RESEARCH PAPER

Therapeutic Outcomes of Comparative Efficacy of Kinesiotape and Low-Level Laser Therapy in Treatment of Hypertrophic Scar. A Randomized Controlled Study: Randomized Controlled Trial

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ABSTRACT

Background: Hypertrophic scars resulting from burns pose a significant therapeutic challenge, often leading to contractures, pain, cosmetic disfigurement, and psychological distress, all of which have an impact on patients' quality of life.

Objective: To evaluate the effectiveness of combining Kinesio taping and low-level laser therapy (LLLT) in improving outcomes in post-burn hypertrophic scars.

Methods: Sixty participants aged 10–30 years with post-burn hypertrophic scars resulting from second-degree burns were included. All participants had scars that had completely healed between two months and four years prior to the study. Participants with skin phototype IV and scars located on the upper or lower limbs were included. Participants were randomly assigned to one of three groups: Group A received Kinesio tape and medication, Group B received LLLT and medication, and Group C received both Kinesio tape and LLLT and medication. All interventions were administered three times a week for 8 weeks, alongside a standardized scar management protocol. Scar firmness was assessed using a modified Schiotz tonometer, and pain intensity was measured using the Visual Analogue Scale (VAS), both before and after the intervention.

Results: All groups showed significant improvement in scar firmness post-intervention ($p < 0.001$), with the greatest improvement observed in Group C, followed by Group A. Intergroup differences in post-treatment scar firmness were statistically significant ($p < 0.05$). VAS scores also improved significantly in all groups ($p < 0.001$), with Group C showing the greatest reduction in pain. Significant differences in VAS scores were noted between the groups ($p < 0.05$) following the treatment.

Conclusion: Combining Kinesio taping with LLLT resulted in superior improvements in post-burn scar outcomes compared to either treatment alone. However, given the small sample size in this study, these findings should be interpreted with caution, and further research with larger samples is necessary to validate them. This combined approach may offer potential for inclusion in rehabilitation protocols for hypertrophic burn scars, but further studies are needed to confirm its efficacy.

Keywords: Hypertrophic scar, Schiotz tonometer, Kinesio taping, Low-Level LASER therapy, Visual Analog Scale

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INTRODUCTION

Hypertrophic scars and keloids develop from skin trauma that extends deep enough to affect dermal tissue layers. These scars can result from burns, surgical procedures, insect bites, tattoos, acne, chickenpox, and piercings. Although the exact mechanisms remain unclear, various factors are believed to influence aberrant scar development. Systemic inflammation is thought to increase the risk of hypertrophic scars and keloids, and conditions that elevate inflammatory markers may exacerbate both hypertrophic and keloid scarring (Wang et al., 2020).

Several studies suggest that sex hormones may influence keloid formation by intensifying inflammation, leading to collagen overproduction (Ibrahim et al., 2020). Other research indicates that keloid size and number may increase in individuals with hypertension, although the causal relationships remain unclear. Mechanical forces exerted on wounds are crucial in the formation of pathological scars, as heightened skin tension can promote excessive collagen accumulation and increased fibroblast activity. (Zhang & Li-Tsang, 2017).

Hypertrophic scars are frequently associated with persistent pain, pruritus, functional limitations, and significant psychosocial distress that negatively affect patients' quality of life (Trace et al., 2016; Zhang et al., 2020). Various therapeutic options exist; however, each is associated with certain limitations and potential adverse effects. Pruritus represents the most prevalent complication arising from keloids and hypertrophic scars, while pain ranks as the second most common concern. The positioning and dimensions of these scars can influence the mobility of patients, and considerable evidence highlights the psychosocial repercussions of scarring (Trace et al., 2016).

Mechanism of Action for Kinesio taping and Low-Level Laser Therapy (LLLT)

Kinesio taping has been shown to enhance the pliability and cosmetic appearance of hypertrophic scars (HTS), reduce thickness, and decrease the need for surgical intervention by reducing tensile forces on post-burn scars while promoting collagen and laminin production (Tawfik et al., 2018). Proper Kinesio taping has been reported to improve scar pliability, decrease mechanical tension across the scar tissue, and enhance lymphatic drainage, which contributes to improved scar remodeling (Abdalla et al., 2023).

Low-Level Laser Therapy (LLLT) promotes photo-biomodulation by stimulating mitochondrial activity, increasing fibroblast proliferation, and enhancing collagen remodeling within scar tissue (Ibrahim et al., 2020; Wang et al., 2020). Despite these benefits, the research on LLLT for burn scar management remains limited, and further studies are needed to solidify its therapeutic efficacy in hypertrophic scar treatment.

