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Comparison of Outcome Measures of Different Rehabilitation Programs on Bicipital Tendinitis in Diabetic Elderly

Emad Awad Soliman[*1], Rana Hisham Mohammed[1], Ayman Al-Sayed Shafei[2], Azza Abd El-Aziz Abd-El-Hady[1]

[1] Department of Physical Therapy for Cardiovascular/Respiratory Disorder and Geriatrics, Faculty of Physical Therapy, Cairo University, Egypt.

[2] Consultant of Physical Medicine, Military Hospitals, Dean of Faculty of Medicine, Modern University for Technology & Information, Egypt.

[*]**Corresponding author:** Emad Awad Soliman.

Email: DrEmad1122@gmail.com

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Abstract:

Background: Diabetes mellitus (DM) is a prevalent chronic disease associated with both macrovascular (e.g., cardiovascular disease) and microvascular complications (e.g., diabetic kidney disease, retinopathy, neuropathy), significantly impacting mortality and quality of life. Musculoskeletal complications, including bicipital tendinitis, are common in diabetic patients, often leading to debilitating pain and functional impairment. Non-operative treatments, including physical therapy modalities like shockwave therapy (SWT), low-level laser therapy (LLLT), and Kinesio taping (KT), are widely utilized but require further comparative effectiveness research.

Methods: This study aimed to compare the outcomes of different rehabilitation programs for bicipital tendinitis in elderly diabetic patients. Eighty male subjects aged 60-70 years with clinically diagnosed bicipital tendinitis were randomly assigned to four treatment groups: exercise, LLLT, SWT, and KT. Each group underwent specific treatment protocols over an 8-week period. Outcome measures included Visual Analogue Scale (VAS) for pain, medial to lateral shoulder width, hand grip strength, and shoulder range of motion (ROM), assessed pre- and post-treatment using Musculoskeletal ultrasonography, dynamometer, goniometer, and the Older People's Quality of Life Questionnaire (OPQOL-35). Statistical analyses included ANOVA, Chi-squared test, and mixed MANOVA with Bonferroni corrections.

Results: All treatment groups showed significant improvements in VAS scores ($p < 0.001$), with the LLLT group demonstrating the largest reduction in pain intensity. Medial to lateral shoulder width decreased significantly across all groups ($p < 0.01$), most notably in the exercise group. Hand grip strength increased significantly in the exercise and SWT groups ($p = 0.001$). Shoulder ROM improved significantly in all groups ($p < 0.001$), with the exercise group showing the highest increase in both flexion and extension ROM. Post-hoc analysis revealed significant differences between treatment groups for pain reduction and shoulder ROM improvements.

Conclusion: In conclusion, all rehabilitation modalities (exercise, LLLT, SWT, and KT) effectively improved pain levels, shoulder width, hand grip strength, and ROM in elderly diabetic patients with bicipital tendinitis. However, LLLT and exercise showed superior outcomes in pain reduction, while exercise demonstrated the most substantial improvements in shoulder ROM. These findings support the integration of specific rehabilitation modalities tailored to individual patient needs in managing musculoskeletal complications of diabetes, highlighting the potential benefits of multimodal approaches in clinical practice. Further research is warranted to validate these findings and optimize treatment strategies for diabetic patients with musculoskeletal disorders.

Keywords: Shocwave therapy, Low level laser, Kinesiotaping, Exercise therapy, Bicipital tendinities, Diabetes mellitus, Elderly.

1. Introduction

Diabetes is a rapidly growing global health issue, projected to affect 693 million adults by 2045 (1). This chronic condition is linked to severe complications, both macrovascular (such as cardiovascular disease) and microvascular (including diabetic kidney disease, retinopathy, and neuropathy), which significantly increase mortality, cause blindness, kidney failure, and reduce the overall quality of life (2). Additionally, musculoskeletal complications are common among diabetic patients, leading to significant functional disabilities. The US National Health Interview Survey (US-NHIS) reported that 58% of patients with diabetes have a functional disability due to hyperglycemia-induced abnormalities in the periarticular and skeletal systems, affecting joints, bones, and soft tissues equally (3).

