Response of liver enzymes to 12 weeks of resistance band training program in burned patients

Respuesta de las enzimas hepáticas a 12 semanas de programa de entrenamiento con bandas de resistencia en pacientes quemados

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Abstract

Background: Alteration of liver morphology and function is common following major burns; however, it has not received much attention.
Objectives: To explore the response of liver enzymes (LE) to a 12-week Resistance Band Training (RBT) in Burned Patients.
Methods: Single-blinded, RCT, sixty participants, aged 25 to 40, with burn injuries encompassing 30 to 50% of their body surface area, were distributed randomly into two equal groups. Group A underwent a Resistance Band Training (RBT) with conventional physical therapy and medical treatment. Group B underwent only conventional physical therapy and medical treatment. Measuring liver enzyme levels, comprising aspartate transaminase (AST) and alanine transaminase (ALT) were done utilizing a spectrophotometer.
Results: A substantial primary effect of therapy was observed. ($F = 10.89$, $p = 0.001$, $\eta^2 = 0.28$) in comparison to the control group, with percentage improvements of 49.61% and 37.89%, respectively, versus 42.79% and 17.88% in Group B.
Conclusion: RBT appears to be an effective complementary intervention for improving liver enzyme levels and promoting hepatic function in burn patients.

Keywords

Burn rehabilitation; exercise therapy; hepatic function; liver enzymes; resistance training; band training.

Resumen

Antecedentes: La alteración de la morfología y función hepática es común después de quemaduras graves; sin embargo, no ha recibido mucha atención.
Objetivos: Explorar la respuesta de las enzimas hepáticas (LE) a un Entrenamiento con Bandas de Resistencia (RBT) de 12 semanas en Pacientes Quemados.
Métodos: Sesenta participantes, ECA, cegados individualmente, de 25 a 40 años, con lesiones por quemaduras que abarcaban del 30 al 50% de su superficie corporal, se distribuyeron al azar en dos grupos iguales. El grupo A se sometió a un Entrenamiento con Bandas de Resistencia (RBT) con fisioterapia convencional y tratamiento médico. El grupo B se sometió solo a fisioterapia convencional y tratamiento médico. La medición de los niveles de enzimas hepáticas, que comprenden aspartato transaminasa (AST) y alanina transaminasa (ALT) se realizó utilizando un espectrofotómetro.
Resultados: Se observó un efecto primario sustancial de la terapia. ($F = 10,89$, $p = 0,001$, $\eta 2 = 0,28$) en comparación con el grupo control, con mejoras porcentuales del 49,61% y 37,89%, respectivamente, frente al 42,79% y 17,88% en el Grupo B.
Conclusión: La RBT parece ser una intervención complementaria eficaz para mejorar los niveles de enzimas hepáticas y promover la función hepática en pacientes quemados.

Palabras clave

Quemar la rehabilitación; el ejercicio de la terapia; la función hepática; las enzimas hepáticas; el entrenamiento de la Resistencia; la formación de la banda.

Introduction

Significant metabolic increases brought on by severe burn injuries may continue for up to 24 months following the injury. An elevated body temperature, increased consumption of oxygen and glucose, the production of CO_2, glycogen breakdown, proteolysis, and futile substrates cycle are all characteristics of this hypermetabolic response (Williams et al., 2009). The response is driven by substantial rises in inflammatory cells, plasma catecholamines, and cortisol, which results in widespread tissue breakdown, increased resting energy consumption, and dysfunction of multiple systemic organs. These metabolic and physiological alterations present major challenges to burn patients' full recovery and reintegration into the community (Al-Ghabeesh & Mahmoud, 2022).

Among the affected organs, the liver is particularly susceptible to damage following thermal injury. Several mechanisms contribute to this hepatic impairment, including hypoperfusion, proinflammatory cytokine release, signals of cell death, edema formation, and fatty infiltration (Steinvall et al., 2012). The integrity of the liver depends critically on lipid homeostasis and the antioxidant glutathione system, both of which are compromised after burn trauma (Juan-Pablo et al., 2021).

