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Physiotherapy Management of Medial Meniscus Tear Using Ultrasound and Exercise Therapy to Improve Functional Ability

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ABSTRACT

Purpose of the study: This study aimed to determine the effectiveness of physiotherapy management using Ultrasound, Transcutaneous Electrical Nerve Stimulation, and Exercise Therapy in reducing pain, increasing muscle strength, improving physical activity, and enhancing functional ability in patients with medial meniscus tear knee sinistra.

Methodology: This study used a descriptive case study approach conducted at RSP Dr. Ario Wirawan Salatiga. The subject was one patient diagnosed with medial meniscus tear knee sinistra. Data collection techniques included observation, interview, and functional examination using Visual Analogue Scale (VAS), Manual Muscle Testing (MMT), and Knee Injury and Osteoarthritis Outcome Score (KOOS). Physiotherapy interventions included Ultrasound, Transcutaneous Electrical Nerve Stimulation, isometric exercise, and closed kinetic chain exercise.

Main Findings: The results showed decreased pain intensity after four therapy sessions, with silent pain decreasing from 1 to 0, tenderness from 4 to 1, and movement pain from 5 to 2 based on VAS measurements. Muscle strength improved from grade 4 to 5 using MMT assessment. Functional ability also increased significantly, indicated by KOOS scores improving from 79% to 94% following physiotherapy interventions.

Novelty/Originality of this study: This study integrates Ultrasound, Transcutaneous Electrical Nerve Stimulation, isometric exercise, and closed kinetic chain exercise in managing medial meniscus tear conditions. The study provides practical evidence regarding the combined effectiveness of electrotherapy and therapeutic exercise in improving pain reduction, muscle strength, and functional recovery among adolescent patients with knee meniscus injuries

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1. INTRODUCTION

Sports activities have become an essential part of modern lifestyles because they contribute significantly to physical fitness, health maintenance, and psychological well-being. Physical activity performed regularly can improve cardiovascular endurance, muscle strength, flexibility, and overall body function [1]-[3]. Among various sports activities, running has become increasingly popular, especially among adolescents and young adults. The growing interest in running activities is supported by the increasing number of sporting events, recreational

competitions, and public awareness regarding healthy lifestyles. However, intensive physical activities, repetitive movement patterns, and improper exercise techniques may increase the risk of musculoskeletal injuries, particularly injuries involving the knee joint [4], [5]. The knee joint plays an important role in supporting body weight and facilitating movement activities, making it highly vulnerable to injury during sports activities and excessive physical movement.

Knee injuries are among the most common musculoskeletal disorders experienced by athletes and physically active individuals. One of the most frequent knee injuries is meniscus tear, which refers to damage or rupture of the fibrocartilage structure functioning as a shock absorber within the knee joint [6], [7]. The meniscus serves essential biomechanical functions, including load distribution, joint stabilization, lubrication, and impact absorption during movement. Damage to the meniscus can significantly interfere with knee joint stability and functional mobility. Meniscus tears may occur due to traumatic mechanisms such as sudden twisting movements, excessive rotational forces, jumping activities, or sports collisions. In addition, degenerative factors associated with aging and repetitive stress may also contribute to meniscal injury development. Consequently, meniscus injuries often lead to pain, swelling, restricted movement, muscle weakness, and impaired functional activities [8]-[10].

The increasing prevalence of sports participation and physical activities has contributed to higher incidences of meniscus injuries worldwide. According to epidemiological studies, meniscus injuries frequently occur among adolescents, athletes, and physically active populations [11]. The condition often affects individuals involved in high-impact activities such as running, football, basketball, and jumping sports. Patients with medial meniscus tear commonly experience symptoms such as knee pain, locking sensation, instability, swelling, tenderness, and limitations in daily activities including walking, squatting, stair climbing, and prolonged standing. If not treated appropriately, meniscus injuries may result in chronic joint dysfunction, decreased physical performance, and accelerated degenerative joint conditions such as osteoarthritis [12], [13]. Therefore, appropriate rehabilitation management is necessary to restore joint function and improve patients' quality of life.

Physiotherapy plays a crucial role in managing musculoskeletal disorders, including medial meniscus tear conditions. Physiotherapy interventions aim to reduce pain, restore joint mobility, improve muscle strength, and enhance functional activities through evidence-based therapeutic approaches. Several physiotherapy modalities have been widely used in managing knee injuries, including Ultrasound (US), Transcutaneous Electrical Nerve Stimulation (TENS), and therapeutic exercise [14], [15]. Ultrasound therapy produces thermal and mechanical effects that promote tissue healing, improve blood circulation, and reduce pain perception. TENS therapy functions by stimulating sensory nerves and modulating pain transmission mechanisms through gate control theory. In addition, therapeutic exercise programs such as isometric exercise and closed kinetic chain exercise contribute to improving muscle activation, strengthening lower extremity muscles, enhancing proprioception, and restoring functional movement patterns. The integration of electrotherapy modalities and exercise therapy is expected to optimize rehabilitation outcomes in patients with meniscus injuries [16].