Research Gap and Significance of the Study

Although research exists that supports the individual application of Kinesio taping and low-level laser therapy (LLLT) for hypertrophic scars, there are no studies that have directly compared the combined effects of these treatments on post-burn hypertrophic scars. Previous studies have indicated that Kinesio taping is beneficial for enhancing scar pliability and minimizing scar formation, while LLLT has demonstrated potential in promoting tissue regeneration and decreasing scar tissue. Nevertheless, the synergistic effects of these two therapies have yet to be investigated.

This study aims to fill this gap by evaluating the combined therapeutic effects of Kinesio taping and LLLT on hypertrophic scars following burns. By comparing the outcomes of these treatments individually and in combination, the study aims to provide insights into whether their combined use offers superior benefits over each modality alone. The findings from this study could contribute significantly to the development of effective rehabilitation protocols for post-burn scar management, providing both clinical and emotional benefits to patients suffering from the consequences of burn injuries.

MATERIAL AND METHODS:

Study Design:

The current research employed a randomized, controlled trial (RCT) design with pre- and post-experimental measures. The study was single-blinded, the outcome assessor was also blinded to the group assignment to minimize potential bias in the measurements. Ethical approval was obtained from the Research Ethics Committee of the Faculty of Physical Therapy, Badr University (Ref. No: IRB00014233-46). Written informed consent was obtained from participants before they participated in the study. The study was registered at ClinicalTrials.gov (NCT07209891) on 2-11-2025.

Participants:

Sixty participants with hypertrophic scarring resulting from burn injuries, aged 10–30 years, were enrolled from the Outpatient Clinic of the Faculty of Physical Therapy, Cairo University, Giza, Egypt. Participants were randomly allocated to three equal groups: Group A (Kinesio Tape), Group B (Low-Level Laser Therapy), and Group C (Combination of Kinesio Tape and Low-Level Laser Therapy). All participants received comprehensive information regarding the characteristics and potential outcomes of the measurement and treatment procedures.

Selection Criteria:

Inclusion Criteria: Participants of either sex, aged 10–30 years, with clinically diagnosed hypertrophic scars secondary to second-degree burns after complete healing. The scars should have occurred between two months and four years after complete wound healing. This wide range was chosen to encompass different stages of scar maturation and ensure that the treatment could be evaluated across a variety of scar conditions, recognizing that scar pliability may vary across this time span (for example, scars at 2 months may still be more rigid, whereas scars at 4 years are likely more stabilized). Participants should have skin phototype IV and scars located on the upper and lower limbs. Excluded were individuals with other systemic or local pathologies that could affect scar characteristics or treatment response, such as previous treatment for hypertrophic scars or active conditions that could influence healing (e.g., diabetes, immunosuppression). Participants must have the ability and willingness to comply with the treatment protocol and attend all scheduled sessions. Exclusion Criteria: Participants were excluded if they had

open wounds or ulceration at or near the scarred area, systemic conditions like uncontrolled diabetes mellitus, cardiovascular disease, or a history of skin malignancy in the treatment region. Other exclusion factors included deep vein thrombosis (DVT), non-adherence, unwillingness to participate, or inability to follow the protocol. Participants with cognitive impairment, psychiatric illness, or communication barriers affecting informed consent or participation were also excluded.

Randomization and Allocation:

Participants were randomly assigned to the treatment groups using a computer-generated randomization sequence. Allocation concealment was ensured through the use of sealed, opaque envelopes. Randomization occurred after baseline assessments by an independent researcher who was not involved in the treatment or outcome assessment, thus ensuring unbiased treatment assignment.

Intervention

The participants were divided into three equal groups:

Group A (Kinesio Tape Therapy Group):

Participants in Group A received Kinesio taping applied over the hypertrophic scar according to standardized therapeutic guidelines. The tape was applied with 25–50% tension to reduce mechanical stress across the scar and enhance tissue mobility, following the guidelines from Abdalla et al. (2023). The treatment was administered three times weekly for 8 consecutive weeks.

Group B (Low-Level Laser Therapy Group):

This group included 20 patients (9 males, 11 females) with post-burn hypertrophic scars who underwent low-level laser therapy (LLLT) alone. The Giotto MED SPA—Italy—Ga-As low-level laser device was utilized with the following specifications: 905 nm wavelength, 16.2 J/cm² energy density, 3000 Hz frequency pulsed mode, and 30 W maximum output power. A circular cluster probe configuration with three output beams (30 W each) was used. The length of therapy varied depending on the scar size. The treatment was given three times weekly for 8 weeks.

