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Comparative Study of the Effects of Tecar Therapy, Extracorporeal Shock Wave Therapy, and Massage Therapy in the Management of Dorsal Hand Hypertrophic Scars: A Prospective Randomized Controlled Study

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ABSTRACT:

Background: Hypertrophic scars of the dorsal hand can cause pain, stiffness, impaired elasticity, and functional limitations. Although several treatment modalities are available, an established gold-standard treatment has not been identified. This study aimed to compare the effects of Tecar therapy combined with massage, extracorporeal shock wave therapy (ESWT) combined with massage, and massage therapy alone in the management of dorsal hand hypertrophic scars.

Methods: This prospective, randomized controlled study included 45 adults with clinically stable hypertrophic scars of the dorsal hand. Participants were randomly assigned to three groups (n=15 each): Tecar therapy plus massage, ESWT plus massage, or massage therapy alone. Interventions were administered for 6 weeks, with outcomes assessed at baseline, week 6, and week 8. Pain intensity, scar elasticity, scar characteristics, and hand function were evaluated using the Visual Analogue Scale (VAS), durometer measurements, Vancouver Scar Scale (VSS), and Disabilities of the Arm, Shoulder and

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Hand (DASH) questionnaire, respectively. Statistical analyses included one-way ANOVA, paired t-tests, Tukey HSD post-hoc comparisons, and Cohen's d effect sizes.

Results: All three groups demonstrated significant improvements in pain, elasticity, scar appearance, and hand function at week 8 ($p<0.001$). ESWT plus massage produced the greatest improvements, with pain reduction of 52.7%, elasticity improvement of 40.9%, VSS reduction of 48.2%, and DASH improvement of 53.6%. Tecar plus massage achieved corresponding changes of 47.0%, 36.8%, 42.9%, and 47.9%, while massage alone achieved 29.2%, 22.4%, 24.5%, and 30.4%, respectively. Between-group differences were statistically significant for all primary outcomes ($p<0.001$). The overall clinical responder rate was 100% for ESWT plus massage, 73% for Tecar plus massage, and 20% for massage alone. No serious adverse events were reported.

Conclusion: ESWT combined with massage and Tecar therapy combined with massage were effective and well-tolerated non-invasive treatments for dorsal hand hypertrophic scars. ESWT plus massage demonstrated the greatest improvements across pain, elasticity, scar appearance, and functional outcomes. Larger multicenter studies with longer follow-up are warranted to confirm these findings.

INTRODUCTION

Hypertrophic scar occurs from an abnormal wound healing process that involves excessive dermal collagen production. It may affect patients in several ways, such as pruritic sensation, scar tenderness, and limited range of motion. These negatively impact the quality of life of patients.[1] The reported incidences of hypertrophic scars following surgical incision wounds ranged from 40 to 70%. However, incidences of up to 90% have been reported after burns, especially in individuals with a higher Fitzpatrick skin tone.[2]

Approximately 1,200 patients seek hypertrophic scar treatment annually at our outpatient plastic surgery department. Currently, there is no established gold standard for hypertrophic scar treatment since the responses to treatment and recurrence rates have varied. Several treatment modalities have been combined for hypertrophic scar treatment, such as intralesional steroid injections, pressure dressings, surgical excision, pulsed dye lasers, and radiation therapy.

However, no combination proved to be successful curative therapy. Furthermore, most modalities require multiple treatment sessions and have adverse effects associated with their use. Therefore, a noninvasive treatment modality with good efficacy could be a preferable treatment option.[2,3]

Extracorporeal shock wave therapy (ESWT) has been widely used as a noninvasive and well-tolerated treatment for tendinopathy in general. It is also used for other orthopaedic diseases, nephroureterolithiasis, ischemic cardiovascular disease, burn wound scars, acute and chronic wounds.

The wide range of applications highlights the versatile benefits and regenerative potential of ESWT.[4-11] ESWT transmits a mechanical force via an acoustic wave to facilitate wound healing. The force stimulates the release of neuropeptides from nerve endings and improves wound healing.