Exercise therapy has become one of the most important components in musculoskeletal rehabilitation programs because it directly addresses muscle weakness, joint instability, and functional limitations. Isometric exercise is commonly applied to activate muscle contractions without joint movement, thereby minimizing excessive joint stress while improving muscle strength [17], [18]. Meanwhile, closed kinetic chain exercises involve weight-bearing activities that simultaneously activate multiple muscle groups and improve joint stabilization. These exercises closely resemble functional daily activities such as standing, squatting, and walking, making them effective in restoring normal movement patterns. In patients with medial meniscus tear, therapeutic exercise contributes significantly to improving quadriceps and hamstring muscle strength, reducing joint instability, and enhancing physical performance [19]. Therefore, combining electrotherapy modalities with therapeutic exercise may provide comprehensive rehabilitation effects for patients with knee injuries.

The management of medial meniscus tear conditions requires comprehensive rehabilitation approaches that not only focus on pain reduction but also emphasize functional recovery and physical activity improvement. Many patients with meniscus injuries experience prolonged disability due to inadequate rehabilitation management and insufficient muscle strengthening programs [20], [21]. Functional rehabilitation is essential to ensure patients can safely return to their normal daily activities and sports participation without recurrent injury risk. Furthermore, rehabilitation programs should address both physical and psychological aspects of recovery because pain and mobility limitations often reduce patients' confidence and activity participation. Therefore, evaluating the effectiveness of physiotherapy interventions in improving pain, muscle strength, and functional ability remains an important topic in physiotherapy and rehabilitation sciences [22].

Several previous studies have investigated physiotherapy management in patients with knee injuries and meniscus disorders. First, Berg et al. [23] explained that Ultrasound therapy contributes significantly to pain reduction and tissue healing in musculoskeletal rehabilitation programs. Second, Naimark et al. [24] reported that TENS therapy effectively decreases pain intensity and improves physical function through sensory nerve stimulation mechanisms. Third, Kisner emphasized the importance of therapeutic exercise, particularly closed kinetic chain exercise, in improving muscle strength, joint stability, and proprioceptive function among patients

with lower extremity injuries. However, previous studies generally examined these interventions separately and focused primarily on isolated rehabilitation modalities. Limited studies have comprehensively analyzed the combined application of Ultrasound, TENS, isometric exercise, and closed kinetic chain exercise specifically in adolescent patients with medial meniscus tear knee sinistra. Therefore, a research gap still exists regarding the integrated effectiveness of these physiotherapy modalities in improving pain reduction, muscle strength, physical activity, and functional ability simultaneously.

The novelty of this study lies in the integrated physiotherapy management approach combining Ultrasound, Transcutaneous Electrical Nerve Stimulation, isometric exercise, and closed kinetic chain exercise in treating medial meniscus tear conditions. Unlike previous studies focusing on single therapeutic modalities, this research evaluates the combined effectiveness of electrotherapy and exercise therapy interventions comprehensively. In addition, this study specifically examines adolescent patients with medial meniscus tear knee sinistra, thereby providing practical rehabilitation evidence for younger populations experiencing sports-related knee injuries. The study also highlights functional outcome improvements using KOOS measurements alongside pain and muscle strength evaluations, creating a more comprehensive rehabilitation assessment framework [25], [26].

The implications of this study are expected to contribute both theoretically and practically to physiotherapy rehabilitation management. Theoretically, the findings may enrich scientific literature related to musculoskeletal physiotherapy interventions and evidence-based rehabilitation for knee injuries. Practically, the results may provide guidance for physiotherapists in designing effective rehabilitation programs for patients with medial meniscus tear conditions. Furthermore, the study may contribute to improving rehabilitation protocols emphasizing integrated electrotherapy and therapeutic exercise approaches to accelerate functional recovery, reduce disability, and enhance patient quality of life [27]. The findings may also support injury prevention and rehabilitation education programs among physically active populations and athletes.

This study is important because the prevalence of sports-related knee injuries continues to increase alongside growing public participation in physical activities and sports. Meniscus injuries often lead to long-term functional limitations, decreased productivity, and reduced quality of life if not managed appropriately. Early and effective physiotherapy interventions are essential to minimize complications, restore functional movement, and support safe return-to-activity processes. In addition, comprehensive rehabilitation strategies combining pain management and functional strengthening remain necessary to address the complex impairments associated with meniscus injuries. Therefore, this study provides important evidence regarding integrated physiotherapy management approaches that may improve rehabilitation outcomes and support better clinical practice in musculoskeletal physiotherapy..