Group C (Kinesio Tape and Low-Level Laser Therapy Group):

This group included 20 patients (8 males, 12 females) who received both Kinesio tape and LLLT. The combined treatment was applied three times weekly for 8 weeks, with the tape being replaced after each LLLT session to ensure that both interventions were maximally effective.

Outcome Measures:

Schiotz Tonometer:

The Riester Schiotz tonometer (Germany, 0124) was used as an objective tool to evaluate hypertrophic scar elasticity. The tonometer was adapted for dermatological assessment by measuring tissue firmness through indentation. A weighted plunger applies standardized pressure to the scar surface, and the depth of indentation indicates tissue pliability. Lower readings reflect firmer scars, and higher readings indicate softer tissue. This method is reliable for assessing the firmness of scar tissue (Cordero, 2014).

Pain Assessment by Visual Analogue Scale (VAS):

The VAS is a commonly used tool to measure pain intensity on a scale from 0 to 100. The scale is continuous, with higher values reflecting greater pain intensity (Delgado et al., 2018). Participants indicated their pain intensity by marking a point on a 10-cm line between “no pain” and “worst pain”. This measure is reliable for tracking pain intensity in various medical conditions, including post-burn pain (Weigl & Forstner, 2021).

Sample Size Calculation:

The sample size was calculated using G*Power software (version 3.0.10), considering an effect size of 0.5 (moderate effect), $\alpha = 0.05$, and power = 0.80. This analysis determined that 60 participants (20 per group) would provide sufficient power to detect significant differences between groups in scar elasticity and pain reduction.

Medications and Dosage:

Participants were given a standardized pain medication regimen (Ibuprofen 400 mg three times daily) as per the usual protocol for post-burn patients to manage any discomfort unrelated to the interventions. The medication was not expected to influence the primary outcomes (scar elasticity or pain reduction specifically due to the interventions).

Side Effects of Interventions:

There were no significant adverse effects reported from the Kinesio taping or LLLT. Minor irritation from the tape was noted in a few participants, but this did not result in discontinuation. No side effects related to LLLT were observed.

Data analysis and statistical design

Data presentation utilized the mean ± SD format. The Shapiro-Wilk test assessed the normality of the data distribution. Within-group and between-group effects for measured variables were compared using MANOVA, with Bonferroni post hoc testing for between-group comparisons. Data analysis procedures utilized the Statistical Package for the Social Sciences (SPSS) software (version 20 for Windows; SPSS Inc., Chicago, Illinois, USA). Significance levels were established at $P \leq 0.05$.

RESULTS

This study aimed to evaluate the effectiveness of combining Kinesio taping (KT) and low-level laser therapy (LLLT**)** in improving post-burn hypertrophic scar outcomes. Sixty participants were divided into three equal groups: Group A (Kinesio tape + medication), Group B (LLLT + medication), and Group C (Kinesio tape + LLLT + medication).

Demographic and baseline characteristics of all groups are provided in Table 1. The mean age ± SD for Group A, Group B, and Group C were 19.7 ± 4.17, 20.2 ± 3.72, and 21.8 ± 2.07 years, respectively. The mean weight ± SD was 62.45 ± 8.64, 66.5 ± 6.72, and 66.95 ± 7.01 kg, respectively. Height, BMI, and gender distribution were also comparable across groups. Statistical analysis (ANOVA) revealed no significant differences in age, weight, height, BMI, or gender distribution among the three groups ($p > 0.05$). Participants had second-degree burns, all located on the upper and lower limbs, and had skin phototype IV. Pain intensity was assessed using the Visual Analogue Scale (VAS) at baseline. Figure 1 shows the CONSORT flowchart, illustrating participant allocation and attrition.

