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EFFECTS OF PARAFFIN WAX BATH THERAPY WITH AND WITHOUT MUSCLE ENERGY TECHNIQUE IN CHILDREN WITH POST BURN HAND CONTRACTURE

Original Research

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ABSTRACT

Background: Pediatric hand burns are frequently associated with long-term functional limitations due to contractures and joint stiffness. The thin skin and rapidly growing structures of children's hands increase the risk of deep tissue injury and hypertrophic scarring. Rehabilitation is further complicated by limited patient compliance in younger age groups. Paraffin wax therapy provides uniform moist heat, enhancing tissue extensibility, while Muscle Energy Techniques (METs) offer a manual therapy approach targeting joint mobility and soft tissue flexibility.

Objective: To evaluate and compare the effectiveness of paraffin wax bath therapy alone and in combination with Muscle Energy Techniques (METs) in improving range of motion and functional hand use in children with post-burn hand contractures.

Methods: A randomized controlled trial was conducted involving 26 children aged 1 to 10 years with post-burn hand contractures. Participants were randomly assigned into two groups using a lottery method. Group A received paraffin wax bath therapy alone, while Group B received paraffin wax therapy combined with METs. Both groups were treated for 8 weeks with three sessions per week. Outcome measures included goniometry for wrist flexion and extension, and the ABIL-HAND scale for hand function. Data were analyzed using SPSS version 25, with statistical significance set at $p < 0.05$.

Results: In Group B (Paraffin + METs), wrist flexion improved by 8.076 ± 2.900 degrees and wrist extension by 10.538 ± 3.821 degrees ($p = 0.00$). ABIL-HAND scores increased by 1.692 ± 0.480 ($p = 0.00$). Group A also showed significant improvement, though with smaller gains. Post-intervention ABIL-HAND scores were 0.76 ± 0.20 (Group A) and 0.73 ± 0.21 (Group B), both with $p = 0.01$.

Conclusion: Paraffin wax bath therapy combined with METs was significantly more effective in improving range of motion and hand function compared to paraffin wax therapy alone in children with post-burn contractures.

Keywords: Burns, Contracture, Hand injuries, Muscle energy technique, Paraffin, Pediatric rehabilitation, Range of motion.

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INTRODUCTION

Burn injuries remain a significant source of preventable morbidity and mortality in children, with thermal and chemical burns representing the most common types. While these injuries may present similarly and are generally treated using comparable approaches, the severity and onset can vary based on factors such as the intensity of the heat and duration of exposure. Burn classification is commonly determined by the depth and total body surface area affected (1). Pediatric burn injuries have a profound impact not only on the physical health of children but also on the emotional well-being of both the children and their caregivers. The recovery journey often involves painful dressing changes, surgical interventions, extended hospital stays, and psychological challenges such as fear and anxiety (2). Young children are especially vulnerable to burn injuries due to their limited understanding of danger and increased exposure to risk-prone environments. As a result, burns in pediatric patients are not only more frequent but also more complex, often requiring multidisciplinary management. The World Health Organization has recognized burns as one of the most catastrophic forms of trauma, given their long-term physical and psychosocial implications (3). Among the health professionals involved in pediatric burn care, occupational therapists and physiotherapists play a crucial role. Their ability to assess and manage cases with clinical sensitivity and precision is essential in promoting recovery and minimizing disability (4).

Rehabilitation following burns, particularly those involving the hands, is a cornerstone of pediatric burn care. One of the most promising adjunctive treatments in recent years is paraffin wax bath therapy. Paraffin therapy involves the application of heated wax, typically between 115–118°F, which provides uniform heat distribution and softens the skin surface, making it especially effective in managing hypertrophic scars and joint stiffness (2,5). This method has been integrated into physiotherapy departments as a simple, cost-effective tool for releasing contractures and improving skin pliability in children (6). Unlike other heat applications, paraffin wax avoids trapping in scar grooves and instead leaves a smooth surface, which may benefit uneven pigmentation and tissue adhesions. Another essential aspect of pediatric burn rehabilitation is the role of caregivers (7). Children admitted to burn units often rely heavily on their caretakers for emotional support and participation in therapeutic exercises. Caregivers help in reducing fear, ensuring compliance, and facilitating communication with healthcare professionals throughout physiotherapy sessions, which may otherwise be distressing for pediatric patients (8). Additionally, nutritional status has been shown to significantly affect healing outcomes. Malnutrition in hospitalized burn patients is associated with delayed recovery, impaired wound healing, reduced functional capacity, and prolonged hospital stays, further complicating clinical management (9).

