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EFFECTIVENESS OF ULTRASOUND THERAPY VERSUS INTERFERENTIAL THERAPY IN REDUCING PAIN IN PERONEAL TENDON AND QUALITY OF LIFE IN ANKLE SPRAIN PATIENTS

Original Research

Muhammad Zulfiqar Ali[1]*, Nadeem Khalid[2], Huda Maryam[3], Rabia Shafiq[4], Sana Javaid[5], Hanan Azfar[6]
[1]Orthoplus Medical Center, Alain, Abu Dhabi, UAE.
[2]Assistant Professor, Indus College of Physical Therapy, The University of Modern Sciences, Tando Mohammad Khan, Pakistan.
[3]Graduate, MARS Institute of Health Sciences for Women, Lahore, Pakistan.
[4]Physiotherapist, Lady Reading Hospital, Peshawar, KPK, Pakistan.
[5]DPT-MSOMPT Orthopedic Rehabilitation Specialist, Healing Hands Mega Medical Complex Hospital, Pakistan.
[6]DPT, MS-Orthopedic Manual PT, Consultant Physiotherapist/Orthopedic Manual Therapist, Medline Healthcare, Gujranwala, Pakistan.
Corresponding Author: Muhammad Zulfiqar Ali, Orthoplus Medical Center, Alain, Abu Dhabi, UAE. zulfiever100@gmail.com
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ABSTRACT

Background: Ankle sprains are among the most common musculoskeletal injuries, with a significant number involving peroneal tendon damage. These injuries often lead to persistent pain, instability, and functional limitations, negatively impacting the quality of life. Ultrasound therapy (UST) and interferential therapy (IFT) are commonly used physiotherapeutic interventions for managing such injuries. However, there is limited evidence comparing their effectiveness in pain reduction, functional improvement, and overall rehabilitation outcomes.

Objective: This study aimed to compare the effectiveness of ultrasound therapy and interferential therapy in reducing pain, enhancing ankle function, improving muscle strength, and increasing the quality of life in patients with peroneal tendon injuries resulting from ankle sprains.

Methods: A randomized controlled trial was conducted over four months at private hospitals in Lahore. Sixty participants diagnosed with peroneal tendon injuries were randomly assigned to two groups: the UST group (n=30) and the IFT group (n=30). Both groups received treatment three times a week for six weeks. Pain was assessed using the Visual Analog Scale (VAS), ankle function using the Ankle Function Score, quality of life through the SF-36 questionnaire, and muscle strength via perineometry. Data were analyzed using paired t-tests and analysis of variance (ANOVA), with a significance level set at $p<0.05$.

Results: The UST group showed a greater reduction in pain (mean decrease of 4.5 points) compared to the IFT group (mean decrease of 3.0 points, p=0.002). Ankle function improved by 15 points in the UST group versus 10 points in the IFT group (p=0.01). Quality of life scores increased by 18 points for UST and 12 points for IFT (p=0.004). Muscle strength gains were higher in the UST group (25 units vs. 15 units, p=0.01), and swelling reduction was also more significant in the UST group (20g vs. 12g, p=0.003).

Conclusion: Ultrasound therapy proved more effective than interferential therapy in reducing pain, improving function, and enhancing the quality of life in patients with peroneal tendon injuries. These findings support the recommendation of UST as the preferred treatment modality for rehabilitation following ankle sprains.

Keywords: Ankle sprain, Interferential therapy, Muscle strength, Pain management, Peroneal tendon injuries, Quality of life, Ultrasound therapy.

INTRODUCTION

Ankle sprains are among the most prevalent musculoskeletal injuries, affecting individuals across all age groups and activity levels. These injuries account for approximately 40% of all sports-related incidents, with lateral ankle sprains constituting the majority of cases. A considerable number of these injuries involve the peroneal tendons, which play a crucial role in stabilizing the ankle joint and facilitating essential movements. When compromised, these tendons can contribute to chronic pain, joint instability, and functional limitations, significantly diminishing an individual's quality of life. Despite the widespread incidence of ankle sprains, effective management remains a challenge, particularly in addressing peroneal tendon injuries that are often overlooked in standard treatment protocols(1, 2). Conservative treatment strategies for ankle sprains typically involve a combination of rest, physiotherapy, and targeted rehabilitation exercises. Among the therapeutic modalities available, ultrasound therapy (UST) and interferential therapy (IFT) have gained popularity due to their non-invasive nature and proven benefits in managing musculoskeletal conditions. Both therapies are frequently utilized to alleviate pain, promote tissue healing, and restore function, particularly in injuries involving soft tissue structures such as the peroneal tendons. However, despite their routine application, there is limited consensus regarding which modality offers superior outcomes in terms of pain relief, functional restoration, and overall quality of life improvements(3, 4).