Table 1: Demographic and Baseline Data

Characteristic	Group A (n=20)	Group B (n=20)	Group C (n=20)	F-value	p-value
Age (years)	19.7 ± 4.17	20.2 ± 3.72	21.8 ± 2.07	2.03	0.140
Weight (kg)	62.45 ± 8.64	66.5 ± 6.72	66.95 ± 7.01	2.18	0.122
Height (cm)	165.15 ± 8.62	169.1 ± 7.56	169.5 ± 7.76	1.80	0.173
BMI (kg/m²)	23.13 ± 1.52	23.2 ± 1.02	23.27 ± 1.06	0.06	0.941
Gender (M/F)	9 (45%) / 11 (55%)	8 (40%) / 12 (60%)	9 (45%) / 11 (55%)	0.14	0.934
Skin Phototype (IV)	20 (100%)	20 (100%)	20 (100%)	-	-
Burn Type	2nd degree	2nd degree	2nd degree	-	-
Pain Intensity (VAS)	7.11 ± 1.13	7.00 ± 1.03	7.21 ± 1.03	0.826	0. 7

F-value: ANOVA, F value p-value: Probability value M/F: Male/Female

Data screening procedures evaluated normality assumptions, variance homogeneity, and the presence of extreme scores. The Shapiro-Wilk normality test indicated normal distribution patterns for all measured variables (hypertrophic scar elasticity and pain). Mixed MANOVA procedures examined treatment influences on measured variables. Statistical analysis revealed significant interaction effects between treatment × time ($p = 0.001$) and significant temporal effects ($p = 0.001$). Treatment effects also demonstrated statistical significance ($p = 0.017$).

Hypertrophic Scar Elasticity:

Inter-group comparison analysis identified statistically significant post-study variations among the three groups ($p = 0.004$). Bonferroni testing indicated no statistically significant variation between Groups A and B ($P = 0.999$). Conversely, Group C demonstrated a statistically significant increase in hypertrophic scar elasticity relative to Group A ($p = 0.007$) and Group B ($p = 0.025$). Intra-group comparison revealed statistically significant mean value increases for hypertrophic scar elasticity across Groups A, B, and C when comparing post-study with pre-study measurements ($p = 0.001$) (Tables 2 and 2.a).

Pain Level (VAS):

Inter-group comparison demonstrated statistically significant post-study variations among the three groups ($p = 0.001$). Bonferroni analysis showed statistically significant pain reduction in Group B compared with Group A ($P = 0.001$) and in Group C compared with Group A ($P = 0.001$). No statistically significant variation occurred between Groups B and C ($P = 0.898$). Intra-group comparison revealed statistically significant mean value decreases for pain levels across Groups A, B, and C when comparing post-study with pre-study assessments ($p = 0.001$) (Tables 3 and 3.a).

Table 2: Comparison Between Pre- and Post-study Mean Values of Hypertrophic Scar Elasticity (mmHg)

Hypertrophic Scar Elasticity (mmHg)	Kinesio Tape (Group A)	Low-Level Laser (Group B)	Kinesio Tape and Low-Level Laser (Group C)	P value	η²
Pre-study	9.19 ± 3.35	10.27 ± 4.19	9.92 ± 3.8	0.679	0.014
Post-study	14.87 ± 3.9	15.67 ± 4.9	19.49 ± 4.13	0.004*	0.182
MD (95% CI)	-5.68 (-6.5, -4.8)	-5.4 (-6.2, -4.6)	-9.57 (-10.4, -8.7)		
(P-value)	0.001*	0.001*	0.001*		

Table 2.a: Bonferroni Test for Between-group Comparison Post-study for Hypertrophic Scar Elasticity

Comparison	Group A vs B	Group A vs C	Group B vs C
MD (95% CI)	-0.8 (-4.3, 2.7)	-4.62 (-8.2, -1.1)	-3.82 (-7.3, -0.36)
p-value	0.999	0.007*	0.025*

Table 3: Comparison Between Pre- and Post-study Mean Values of Pain (VAS)

Pain by VAS (cm)	Kinesio Tape (Group A)	Low-Level Laser (Group B)	Kinesio Tape and Low-Level Laser (Group C)	P value	η²
Pre-study	7.11 ± 1.13	7 ± 1.03	7.21 ± 1.03	0.826	0.007
Post-study	4.33 ± 1.08	2.85 ± 0.67	2.58 ± 0.61	0.001*	0.483
MD (95% CI)	2.78 (2.41, 3.14)	4.15 (3.8, 4.5)	4.63 (4.28, 5)		

Table 3. a: Bonferroni Test for Between-group Comparison Post-study for Pain

Comparison	Group A vs B	Group A vs C	Group B vs C
MD (95% CI)	1.48 (0.83, 2.13)	1.75 (1.1, 2.41)	0.27 (-0.37, 0.91)
p-value	0.001*	0.001*	0.898

Data is represented as mean ± SD, significant, η²: partial eta square, MD: mean difference, CI: confidence interval.