Experimental studies have demonstrated that thermal skin injury leads to significant hepatic changes, including a 48% increase in hepatic malondialdehyde (MDA), a 30% rise in plasma C-reactive protein (CRP), and substantial rises in plasma aspartate transaminase (AST) and alanine transaminase (ALT) concentrations by 2- and 3.5-fold, respectively (Bekyarova et al., 2009). These serum transaminases, particularly ALT and AST, are key biochemical markers of liver injury. Their concentrations rise sharply after burn trauma and are reported to persist considerably raised for up to three years after injury (Jeschke et al., 2011).

Resistance training (RT) is a crucial form of training that the American College of Sports Medicine suggests for promoting a variety of physical benefits particularly increases in muscle mass and power in healthy individuals. (Paul et al., 2018). RT has been demonstrated to effectively enhance skeletal muscle strength and mass and is therefore incorporated into national and international exercise guidelines aimed at improving general health, preventing disease, and optimizing outcomes in clinical populations (Paul et al., 2021).

In addition to musculoskeletal benefits, RT has demonstrated positive effects on metabolic health. It has been demonstrated to lower aminotransferase levels and minimize the probability of insulin resistance, improve lipid profiles, and enhance glucose-lipid metabolism (Kistler et al., 2011). In burn patients, progressive resistance training implemented alongside conventional physical rehabilitation has been found to be both safe and feasible throughout the acute recovery stage. Evidence suggests that it contributes to enhancing life and quality reducing disability in this population (Paul et al., 2021).

We hypothesized that (a) the RBT has effects on ALT and (b) the RBT would produce changes in AST levels.

Accordingly, the present study's aim was to evaluate the therapeutic effectiveness of a RBT regimen on liver enzyme levels in patients following major burn injuries. The ultimate aim is to encourage the development of an effective physiotherapy strategy to promote early restoration of normal liver function post-burn.

Method

Study design

This randomized controlled trial was carried out at the Orabi Hospital for Burns' Physical Therapy Department for Burns in Al Obour City, Qalyubia, Egypt, from November 2023 to May 2024.

Participants

Sixty patients (male and female) with burn injuries involving 30–50% of the total body surface area (TBSA) were recruited after being discharged from the intensive care unit (ICU). All participants were between 25 and 40 years of age. Patients with previous instances of hepatic disease, upper or lower extremities amputation, burns on the soles of the feet, exposed tendons in the hands or feet, heart problems, or a body mass index (BMI) more than 30 kg/m^2 were not included.

Ethics Approval

Ethical approval was authorized by the Physical Therapy Ethics Committee, Cairo University, Giza, Egypt (Approval No: P.T.REC/012/004652). Additionally, the trial had a Clinical Trials Registry authorization (NCT06067711). Each participant gave written informed consent after being informed of the study's goals and procedures.

Sample Size

ALT testing results from a pilot trial with 6 participants in each group were used to determine the sample size. After running the numbers via G*POWER (version 3.1.9.2; Franz Faul, Universitat Kiel, Germany), we found that N = 60 (30 participants in each group) was the optimal number of participants for this research. An effect size of 0.43, α=0.05, and β=0.2 were used in the calculation.

Randomization

Randomization was carried out using sequentially numbered index cards placed in opaque, sealed envelopes. Each envelope was opened by a blinded researcher, who then assigned participants to the study or control groups.

Outcome Measurements

Blood samples were collected from seated participants by certified technicians from the antecubital vein and collected in heparinized tubes and analyzed for liver enzymes (ALT and AST) or frozen and stored at -70˚C. Measuring plasma alanine transaminase (ALT) and aspartate transaminase (AST) concentrations was done utilizing a spectrophotometer (Double Beam, SP- LUV7600) (Bio system S.A., Barcelona, Spain). The device featured a double-beam system equipped with halogen and deuterium light sources, a silicon photodiode detector, and a thermoelectric temperature-controlled sample holder (Nilsson, 2010). For ALT and AST, the normal reference values were 0–45 IU/L and 0–35 IU/L, respectively (Limdi & Hyde, 2003). Measurements were obtained at two-time points: baseline (before treatment) and following 12 weeks of intervention (after treatment).