Pediatric hand burns, which are predominantly caused by scald injuries, present unique clinical challenges. These injuries require meticulous assessment and often respond well to conservative treatment, particularly when managed under well-defined protocols (10). Studies have highlighted that, children tend to regain mobility faster than adults after immobilization, though preventing long-term contracture formation remains a therapeutic priority. Paraffin wax bath therapy has demonstrated significant clinical benefits in burn rehabilitation. It has been shown to reduce the severity of contractures, enhance range of motion, and restore functional independence in affected hands (11). When combined with Muscle Energy Techniques (METs), the treatment has also been effective in minimizing scar tissue formation and improving manual dexterity. Emerging literature increasingly supports the integration of paraffin wax therapy into pediatric rehabilitation programs, citing its long-term benefits in maintaining joint mobility and skin flexibility (10,11). These findings are encouraging, suggesting that even beyond immediate recovery, children continue to benefit from improved function and quality of life.

Given the growing body of evidence, the present study aims to objectively evaluate the efficacy of paraffin wax bath therapy in conjunction with muscle energy techniques in improving hand function, range of motion, and activities of daily living (ADLs) in children with post-burn hand contractures. By focusing on a holistic, evidence-based approach, this study seeks to contribute valuable insights into optimizing pediatric burn rehabilitation strategies.

METHODS

This randomized controlled trial was conducted following approval from the Institutional Review Board (IRB). Written informed consent was obtained from the legal guardians of all participants, ensuring comprehension in the language most familiar to them. The

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study recruited pediatric patients between 1 and 10 years of age using a straightforward sampling technique. Inclusion criteria consisted of children diagnosed with post-burn hand contractures, while the exclusion criteria include children with open wounds, active infections, neurological impairments, hypersensitivity to heat, or any contraindication to paraffin or manual therapy interventions. Participants were randomly assigned into two intervention groups through a simple randomization process (3,5). The method of randomization was computer-generated sequence. The first group received paraffin wax bath therapy alone, and the second group was treated with paraffin wax bath combined with Muscle Energy Techniques (METs). Each participant underwent treatment for a duration of eight weeks. Two supervised physiotherapy sessions were conducted per week, with an additional home-based session prescribed once weekly, making a total of three sessions per week. This was done to enhance adherence and therapeutic effectiveness while resolving the earlier ambiguity regarding session frequency. Each treatment session lasted approximately 40 to 50 minutes and included a single set of ten repetitions for each prescribed exercise. The intervention was individualized based on the clinical assessment and needs of each child.

Standardized outcome assessment tools were used to measure functional and physical improvements pre- and post-intervention. Joint range of motion was evaluated using a Goniometer, while functional hand performance was assessed using the ABIL-HAND questionnaire, a validated tool designed to measure manual ability in pediatric populations. These tools ensured objective and reliable data collection across both intervention arms. All statistical analyses were performed using IBM SPSS software version 25. Descriptive statistics, including means and standard deviations for continuous variables, and frequencies and percentages for categorical variables, were calculated. The Shapiro-Wilk test was used to confirm the normality of the data distribution prior to conducting parametric analyses. An independent t-test was planned to compare the outcomes between the two intervention groups, and a paired sample t-test was designated for assessing within-group changes pre- and post-intervention. A p-value of less than 0.05 was considered statistically significant.

RESULTS

The study included a total of 26 pediatric participants, with 13 in each group. The mean age of the participants was 3.54 years with a standard deviation of ±1.24, indicating a relatively young sample appropriate for pediatric rehabilitation. Normality of data was assessed using the Shapiro-Wilk test. The pre-treatment ABIL-HAND scores ($p = 0.58$), wrist flexion ($p = 0.71$), and wrist extension ($p = 0.55$) all demonstrated p-values greater than 0.05, confirming normal distribution of the data. Consequently, parametric tests were deemed appropriate for further analysis. Between-group comparison using the independent t-test showed no statistically significant difference in pre-treatment ABIL-HAND scores between the control group (paraffin wax therapy only) with a mean ± SD of 0.15 ± 0.16, and the experimental group (paraffin wax with METs), which had a mean ± SD of 0.12 ± 0.15 ($p = 0.37$). However, post-treatment ABIL-HAND scores improved markedly in both groups. The control group reached a mean of 0.76 ± 0.20 and the experimental group 0.73 ± 0.21, with both achieving statistical significance ($p = 0.01$), indicating improvement in functional hand performance after intervention.