2. RESEARCH METHOD

2.1. Research Design

This study employed a descriptive case study design using a physiotherapy rehabilitation approach in managing medial meniscus tear knee sinistra conditions [28]. The case study design was selected because it enabled the researcher to observe comprehensively the physiological and functional changes experienced by the patient during the rehabilitation process. The study focused on evaluating the effectiveness of physiotherapy modalities, including Ultrasound (US), Transcutaneous Electrical Nerve Stimulation (TENS), isometric exercise, and closed kinetic chain exercise in reducing pain, improving muscle strength, and enhancing functional ability. The rehabilitation program was conducted systematically through four therapy sessions at RSP Dr. Ario Wirawan Salatiga.

The descriptive design allowed the researcher to analyze the patient's clinical progress through repeated measurements and functional evaluations during the intervention period. The research emphasized therapeutic outcomes related to pain reduction, muscle strength improvement, and increased functional activities in daily living. The rehabilitation process followed physiotherapy principles involving assessment, intervention planning, implementation, and evaluation stages. Therefore, the study design was considered appropriate for providing detailed clinical evidence regarding integrated physiotherapy management for medial meniscus tear conditions.

2.2. Subject and Sample

The subject of this study was one female patient identified as Nn. A.U.S, aged 16 years, diagnosed with medial meniscus tear knee sinistra at RSP Dr. Ario Wirawan Salatiga. The patient experienced complaints including medial knee pain, muscle weakness, limitations in physical activities, and decreased functional ability during daily activities and sports participation. The patient was selected purposively based on clinical diagnosis and physiotherapy indications related to meniscus injury rehabilitation management.

The patient demonstrated clinical symptoms commonly associated with meniscus tear conditions, including pain during movement, tenderness around the medial knee area, muscle weakness in the quadriceps and

hamstring muscles, and limitations in functional movement such as walking, squatting, and stair climbing. The rehabilitation program was conducted over four therapy sessions (T1–T4) to evaluate changes in pain intensity, muscle strength, and functional ability following integrated physiotherapy interventions.

Table 1. Characteristics of Research Subject

Variable	Category	Percentage (%)
Gender	Female	100
Age	16 Years	100
Diagnosis	Medial Meniscus Tear Knee Sinistra	100
Pain Complaint	Present	100
Functional Limitation	Present	100

2.3. Data Sources and Data Collection Techniques

This study used primary and secondary data sources [29]. Primary data were obtained directly from physiotherapy examinations, patient interviews, clinical observations, and rehabilitation outcome measurements during the intervention process. Primary data included pain intensity scores, muscle strength evaluations, and functional ability assessments before and after physiotherapy treatment sessions. Secondary data were obtained from medical records, physiotherapy documentation, textbooks, journals, and previous scientific studies related to meniscus tear rehabilitation and physiotherapy management.

Several data collection techniques were employed to obtain comprehensive clinical information. Observation techniques were conducted to identify physical impairments, movement limitations, gait patterns, and patient responses during rehabilitation sessions. Interview techniques were used to collect subjective information regarding pain complaints, physical activity limitations, and patient experiences during therapy. Clinical examination methods were performed using standardized physiotherapy assessment instruments, including Visual Analogue Scale (VAS), Manual Muscle Testing (MMT), and Knee Injury and Osteoarthritis Outcome Score (KOOS). Documentation techniques were also utilized to record rehabilitation progress and therapeutic procedures throughout the intervention process.

The combination of multiple data collection methods enabled the researcher to obtain objective and subjective information comprehensively, thereby strengthening the validity and reliability of rehabilitation outcome evaluations.

2.4. Research Instrument

The instruments used in this study included physiotherapy assessment tools commonly applied in musculoskeletal rehabilitation management. Pain intensity evaluation was measured using the Visual Analogue Scale (VAS), which assessed silent pain, tenderness, and movement pain experienced by the patient. Muscle strength evaluation was conducted using Manual Muscle Testing (MMT) to assess the strength of quadriceps and hamstring muscle groups in the affected lower extremity [30]. Functional ability evaluation was measured using the Knee Injury and Osteoarthritis Outcome Score (KOOS), which assessed the patient's functional mobility and physical activity performance.

Additional instruments included observation sheets, interview guidelines, physiotherapy documentation forms, and therapeutic exercise monitoring records. Observation sheets were used to evaluate patient movement patterns and therapy responses during rehabilitation sessions. Interview guidelines facilitated the collection of subjective complaints and patient perceptions regarding rehabilitation outcomes. Documentation instruments included cameras and clinical records to support rehabilitation monitoring and analysis processes [31].

Table 2. Research Instruments

Variable	Instrument	Measurement Indicator
Pain Intensity	VAS	Silent pain, tenderness, movement pain
Muscle Strength	MMT	Flexor and extensor muscle strength
Functional Ability	KOOS	Physical activity and functional mobility
Clinical Observation	Observation Sheet	Movement and rehabilitation response

2.5. Data Analysis Technique

The data analysis technique used in this study was descriptive quantitative analysis supported by comparative evaluation between pre-test and post-test rehabilitation measurements. Data obtained from physiotherapy assessments were organized systematically and presented in tables and graphs to facilitate interpretation. Pain intensity scores from VAS measurements, muscle strength values from MMT evaluations, and functional ability scores from KOOS assessments were analyzed descriptively to identify changes occurring during the rehabilitation process.