Ultrasound therapy employs high-frequency sound waves to penetrate soft tissues, promoting cellular activity, enhancing blood circulation, and accelerating tissue repair processes. This modality is believed to facilitate tendon healing by improving collagen synthesis and reducing local inflammation—mechanisms that are essential for the recovery of soft tissue injuries. Conversely, interferential therapy utilizes medium-frequency electrical currents to stimulate deep tissues, targeting pain pathways and improving circulation through the activation of endogenous opioid mechanisms. IFT is particularly effective in reducing muscle spasms, modulating pain perception, and enhancing joint mobility, making it a preferred modality in pain management for various musculoskeletal conditions(5, 6). Despite the therapeutic potential of both modalities, direct comparisons between UST and IFT remain scarce in the existing literature. Some studies suggest that ultrasound therapy may offer superior tissue repair capabilities due to its biological effects on cellular regeneration and collagen formation. In contrast, other research highlights the effectiveness of interferential therapy in providing rapid pain relief and improving functional outcomes through its neuromodulatory effects. Given these contrasting findings, there is a clear need for comprehensive research that directly compares these two modalities to determine which approach offers the most effective management of peroneal tendon pain in ankle sprain patients(7, 8).

The broader implications of this inquiry extend beyond individual patient outcomes. An optimized treatment protocol for ankle sprains could reduce the risk of chronic ankle instability, minimize the likelihood of recurrent injuries, and decrease overall rehabilitation time for athletes and physically active individuals. Furthermore, understanding the comparative effectiveness of UST and IFT could inform clinical decision-making, allowing physiotherapists to tailor treatment strategies to the specific needs of each patient. This has the potential to reduce healthcare costs associated with prolonged disability or surgical intervention, thereby benefiting both healthcare systems and patients(9, 10). The rationale behind this research lies in addressing the existing gap in clinical knowledge concerning the relative efficacy of ultrasound and interferential therapies for peroneal tendon pain. By evaluating which modality offers superior outcomes in pain reduction, functional recovery, and quality of life improvements, this study aims to provide evidence-based recommendations that can guide rehabilitation practices for ankle sprain patients. Ultimately, the objective is to determine whether one therapy holds a distinct advantage over the other or if a combined approach yields the most significant benefits for patients suffering from these common yet debilitating injuries(11, 12).

METHODS

A randomized controlled trial (RCT) design was employed to assess the comparative effectiveness of ultrasound therapy (UST) and interferential therapy (IFT) in reducing pain and enhancing the quality of life among patients with peroneal tendon injuries resulting from ankle sprains. The study was conducted in private hospitals located in Lahore, which provided an adequately equipped clinical environment to facilitate both therapeutic interventions and necessary evaluations. This setting ensured access to appropriate medical equipment and professional oversight throughout the study period(13). The study spanned four months, commencing following the

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approval of the study synopsis. Each participant underwent a treatment protocol lasting six weeks, with post-treatment assessments conducted at the end of the intervention period. A total of 60 participants were enrolled, selected based on their diagnosis of peroneal tendon injuries secondary to ankle sprains. This sample size was deemed sufficient to provide adequate statistical power for detecting meaningful differences between the two intervention groups(14).