Furthermore, it also stimulates fibroblasts, which are mechanoresponsive cells and play a role in remodeling of the extracellular matrix in wound healing and scars.[12-20] The molecular mechanism of ESWT has not yet been fully identified. However, induction of angiogenesis via stimulation of toll-like receptor 3 during ESWT was proposed in the literature, possibly indicating the benefits of soft tissue regeneration.[21,22] In the research by Fioramonti et al, the effectiveness of ESWT for burn scars was found to be promising, with no adverse events observed.[4]

In this current study we aim to compare the effectiveness of extracorporeal shock wave therapy combined with massage, Tecar therapy combined with massage, and massage therapy alone in the treatment of hypertrophic scars, by evaluating pain, scar characteristics, and functional outcomes using validated clinical scales.

METHODS

Study Design

This study was designed as a prospective, randomized controlled trial with three parallel groups evaluated over an 8-week treatment period. Forty-five participants with hypertrophic scars of the dorsal hand were randomly assigned to three intervention groups at a 1:1:1 ratio: Group A (Tecar Therapy combined with massage therapy), Group B (Extracorporeal Shock Wave Therapy combined with massage therapy), and Group C (massage therapy alone). All procedures adhered to the Standard Protocol Items: Recommendations for Interventional Trials (SPIRIT) guidelines.

Participants

Inclusion Criteria:

- Adults aged 18-75 years
- Patients with post-traumatic or post-burn hypertrophic scar on the dorsal hand (>=3 months duration)
- Clinically stable scars without active infection or ulceration
- Vancouver Scar Scale score>=6 at baseline assessment
- Willing to participate and provide informed consent

Exclusion Criteria:

- History of hypertrophic scar-related treatment within 2 months prior to enrollment
- Conditions or risk factors for impaired wound healing
- Pregnancy
- Keloid scars
- Metal implants or pacemaker (contraindication for Tecar therapy)
- Open wounds or infection in the treatment area
- Previous scar surgery or laser therapy in the past 3 months

Sample Size Calculation

The required sample size was calculated based on expected differences in the primary outcome measure (scar elasticity via durometer measurements) among the three groups. A sample size of 13 patients per group was determined to provide 80% power to detect significant differences at an alpha level of 0.05 using one-way analysis of variance (ANOVA). Accounting for a potential dropout rate of approximately 15-20%, the total sample size was set at 45 participants (15 per group).

Interventions

Group A: Tecar Therapy + Massage Therapy

Participants received Tecar (Capacitive and Resistive Electric Transfer) therapy combined with massage therapy. Treatment sessions were supervised by trained physiotherapists two times per week for 6 weeks. Each Tecar session lasted 15 minutes using capacitive and resistive modes at frequency of 0.5-1 MHz with power output adjusted to 30-50% of device capacity (adjusted to patient tolerance). Massage therapy was performed 1-3 times per week for 6 weeks for 5-30 minutes using friction massage techniques applied systematically to the scar tissue.

Group B: Extracorporeal Shock Wave Therapy (ESWT) + Massage Therapy

Participants received ESWT combined with massage therapy. ESWT was delivered once per week for 6 weeks using radial shock wave device at 1500-2000 pulses per session with energy flux density of 0.08-0.15 mJ/mm2 and frequency of 4-6 Hz. Massage therapy was performed 1-3 times per week for 6 weeks for 5-30 minutes using friction massage techniques applied systematically to the scar tissue.

Group C: Massage Therapy Alone

Participants received massage therapy alone, performed 1-3 times per week for 6 weeks. Each session lasted 5-30 minutes using friction massage techniques applied systematically to the scar and surrounding tissues.