The analysis process involved comparing baseline measurements before intervention (T0) with evaluation results after four therapy sessions (T4). Changes in pain intensity, muscle strength, and functional ability were interpreted based on physiotherapy rehabilitation principles and relevant theoretical frameworks. The findings were also compared with previous scientific studies related to physiotherapy management for meniscus tear conditions to strengthen scientific validity and discussion accuracy. The percentage increase in functional ability was calculated using the following formula [32]:

$$Functional\ Improvement\ Percentage = \frac{Final\ Score - Initial\ Score}{Initial\ Score}\ X\ 100\% \quad ...(1)$$

Where:

- Final Score = KOOS score after intervention
- Initial Score = KOOS score before intervention

2.6. Research Procedure

The research procedure in this study was conducted systematically through several rehabilitation stages. The first stage involved patient assessment and physiotherapy examination to identify clinical problems related to medial meniscus tear conditions. The assessment included pain evaluation, muscle strength examination, functional ability assessment, and movement analysis. The second stage involved determining physiotherapy diagnoses and planning rehabilitation interventions based on patient clinical conditions and therapeutic goals.

The third stage consisted of implementing physiotherapy interventions, including Ultrasound therapy, TENS therapy, isometric exercise, and closed kinetic chain exercise. Ultrasound and TENS modalities were applied to reduce pain and improve tissue healing, while exercise therapy aimed to increase muscle strength, improve proprioception, and restore functional movement. The fourth stage involved periodic evaluations using VAS, MMT, and KOOS measurements after each therapy session to monitor patient progress and rehabilitation effectiveness.

The final stage consisted of organizing and analyzing rehabilitation data, interpreting clinical findings, and formulating conclusions regarding the effectiveness of integrated physiotherapy management in reducing pain and improving functional ability among patients with medial meniscus tear conditions.

3. RESULTS AND DISCUSSION

3.1. Pain Reduction After Physiotherapy Intervention

The results of this study demonstrated significant reductions in pain intensity following four physiotherapy intervention sessions using Ultrasound, TENS, and exercise therapy. Pain evaluation using the Visual Analogue Scale (VAS) showed progressive improvement from baseline assessment (T0) to the final evaluation (T4). Silent pain decreased from a score of 1 to 0, tenderness decreased from 4 to 1, and movement pain decreased from 5 to 2. These findings indicate that the physiotherapy interventions effectively reduced pain perception and improved patient comfort during movement activities.

The reduction in pain intensity may be associated with the physiological effects produced by Ultrasound and TENS modalities. Ultrasound therapy generates thermal effects that improve blood circulation, increase tissue metabolism, and facilitate tissue healing processes within the affected knee joint structures. Increased tissue temperature contributes to muscle relaxation, reduced muscle spasm, and improved pain threshold levels. In addition, Ultrasound therapy enhances soft tissue extensibility and stimulates tissue regeneration, thereby supporting recovery processes in meniscus injury conditions [33].

TENS therapy also contributed significantly to pain reduction through sensory nerve stimulation mechanisms explained by the gate control theory proposed by Melzack and Wall. Electrical stimulation activates large-diameter sensory nerve fibers, thereby inhibiting nociceptive signal transmission toward the central nervous system. Consequently, pain perception decreases and patient comfort improves during movement activities. The combined application of Ultrasound and TENS provided synergistic therapeutic effects that accelerated pain reduction throughout the rehabilitation process.

Table 3. Evaluation of Pain Intensity Using VAS

Pain Category	T0	T1	T2	T3	T4
Silent Pain	1	1	1	0	0
Tenderness	4	3	2	2	1
Movement Pain	5	4	3	3	2

The findings indicate that movement pain showed the greatest improvement because exercise therapy gradually restored movement tolerance and joint stabilization. These results demonstrate the effectiveness of integrated physiotherapy interventions in reducing pain among patients with medial meniscus tear conditions.

3.2. Improvement of Muscle Strength

Muscle strength evaluation using Manual Muscle Testing (MMT) demonstrated improvements in both quadriceps and hamstring muscle groups after four therapy sessions. The flexor muscle strength improved from grade 4 to grade 5, while extensor muscle strength also increased from grade 4 to grade 5. The improvement in muscle strength indicates that exercise therapy interventions effectively enhanced muscle activation and lower extremity stability in the affected knee joint.