Intervention

A standardized physiotherapy protocol and medical treatment were provided to all patients, whereas RBT was applied exclusively to the study group. The physiotherapy protocol included splinting and therapeutic exercises. Custom-made splints were used to prevent joint contractures and were worn for 10 hours daily, followed by a 2-hour rest period. Skin integrity was regularly monitored, and range of motion (ROM) exercises were performed during splint-free intervals (Kwan & Kennis, 2002; Cen et al., 2015). Therapeutic exercises consisted of both active and active-assisted ROM targeting the shoulders, elbows, hips, and knees, performed in various positions such as supine, sitting, and standing. Additionally, static stretching was applied to major muscle groups, with each stretch held for 30 seconds and repeated for 5 to 10 repetitions, based on the patient's state and progress (De Weiger et al., 2003; Kisner & Colby, 2012).

Over the course of 12 weeks, the RBT program was performed three times a week and comprised six exercises as shown in (Table 1): sit-ups, leg press, leg extension, lat pull down, triceps press, and biceps curl. For RBT, the elastic band (Thera-band, Naumcare, Sungnam, South Korea). The length of the elastic band was individualized based on a performer's ability to complete consecutive 10 repetitions for each movement condition. Following an adaptation phase of 3 weeks (1 set of 12 rep) using low resistance (yellow Thera-Band), exercise intensity progressively increased by adapting the resistance of the elastic band (based on the Thera-Band force-elongation table) from yellow to red and further to black as shown in (Table 2) ,always check for wear and tear of the elastic band continuity. The training was conducted in a progressive circuit form which was supervised by trained and experienced physical therapist. The maximum of one repetition (1RM) was calculated using Epley equation = (1+0.0333 x repetitions) x weight. Participants completed two circuits at 50% of their one-repetition maximum (1RM) in weeks 1 to 3, with 10 repetitions for each exercise. The intensity was raised to 60% of 1RM for two circuits in weeks 4 to 6. Participants executed three circuits at 60% of 1RM during weeks 7 to 9, and three circuits at 70% of 1RM during weeks 10 to 12. With 90-second rest intervals in between sets, each session lasted about 45 minutes with five minutes warming up and five minutes cooling down (Hallsworth et al., 2011).

Table 1. The order phases of Resistance Band Training (RBT) (Hallsworth et al., 2011).

NO	Task	Targeted muscle	Performance	Duration
1	Sit-ups	Abdominal muscles	Lying on the mat with knees bent and feet flat on the floor, ensuring a stable starting position. Take the ends of the resistance band and hold them at shoulder height. Focus on engaging core muscles, with a controlled motion; perform a sit-up by lifting your upper body toward your knees, maintaining tension in the band throughout the movement. Once reach the top of the sit-up, pause briefly, and then gradually return to the starting position.	7 minutes
2	Leg press	Quadriceps, Hamstrings, and Glutes	Anchoring the resistance band low to a sturdy object. Next, sit comfortably against the backrest with feet placed shoulder-width apart on the platform. Ensure firmly hold the band or securely attach it to the platform. Once in position, extend legs to push against the resistance band, engaging leg muscles fully. After reaching the fully extended position, gradually return to the starting position.	8 minutes
3	Leg extension	Quadriceps muscles	Sit comfortably on a chair and attach the other end of the band to ankle. This setup allow performing the exercise with proper form. To execute the movement, extend knee to straighten the leg fully, engaging the muscles throughout the motion. After reaching full extension, gradually return to the starting position.	8 minutes
4	Lat pull down	Latissimus dorsi and upper back	Sit or kneel so that arms can be fully extended overhead while holding the band in both hands. With a controlled motion, pull the band down towards upper chest, engaging back and shoulder muscles effectively. It is important to maintain proper posture throughout the movement to prevent injury. After reaching the chest, slowly return to the starting position.	7 minutes
5	Triceps press	Triceps muscles	Fixing the resistance band to a high anchor point. Once the band is in place, choose to either stand or sit, ensuring elbows are bent at a 90-degree angle while firmly holding the band. With controlled motion, extend arms downward to fully straighten them, engaging muscles throughout the movement. After reaching the full extension, slowly return to the starting position.	8 minutes
6	Biceps curl	Biceps muscles	Start by standing on the resistance band or securely anchoring it at a low point to ensure stability. Grasp the ends of the band with palms facing upward, maintaining a firm grip. With controlled motion, curl the band towards shoulders, engaging biceps as you lift. Once at the top of the curl, pause briefly to maximize muscle contraction, and then gradually lower the band back to the starting position.	7 minutes

Table 2. Training phases and progression course (Hallsworth et al., 2011).

