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EFFECT OF BRIME PROTOCOL ON PAIN AND QUADRICEPS STRENGTHENING IN SUBJECTS WITH ANTERIOR KNEE PAIN OR PATELLOFEMORAL PAIN SYNDROME: AN EXPERIMENTAL STUDY

Physiotherapy

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ABSTRACT

Background: Patellofemoral pain syndrome (PFPS) is a widespread musculoskeletal condition causing anterior knee pain that impairs function, especially in adolescents and physically active adults. **Aim:** This study aimed to evaluate the effectiveness of the Brief Repetitive Isometric Muscle Exercise (BRIME) protocol combined with ultrasound therapy in improving pain, knee range of motion, and quadriceps strength in adults with PFPS. **Methodology:** Twenty-four participants diagnosed with PFPS underwent a three-week intervention with daily BRIME protocol exercises targeting isometric quadriceps contractions (emphasizing the vastus medialis obliquus) alongside ultrasound therapy. Pain (Numerical Pain Rating Scale), knee range of motion (goniometry), and quadriceps strength (Manual Muscle Testing) were assessed pre- and post-intervention. **Results:** Significant improvements were observed, including reductions in pain scores (from 7.16 ± 1.12 to 3.25 ± 0.98), increased knee range of motion (active ROM from $111.15° \pm 8.20$ to $116.92° \pm 6.62$; painful ROM from $113.54° \pm 10.68$ to $126.87° \pm 7.19$), and enhanced quadriceps strength (MMT from 3.64 ± 0.49 to 4.94 ± 0.24) (all with $p < 0.05$). **Conclusions:** The BRIME protocol combined with ultrasound therapy is an effective, safe, and cost-effective early rehabilitation strategy for PFPS, yielding meaningful improvements in pain, mobility, and muscle strength.

KEYWORDS

Patellofemoral pain syndrome, Anterior knee pain, BRIME protocol

INTRODUCTION:

Patellofemoral pain (PFP) is a common musculoskeletal condition characterized by diffuse anterior knee pain, commonly localized to the retro-patellar and peripatellar regions. It results from multiple biomechanical and physical factors that alter patellofemoral joint loading [1]. Pain is typically provoked by stair climbing, squatting, running, or prolonged sitting with flexed knees [2], causing functional limitations and reduced quality of life, particularly in adolescents and physically active individuals.

The annual prevalence of PFP is 22.7% in the general population and 28.9% in adolescents [3], with females having a 2.23-fold higher risk [4–6]. PFPS accounts for 11–17% of knee complaints in primary care and 25–40% in athletes, with a female-to-male ratio of 2:1 [7,8]. It commonly results from repetitive knee flexion and overuse, leading to irritation of the patellar articular surface and activity-related pain [9].

The aetiology of PFPS is multifactorial, involving patellar mal-tracking, cartilage degeneration, altered patellar contact mechanics, malalignment, quadriceps weakness (especially of the vastus medialis obliquus [VMO]), soft tissue tightness, and delayed VMO activation [10-13].

Patients often present with anterior knee pain, swelling, crepitus, instability, and reduced function [14]. Diagnosis is primarily clinical, using patellar compression, tilt, apprehension, grind, and functional squat tests, along with Q-angle measurement, and the J-sign [15,16]. Imaging is used mainly to exclude structural abnormalities in refractory cases [17].

Management of PFPS is multidisciplinary, including medical, surgical, and physiotherapeutic approaches. NSAIDs are used for pain control, with surgical options such as lateral release or patellar realignment reserved for cases unresponsive to conservative care [18-20]. Physiotherapy is the cornerstone of treatment, focusing on hip and knee strengthening [1, 20], patellar mobilization, IT band stretching, soft tissue techniques, taping, bracing, orthoses [21], biofeedback, neuromuscular stimulation [13 ,22], and pain-relieving modalities like ultrasound, TENS, and cryotherapy [23].

The VMO plays a critical role in stabilizing the patella and preventing lateral displacement. Weakness or imbalance between the VMO and vastus lateralis increases joint stress, leading to cartilage degeneration. VMO strengthening is therefore a key rehabilitation strategy, shown to reduce pain, improve patellar alignment, and enhance quadriceps function [24-28].

Gerber and Hicks introduced the Brief Isometric Exercise (BRIME) protocol, consisting of one to six isometric contractions held for 3–6 seconds with 20-second rest intervals. This approach maintains or slightly improves quadriceps strength during periods of knee inflammation and restricted mobility. However, clinical evidence for its effectiveness in PFPS is limited, and further research is needed to establish its effectiveness as an early rehabilitation strategy for reducing pain and strengthening the quadriceps.