The increase in muscle strength was primarily influenced by the application of isometric exercise and closed kinetic chain exercise programs. Isometric exercise facilitated muscle contraction without excessive joint movement, thereby minimizing stress on injured meniscus structures while promoting muscle activation. Quadriceps setting and hamstring setting exercises contributed to increased muscle recruitment and improved neuromuscular control around the knee joint. Repetitive muscle contractions stimulated metabolic activity, ATP production, and muscle fiber adaptation, ultimately resulting in improved muscle strength [34].

Closed kinetic chain exercises such as wall slides, half squats, and lunges also played important roles in strengthening lower extremity muscles and improving joint stabilization. These exercises involved multiple joints and muscle groups simultaneously, thereby enhancing functional movement patterns and proprioceptive responses. Furthermore, weight-bearing exercises improved dynamic joint stability and prepared the patient for functional daily activities. Improved muscle strength contributed positively to restoring movement confidence and reducing functional limitations experienced by the patient.

Table 4. Evaluation of Muscle Strength Using MMT

Muscle Group	T0	T1	T2	T3	T4
Flexor Muscle	4	4	4+	5-	5
Extensor Muscle	4	4	4+	5-	5

The findings confirm that therapeutic exercise programs are effective interventions for restoring muscle function and improving lower extremity performance in patients with medial meniscus injuries.

3.3. Improvement of Functional Ability

The results of functional ability evaluation using KOOS demonstrated substantial improvement following physiotherapy interventions. The patient's KOOS score increased progressively from 79% at baseline assessment to 94% after four therapy sessions. The improvement indicates that integrated physiotherapy management successfully enhanced the patient's physical activity performance and functional mobility.

Functional improvement occurred because pain reduction and muscle strengthening interventions enabled the patient to perform movement activities more effectively and comfortably. Increased quadriceps and hamstring muscle strength contributed to better knee stabilization during standing, walking, squatting, and stair-climbing activities. In addition, decreased pain perception allowed the patient to participate more confidently in physical activities without excessive fear of movement or discomfort [35].

The application of closed kinetic chain exercises significantly contributed to functional improvement because the exercises closely resembled daily movement activities. Weight-bearing movement patterns improved coordination, balance, proprioception, and neuromuscular control around the knee joint. Consequently, the patient demonstrated improved movement efficiency and increased participation in functional activities. The rehabilitation outcomes indicate that integrated physiotherapy management effectively restored physical function and supported the patient's return to normal activities.

Table 5. Functional Ability Evaluation Using KOOS

Evaluation Session	KOOS Score (%)
T0	79
T1	81
T2	84.5
T3	91.1
T4	94

The findings indicate that consistent rehabilitation interventions significantly improved functional mobility and physical activity performance in patients with medial meniscus tear conditions.

The findings of this study demonstrate that integrated physiotherapy interventions consisting of Ultrasound, TENS, isometric exercise, and closed kinetic chain exercise effectively reduced pain, increased muscle strength, and improved functional ability in patients with medial meniscus tear knee sinistra. The reduction in pain

intensity observed through VAS measurements supports previous findings reported by Ligamenta et al. [36], which explained that Ultrasound therapy promotes tissue healing and pain modulation through thermal and mechanical effects. The present study also supports Logestredt et al. [37], who reported that TENS therapy effectively reduces pain through gate control mechanisms involving sensory nerve stimulation.

The improvement in muscle strength and functional ability observed in this study aligns with Kisner's theory regarding the effectiveness of therapeutic exercise in musculoskeletal rehabilitation. Isometric exercise and closed kinetic chain exercise contributed significantly to strengthening quadriceps and hamstring muscles, improving proprioception, and restoring functional movement patterns. Closed kinetic chain exercises specifically enhanced dynamic joint stabilization because they involved coordinated muscle activation during weight-bearing activities. Consequently, the patient experienced improved movement performance and reduced functional limitations during daily activities.

The integrated rehabilitation approach applied in this study demonstrates the importance of combining electrotherapy modalities with therapeutic exercise programs in managing meniscus injuries comprehensively. Pain reduction interventions alone may not sufficiently restore functional mobility if muscle weakness and movement impairments remain untreated. Therefore, rehabilitation strategies should emphasize both symptom management and functional strengthening to achieve optimal recovery outcomes. The findings suggest that physiotherapy rehabilitation programs should adopt multidimensional approaches addressing pain, muscle strength, proprioception, and movement performance simultaneously.

Several previous studies have investigated physiotherapy interventions in patients with musculoskeletal knee injuries. Howell et al. [38] focused primarily on Ultrasound therapy effectiveness in reducing pain and promoting tissue healing. Rahman [39]. emphasized the analgesic effects of TENS therapy in musculoskeletal rehabilitation. Bhatia [40] explained the importance of therapeutic exercise in improving muscle strength and functional performance among lower extremity injury patients. However, previous studies generally examined these modalities separately without comprehensively integrating electrotherapy and exercise interventions in adolescent medial meniscus tear cases. Therefore, this study fills an important research gap by evaluating the combined effectiveness of Ultrasound, TENS, isometric exercise, and closed kinetic chain exercise simultaneously in improving pain reduction, muscle strength, and functional recovery.