Weeks	Circuit	Intensity	Repetitions	Resistance
1 to 3 (Adaptation phase)	Two	50% of the participant's one-repetition maximum (1RM)	10 per exercise	Yellow Thera-Band
4 to 6	Two	60% of the participant's one-repetition maximum (1RM)	10 per exercise	Yellow Thera-Band
7 to 9	Three	60% of the participant's one-repetition maximum (1RM)	10 per exercise	Red Thera-Band
10 to 12	Three	70% of the participant's one-repetition maximum (1RM)	10 per exercise	Black Thera-Band

Statistical Analysis

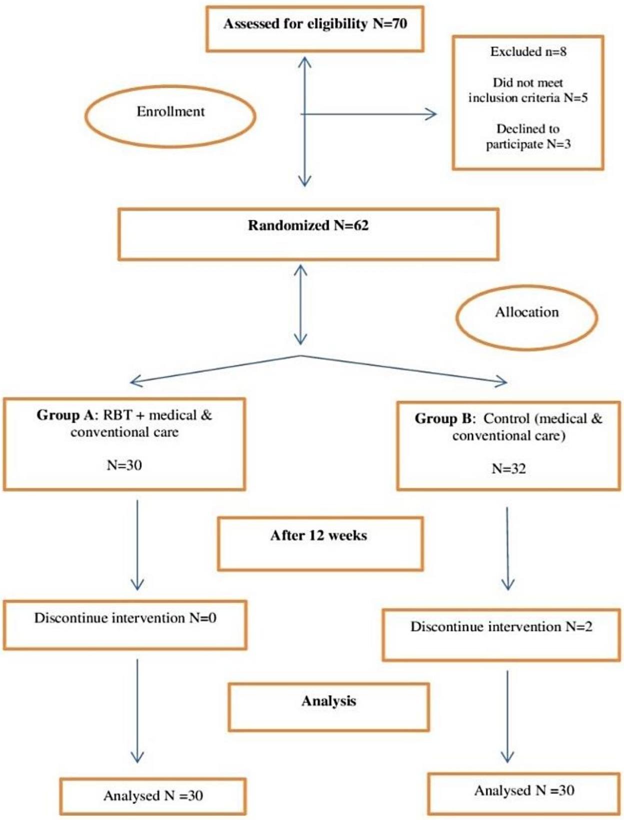
Statistics were applied to demonstrate subjects' characteristics. Between-group comparisons of age, BMI, and TBSA were analyzed using unpaired t-tests, while sex distribution was assessed using the Chi-square test. The Shapiro–Wilk test was applied to check the normality of data distribution, and Levene's test was employed to determine the homogeneity of variances.

A mixed-design multivariate analysis of variance (MANOVA) was employed to determine both within-group and between-group differences in ALT and AST levels across time. When significant differences were found, Bonferroni-adjusted post hoc tests were employed for multiple comparisons. Statistical significance was set at $p < 0.05$. Data analysis was done by SPSS version 25 for Windows (IBM SPSS Statistics, Chicago, IL, USA).

Results

Figure 1 illustrates the flowchart of participants' allocation and progression throughout the study. 70 patients with burn injuries were initially assessed for eligibility; 5 patients did not fulfill the eligibility criteria, 2 patients left the study, and 3 patients were postponed due to pending surgical procedures. As a result, 60 participants were deemed eligible and were split randomly into two groups equal in number (n = 30 each). No adverse events were reported during or after the resistance band exercises or any component of the physiotherapy protocol.

Figure 1. The flowchart of the study



Participants' characteristics

The participants' demographics of groups A and B are displayed in Table (3). Age, BMI, TBSA, and sex distribution were not significantly different across groups (p > 0.05).

Table 3. Participants characteristics.