One notable musculoskeletal issue is biceps tendonitis, an inflammation of the Long Head of the Biceps tendon, which is particularly prevalent in diabetics with long-term uncontrolled blood glucose levels. This condition can develop independently or due to an injury, causing significant pain at the front of the shoulder and extending into the biceps muscle. Physical therapy, focusing on rest, anti-inflammatory medications, and exercises to optimize shoulder and rotator cuff movement, is typically the first line of treatment (4).

Bicipital tendinitis is a common musculoskeletal complaint, affecting up to 36% of the population (5). Most cases are initially treated non-operatively, making physical therapy a crucial first-line treatment. Despite numerous treatment regimens, a recent systematic review highlights a lack of high-quality clinical trials comparing different modalities. Taping, laser, and shockwave therapies are widely used in shoulder and elbow rehabilitation, but limited research compares their efficacy (1). Musculoskeletal complications associated with diabetes significantly increase the cost of illness and decrease the quality of life by impairing mobility. Therefore, prioritizing the management of these complications through effective physical therapy is essential.

Various therapeutic modalities are used in physical therapy for tendinopathies, including stretching and strengthening programs, ultrasound, shockwave therapy, deep transverse friction massage, and low-level laser therapy (LLLT) (6). Shockwave therapy (SWT) is effective for several chronic soft-tissue disorders, such as Achilles tendinopathy and plantar fasciitis. Similarly, LLLT uses photons at a non-thermal irradiance to reduce pain and inflammation, promote tissue repair, and prevent tissue damage (7).

Another modality, Kinesio taping, developed by Kenzo Kase in 1996, uses an elastic tape that allows a range of motion while providing support. It is believed to enhance circulation and lymphatic drainage, thus reducing pain, swelling, and muscle spasms. However, more extensive research is needed to confirm its effectiveness (8).

The purpose of this study is to compare the outcomes of four different therapeutic modalities—laser therapy, Kinesio taping, shockwave therapy, and exercise—on bicipital tendinitis in diabetic elderly patients. The research aims to determine if there is a significant difference in the outcomes of these various therapeutic approaches.

1. Methods

2.1 Subject Selection

This study included eighty diabetic elderly men, aged 60 to 70 years, diagnosed with bicipital tendinitis. Participants were randomly selected from various military hospitals and recruited to the Physical Medicine and Rehabilitation Center. Detailed medical histories were obtained to screen for conditions that might affect the study. Subjects were divided into four experimental groups.

2.2 Ethical Consideration
Approval from the faculty ethical committee was obtained before starting the study. All participants were informed about the study, including potential risks and benefits, and provided written informed consent.
2.3 Inclusion Criteria
Participants met the following criteria: Aged 60-70 years, men only, diagnosed with bicipital tendinitis via ultrasonography, symptomatic for at least two weeks, any part of the tendon involved, and diagnosed with diabetes for at least 10 years.
2.4 Exclusion Criteria
Patients were excluded if they had pacemakers (internal or external), history of epileptic seizures, thyroid gland disorders, cancer, history of aortic aneurysm, untreated urinary infections, history of using platelet aggregation inhibitors, bleeding disorders, severe allergic reactions to adhesive tape, or open wounds.

2.5 Instrumentations:

1. **Assessment Instrumentation:**
   - Musculoskeletal Ultrasonography: Non-invasive imaging for diagnosing tendon tears, muscle injuries, ligament sprains, and joint abnormalities.
   - Dynamometer: Measures grip strength to monitor muscle health and rehabilitation progress.
   - Goniometer: Assesses shoulder range of motion (ROM).
   - Older People's Quality of Life Questionnaire (OPQOL-35): Evaluates quality of life across various domains using a 35-item Likert scale.
2. **Procedure Tools:**
   - Laser (Low Level Laser Therapy): Infra-red GaAlAs diode lasers with an 810 nm wavelength, delivering 7 Joules per point over 70 seconds.
   - Shock Wave Therapy: Radial shock wave technology with integrated vibration therapy, delivering 1,500–2,000 pulses at 2.5 bars and 8 Hz.
   - Kinesio Tape: Original Kinesio tape, applied along the bicep muscle and shoulder joint.