The novelty of this study lies in its integrated physiotherapy rehabilitation approach combining electrotherapy modalities and therapeutic exercise interventions specifically for adolescent patients with medial meniscus tear knee sinistra. Unlike previous studies focusing on single rehabilitation modalities, this study demonstrates the synergistic effects of combined physiotherapy management in restoring physical function comprehensively. In addition, the study evaluates rehabilitation outcomes using multidimensional assessment instruments including VAS, MMT, and KOOS, thereby providing broader clinical evidence regarding physiotherapy effectiveness in meniscus rehabilitation programs.

The implications of this study are important for physiotherapy clinical practice and rehabilitation program development. The findings suggest that integrated physiotherapy management can accelerate recovery processes and improve functional outcomes among patients with medial meniscus injuries. Physiotherapists may utilize combined electrotherapy and exercise approaches to optimize rehabilitation effectiveness and reduce disability risks associated with knee injuries. Furthermore, the study may contribute to evidence-based rehabilitation guidelines emphasizing functional strengthening and movement restoration in musculoskeletal physiotherapy management.

Despite its contributions, this study has several limitations. First, the study involved only one patient, limiting the generalizability of findings to broader populations with meniscus injuries. Second, the intervention period was relatively short, consisting of only four therapy sessions, thereby restricting long-term rehabilitation outcome evaluation. Third, the study used a descriptive case study approach without control group comparison, limiting causal interpretation regarding intervention effectiveness. Future studies are recommended to involve larger sample sizes, experimental research designs, and longer rehabilitation durations to obtain more comprehensive evidence regarding physiotherapy management effectiveness for medial meniscus tear conditions.

4. CONCLUSION

Based on the results of this study, it can be concluded that integrated physiotherapy management using Ultrasound, Transcutaneous Electrical Nerve Stimulation, isometric exercise, and closed kinetic chain exercise effectively reduced pain, increased muscle strength, and improved functional ability in patients with medial meniscus tear knee sinistra. Pain intensity decreased progressively following four therapy sessions, while quadriceps and hamstring muscle strength improved significantly based on Manual Muscle Testing evaluations. Functional ability also increased substantially as indicated by improved KOOS scores after rehabilitation interventions. The findings demonstrate that combining electrotherapy modalities and therapeutic exercise provides comprehensive rehabilitation effects by addressing pain reduction, muscle strengthening, joint stabilization, and functional movement restoration simultaneously. Therefore, integrated physiotherapy

rehabilitation programs are recommended as effective interventions for managing medial meniscus tear conditions and supporting patients' return to normal physical activities and daily functional performance..