Outcome Measures

Primary Outcome Measures:

- Pain intensity: Visual Analogue Scale (VAS, 0-10 points)
- Scar elasticity: Durometer measurements (Shore A scale, units)
- Scar appearance: Vancouver Scar Scale (VSS, 0-15 points)
- Hand function: Disabilities of the Arm, Shoulder and Hand (DASH) questionnaire (0-100 points)

Secondary Outcome Measures:

- Clinical responder rate (>=30% improvement from baseline)
- Patient satisfaction with treatment outcomes
- Adverse events and treatment tolerability

Assessment time points: Baseline, week 6 (post-intervention), and week 8 (follow-up)

Statistical Analysis

One-way ANOVA was used to compare outcomes among three groups. Paired t-tests compared within-group changes from baseline to week 6 and week 8. Post-hoc pairwise comparisons used Tukey HSD test. Cohen d effect sizes were calculated for treatment effects. Chi-square tests compared clinical responder rates. All p-values were two-tailed with significance set at $p<0.05$.

RESULTS

Baseline Characteristics

We enrolled 45 patients randomized into three treatment groups (n=15 per group). The completion rate was 100% as all participants completed the 6-week intervention period and the 8-week follow-up assessment. There was so statistically significant difference among the study groups confirm successful randomization as shown in table 1.

Table 1. Baseline Demographic and Clinical Characteristics

Characteristic	Tecar + Massage (n=15)	ESWT + Massage (n=15)	Massage Alone (n=15)	p-value
Age (years), mean +/- SD	42.8 +/- 8.2	44.8 +/- 7.5	42.3 +/- 8.9	0.68
Gender, n (%)				0.54
Male	9 (60%)	8 (53%)	10 (67%)	
Female	6 (40%)	7 (47%)	5 (33%)	
Scar Duration (months), mean +/- SD	18.2 +/- 8.4	18.8 +/- 8.1	18.2 +/- 8.3	0.43
Body Mass Index (kg/m2), mean +/- SD	24.6 +/- 3.2	25.1 +/- 3.8	24.3 +/- 3.5	0.62

Baseline Outcome Measures

All our study outcomes didn't show any statistically significinat difference all p values were larger than 0.05.

Table 2. Study Outcomes at baseline

Characteristic	Tecar + Massage (n=15)	ESWT + Massage (n=15)	Massage Alone (n=15)	p-value
Visual Analogue Scale (0-10)	7.1 +/- 1.0	7.2 +/- 1.1	7.3 +/- 0.9	0.82
Durometer (Shore A)	40.8 +/- 4.1	41.2 +/- 4.3	41.5 +/- 3.9	0.78
Vancouver Scar Scale (0-15)	11.4 +/- 1.6	11.2 +/- 1.5	11.0 +/- 1.4	0.71
DASH Questionnaire (0-100)	70.2 +/- 9.1	68.4 +/- 8.9	69.8 +/- 8.7	0.73

Within-Group Changes

All three treatment groups experienced statistically significant improvements by week 8 post-intervention across all primary outcome measures as presented in details at table 3.

Table 3. Within-Group Changes from Baseline to Week 8

Outcome Measure	Group	Baseline	Week 8	% Change	p-value	Cohen's d
Visual Analogue Scale (Pain)	Tecar + Massage	7.1 +/- 1.0	3.8 +/- 1.4	-47.0%	<0.001	2.86
	ESWT + Massage	7.2 +/- 1.1	3.4 +/- 1.3	-52.7%	<0.001	3.24
	Massage Alone	7.3 +/- 0.9	5.2 +/- 1.6	-29.2%	<0.001	1.25
Durometer (Elasticity)	Tecar + Massage	40.8 +/- 4.1	55.8 +/- 4.2	+36.8%	<0.001	3.68
	ESWT + Massage	41.2 +/- 4.3	58.3 +/- 3.8	+40.9%	<0.001	4.15
	Massage Alone	41.5 +/- 3.9	50.8 +/- 4.7	+22.4%	<0.001	2.15
Vancouver Scar Scale	Tecar + Massage	11.4 +/- 1.6	6.5 +/- 1.4	-42.9%	<0.001	3.22
	ESWT + Massage	11.2 +/- 1.5	5.8 +/- 1.2	-48.2%	<0.001	3.45
	Massage Alone	11.0 +/- 1.4	8.3 +/- 1.8	-24.5%	<0.001	1.85
DASH Questionnaire	Tecar + Massage	70.2 +/- 9.1	36.5 +/- 10.2	-47.9%	<0.001	3.35
	ESWT + Massage	68.4 +/- 8.9	31.7 +/- 9.5	-53.6%	<0.001	3.87
	Massage Alone	69.8 +/- 8.7	48.6 +/- 11.3	-30.4%	<0.001	1.96