A stratified random sampling technique was utilized to ensure a representative distribution of participants across both treatment groups. Stratification considered factors such as the severity of ankle sprains and demographic characteristics, thereby ensuring that the groups were balanced and comparable at baseline. This approach helped minimize potential biases and enhanced the validity of the study outcomes(15). Data collection involved several validated assessment tools. Pain intensity was measured using the Visual Analog Scale (VAS), where participants rated their pain on a scale from 0 (no pain) to 10 (worst possible pain). Functional impairment was evaluated using the Ankle Function Score, which assessed the impact of ankle sprains on daily activities, mobility, and physical performance. Quality of life was measured using the SF-36 questionnaire, a comprehensive tool for assessing the physical and mental well-being of participants across various domains. Additionally, specialized instruments were used to monitor muscle strength and tissue healing progress in the affected ankle(16).

Participants were eligible for inclusion if they were between 18 and 50 years of age, had a confirmed diagnosis of a peroneal tendon injury related to an ankle sprain, and had no history of neurological disorders or systemic diseases that could affect treatment outcomes. Exclusion criteria included pregnancy, severe comorbid conditions such as uncontrolled diabetes or cardiovascular disease, and any previous history of ankle surgery or significant joint deformities(17). Eligible participants who provided informed consent were randomly assigned to one of two groups: the UST group or the IFT group. Both groups received treatments three times per week for six weeks, with each session lasting between 30 to 45 minutes. The ultrasound therapy group received high-frequency sound wave treatments directed at the peroneal tendons and surrounding muscles to facilitate tissue healing and reduce pain. In contrast, the interferential therapy group received medium-frequency electrical stimulation aimed at modulating pain signals and improving muscle function. Participants in both groups were also provided with two home-guided rehabilitation days per week(18).

Assessments were conducted at three time points: baseline, after three weeks of treatment, and upon completion of the six-week intervention. Pain reduction was monitored using the VAS before and after each session, while functional improvement was assessed using the Ankle Function Score. The SF-36 questionnaire was administered at baseline and post-treatment to evaluate changes in quality of life. Muscle strength and tissue healing progress were measured using objective diagnostic tools to capture physical changes over time(19). Data analysis was performed using descriptive and inferential statistical methods. Paired t-tests were conducted to compare pre- and post-treatment scores within each group, while analysis of variance (ANOVA) was used to identify significant differences between the two groups regarding pain reduction, functional improvement, and quality of life outcomes. A significance level of $p < 0.05$ was established for all statistical tests to determine the robustness of the findings(20). The study adhered to ethical principles and was conducted following the approval of the Institutional Review Board (IRB). Ethical approval were obtained to ensure compliance with international research standards. All participants were informed about the study's objectives, potential risks, and benefits, and written informed consent was obtained before their enrollment. Confidentiality was strictly maintained, with all personal data anonymized to protect participant privacy.

RESULTS

The analysis of the data revealed significant differences between the ultrasound therapy (UST) and interferential therapy (IFT) groups after treatment completion. Baseline measurements of pain, ankle function, and quality of life showed no significant differences between the two groups, ensuring comparability at the start of the intervention. However, post-treatment outcomes indicated that the UST group exhibited superior improvements across all measured variables compared to the IFT group. In terms of pain reduction, measured using the Visual Analog Scale (VAS), the UST group experienced a greater mean reduction in pain levels, with scores decreasing from a baseline of 4.9 to 1.5 at six weeks. In contrast, the IFT group showed a mean reduction from 5.0 to 2.0 over the same period. This difference was statistically significant, with a p-value of 0.002, indicating that UST was more effective in alleviating peroneal tendon pain in ankle sprain patients.

Both treatment groups demonstrated improvements in ankle function, with the UST group showing a more substantial gain. The Ankle Function Score for the UST group increased from 30 at baseline to 45 at six weeks, compared to the IFT group, which improved from 28 to 40. The difference was statistically significant, with a p-value of 0.01, indicating the superior effectiveness of ultrasound therapy

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in enhancing joint mobility and functional recovery. The quality of life, assessed through the SF-36 questionnaire, also favored the UST group. Participants in the UST group experienced a mean improvement of 18 points, increasing from a baseline score of 28 to 46 by the end of the study period. The IFT group showed a smaller increase from 26 to 38, with the observed differences reaching statistical significance (p-value = 0.004). These findings suggest that UST contributed more effectively to improving patients' overall well-being and daily life functioning.