AIM:

This study aimed to evaluate the effectiveness of the BRIME protocol on pain, range of motion, and quadriceps strength in individuals with anterior knee pain or patellofemoral pain syndrome.

OBJECTIVES:

1. To analyze the effect of the BRIME protocol on pain, measured by the Numerical Pain Rating Scale (NPRS), in subjects with anterior knee pain.
2. To analyze the effect of the BRIME protocol on knee range of motion, measured by the goniometry, in subjects with anterior knee pain.
3. To analyze the effect of the BRIME protocol on quadriceps strength, assessed using Manual Muscle Testing (MMT), in subjects with anterior knee pain

MATERIALS AND METHODS:

Materials Used:

- Treatment couch and plinth
- Weight cuffs
- Ultrasound therapy machine
- Universal goniometer
- Stopwatch

Methodology:
- **Study Design:** Pre- and post-experimental study
- **Sample Size:** 24 participants
- **Study Duration:** 3 weeks
- **Study Setting:** College of Physiotherapy, SVIMS University, and BIRRD Hospital, Tirupati

Inclusion Criteria:
- Individuals diagnosed with anterior knee pain or patellofemoral pain syndrome
- Aged between 21 and 50 years
- Willing to participate and provide informed consent

Exclusion Criteria:
- Previous fractures of the lower limb
- Corticosteroid injections in the past year
- History of stroke or neurological disorders
- Limb length discrepancy
- Sciatica or foot drop
- Varicose veins
- Diagnosed heart disease
- Gait abnormalities
- Rheumatoid arthritis or osteoarthritis

Outcome Measures:
1. Pain intensity – measured the Numerical Pain Rating Scale (NPRS)
2. Knee range of motion (ROM) – measured with a goniometer
3. Quadriceps muscle strength – assessed using Manual Muscle Testing (MMT)

Procedure:
The condition was diagnosed by an orthopaedician, and participants were included in the study based on the inclusion and exclusion criteria.

Baseline Assessment (Day 1):
1. Pain – Numerical Pain Rating Scale (NPRS)
2. Knee Range of Motion (ROM) – Goniometry
3. Quadriceps Strength – Manual Muscle Testing (MMT)

These outcome measures were reassessed after 3 weeks
Intervention: BRIME PROTOCOL + ULTRASOUND THERAPY
Participants underwent the BRIME protocol combined with ultrasound therapy for a duration of 3 weeks.

1. BRIME Protocol (Brief Repetitive Isometric Muscle Exercise):
Position: Seated or supine with the knee in 0° to 30° of flexion (targeting VMO activation)

Contraction: Isometric quadriceps contraction, especially activating the VMO

Resistance: An ankle weight cuff was applied to provide an external load during isometric contractions, thereby enhancing muscle recruitment and strength.

Hold Time: 3 to 6 seconds per contraction

Repetitions: 1 to 6 contractions per set

Rest Interval: 20 seconds between contractions

Frequency: Daily sessions under the supervision of a physiotherapist

Progression: Based on patient tolerance-gradual increase in contraction duration and repetitions

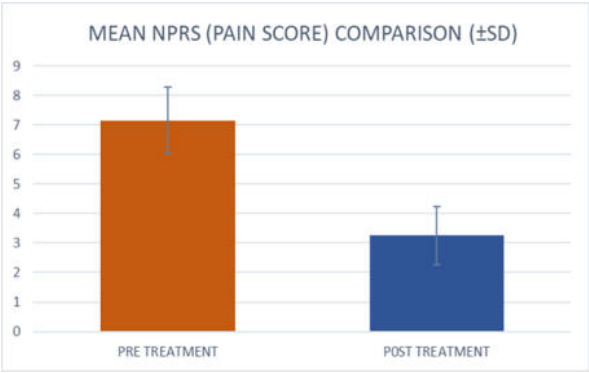
2. Ultrasound Therapy (US): Ultrasound therapy was administered in continuous mode with a frequency of 1 MHz and an intensity of 1.5 W/cm² for a duration of 8 minutes. The treatment was applied around the patellar tendon and the anterior knee region, using circular movements with a coupling medium to ensure effective transmission of ultrasonic waves.

Statistical Analysis:
The data were analyzed using SPSS software, version 29.2.

Table 1: Pre And Post Treatment Values Of Pain Intensity Measured By NPRS With The BRIME Protocol In Patients With Anterior Knee Pain

NPRS	Mean	SD	t-value	p-value
Pre treatment	7.16	1.12	-15.820	< 0.05
Post treatment	3.25	0.98		

Table 1 presents the pre- and post-treatment NPRS values, where the mean ± SD pain score decreased from 7.16 ± 1.12 (pre-treatment) to 3.25 ± 0.98 (post-treatment). This reduction was statistically significant ($t = -15.820$, $p < 0.05$), indicating that the BRIME protocol was effective in alleviating anterior knee pain.