Within-group analysis using paired sample t-tests revealed highly significant post-treatment improvements in the experimental group. The ABIL-HAND scores improved with a mean difference of 1.692 ± 0.480 ($p < 0.001$). For goniometric assessments, wrist flexion improved by 8.076 ± 2.900 degrees ($p < 0.001$), and wrist extension improved by 10.538 ± 3.821 degrees ($p < 0.001$), further supporting the effectiveness of the intervention involving paraffin wax and METs. the substantial increase in ABIL-HAND scores post-intervention suggests functional improvements that likely translate to enhanced daily manual activities. In the group treated with paraffin wax and METs, the mean improvement in ABIL-HAND score was 1.692 ± 0.480 ($p < 0.001$), indicating a significant enhancement in functional hand use, which is crucial for ADLs in pediatric patients.

Table 1: Demographic Characteristics

Group	Number of Participants	Mean Age (Years)	Standard Deviation (Age)
Paraffin Only	13	3.54	1.24
Paraffin + METs	13	3.54	1.24

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Table 2: Test for Normality

	Statistic	Significance
Pre-Treatment ABIL-HAND	0.925	0.58
Pre-Treatment Goniometry Flexion	0.973	0.71
Pre-Treatment Goniometry Extension	0.967	0.55

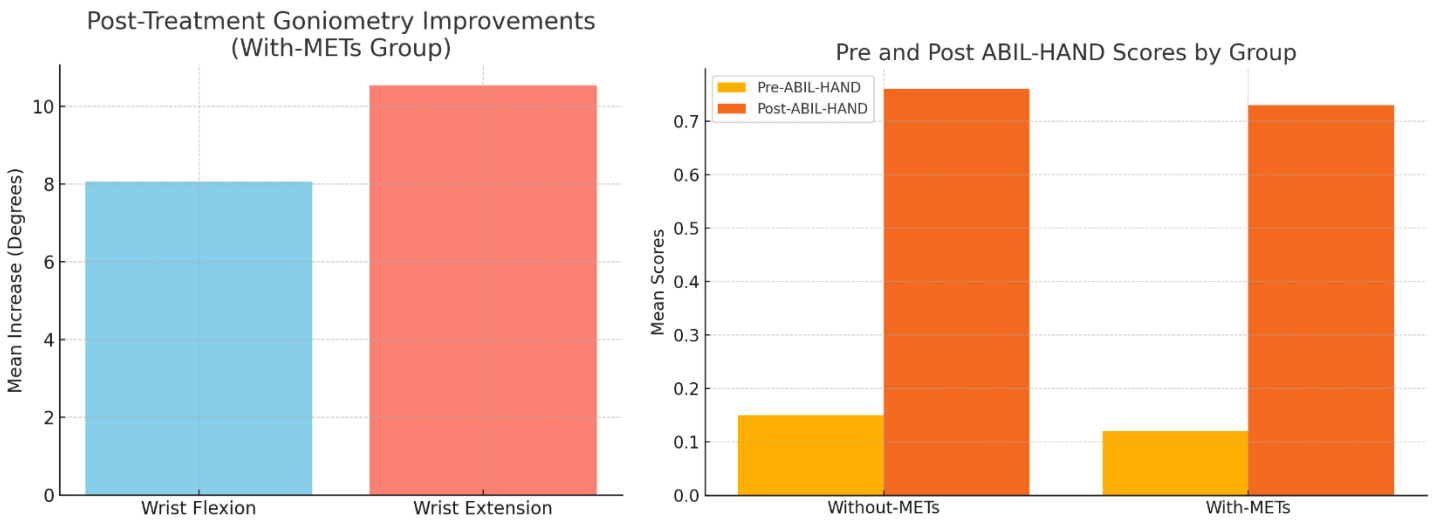
Table 3: Comparison of Pre and Post values of ABIL-HAND in Groups

Independent t-Test				
		N	Mean ± SD	P-Value
Pre	Without-METs	13	0.15 ± 0.16	0.37
	With-METs	13	0.12 ± 0.15	0.37
Post	Without-METs	13	0.76± 0.20	0.01
	With-METs	13	0.73 ± 0.21	0.01