Between-Group Comparisons

One-way analysis of variance showed statistically significant differences in treatment effects among the three groups for all primary outcome measures showing ESWT superiority (Table 4).

Table 4. Between-Group Comparisons at Week 8

Outcome Measure	F-value	p-value	Post-hoc Comparisons
Visual Analogue Scale (Pain)	$F(2,42)=18.4$	<0.001	ESWT>Tecar ($p=0.008$); ESWT>Control ($p<0.001$); Tecar>Control ($p=0.012$)
Durometer (Elasticity)	$F(2,42)=24.6$	<0.001	ESWT > Tecar ($p<0.001$); ESWT > Control ($p<0.001$); Tecar>Control ($p<0.001$)
Vancouver Scar Scale	$F(2,42)=21.3$	<0.001	ESWT>Tecar ($p=0.004$); ESWT>Control ($p<0.001$); Tecar>Control ($p<0.001$)
DASH Questionnaire	$F(2,42)=19.8$	<0.001	ESWT>Tecar ($p=0.006$); ESWT>Control ($p<0.001$); Tecar>Control ($p<0.001$)

Cohen's d effect sizes were calculated for all pairwise comparisons to quantify the magnitude of treatment differences (Table 5).

Table 5. Effect Sizes and Clinical Significance

Comparison	Cohen's d	Interpretation	Clinical Significance
Pain Reduction: ESWT vs Control	1.99	Large	100% vs 56% responder rates
Pain Reduction: Tecar vs Control	1.61	Large	92% vs 56% responder rates
Pain Reduction: ESWT vs Tecar	0.38	Small	Comparable efficacy
Elasticity: ESWT vs Control	2.00	Very Large	+40.9% vs +22.4% improvement
Elasticity: Tecar vs Control	1.53	Large	+36.8% vs +22.4% improvement
Elasticity: ESWT vs Tecar	0.47	Small	Comparable efficacy
Functional Recovery: ESWT vs Control	1.91	Large	53.6% vs 30.4% improvement
Functional Recovery: Tecar vs Control	1.39	Large	47.9% vs 30.4% improvement
Functional Recovery: ESWT vs Tecar	0.52	Small	Comparable efficacy

Clinical Responder Analysis

Responder analysis examined the proportion of patients achieving clinically meaningful improvement, defined as>=30% reduction from baseline (Table 6).

Table 6. Clinical Responder Analysis

Outcome	Tecar + Massage	ESWT + Massage	Massage Alone	p-value
Pain Response (>=30% improvement)	14/15 (93%)	15/15 (100%)	8/15 (53%)	<0.001
Elasticity Response (>=30% improvement)	13/15 (87%)	15/15 (100%)	7/15 (47%)	<0.001
VSS Response (>=30% improvement)	12/15 (80%)	15/15 (100%)	6/15 (40%)	<0.001
DASH Response (>=30% improvement)	13/15 (87%)	15/15 (100%)	7/15 (47%)	<0.001
Overall Composite Response	11/15 (73%)	15/15 (100%)	3/15 (20%)	<0.001

No serious adverse events were reported during the study period only 3 patients complained mild transient erythema was reported by (20%) in Group A after Tecar therapy sessions and less than that there was 2 patients (13.3%) in Group B following ESWT sessions. All reported erythema resolved within 24 hours without intervention. No patients discontinued treatment due to adverse events. No skin breakdown, infection, or other complications were observed in any treatment group.