Variables	Group A	Group B	MD	t- value	p-value
	Mean ± SD	Mean ± SD			
Age (years)	29.43 ± 6.83	32 ± 6.09	-2.57	-1.53	0.13
BMI (kg/m^2)	21.34 ± 4.07	22.73 ± 3.26	-1.39	-1.45	0.15
TBSA (%)	42.13 ± 6.15	40.27 ± 7.12	1.86	1.08	0.28
Sex, n (%)					
Females	15 (50%)	17 (57%)		χ^2 = 0.27	0.61
Males	15 (50%)	13 (43.3%)			

SD, standard deviation; MD, mean difference; χ^2, Chi squared value; p-value, level of significance

Efficacy of treatment on ALT and AST

A mixed-design MANOVA indicated a significant interaction between treatment and time on liver enzymes ($F = 3.47$, $p = 0.03$, $\eta^2 = 0.11$). There were also significant main effects for time ($F = 363.83$, p =

0.001, $\eta^2 = 0.93$) and for treatment ($F = 10.89$, $p = 0.001$, $\eta^2 = 0.28$), indicating that changes in ALT and AST were influenced both by the passage of time and the treatment group.

Within-Group Comparison

The two groups exhibited significant decline in ALT and AST levels following the 12-week program ($p < 0.001$). In Group A, the reduction percent was 49.61% for ALT and 37.89% for AST. In comparison, Group B showed smaller reductions of 42.79% for ALT and 17.88% for AST (Table 4).

Between-Group Comparison

No statistically significant changes were noticed across both groups at baseline for either ALT or AST levels ($p > 0.05$). However, after treatment findings demonstrated that Group A had significantly lower ALT and AST values in comparison to Group B ($p < 0.01$). The effect sizes were moderate to large, with ALT showing an ES = 0.71 and AST an ES = 1.26, indicating a greater treatment effect in the resistance band training group (Table 4).

Table 4. Mean ALT and AST before and after treatment of the two groups:

	Group A	Group B			
	Mean ±SD	Mean ±SD	MD (95% CI)	P value	ES
ALT (IU/l)					
Pre-treatment	59.40 ± 9.06	62.63 ± 8.77	-3.23 (-7.84: 1.38)	0.16	
Post-treatment	29.93 ± 7.72	35.83 ± 8.85	-5.90 (-10.19: -1.61)	0.008	0.71
MD (95% CI)	29.47 (26.54: 32.39)	26.80 (23.87: 29.73)			
% of change	49.61	42.79			
p-value	p = 0.001	p = 0.001			
AST (IU/l)					
Pre-treatment	43.63 ± 7.50	46.80 ± 8.41	-3.17 (-7.29: 0.95)	0.13	
Post-treatment	27.10 ± 8.03	38.43 ± 9.91	-11.33 (-15.99: -6.67)	0.001	1.26
MD (95% CI)	16.53 (12.09: 20.97)	8.37 (3.93: 12.81)			
% of change	37.89	17.88			
p-value	p = 0.001	p = 0.001			

SD, Standard deviation; MD, Mean difference; CI, Confidence interval; p-value, Level of significance; ES, Effect size

The data presents in table 4. A comparative analysis of liver enzyme levels (ALT and AST) between the two groups before and after intervention. For ALT levels, Group A showed a mean decrease from 59.40 IU/l pre-treatment to 29.93 IU/l post-treatment, with a mean difference of -5.90 (95% CI: -10.19 to -1.61), which is statistically significant ($p = 0.008$) and indicates a moderate effect size (ES = 0.71). Group B also experienced a decrease, but it was less pronounced, with a mean difference of -3.23, which was not statistically significant ($p = 0.16$). For AST levels, Group A experienced a significant reduction from 43.63 IU/l to 27.10 IU/l, with a mean difference of -11.33 (95% CI: -15.99 to -6.67), which is highly significant ($p = 0.001$) and reflects a large effect size (ES = 1.26). Group B also saw a reduction, but to a lesser extent with a mean difference of -3.17, again not statistically significant ($p = 0.13$). The percentage change for Group A was notably higher in both enzyme levels compared to Group B, suggesting that the treatment was more effective for Group A.