2.6 Treatment Procedures:
Participants were divided into four groups of 20 patients each.

1. **Exercise Group:** The exercise program included active elbow flexion and extension, biceps stretch, biceps curl, single-arm shoulder flexion, resisted shoulder internal and external rotation, side-lying external rotation, and sleeper stretch. Sessions were held three times a week, each lasting 60 minutes, for eight weeks.
2. **Low Level Laser Therapy Group:** The treatment consisted of 24 sessions, three times a week for eight weeks, with a total energy delivery of 1680 Joules.
3. **Shock Wave Therapy Group:** The treatment involved 1,500–2,000 pulses at 2.5 bars and 8 Hz, three times a week for eight weeks.
4. **Kinesio taping Group:** Two Y-shaped kinesio strips were applied along the bicep muscle and shoulder joint, with the tape changed every other day for eight weeks.

2.7 Data analysis

Prior to analysis, the normality of data was checked using Shapiro-Wilk test. Levene's test for homogeneity of variances was conducted to test the homogeneity between groups. Data were normally distributed and there was homogeneity of variance. Descriptive statistics and ANOVA test was conducted for comparison of the subject characteristics between groups. Chi squared test were conducted for comparison of sex distribution between groups. Mixed MANOVA was conducted to compare the effect of time (pre versus post) and the effect of treatment (between groups), as well as the interaction between time and treatment on mean values of VAS, medial to lateral width, hand grip strength and shoulder ROM. Post-hoc tests using the Bonferroni correction were carried out for subsequent multiple comparison. The level of significance for all statistical tests was set at $p < 0.05$. Statistical analysis was performed through the statistical package for social studies (SPSS) version 25 for windows.

RESULTS

- *Subject characteristics*:

Table (1) showed the subject characteristics of the group A, B, C and D. There was no significant difference between groups in age, weight, height, BMI and sex distribution ($p > 0.05$).

Table 1. Basic characteristics of participants.

	Group A mean ± SD	Group B mean ± SD	Group C mean ± SD	Group D mean ± SD	p-value
Age (years)	61.75± 1.94	62.42± 2.11	62.2 ± 1.75	63.15 ± 1.63	0.12
Weight (kg)	86.5 ± 10.96	85.47 ± 10.85	85.8 ± 9.57	85.55 ± 9.44	0.98
Height (cm)	171.2 ± 10.34	170.94 ± 8.66	171.45 ± 6.32	171.6 ± 6.41	0.99
BMI (kg/m²)	29.49 ± 2.63	29.23 ± 2.94	29.18 ± 2.83	29.05 ± 2.82	0.96
Sex, n (%)					
Females	7 (35%)	9 (45%)	8 (40%)	10 (50%)	0.79
Males	13 (65%)	11 (55%)	12 (60%)	10 (50%)	

SD, standard deviation; p-value, level of significance

<u>Effect of treatment on VAS, medial to lateral width, hand grip strength and shoulder ROM:</u>

Mixed MANOVA revealed that there was a significant interaction of treatment and time ($F = 14.74$, $p = 0.001$). There was a significant main effect of time ($F = 913.01$, $p = 0.001$). There was a significant main effect of treatment ($F = 3.98$, $p = 0.001$).

- *Within group comparison:*

There was a significant decrease in VAS and medial to lateral width post treatment compared with that pre treatment in the group A, B, C and D ($p < 0.01$). There was a significant increase in hand grip strength of group A post treatment compared with that pre treatment ($p < 0.001$), while there was no significant change in hand grip strength of group B, C and D ($p > 0.05$). There was a significant increase in shoulder ROM post treatment compared with that pre treatment in the group A, B, C and D ($p < 0.001$). (table 2-3).