DISCUSSION

This randomized controlled trial evaluated extracorporeal shock wave therapy (ESWT) and Tecar therapy, both combined with massage, compared to massage alone for treating hypertrophic scars. Both active treatments showed superiority outcomes across pain, elasticity, appearance, and function measures as we are going to discuss.

ESWT reduced pain by 52.7% ($p<0.001$), Tecar by 47.0% ($p<0.001$), and massage control by 29.2% ($p<0.001$). The 100% responder rate for ESWT demonstrates clinically meaningful superiority. Moortgat et al. (2020) observed pain improvements in both ESWT and control groups (pain decreased from 2.90 to 1.35 in ESWT group versus 2.65 to 1.55 in placebo), though they found no statistically significant interaction between intervention and time for pain outcomes.[23]

However, Aguilera-Sáez et al. (2022) presented contrasting results in their RCT of 40 burn scar patients who received 512 impulses of 0.15 mJ/mm^2 ESWT twice weekly for 4 weeks. Nonetheless, they found that "the results failed to show statistically significant differences between the ESWT and the control group neither at two weeks after treatment nor at 5 months after treatment" ($p>0.05$). The authors concluded that their study "questions the relevance of ESWT as adjunctive treatment for burn scars as far as outward appearance, pain and pruritus as end-results are concerned." This discrepancy may reflect their lower energy density compared to our protocol.[24]

ESWT improved elasticity by 40.9% ($p<0.001$), surpassing Tecar (36.4%) and control (22.3%). Moortgat et al. (2020) strongly support these findings, demonstrating significant elasticity improvements with ESWT compared to placebo using cutometry measurements. They reported "a statistically significant interaction between the intervention and time with moderate effect size on elasticity, $F(3,114)=4.562$, $p=0.011$, partial $\eta^2=0.107$" with "a statistically significant mean difference of 0.23 mm for elasticity between the interventions after six months in favour of the intervention group, $F(1,37)=9.288$, $p=0.004$, partial $\eta^2=0.201$."

Their elasticity values improved from 0.46 to 0.77 mm in the ESWT group versus 0.48 to 0.54 mm in placebo, supporting our durometer findings.[23]

In contrast, Nedelec et al. (2019) found no long-term massage benefit on elasticity in their 12-week RCT of burn survivors (70 enrolled, 60 completed). Their within-patient control design showed both massage and control scars improved equally over time with no significant group effect. They stated: "The immediate impact of forces applied during massage therapy may lead patients and therapists to believe that there are long-term changes in elasticity, erythema, and pigmentation, however, once baseline measures, the control scar, and time were incorporated in the analysis there was no evidence of long-term benefit." This contradicts our control group's 22.3% elasticity improvement, possibly due to methodological differences.[25]

Vancouver Scar Scale scores improved 49.0% with ESWT, 43.0% with Tecar, and 25.0% with control (all $p<0.001$). Moortgat et al. (2020) reported mixed results with POSAS appearance scores, finding significant improvements only in specific subscales. They noted improvements in stiffness (from 6.35 to 3.55 in ESWT versus 6.70 to 4.20 in placebo, $p=0.027$) and overall opinion (from 5.05 to 3.00 in ESWT versus 4.90 to 3.55 in placebo, $p=0.027$), but concluded that "ESWT can give added value to non-invasive treatment of pathological scars more specifically to improve elasticity in the early phase of healing."[23]

Yang et al. (2025) in their network meta-analysis of non-surgical treatments for post-burn scars found that massage therapy demonstrated the most significant efficacy in reducing VSS score (SUCRA=89.0%), with ESWT plus routine treatment ranking second (SUCRA=63.5%). They concluded that "massage therapy, CO_2 laser therapy and extracorporeal shock wave therapy + routine treatment are the most effective non-surgical treatments for reducing Vancouver Scar Scale score, scar thickness and Visual Analogue Scale score for post-burn scars, respectively." This supports our combined modality approach where ESWT and Tecar were both paired with massage.[26]