Discussion

Severe burn injuries provoke a profound and prolonged hypermetabolic and catabolic response, often resulting in substantial losses of lean body mass. While early hypotheses posited that this catabolic activity would diminish following wound closure, current evidence suggests that elevated energy consumption and protein degradation persist for nine months as a minimum after injury. Restoration of lean tissue and normalization of metabolic function may only begin between nine and twelve months after trauma (Hart et al., 2000a). This response is further worsening by extended instances of immobility and physical inactivity during hospitalization, contributing to generalized muscle atrophy. Importantly, the effects of catabolism are not limited to the site of injury but extend to distant muscle groups, underscoring the systemic impact of burn trauma (Hart et al., 2000b)

In addition to musculoskeletal deterioration, systemic inflammation and edema contribute to hepatic cellular stress. These processes compromise hepatocyte membrane integrity and lead to the release of intracellular enzymes, involving aspartate transaminase (AST) and alanine transaminase (ALT), into the circulation. As such, elevated plasma AST and ALT levels are considered reliable predictors of liver dysfunction and are commonly used as prognostic markers in burn patients. Disruptions in vascular permeability and electrolyte imbalances (e.g., hyponatremia and hyperkalemia) further exacerbate hepatocellular damage (Adiga & Adiga, 2015).

The liver is essential to maintaining homeostasis, regulating drug metabolism, glucose and lipid balance, bile synthesis, and protein production, as well as contributing to immune defense through detoxification and microbial control. Pathological hepatic changes—such as glycogen accumulation—have been observed in systemic conditions including diabetes mellitus, sepsis, tuberculosis, hepatitis, and autoimmune liver disease. Without appropriate intervention, these changes may lead to irreversible hepatic damage (Jamali & Jamali, 2012).

The current study explored the efficacy of a 12-week RBT regimen on liver enzyme levels in moderate-to-severe burn injury sufferers. The findings revealed a statistically significant reduction in plasma ALT and AST levels in both groups; however, the resistance training group demonstrated greater improvements in comparison to the control group. Specifically, Group A exhibited reductions of 49.61% in ALT and 37.89% in AST, while Group B showed decreases of 42.79% and 17.88%, respectively. These findings highlight the impact of resistive band training as a supportive intervention for improving hepatic function during burn rehabilitation.

The observed reduction in liver enzyme levels can be attributed to multiple interconnected physiological adaptations elicited by resistance exercise. One primary mechanism is the attenuation of systemic inflammation. Resistance training has been shown to down regulate proinflammatory cytokines involving interleukin-6 (IL-6) and tumor necrosis factor-alpha (TNF-α), though concurrently augmenting antioxidant defense systems. These changes lessen oxidative stress in hepatocytes and reduce the leakage of ALT and AST into the bloodstream (Petersen & Pedersen, 2005).

Additionally, resistance training stimulates muscle protein synthesis, promoting hypertrophy and a favorable nitrogen balance. This alleviates the liver's metabolic burden, which is heightened in burn patients due to sustained hypercatabolism. The exercise-induced enhancement of mitochondrial biogenesis and function also facilitates improved fatty acid oxidation, thereby reducing hepatic lipid accumulation and contributing to better liver health (Church et al., 2007; Damas et al., 2015).

Regular resistance exercise has also been shown to enhance hepatic blood flow and oxygen delivery, creating a more favorable environment for hepatocyte regeneration and tissue repair. Furthermore, resistance training promotes hormonal regulation by lowering elevated cortisol and catecholamine levels—common in burn patients and detrimental to liver function—thereby further supporting hepatic recovery (Trefts et al., 2015). Collectively, these mechanisms likely explain the greater reduction in liver enzyme levels observed in the intervention group.

These findings align with existing research. Resistance training is well-established for its role in enhancing muscle strength and mass and is endorsed by national and international health organizations as part of comprehensive treatment strategies for systemic and chronic diseases (Grisbrook et al., 2013). Shamsoddini et al. (2015) reported similar reductions in liver enzyme levels following aerobic and resistive training in non-alcoholic fatty liver disease (NAFLD) patients, supporting the benefits of resistance training on hepatic health.

However, the findings are not entirely consistent throughout the literature. Yao et al. (2018) found that aerobic but not resistance training significantly reduced ALT and triglyceride levels in Chinese NAFLD patients, potentially reflecting differences in demographic characteristics, baseline health status, or exercise intensity. Similarly, in a study involving burn survivors two years post-injury, Grisbrook et al. (2012) observed no improvements in pulmonary function after 12 weeks of resistance and interval training, although participants did experience gains in aerobic capacity and functional performance.