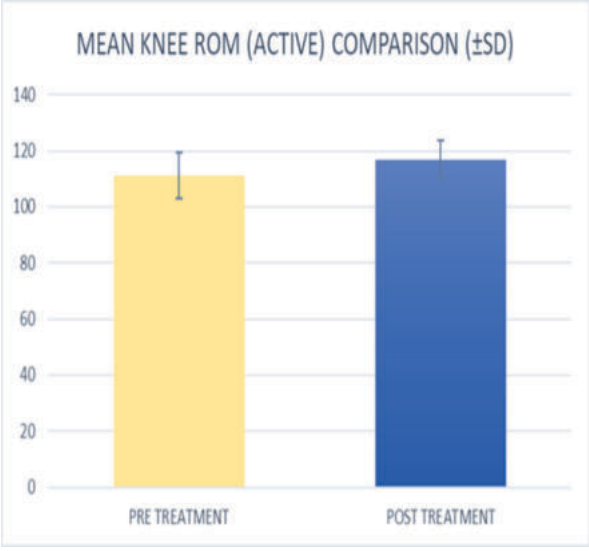


Graph 1: Graph 1 represents the values of Table 2, demonstrating a significant reduction in mean NPRS scores from pre- to post-treatment following the BRIME protocol.

Table 2: Pre And Post Treatment Values Of Active Knee Range Of Motion With The BRIME Protocol In Patients With Anterior Knee Pain

Knee ROM-active	Mean	SD	t-value	p-value
Pre treatment	111.15	8.20	6.040	< 0.05
Post treatment	116.92	6.62		

As shown in Table 2, the active knee ROM increased from a pre-treatment mean ± SD of 111.15° ± 8.20 to 116.92° ± 6.62 post-treatment. This improvement was statistically significant ($t = 6.040$, $p < 0.05$), demonstrating enhanced functional knee mobility following the intervention.



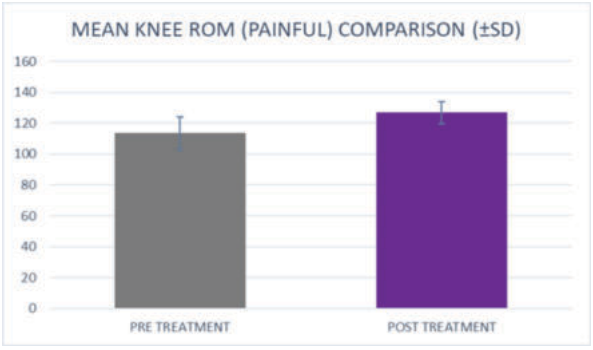
Graph 2: Graph 2 depicts the data from Table 3, highlighting increased knee ROM after BRIME protocol treatment.

Table 3: Pre And Post Treatment Values Of Painful Knee Range Of Motion With The BRIME Protocol In Patients With Anterior Knee Pain

Knee ROM painful	Mean	SD	t-value	p-value
Pre treatment	113.54	10.68	9.305	<0.05
Post treatment	126.87	7.19		

Table 3 illustrates that the painful knee ROM improved from 113.54° ± 10.68 before treatment to 126.87° ± 7.19 after treatment. The change was statistically significant ($t = 9.305$, $p < 0.05$), indicating a marked

reduction in pain-induced movement limitation.

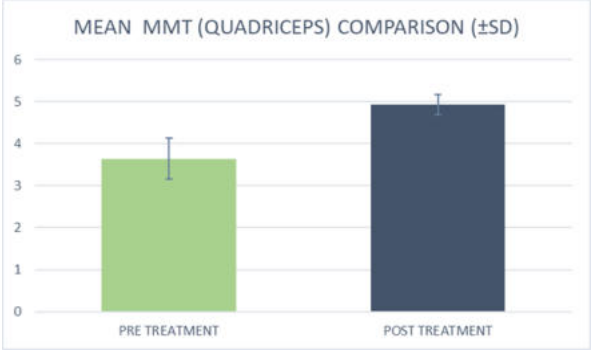


Graph 3: Graph 3 corresponds to Table 4 and demonstrates a significant improvement in painful knee ROM, reflecting reduced movement limitation after BRIME protocol treatment.