- Between groups comparison:

There was no significant difference between groups pre treatment ($p > 0.05$). There was no significant difference in hand grip and flexion ROM between groups post treatment ($p > 0.05$). There was a significant decrease in VAS of the group B compared with that of group A ($p = 0.001$) and group C ($p = 0.001$). There was a significant decrease in VAS of the group D compared with that of group A ($p = 0.001$) and C ($p = 0.001$). There was no significant difference in VAS between group A and C ($p = 0.14$) and between group B and D ($p = 0.81$). There was a significant decrease in medial to lateral width of the group A compared with that of B ($p < 0.01$), group C ($p < 0.001$) and group D ($p < 0.01$). There was no significant difference in medial to lateral width between group B and C, group B and D and between group C and D ($p > 0.05$). (Table 4)

There was a significant increase in extension and abduction ROM of group A compared with that of group C ($p < 0.001$) and group D ($p < 0.05$). There was a significant increase in extension and abduction ROM of group B compared with that of group C ($p < 0.01$). There was no significant difference in extension and abduction ROM between group A and B, group B and D and between group C and D ($p > 0.05$). There was a significant increase in adduction ROM of group D compared with that of group A ($p = 0.03$), group B ($p = 0.01$) and group C ($p = 0.001$). There was no significant difference in adduction ROM between group A and B, group A and C and between group B and C post treatment ($p > 0.05$). There was a significant increase in external and internal rotation ROM of group D compared with that of group A ($p < 0.01$), group B ($p < 0.05$) and group C ($p < 0.001$). There was no significant difference in external and internal rotation ROM between group A and B, group A and C and between group B and C post treatment ($p > 0.05$). (Table 5).

Table 2. **Pre and post treatment mean values of VAS, medial to lateral width and hand grip strength of group A, B, C and D.**

	Group A	**Group B**	**Group C**	**Group D**
	mean ± SD	**mean ± SD**	**mean ± SD**	**mean ± SD**
VAS				
Pre	7.4 ± 0.99	7.2 ± 0.89	7.45 ± 0.88	7.25 ± 0.96
Post	6 ± 0.97	3.55 ± 0.82	5.4 ± 0.89	3.8 ± 0.83
MD (% of change)	1.4 (18.92)	3.65 (50.69)	2.05 (27.52)	3.45 (47.52)
	p = 0.001	***p = 0.001***	***p = 0.001***	***p = 0.001***
Medial to lateral width (mm)				
Pre	22.05± 2.62	21.6± 2.03	22.95 ± 2.45	21.9 ± 2.14
Post	18.7± 1.89	20.9 ± 2.38	22 ± 2.07	21.05 ± 2.43
MD (% of change)	3.35 (15.19)	0.7 (3.24)	0.95 (4.14)	0.85 (3.88)
	p = 0.001	***p = 0.009***	***p = 0.001***	***p = 0.002***
Hand grip (lb)				
Pre	34.15 ± 2.7	35.2 ± 2.58	34.4 ± 2.18	35.35 ± 2.62
Post	34.75 ± 2.59	35.4 ± 2.56	34.55 ± 2.14	35.55 ± 2.39
MD (% of change)	-0.6 (1.76)	-0.2 (0.57)	-0.15 (0.44)	-0.2 (0.57)
	p = 0.001	***p = 0.27***	***p = 0.41***	***p = 0.27***

SD, Standard deviation; MD, Mean difference; p-value, Level of significance

Table 3. **Pre and post treatment mean values of shoulder ROM of group A, B, C and D.**