Moreover, Ebid et al. (2012) indicated that isokinetic strength exercise effectively improved thigh muscular performance in burn patients, reinforcing the value of structured resistance programs as part of a comprehensive rehabilitation protocol. These studies collectively underscore the therapeutic potential of resistance exercise not only for musculoskeletal restoration but also for enhancing metabolic and hepatic outcomes.

This study offers several strengths. It is one of the first to study the impact of resistance band training on liver enzyme levels in burned patients, contributing to a novel area of rehabilitation. The randomized controlled design enhanced internal validity, while standardized protocols and outcome measures improved reliability. A relatively homogenous sample in terms of age, TBSA, and BMI helped reduce confounding.

However, the study also has limitations. The modest sample size and single-center setting may limit generalizability. Liver function was assessed only through ALT and AST; broader hepatic and inflammatory markers would offer a more complete picture. Long-term follow-up was not conducted, and external factors involving diet, medication use, and physical activities were not controlled.

Future research should include larger, multicenter trials with diverse populations and extended follow-up periods. Incorporating additional biomarkers and evaluating combined interventions—such as exercise with nutritional or pharmacologic support—may provide a more comprehensive strategy for enhancing liver function and recovery in burn patients.

Conclusions

The findings of this study demonstrate that a 12-week RBT regimen significantly reduces plasma levels of ALT and AST in moderate-to-severe burn injury sufferers. The intervention group exhibited further improvements than the control group, demonstrating the promise of resistive training as a safe and effective complementary therapy for enhancing hepatic function during burn rehabilitation. Incorporating structured resistance exercise into standard physiotherapy protocols may accelerate recovery and improve clinical outcomes related to liver health in burn survivors.

Implications for Physiotherapy Practice

The incorporation of a 12-week resistance band training program for burned patients can significantly enhance physical therapy practices by offering a low-impact, adaptable, and accessible form of exercise that may facilitate improvements in liver enzyme levels. This method provides a practical rehabilitation option that can be tailored to the individual needs of patients, potentially improving overall metabolic health and accelerating recovery. By integrating resistance band exercises into therapy routines, practitioners can help optimize liver function, which is crucial for the detoxification and metabolic processes affected in burned patients. Additionally, this approach may contribute to a holistic recovery, addressing both muscular and systemic health, and offering an evidence-based strategy to support enhanced patient outcomes in physical therapy settings.

References

Adiga, U., & Adiga, S. (2015). Biochemical changes in burns. International Journal of Research Studies in Biosciences, 3(7), 88–91.

Al-Ghabeesh, S. H., & Mahmoud, M. M. (2022). Mindfulness and its positive effect on quality of life among chronic burn survivors: A descriptive correlational study. Burns, 48(5), 1130–1138. https://doi.org/10.1016/j.burns.2021.09.022

Bekyarova, G., Tancheva, S., & Hristova, M. (2009). Protective effect of melatonin against oxidative hepatic injury. Methods and Findings in Experimental and Clinical Pharmacology, 31(1), 11–14.

Cen, Y., Chai, J., Chen, H., et al. (2015). Guidelines for burn rehabilitation in China. Burns & Trauma, 3(1), 1–10.

Church, T., Kuk, J., Ross, R., Priest, E., Biltoff, E., & Blair, S. (2007). Association of cardiorespiratory fitness, body mass index and waist circumference to nonalcoholic fatty liver disease. Gastroenterology, 130(7), 2023–2030.

Damas, F., Phillips, S., Vechin, F. C., & Ugrinowitsch, C. (2015). A review of resistance training-induced changes in skeletal muscle protein synthesis and their contribution to hypertrophy. Sports Medicine, 45(6), 801–807. https://doi.org/10.1007/s40279-015-0320-0