Table 4: Comparison of Pre and Post values of within Groups

	Paired sample t test **Group 2**		
	N	Mean ± SD	P-Value
ABIL-HAND	13	1.692 ± 0.480	0.00
Goniometry Wrist flexion	13	8.076 ± 2.900	0.00
Goniometry Wrist extension	13	10.538±3.821	0.00

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DISCUSSION

The present study aimed to evaluate the effects of paraffin wax bath therapy with and without Muscle Energy Techniques (METs) in children with post-burn hand contractures. Out of the 28 initially enrolled participants, 26 completed the study, and were evenly divided into two groups: one receiving paraffin wax therapy alone and the other receiving paraffin wax therapy in conjunction with METs. The findings revealed that both groups showed statistically significant improvements in hand function and range of motion (12). However, the group that received the combined intervention demonstrated superior outcomes in terms of joint mobility and functional hand performance, as measured by goniometry and ABIL-HAND scale. The application of paraffin wax bath therapy has long been recognized for its ability to deliver uniform moist heat, which softens hypertrophic scarring, enhances local circulation, reduces joint stiffness, and improves skin pliability (13). These effects facilitate increased joint movement, particularly when followed by active or passive mobilization. In previous studies, paraffin wax therapy alone showed positive outcomes in scar management and pain relief (14). However, in the current study, its therapeutic potential was significantly enhanced when paired with METs. This reflects the synergistic interaction between thermal therapy and manual stretching techniques that target soft tissue extensibility and neuromuscular balance (15).

Earlier investigations into pediatric burn rehabilitation have primarily focused on compressive splinting and passive stretching as standard interventions. The current study adds to this body of knowledge by demonstrating the added value of METs, which promote active muscle engagement and joint mobilization through controlled isometric contractions (16). Notably, improvements observed in the experimental group extended to both wrist flexion and extension, with statistically significant increases in the range of motion, emphasizing the role of combined modalities in functional recovery (17). The findings also align with previous evidence supporting early and structured interventions to prevent the progression of contractures in children with deep or extensive burns (18). The functional gains recorded on the ABIL-HAND scale suggest meaningful improvements in hand use, which are critical for performing basic activities of daily living. Although the ABIL-HAND tool served as an indirect indicator of ADL performance in this study, future investigations would benefit from including a dedicated pediatric ADL scale to capture the broader impact of rehabilitation on independence and quality of life (19). Despite the positive results, the absence of long-term follow-up limits the ability to conclude the sustainability of these improvements over time. In addition, while outcome measures such as goniometry and ABIL-HAND were appropriate for quantifying physical improvements, subjective parameters such as pain relief or psychological well-being were not assessed and may provide further insight into overall recovery.

Another limitation of the study was the relatively small sample size and the lack of gender or burn severity stratification, which may influence the generalizability of the results. Nonetheless, the study's strengths lie in its structured intervention protocol, the use of validated outcome measures, and its focus on a pediatric population, which is often underrepresented in burn rehabilitation research. In

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conclusion, the findings of this study support the effectiveness of paraffin wax bath therapy in improving joint mobility and hand function in children with post-burn contractures (20). Moreover, the combination of paraffin wax with METs yielded superior outcomes compared to paraffin therapy alone. These results advocate for the incorporation of manual therapy techniques alongside thermal modalities in pediatric rehabilitation protocols. Future research should focus on long-term outcomes, inclusion of functional ADL-specific tools, and larger, multi-centered trials to validate and extend these findings.

CONCLUSION

This study concluded that paraffin wax bath therapy combined with Muscle Energy Techniques (METs) was more effective in improving hand function and reducing post-burn hand contractures in children compared to paraffin wax therapy alone. While both interventions led to significant improvements in joint mobility and manual ability, the combined approach showed greater therapeutic benefit. These findings highlight the value of integrating manual therapy techniques with heat-based modalities in pediatric burn rehabilitation, offering a practical and accessible strategy for enhancing recovery and functional independence in affected children.

Author Contributions

Author	Contribution
Aiman Arif	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Syeda Nayab Raza	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
Ramsha Ali	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published
Iqra Khan	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Mymunah Ahmed	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
M Behzad Ali	Substantial Contribution to study design and Data Analysis Has given Final Approval of the version to be published
Adnan Hashim	Contributed to study concept and Data collection Has given Final Approval of the version to be published

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