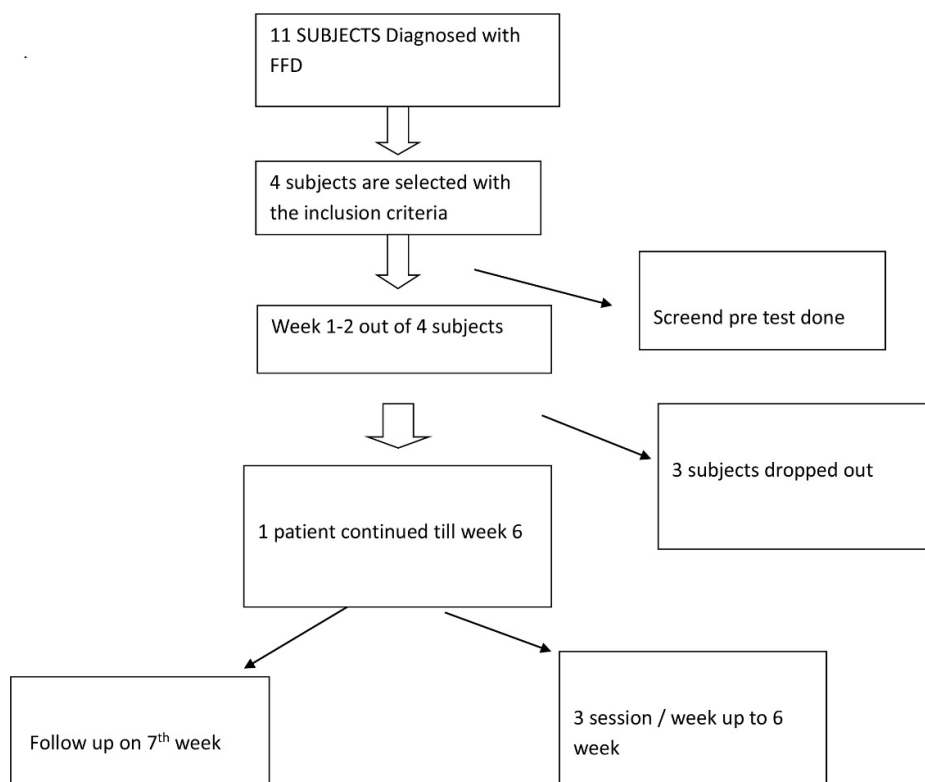
Posterior capsule tightness test: positive.

Outcome Measures

Visual Ana log Scale (VAS): for pain.

Goniometer: for knee extension angle (FFD).

Manual Muscle Testing (MMT): for quadriceps and hamstrings



Week	Intervention	Description	Frequency	Duration / Hold
Week 1	Muscle Energy Technique (Hamstring – Post Isometric Relaxation)	Therapist applies gentle isometric contraction of hamstrings, followed by passive stretch to improve knee extension.	3 reps/session 3 session per week	30 sec hold
Week 2	MET + VMO Activation (Static Quadriceps)	Isometric contraction of quadriceps, focusing on VMO activation with knee supported.	3reps/session 3session per week	30 sec hold
Week 3	MET + Straight Leg Raise (SLR)	MET for hamstrings followed by SLR to activate quadriceps/VMO.	3 reps / session 3 session per week	30 sec hold
Week 4	MET + VMO Strengthening (Terminal Knee Extension)	Resistance band TKE exercise focusing on VMO contraction.	3 reps / session	30 sec hold
Week 5	MET + Functional VMO Strengthening (Mini Squats, Step-ups)	Add closed-chain strengthening for VMO under therapist guidance.	3 reps / session 3 session per week	30 sec hold
Week 6	MET Maintenance + VMO Endurance (Wall Sits, TKE hold)	Combined MET with endurance training of VMO to stabilize knee in full extension.	3reps/session3 session per week	30 sec hold

Treatment procedure

The treatment program lasted for six weeks and included Muscle Energy Technique (MET) and Vastus Medialis Oblique (VMO) strengthening exercises. MET was used to relax and stretch the tight hamstring muscles that were restricting knee extension. During MET, the patient bent the knee slightly and gently pushed against the therapist's resistance for 5–8 seconds, then relaxed. After each relaxation, the therapist stretched the muscle a little further. This was repeated three times in each session, three times a week. Along with MET, VMO strengthening exercises were done to improve knee extension and quadriceps control. These exercises included static quadriceps contractions, straight leg raises, terminal knee extensions, and mini-squats. Each exercise was performed for 3 sets with a 30-second hold, three times per week. Supportive treatments such as cryotherapy (ice application), patellar mobilization, and gentle stretching were also used to reduce pain and swelling. Progress was measured weekly using a goniometry for knee extension range, a visual analog scale (VAS) for pain, and manual muscle testing (MMT) for quadriceps strength



Figure 1
Performing met
technique performing on



Figure 2
straight leg raise

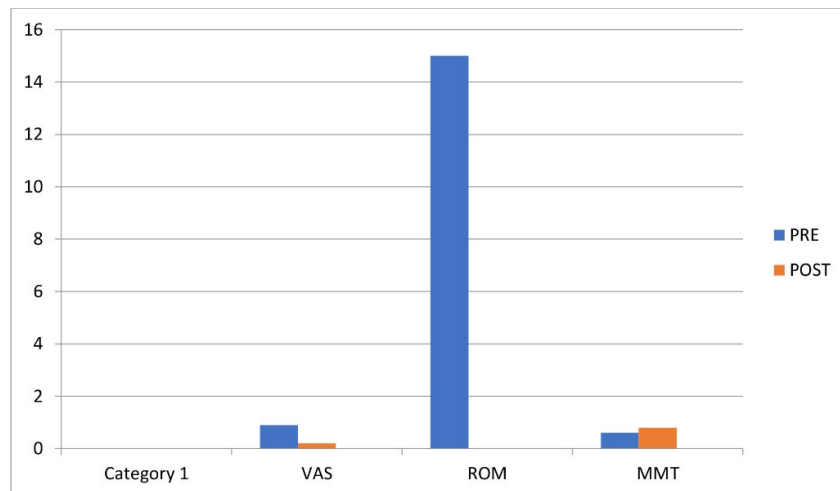
Quadriceps muscle



Figure 3
Terminal knee of extension

RESULTS

CATERAGORY	PRE	POST
VAS	9/10	1/10
ROM	-15	0
MMT	3/5	4/5



The graph show a comparison of pre- post treatment values for vas, rom, and mmt

* Vas reduced significantly from 9/10 to 1/10 indicating major reduction in pain

* Range of motion improved from -15 to flexion deformity to 0 showing complete correction of extension lag

* Muscle strength increased 3/5 to 4/5 indicating improvement in quadriceps strength

CONCLUSION

The six-week program using Muscle Energy Technique (MET) and VMO strengthening was effective in improving knee extension, reducing pain, and increasing quadriceps strength in patients with fixed flexion deformity after ACL reconstruction. MET helped release hamstring tightness, while VMO exercises improved knee control and stability. Early use of these techniques can prevent long-term extension problems and promote better functional recovery after surgery.

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