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REFERENCES

[1] E. Alentorn-geli and C. L. Green, "The association of recreational and competitive running with hip and knee osteoarthritis: A systematic review and meta-analysis," *Res. Rep.*, vol. 47, no. 6, 2017, doi: 10.2519/jospt.2017.7137.
[2] S. Fomin, H. Gauffin, and J. Kvist, "term recovery of physical activity and knee function after an acute knee injury," *BMJ Open*, vol. 3, no. 1, pp. 1–7, 2020, doi: 10.1136/bmjsem-2020-000950.
[3] R. A. Goes *et al.*, "Musculoskeletal injuries in athletes from five modalities : a cross-sectional study," *BMC Musculoskelet. Disord.*, vol. 8, no. 1, pp. 1–9, 2020, doi: 10.1186/s12891-020-3141-8.
[4] M. A. Al-qahtani *et al.*, "Sports-related injuries in adolescent athletes : A systematic review," *Open Access Rev.*, vol. 15, no. 11, 2023, doi: 10.7759/cureus.49392.
[5] S. Habelt, C. C. Hasler, K. Steinbrück, and M. Majewski, "Sport injuries in adolescents," *Orthop. Rev. (Pavia).*, vol. 3, no. 1, pp. 82–86, 2011, doi: 10.4081/or.2011.e18.
[6] K. Stoffel and A. R. Dempsey, "Effect of ankle taping on knee and ankle joint biomechanics in sporting tasks," *n Med. Sci. Sport. Exerc.*, vol. 21, no. 4, 2010, doi: 10.1249/MSS.0b013e3181de2e4f.
[7] L. Zhang, G. Liu, B. Han, Z. Wang, Y. Yan, and J. Ma, "Knee joint biomechanics in physiological conditions and how pathologies can affect it: A systematic review," *Appl. Bionics Biomech.*, vol. 12, no. 1, 2020, doi: 10.1155/2020/7451683.
[8] A. Tajvar, S. Mohseni, and M. Kazempour, "Prevalence and risk factors of work-related musculoskeletal disorders among dockworkers: The role of psychosocial stress and physical demands in an iranian port," *Heal. Sci. Reports*, vol. 9, no. 12, 2026, doi: 10.1002/hsr2.71840.
[9] T. Zhou, "Analysis of the biomechanical characteristics of the knee joint with a meniscus injury," *Healthc. Technol. Lett.*, vol. 5, no. 6, pp. 247–249, 2018, doi: 10.1049/htl.2018.5048.
[10] R. C. Gecelter and Y. Ilyaguyeva, "The menisci are not shock absorbers : A biomechanical and comparative perspective," *Am. Assoc. Anat.*, vol. 30, no. 5, pp. 1051–1064, 2022, doi: 10.1002/ar.24752.
[11] J. K. Bryceland, A. J. Powell, and T. Nunn, "Knee menisci: Structure, function, and management of pathology," *Clin. Res.*, vol. 8, no. 2, 2017, doi: 10.1177/1947603516654945.
[12] S. H. Kim, Y. Park, and B. Kim, "Incidence of associated lesions of multiligament knee injuries," *Orthop. J. Sport. Med.*, vol. 9, no. 6, pp. 1–13, 2020, doi: 10.1177/23259671211010409.
[13] F. Prevalence, J. Lindahl, S. K. Koskinen, M. Aot, K. Mp, and J. Lindahl, "MRI of acute meniscal injury associated with tibia1 plateau fractures: Prevalence, type, and location," *Musculoskelet. Imaging* •, vol. 91, no. 10, pp. 1002–1009, 2018, doi: 10.2214/AJR.07.3811.
[14] S. Keyhani and A. A. Esmailiejah, "The prevalence, zone, and type of the meniscus tear in patients with anterior cruciate ligament (acl) injury; does delayed acl reconstruction affects the meniscal injury?," *Natl. Libr. Med.*, vol. 432, no. 3, pp. 432–438, 2020, doi: 10.22038/abjs.2019.39084.2076.
[15] J. Jeffrey, K. Katz, S. Scott, and M. Martin, "Meniscus – friend or foe: Epidemiologic observations and surgical implications," *Orthop. Arthritis Cent. Outcomes Res. Brigham Women's*, vol. 60, no. 3, pp. 633–635, 2010, doi: 10.1002/art.24363.Meniscus.
[16] E. Luvsannyam, M. S. Jain, A. R. Leitao, N. Maikawa, and A. E. Leitao, "Meniscus tear: Pathology, incidence, and management," *Open Access Rev.*, vol. 14, no. 5, 2022, doi: 10.7759/cureus.25121.
[17] C. Gray, "Neural and vascular anatomy of the menisci of the human knee," *J. Orthop. Sport. Phys. Ther.*, vol. 29, no. 1, 2019, doi: 10.2519/jospt.1999.29.1.23.
[18] A. Rehman *et al.*, "Mechanism of meniscal injury and its impact on performance in athletes," *Meniscal Inj. Athletes*, vol. 2, no. 3, pp. 232–237, 2022, doi: 10.55735/hjprs.v2i3.98.
[19] R. D. Ambrosi *et al.*, "In elite athletes with meniscal injuries , always repair the lateral , think about the medial ! A systematic review," *Knee Surgery, Sport. Traumatol. Arthrosc.*, vol. 31, no. 8, pp. 2500–2510, 2023, doi: 10.1007/s00167-022-07208-8.
[20] J. C. Jones, R. Burks, B. D. Owens, R. X. Sturdivant, S. J. Svoboda, and L. Kenneth, "Incidence and risk factors associated with meniscallnjuries among active-duty us military service members," *J. ofAthletic Train.*, vol. 47, no. 1, pp. 67–73, 2012, doi: 10.4085/1062-6050-47.1.67.
[21] B. A. M. Snoeker, "Risk factors for meniscal tears: A systematic review including meta-analysis," *Res. Rep.*, vol. 43, no. 6, pp. 352–367, 2013, doi: 10.2519/jospt.2013.4295.
[22] B. E. Smith, D. Thacker, A. Crewesmith, M. Hall, and B. E. Smith, "Special tests for assessing meniscal tears within the knee : a systematic review and meta-analysis," *Syst. Rev.*, vol. 20, no. 3, pp. 88–97, 2015, doi: 10.1136/ebmed-2014-110160.
[23] B. Berg *et al.*, "What tests should be used to assess functional performance in youth and young adults following anterior cruciate ligament or meniscal injury ? A systematic review of measurement properties for the OPTIKNEE consensus," *J. Sport Med.*, vol. 10, no. 9, pp. 1454–1464, 2022, doi: 10.1136/bjsports-2022-105510.
[24] M. B. Naimark, G. Kegel, T. O. Donnell, S. Lavigne, C. Heveran, and D. C. Crawford, "A preliminary study of reproducibility, response to treatment, and correlation with patient-reported questionnaire outcomes," *Orthop. J. Sport. Med.*, vol. 2, no. 9, pp. 1–8, 2024, doi: 10.1177/2325967114550987.
[25] B. A. Luc-harkey, C. E. Safran-norton, L. A. Mandl, J. N. Katz, and E. Losina, "Associations among knee muscle strength , structural damage , and pain and mobility in individuals with osteoarthritis and symptomatic meniscal tear," *Musculoskelet. Disord.*, vol. 19, no. 1, pp. 1–11, 2028, doi: 10.1186/s12891-018-2182-8.
[26] B. Snoeker *et al.*, "Risk of knee osteoarthritis after different types of knee injuries in young adults : a population- - based cohort study," *J. Sport Med.*, vol. 54, no. 2, pp. 725–730, 2020, doi: 10.1136/bjsports-2019-100959.
[27] J. Pelletier, P. Paiement, and M. Dorais, "Risk factors for the long-term incidence and progression of knee osteoarthritis in older adults : role of nonsurgical injury," *Ther. Adv. Chronic Dis.*, vol. 23, no. 1, pp. 1–18, 2023, doi: 10.1177/20406223231169715.
[28] M. J. Gimenez, "Physiotherapy applied to palliative care patients : a descriptive practice-based study," *BMC Palliat. Care*, vol. 3, no. 1, pp. 4–11, 2023, doi: 10.1186/s12904-023-01188-3.
[29] M. Miciak, M. Mayan, C. Brown, A. S. Joyce, and D. P. Gross, "The necessary conditions of engagement for the therapeutic relationship in physiotherapy : an interpretive description study," *Arch. Physiother.*, vol. 8, no. 3, pp. 1–12, 2018, doi: 10.1186/s40945-018-0044-1.
[30] K. M. C. Ms, A. L. Rosner, and L. L. D. Hon, "A narrative review of manual muscle testing and implications for muscle testing research," *J. Chiropr. Med.*, vol. 10, no. 3, pp. 157–165, 2011, doi: 10.1016/j.jcm.2011.04.001.