DASH scores improved 53.6% with ESWT, 47.9% with Tecar, and 30.4% with control (all $p<0.001$). Moortgat et al. (2020) did not assess functional outcomes directly, focusing instead on scar characteristics. However, they acknowledged that improved elasticity "will probably lead to amelioration in function," which aligns with our observed functional improvements following elasticity gains.[23]

Moortgat et al. (2020) provided mechanistic explanations for ESWT efficacy, noting that "inhibition of the TGF-β1/Smad signalling pathway and decreased fibroblast density are also observed" with ESWT treatment. They explained that "a significant increase in dermal fibroblast like phenotype with low contractility and high migratory ability, small vessel density and precursors of extracellular matrix components, probably leads to new and thinner collagen fascicles and parallel orientation to the dermo-epidermal junction." These molecular mechanisms through mechanotransduction explain the elasticity and functional improvements observed in our study.[23]

Our massage control group achieved significant improvements (pain 29.2%, elasticity 22.3%, VSS 25.0%, all $p<0.002$). Yang et al. (2025) network meta-analysis ranked massage therapy as most effective for VSS score reduction (SUCRA=89.0%), stating that "the mechanisms underlying the efficacy of MT may include its ability to promote collagen remodeling, enhance tissue elasticity, and reduce scar stiffness through mechanical manipulation."[26]

However, Nedelec et al. (2019) strongly contradicted massage effectiveness in their rigorous within-patient controlled trial. They reported: "there was no significant group effect of massage detected for any of the primary outcomes: elasticity ($p=0.180$), erythema ($p=0.247$), melanin ($p=0.073$) and thickness ($p=0.277$)" and concluded that "massage therapy applied with the objective of increasing scar elasticity or reducing erythema or thickness over the long-term should be reconsidered." This highlights the importance of study design, as our independent group design may better capture massage benefits compared to within-patient controls.[25]

There was no serious events reported in cases we enrolled which came in alignment with Moortgat et al. (2020) who similarly reported reassuring ESWT safety, with no treatment discontinuations. They noted that patient-reported pruritus and pain occurred only during treatment sessions without long-term complications.[23] Aguilera-Sáez et al. (2022) also found ESWT well-tolerated.[24]

Both ESWT and Tecar therapy represent effective treatment options for hypertrophic scars, with 100% responder rates demonstrating clinically transformative benefits. While Aguilera-Sáez et al. (2022) questioned ESWT's relevance,[24] the preponderance of evidence from Moortgat et al. (2020)[23] and Yang et al. (2025)[26] network meta-analysis supports combined modality approaches. Our results align with Yang et al. (2025) conclusion that combining ESWT with routine treatment (including massage) produces superior outcomes compared to monotherapy.

Despite the promising results of our study, there are few limitations that should be acknowledged. First limitation is our relatively small sample size and the single center study. This restricts the generalizability of the data over the population. Additionally, one of the other limitations is the short follow up duration. Eight weeks follow up can reflect the results in a short-term period but the rehabilitation should be assessed over longer duration that preferably would last for more than 12 months to 24 months to assure long term efficacy.

For future research we recommend conducting multicenter trials with larger and more diverse populations and longer follow-up periods of 12 to 24 months for better generalizability and tracking of the long-term efficacy. Future studies should consider cost analysis, treatment frequency and dosage in order to assure the intervention's cost effectiveness.

CONCLUSION

Both ESWT combined with massage and Tecar therapy combined with massage showed a statistically significant superiority over massage therapy alone supporting their indication for hypertrophic scars. ESWT showed the highest improvements superior to the other 2 across all outcomes we assessed, with 100% of patients achieving clinically meaningful responses. Both active treatments are safe, well-tolerated, and effective non-invasive options for hypertrophic scar management, offering substantial benefits for pain reduction, tissue elasticity, scar appearance, and functional recovery.

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