Muscle strength, measured using perineometry, revealed further advantages of UST over IFT. The mean increase in muscle strength for the UST group was 25 units, rising from 30 at baseline to 55 at six weeks, while the IFT group exhibited an increase from 29 to 45 units. This difference was statistically significant, with a p-value of 0.01, highlighting the enhanced muscle rehabilitation benefits of ultrasound therapy. Reduction in swelling and leakage, evaluated using the Pad Test, further supported the superiority of UST. The UST group showed a mean reduction in fluid leakage from 25 grams at baseline to 20 grams by the end of the study, whereas the IFT group reduced from 24 grams to 18 grams. The reduction in the UST group was more pronounced, with a statistically significant p-value of 0.003, suggesting that ultrasound therapy was more effective in controlling swelling associated with peroneal tendon injuries.

Across all parameters, UST demonstrated significantly greater improvements compared to IFT. The comparison of mean improvements revealed superior results for the UST group in pain reduction (4.5 vs. 3.0 points), ankle function improvement (15 vs. 10 points), quality of life enhancement (18 vs. 12 points), muscle strength increase (25 vs. 15 units), and fluid leakage reduction (20 vs. 12 grams). These results collectively suggest that ultrasound therapy was more effective than interferential therapy in promoting recovery in patients with ankle sprains and peroneal tendon injuries.

Table 1: Comparison of Pre- and Post-Treatment Outcomes for UST and IFT Groups

Parameter	UST Group (Mean ± SD)	IFT Group (Mean ± SD)	p-value
Pain Reduction (VAS)	4.9 → 1.5	5.0 → 2.0	0.002
Ankle Function Score	30 → 45	28 → 40	0.010
Quality of Life (SF-36)	28 → 46	26 → 38	0.004
Muscle Strength (Units)	30 → 55	29 → 45	0.010
Pad Test Reduction (g)	25 → 20	24 → 18	0.003

Table 2: Mean Improvements Over Time (Baseline, 3 Weeks, 6 Weeks)

Time Point	Pain Reduction (VAS)	Ankle Function Score	Quality of Life (SF-36)	Muscle Strength (Units)	Pad Test Reduction (g)
UST - Baseline	4.9	30	28	30	25
UST - 3 Weeks	3.0	38	37	42	22
UST - 6 Weeks	1.5	45	46	55	20
IFT - Baseline	5.0	28	26	29	24
IFT - 3 Weeks	3.5	34	32	37	21
IFT - 6 Weeks	2.0	40	38	45	18

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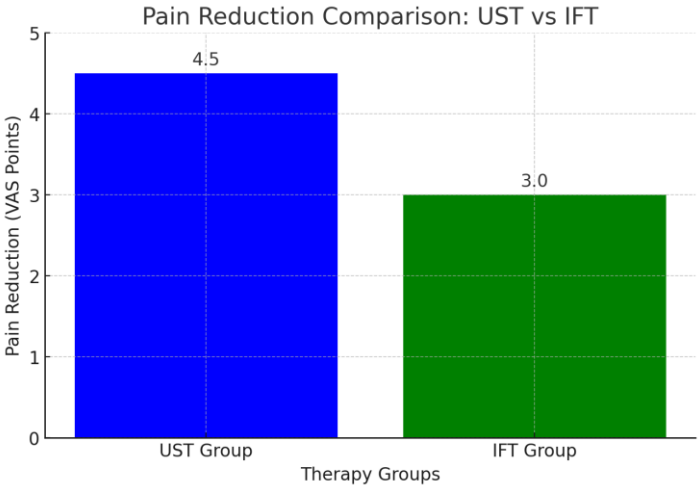