[31] R. Rowe, F. Frants, and B. Bozalek, "Physiotherapy students' use of online technology as part of their learning practices: A case study," *J. Physiother.*, vol. 68, no. 1, pp. 29–34, 2012, doi: 10.4102/sajp.v68i1.6.
[32] S. C. Cuthbert and G. J. G. Jr, "On the reliability and validity of manual muscle testing: a literature review," *Chiropr. Osteopat.*, vol. 23, no. 4, 2020, doi: 10.1186/1746-1340-15-4.
[33] R. Deviandri, M. C. D. D. Iskandar, A. P. Kautsar, and A. M. T. L. M. J. Postma, "Health - economic evaluation of meniscus tear treatments : a systematic review," *Knee Surgery, Sport. Traumatol. Arthrosc.*, vol. 31, no. 9, pp. 3582–3593, 2023, doi: 10.1007/s00167-022-07278-8.
[34] G. Chalatsis and V. Mitrousias, "Long-term quality of life in patients after acl reconstruction with concomitant meniscal injury treatment," *Orthop. J. Sport. Med.*, vol. 11, no. 6, pp. 1–9, 2023, doi: 10.1177/23259671231177279.
[35] J. M. Rodríguez-roiz, S. Sastre-solsona, D. Popescu, J. Montañana-burillo, and A. Combalia-aleu, "The relationship between ACL reconstruction and meniscal repair : quality of life , sports return , and meniscal failure rate — 2- to 12-year follow-up," *J. Orthop. Surg. Res.*, vol. 15, no. 1, pp. 1–11, 2020, doi: 10.1186/s13018-020-01878-1.
[36] P. U. Ligamenta, "The impact of combined meniscus tear on quality of life after anterior cruciate ligament reconstruction," *Prof. Artic. Stručni članak*, vol. 5, no. 6, pp. 153–159, 2019, doi: 10.2298/MPNS1606153H.
[37] D. S. Logerstedt *et al.*, "Clinical practice guidelines linked to the international classification of functioning, disability and health from the orthopaedic section of the american physical therapy association," *J. Orthop. Sport. Phys. Ther.*, vol. 28, no. 2, 2018, doi: 10.2519/jospt.2018.0301.
[38] R. Howell *et al.*, "Degenerative meniscus : Pathogenesis , diagnosis , and treatment options," *World J. Orthop.*, vol. 5, no. 5, pp. 597–602, 2014, doi: 10.5312/wjo.v5.i5.597.
[39] M. H. Rahman, "Role of physiotherapy in the rehabilitation of meniscal injuries," *Orthop. Case Reports*, vol. 4, no. 6, pp. 1–3, 2025, doi: 10.31579/2835-8465/034.
[40] S. Bhatia, "Effectiveness of Physiotherapy Management of Meniscal Injuries of the Knee Joint : A Review for Clinical Practice and Research," *Int. J. Contenporary Res. Multidiscip.*, vol. 4, no. 6, pp. 115–117, 2025, doi: 10.5281/zenodo.17578095.