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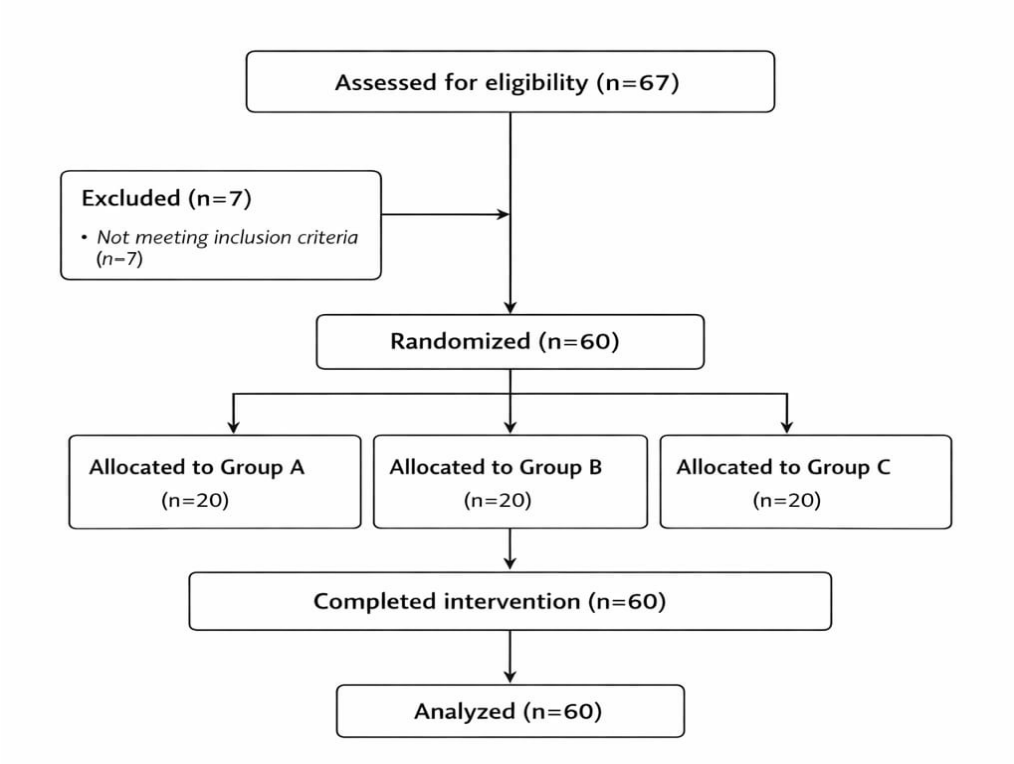

Fig 1: Flow chart of study participants.

DISCUSSION:

This study aimed to evaluate the combined therapeutic effects of Kinesio taping (KT) and Low-Level Laser Therapy (LLLT) on post-burn hypertrophic scars. Our results showed that both KT and LLLT significantly improved scar elasticity and pain reduction in post-burn hypertrophic scars. However, the combined treatment of KT + LLLT (Group C) yielded the most significant improvements in both outcomes, surpassing the effectiveness of either treatment alone. These findings suggest that the combination of KT and LLLT could offer a promising approach for managing post-burn hypertrophic scars by improving both physical and psychological aspects of recovery.

Kinesio taping (KT) demonstrated significant improvements in both scar elasticity and pain relief. Group A (KT group) showed a statistically significant improvement in scar elasticity ($p = 0.001$) and pain reduction ($p = 0.001$) after the 8-week treatment period. The mechanism of action for KT involves reducing tensile forces on the scar tissue by improving skin pliability and enhancing blood circulation and lymphatic drainage. By reducing tension and promoting tissue mobility, KT helps prevent the formation of excess scar tissue and supports the remodeling of the scar (Zieliński et al., 2008).

Previous studies support the beneficial effects of Kinesio taping on hypertrophic scars. Abdalla et al. (2023) reported significant improvements in scar elasticity, pain, and functional outcomes in patients with post-burn hypertrophic scars. Similarly, Moortgat et al. (2015) demonstrated reduced scar tension and improved scar distensibility following Kinesio taping, while Goodridge et al. (2011) reported improvements in scar pliability and pain. These findings are consistent with the present study, supporting the effectiveness of Kinesio taping in improving scar quality and reducing pain.