Table 4: Pre And Post Treatment Values Of Quadriceps Muscle Strength [MMT] With BRIME Protocol In Patients With Anterior Knee Pain

MMT- quadriceps	Mean	SD	t-value	p-value
Pre treatment	3.64	0.49	11.361	< 0.05
Post treatment	4.94	0.24		

Table 4 shows that quadriceps muscle strength improved from 3.64 ± 0.49 (pre-treatment) to 4.94 ± 0.24 (post-treatment). This difference was statistically significant ($t = 11.361$, $p < 0.05$), demonstrating that the BRIME protocol was effective in strengthening the quadriceps, particularly through targeted activation of the VMO.



Graph 4: Graph 4, derived from Table 5, presents the increase in quadriceps MMT values following intervention, indicating successful targeted strengthening through the BRIME protocol.

DISCUSSION:

The present study evaluated the effectiveness of the BRIME protocol in reducing pain, improving knee ROM, and enhancing quadriceps strength in patients with anterior knee pain or PFPS. Significant improvements were observed across all outcome measures, which are consistent with findings from previous literature.

Pain Reduction

Pain intensity decreased significantly after intervention, with NPRS scores reducing from 7.16 ± 1.12 (pre-treatment) to 3.25 ± 0.98 (post-treatment) ($t = –15.820$, $p < 0.05$). Isometric quadriceps contractions were known to reduce patellofemoral joint stress and activate descending inhibitory pathways, contributing to analgesic effects [24,25]. Additionally, ultrasound therapy may have enhanced blood circulation and reduced inflammation, thereby enhancing pain relief [23]. These mechanisms together explain the observed reduction in NPRS scores, aligning with prior evidence on physiotherapeutic management of PFPS [18,19].

Improvement in Range of Motion (ROM)

Enhanced active knee ROM was observed, with mean values improving from 111.15° ± 8.20 to 116.92° ± 6.62 ($t = 6.040$, $p < 0.05$). Painful knee ROM also showed a marked improvement from 113.54° ± 10.68 to 126.87° ± 7.19 ($t = 9.305$, $p < 0.05$). These may be attributed to decreased pain and better quadriceps activation, which reduce joint stiffness and improve functional mobility [1,21]. Prior studies have emphasized that improving VMO strength allows smoother patellar tracking, which decreases movement-related pain and enhances ROM [24-28]. Furthermore, the adjunct use of therapeutic modalities such as ultrasound has been shown to decrease peri-patellar tightness, facilitating improved flexibility [23].

Enhancement of Quadriceps Strength and Metabolic Activation

Quadriceps muscle strength improved significantly following the intervention, increasing from 3.64 ± 0.49 to 4.94 ± 0.24 on MMT ($t = 11.361$, $p < 0.05$). Repetitive isometric contractions were effective for recruiting muscle fibers, promoting muscle growth, and enhancing neuromuscular coordination [24-28]. Previous experimental studies on VMO strengthening have demonstrated similar benefits in improving patellar alignment and reducing PFPS symptoms [Tabassum Ali & Patra; Mikaili et al., 2024].

CONCLUSION:

This study concluded that the BRIME protocol, when combined with ultrasound therapy, was an effective early rehabilitation strategy for patients with patellofemoral pain syndrome. The intervention resulted in a significant reduction in pain, improvements in both active and painful knee ROM, and notable strengthening of the quadriceps, particularly the VMO. A three-week treatment duration was sufficient to achieve these clinically meaningful outcomes. Therefore, the BRIME protocol can be recommended as a simple, safe, and cost-effective approach for managing anterior knee pain and restoring functional performance in individuals with PFPS.

LIMITATIONS:

- The sample size for the study was relatively small (24 participants), which may reduce the generalizability of the findings to the broader population.
- The study duration was short (3 weeks), and therefore the long-term effects and sustainability of the BRIME protocol for patellofemoral pain syndrome were not assessed.
- The absence of a control group or randomization makes it difficult to attribute observed effects solely to the intervention and not to other variables or placebo effects.
- All participants received ultrasound therapy as an adjunct, so it is unclear how much of the improvement was due specifically to the BRIME protocol versus combined therapy.

FUTURE RECOMMENDATIONS:

- Conduct studies with a larger and more diverse sample to improve the robustness and generalizability of the results.
- Implement randomized controlled trials with appropriate control groups to clearly delineate the effects of the BRIME protocol alone and minimize bias.
- Assess long-term outcomes, including functional performance and quality of life, through extended follow-up after the intervention period.
- Explore the isolated effects of the BRIME protocol compared to other physiotherapeutic approaches by controlling or varying adjunct therapies like ultrasound in future research.
- Investigate the protocol's impact across different age groups, activity levels, and severity of patellofemoral pain to tailor recommendations for specific populations.

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