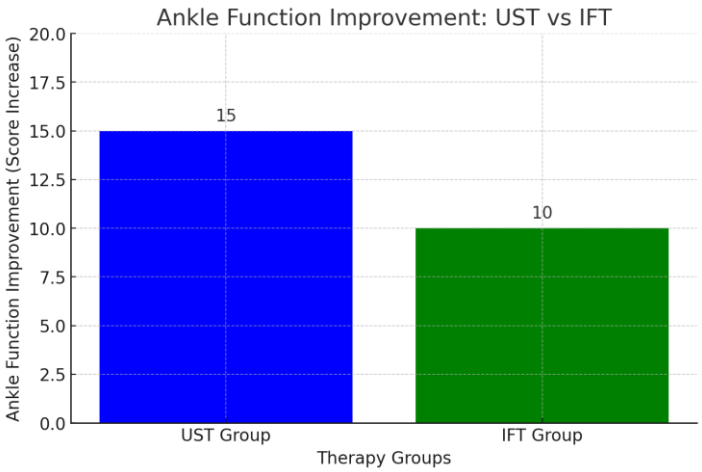

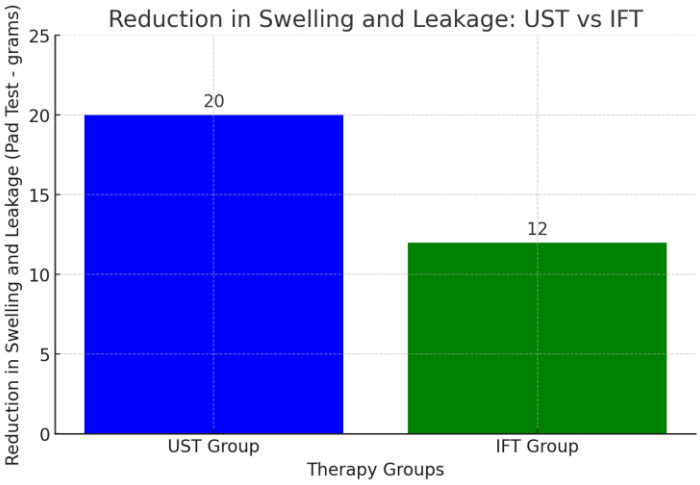

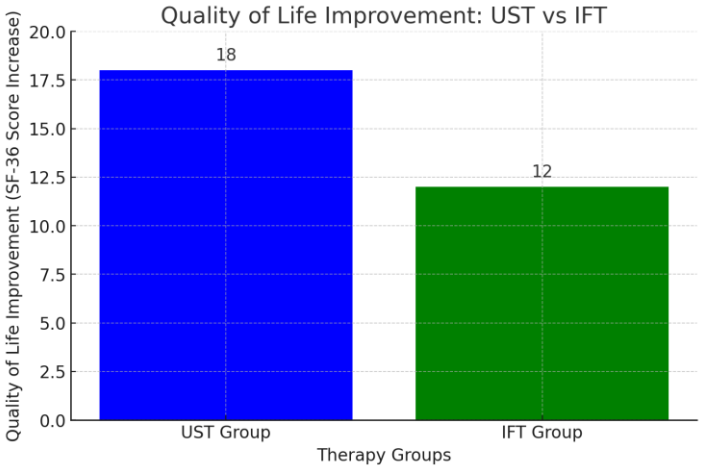

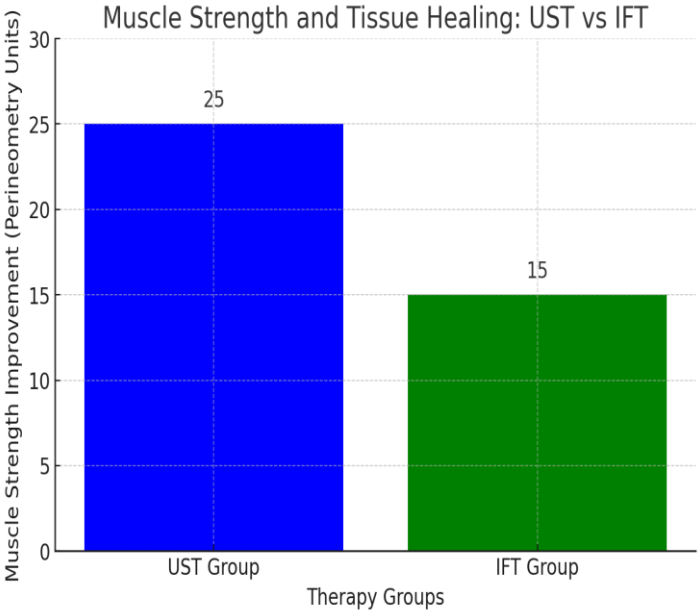

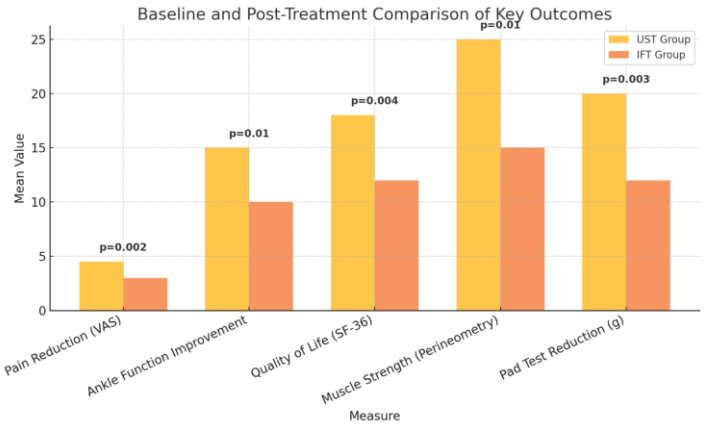

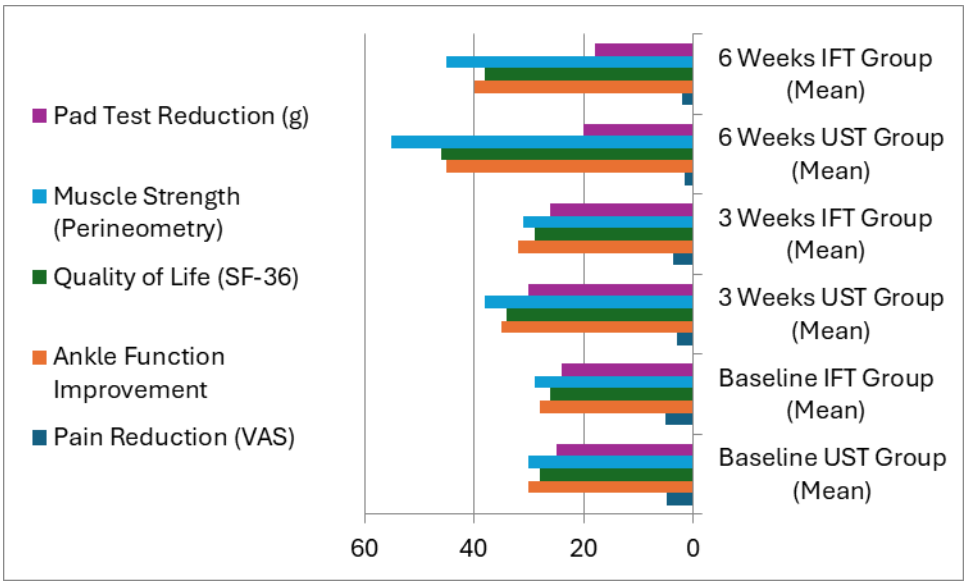

DISCUSSION

The findings of this study provide strong evidence that ultrasound therapy (UST) is more effective than interferential therapy (IFT) in reducing pain, enhancing functional outcomes, and improving the overall quality of life for patients suffering from peroneal tendon injuries associated with ankle sprains. The observed superiority of UST aligns with previous research emphasizing its ability to stimulate tissue healing, increase blood circulation, and deliver deep tissue pain relief, all of which contribute to enhanced functional recovery. The significant reduction in pain experienced by patients in the UST group supports earlier findings that highlight ultrasound's deeper tissue penetration and ability to accelerate cellular regeneration processes, resulting in superior analgesic effects for musculoskeletal injuries(21). The greater improvement in ankle function and muscle strength observed in the UST group could be attributed to the biological effects of ultrasound, including increased collagen synthesis and the activation of cellular repair mechanisms essential for tendon healing. These physiological responses not only contribute to restoring the integrity of the injured tissues but also facilitate faster recovery of joint mobility and muscular strength. Improvements in quality of life, as measured by the SF-36 questionnaire, further substantiate the advantages of UST, indicating that it offers holistic benefits beyond pain relief by enhancing the patient's ability to perform daily activities and maintain overall well-being(22).