Low-Level Laser Therapy (LLLT) also showed significant improvements in scar elasticity and pain reduction. Group B (LLLT group) exhibited a significant increase in scar elasticity ($p = 0.001$) and a reduction in pain ($p = 0.001$). The mechanism of action for LLLT involves photo-biomodulation, where specific wavelengths of light stimulate cellular activities such as fibroblast proliferation, collagen synthesis, and tissue regeneration (Gauglitz, 2017). By increasing blood circulation and reducing inflammation, LLLT helps accelerate the healing process and improve scar characteristics.

Our findings are consistent with previous studies examining the effects of LLLT on hypertrophic scars. For instance, Ucci et al. (2025) reported that LLLT at specific power densities could reduce fibroblast proliferation and collagen synthesis, two key factors in hypertrophic scar formation. Additionally, Suter et al. (2017) found that LLLT promoted wound healing, reduced inflammation, and supported tissue regeneration, confirming its beneficial effects in scar management. These studies, along with our findings, support LLLT as an effective modality for improving hypertrophic scar outcomes.

The combined application of Kinesio taping and low-level laser therapy produced the greatest improvements in scar elasticity and pain reduction compared with either intervention alone. These findings suggest a synergistic therapeutic effect, whereby Kinesio taping reduces mechanical tension and improves tissue mobility, while low-level laser therapy enhances tissue repair through photobiomodulation and modulation of the inflammatory

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response. Consequently, the combined intervention may optimize scar remodeling by targeting complementary mechanical and biological pathways. These findings are consistent with previous reports demonstrating the beneficial effects of Kinesio taping on scar pliability and the positive role of low-level laser therapy in tissue repair and scar remodeling (Harvey, 2022; Morais et al., 2017).

Previous research has suggested that combining mechanical therapy (KT) and light-based therapy (LLLT) can enhance therapeutic effects by targeting different layers of scar tissue. Harvey (2022) found that KT could improve scar pliability, while Morais et al. (2017) showed that LLLT could promote tissue regeneration. Our study aligns with these findings, as the combined approach (Group C) resulted in the most significant improvements in scar pliability and pain relief.

Our results are in agreement with those of Harvey (2022) and Morais et al. (2017) who showed the effectiveness of KT in preventing hypertrophic scarring in post-cesarean section patient and in improving scar characteristics and reducing the need for surgical interventions. These studies, combined with our findings, suggest that KT is an effective treatment modality for hypertrophic scars.

Laser-based therapies have demonstrated promising outcomes in scar remodeling by reducing inflammation and improving collagen organization within hypertrophic scar tissue (Zhang et al., 2020).

While this study provides valuable insights into the effects of KT and LLLT on post-burn hypertrophic scars, there are several limitations to consider:

1. **Sample Size:** The relatively small sample size of 60 participants may limit the generalizability of the findings. Future studies with larger sample sizes would provide more robust conclusions.
2. **Follow-up Duration:** This study had a short follow-up period (8 weeks), and longer-term follow-up is needed to assess the sustainability of the improvements in scar elasticity and pain reduction.
3. **Measurement Methods:** While the Schiotz tonometer and VAS are reliable tools, future studies could benefit from more objective, quantitative measures of scar tissue, such as 3D imaging or histological analysis, to better assess the cellular changes in hypertrophic scars.
4. **Larger Cohorts and Long-term Follow-up:** Further research with larger cohorts and longer follow-up periods is necessary to confirm the long-term benefits of KT and LLLT, particularly in terms of scar prevention and cosmetic appearance over time.
5. **Mechanistic Studies:** Future studies should investigate the molecular mechanisms underlying the combined effects of KT and LLLT, focusing on the cellular pathways involved in fibroblast activity, collagen production, and scar remodeling.

CONCLUSION

In conclusion, the combination of Kinesio taping and Low-Level Laser Therapy proved to be an effective treatment for improving hypertrophic scars following burn injuries. The combined approach resulted in superior outcomes for both scar elasticity and pain reduction, making it a promising treatment option. However, further research with larger sample sizes, longer follow-up, and more objective outcome measures is needed to confirm the long-term efficacy and to optimize treatment protocols.

Ethics Approval and Consent to participate

Ethical approval was obtained from the Research Ethics Committee of the Faculty of Physical Therapy, Badr University (Ref. No: IRB00014233-46).

Clinical Trial Number (NCT07209891).

Availability of Data and Materials

The original contributions presented in this study are included in the article. Further Inquiries can be directed to the corresponding author.

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Declaration of competing interest

The authors declare no competing financial or personal interests.

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