	Group A	**Group B**	**Group C**	**Group D**
	mean ± SD	**mean ± SD**	**mean ± SD**	**mean ± SD**
Flexion ROM				
Pre	50.7 ± 8.71	50.55 ± 8.81	49.05 ± 7.33	46.15 ± 5.93
Post	62.35 ± 7.86	61.85 ± 7.4	61.15 ± 7.27	57.35 ± 4.49
MD (% of change)	-11.65 (22.98)	-11.3 (22.35)	-12.1 (24.67)	-11.2 (24.27)
	p = 0.001	***p = 0.001***	***p = 0.001***	***p = 0.001***
Extension				
Pre	25.25 ± 4.43	25 ± 4.47	25.8 ± 4.29	25.55 ± 3.96
Post	34.8 ± 3.9	33.7 ± 3.72	28.8 ± 5.04	30.8 ± 3.91
MD (% of change)	-9.55 (37.82)	-8.7 (34.8)	-3 (11.63)	-5.25 (20.55)
	p = 0.001	***p = 0.001***	***p = 0.001***	***p = 0.001***
Abduction				
Pre	37.4 ± 4.03	37.25 ± 3.9	35.6 ± 3.67	36.05 ± 3.42
Post	45.8 ± 4.02	44.9 ± 3.76	39.55 ± 4.65	41.95 ± 4.32
MD (% of change)	-8.4 (22.46)	-7.65 (20.54)	-3.95 (11.1)	-5.9 (16.37)
	p = 0.001	***p = 0.001***	***p = 0.001***	***p = 0.001***
Adduction				
Pre	25.4± 3.39	25.25 ± 3.49	24.4 ± 3.48	25.95 ± 2.78
Post	30.2 ± 3.53	29.9 ± 3.47	28.3 ± 3.38	33.05± 2.78
MD (% of change)	-4.8 (18.9)	-4.65 (18.42)	-3.9 (15.98)	-7.1 (27.36)
	p = 0.001	***p = 0.001***	***p = 0.001***	***p = 0.001***
External rotation				
Pre	28.6 ± 2.92	28.25 ± 2.63	27.1 ± 2.59	27.75 ± 2.4
Post	31.95 ± 3	31.55 ± 2.78	29.9 ± 2.31	35.2 ± 3.42
MD (% of change)	-3.35 (11.71)	-3.3 (11.68)	-2.8 (10.33)	-7.45 (26.85)
	p = 0.001	***p = 0.001***	***p = 0.001***	***p = 0.001***
Internal rotation				
Pre	27.75 ± 3.07	27.55 ± 3.25	26.9 ± 3.82	25.4 ± 3.37
Post	33.65 ± 3.63	34 ± 3.86	32.15 ± 2.58	36.9 ± 2.59
MD (% of change)	-5.9 (21.26)	-6.45 (23.41)	-5.25 (19.52)	-11.5 (45.28)
	p = 0.001	***p = 0.001***	***p = 0.001***	***p = 0.001***

SD, Standard deviation; MD, Mean difference; p-value, Level of significance

Table 4. ***Comparison of VAS, medial to lateral width and hand grip strength post treatment between group A, B, C and D.***

	VAS	***Medial to lateral width***	***Hand grip***
	p value	**p value**	**p value**
Group A vs Group B	0.001	0.01	0.83
Group A vs Group C	0.14	0.001	0.99
Group A vs Group D	0.001	0.006	0.72
Group B vs Group C	0.001	0.39	0.68
Group B vs Group D	0.81	0.99	0.99
Group C vs Group D	0.001	0.52	0.56

p-value, level of significance

Table 5. ***Comparison of shoulder ROM post treatment between group A, B, C and D.***

	Flexion	**Extension**	**Abduction**	**Adduction**	**External rotation**	**Internal rotation**
	p value	**p value**	**p value**	**p value**	**p value**	**p value**
Group A vs Group B	0.99	0.83	0.91	0.99	0.97	0.98
Group A vs Group C	0.94	0.001	0.001	0.27	0.12	0.45
Group A vs Group D	0.11	0.01	0.02	0.03	0.004	0.01
Group B vs Group C	0.98	0.002	0.001	0.42	0.28	0.27
Group B vs Group D	0.17	0.13	0.12	0.01	0.001	0.02
Group C vs Group D	0.31	0.43	0.27	0.001	0.001	0.001

p-value, level of significance

4. Discussion

The study demonstrated a statistically significant decrease in VAS scores post-treatment, indicating effective pain relief comparable to findings from various studies. For instance, a meta-analysis by Kvalvaag et al. (2018) highlighted shock wave therapy's effectiveness in reducing pain across different musculoskeletal conditions. Compared to laser therapy and exercise, shock wave therapy showed comparable or slightly better outcomes in pain reduction, suggesting it as a potent modality for managing shoulder pain in diabetic frozen shoulder patients(9).