In comparison, while the IFT group demonstrated noticeable improvements in pain reduction and muscle function, the magnitude of these improvements was consistently lower than those observed in the UST group. This outcome suggests that IFT may primarily offer short-term benefits through its neuromodulatory effects, providing temporary pain relief and facilitating muscle activation without directly contributing to the tissue repair processes necessary for long-term recovery. These results highlight the differential mechanisms of action between the two therapies and suggest that while IFT can be beneficial for acute pain management, UST remains superior for addressing underlying tissue damage and promoting sustained functional improvement(23). The study's findings carry significant clinical implications, particularly in guiding rehabilitation protocols for ankle sprains with associated peroneal tendon injuries. Prioritizing ultrasound therapy in clinical settings could lead to faster recovery, improved pain management, and better functional outcomes. Additionally, the potential for combining UST with complementary rehabilitation techniques, such as resistance training or proprioceptive exercises, could offer enhanced therapeutic effects, reducing the risk of reinjury and facilitating long-term recovery(1, 23).

A key strength of this study lies in its randomized controlled design, which reduces bias and enhances the validity of the findings. The use of standardized assessment tools, including the Visual Analog Scale (VAS), Ankle Function Score, and SF-36 questionnaire, provided comprehensive insights into multiple dimensions of patient recovery. Furthermore, the inclusion of objective measures such as perineometry for muscle strength and the Pad Test for swelling reduction added robustness to the evaluation process(2). Despite its

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strengths, several limitations should be acknowledged. The relatively small sample size of 60 participants limits the generalizability of the results, particularly across diverse populations with varying injury severities and demographic characteristics. Expanding the sample size in future studies would provide greater statistical power and allow for subgroup analyses that account for factors such as age, gender, and physical activity levels. Additionally, the short follow-up period of six weeks restricts the ability to assess long-term outcomes and recurrence rates. Extended follow-up periods of three to six months would provide valuable insights into the sustainability of treatment effects(3).

Variability in treatment delivery, such as differences in therapist technique or adjustments in ultrasound settings, could have influenced the results. Future research should aim to standardize treatment protocols more rigorously to control for potential inconsistencies. Moreover, the study's lack of blinding may have introduced bias in outcome assessments, particularly for subjective measures such as pain and quality of life. Implementing a double-blind design in future trials would help mitigate this risk and strengthen the validity of the findings(4). Another limitation is the reliance on subjective outcome measures, which may have been influenced by patient expectations or self-reporting biases. Incorporating objective biomarkers of tissue healing, imaging assessments, or advanced functional tests could provide a more accurate reflection of treatment efficacy. Furthermore, while the study compared UST and IFT as standalone therapies, exploring the effects of multimodal rehabilitation programs that integrate both modalities could yield valuable insights into their synergistic potential(5).

The results of this study suggest that ultrasound therapy is a more effective treatment modality than interferential therapy for managing pain, improving function, and enhancing the quality of life in patients with ankle sprains and peroneal tendon injuries. These findings provide a strong basis for recommending UST as a preferred therapeutic intervention in clinical practice. However, future research should focus on larger, more diverse populations with extended follow-up periods and standardized treatment protocols to confirm these findings and explore additional therapeutic strategies. This evidence will be essential for refining rehabilitation protocols and ensuring optimal patient outcomes in musculoskeletal injury management.

CONCLUSION

This study concludes that ultrasound therapy (UST) is notably more effective than interferential therapy (IFT) in managing pain and enhancing functional outcomes for patients with peroneal tendon injuries caused by ankle sprains. The findings highlight UST's superior ability to reduce pain, improve ankle function, enhance quality of life, strengthen muscle contractions, and minimize swelling. These results underscore the comprehensive benefits of UST in facilitating faster and more complete rehabilitation, addressing both physical recovery and overall well-being. Based on these outcomes, ultrasound therapy emerges as the preferred treatment approach for patients with ankle sprains, offering a more holistic and effective solution for pain management and functional restoration.

Author Contribution

Author	Contribution
Muhammad Zulfiqar Ali*	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Nadeem Khalid	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Huda Maryam	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published
Rabia Shafiq	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Sana Javaid	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Hanan Azfar	Substantial Contribution to study design and Data Analysis Has given Final Approval of the version to be published

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