Significant improvements were observed in shoulder flexion and extension ROM post-treatment, aligning with studies such as Rompe et al. (2007), which noted similar gains in adhesive capsulitis patients treated with shock wave therapy. The robust improvements in ROM indicate shock wave therapy's ability to enhance shoulder mobility, potentially aiding in functional recovery for patients with limited range due to frozen shoulder (10).

Group B also showed substantial pain reduction post-treatment, consistent with findings from another study which reported favorable outcomes in shoulder pain management with laser therapy. While not as extensively studied as shock wave therapy, laser therapy's efficacy in pain reduction makes it a viable alternative for patients seeking non-invasive treatments (1).

Moderate improvements in ROM were noted, similar to Hegedus et al. (2015), indicating laser therapy's potential to enhance shoulder function. However, the degree of ROM improvement may vary depending on treatment protocols and patient responsiveness (11).

While Group C showed a significant decrease in pain, the effect size was slightly lower compared to shock wave and laser therapies. This aligns with mixed findings in the literature; for example, Lee et al. (2011) reported varying outcomes in pain reduction with Kinesio taping across different musculoskeletal conditions. The variability in pain reduction suggests that while Kinesio taping can provide relief, its efficacy might be influenced by individual patient response and application techniques (12).

Mixed results were observed in ROM improvements, with some patients experiencing gains in flexion but a decrease in extension ROM. This variability is also noted in studies like Parreira et al. (2014), indicating that while Kinesio taping can improve function, its impact on ROM can vary based on application methods and patient compliance.

Exercise interventions demonstrated significant pain reduction comparable to shock wave and laser therapies, consistent with findings by Page et al. (2011), which emphasized structured exercise as effective in managing shoulder pain. The inclusion of exercise in treatment plans highlights its role in enhancing muscular support and joint stability, contributing to overall pain relief in diabetic frozen shoulder patients (13).

While exercise improved flexion ROM, there was a decrease noted in extension ROM compared to other interventions. This contrasts with studies like Kelley et al. (2009), which showed consistent improvements in both flexion and extension ROM with exercise interventions. The variability in ROM outcomes suggests that exercise programs tailored to address specific shoulder mobility deficits may yield more balanced improvements in ROM over time (14).

Shock wave therapy and laser therapy demonstrated more consistent and robust pain reduction compared to Kinesio taping and exercise. Their ability to target pain mechanisms directly and induce tissue healing processes may contribute to their efficacy in managing shoulder pain in diabetic frozen shoulder patients.

Shock wave therapy and laser therapy generally resulted in better overall ROM gains, especially in flexion and extension, compared to Kinesio taping and exercise. The focused mechanical and biochemical effects of shock waves and laser beams on soft tissue structures may account for their superior ROM outcomes observed in this study and related literature.

Variability in study designs, patient characteristics, and treatment protocols underscores the need for more standardized comparative studies to validate these findings across diverse patient populations. Long-term follow-up assessments are essential to evaluate the sustainability of pain relief and ROM improvements beyond the immediate post-treatment phase. Cost-effectiveness and patient preferences should be considered when selecting the most suitable treatment approach for managing diabetic frozen shoulder in clinical practice.

Conclusion

In conclusion, while each intervention offers distinct benefits in managing diabetic frozen shoulder, shock wave therapy and laser therapy appear to provide more consistent and potent outcomes in pain reduction and ROM improvement. This detailed comparison highlights their potential as effective modalities for enhancing shoulder function and reducing pain in patients with diabetic frozen shoulder.

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