De Weiger, V., Gorniak, G., & Shamus, E. (2003). The effect of static stretch and warm-up exercise on hamstring length over the course of 24 hours. Journal of Orthopaedic & Sports Physical Therapy, 33(12), 727–732.
Ebid, A. A., Omar, M. T., & Abd El Baky, A. M. (2012). Effect of 12-week isokinetic training on muscle strength in adults with healed thermal burn. Burns, 38(1), 61–68.
Grisbrook, T. L., Elliott, C. M., Edgar, D. W., Wallman, K. E., Wood, F. M., & Reid, S. L. (2013). Burn-injured adults with long-term functional impairments demonstrate the same response to resistance training as uninjured controls. Burns, 39(4), 680–686.
Grisbrook, T. L., Wallman, K. E., Elliott, C. M., Wood, F. M., Edgar, D. W., & Reid, S. L. (2012). The effect of exercise training on pulmonary function and aerobic capacity in adults with burn. Burns, 38(4), 607–613.
Hallsworth, K., Fattakhova, G., Hollingsworth, K., Thoma, C., Moore, S., & Taylor, R. (2011). Resistance exercise reduces liver fat and its mediators in non-alcoholic fatty liver disease independent of weight loss. Gut, 60(9), 1278–1283.
Hart, D. W., Wolf, S. E., Mlcak, R., Chinkes, D. L., Gore, D. C., Mlcak, R. P., Beauford, R. B., Obeng, M. K., Lal, S., Gold, W. F., Wolfe, R. R., & Herndon, D. N. (2000). Determinants of skeletal muscle catabolism after severe burn. Annals of Surgery, 232(4), 455–465.
Hart, D. W., Wolf, S. E., Mlcak, R., Chinkes, D. L., Ramzy, P. I., Obeng, M. K., Ferrando, A. A., Wolfe, R. R., & Herndon, D. N. (2000). Persistence of muscle catabolism after severe burn. Surgery, 128(2), 312–319.
Jamali, R., & Jamali, A. (2012). Non-alcoholic fatty liver disease. Feyz: Journal of Kashan University of Medical Sciences, 14(2), 169–181.
Jeschke, M., Gauglitz, G., Kulp, G., et al. (2011). Long-term persistence of the pathophysiologic response to severe burn injury. PLoS One, 7(6), 212–245.
Juan-Pablo, M., Devin, M., Soncy, B. S., Travis, W., Rachel, H., & Elizabeth, J. (2021). Advanced age heightens hepatic damage in a murine model of scald burn injury. Journal of Trauma and Acute Care Surgery, 90(4), 731–737.
Kisner, C., & Colby, L. (2012). Therapeutic exercise: Foundations and techniques (6th ed., Chapter 3, p. 52). F. A. Davis Company.
Kistler, K., Brunt, E., Clark, J., et al. (2011). Physical activity recommendations, exercise intensity and histological severity of nonalcoholic fatty liver disease. American Journal of Gastroenterology, 106(3), 460–468.
Kwan, M., & Kennis, W. (2002). Splinting programme for patients with burnt hand. Hand Surgery, 7, 231–241.
Limdi, J., & Hyde, G. (2003). Evaluation of abnormal liver function tests. Postgraduate Medical Journal, 79, 307–312.
Nilsson, E. (2010). Spectrophotometric measurement automatization for the analysis of enzymatic processes (p. 57). Uppsala University.
Paul, M., Benedict, M., Dana, A., Tiffany, L., Fiona, M., & Dale, W. (2021). The efficacy of resistance training in addition to usual care for adults with acute burn injury: A randomized controlled trial. Burns, 47(1), 84–100.
Paul, M., Tiffany, L., Dale, W., Fiona, M., Benedict, M., & Neil, E. (2018). Resistance training for rehabilitation after burn injury: A systematic literature review and meta-analysis. Burns, 44(4), 731–751.
Petersen, A. M., & Pedersen, B. K. (2005). The anti-inflammatory effect of exercise. Journal of Applied Physiology, 98(4), 1154–1162. https://doi.org/10.1152/japplphysiol.00164.2004
Shamsoddini, A., Sobhani, V., Ebrahim, M., Moayed, S., & Zareeaa, A. (2015). Effect of aerobic and resistance exercise training on liver enzymes and hepatic fat in Iranian men with nonalcoholic fatty liver disease. Hepatitis Monthly, 15(10), 314–334.
Steinvall, I., Fredrikson, M., Bak, Z., & Sjoberg, F. (2012). Incidence of early burn-induced effects on liver function as reflected by the plasma disappearance rate of indocyanine green: A prospective descriptive cohort study. Burns, 38(2), 214–224.
Trefts, E., Williams, A. S., & Wasserman, D. H. (2015). Exercise and the regulation of hepatic metabolism. Progress in Molecular Biology and Translational Science, 135, 203–225.
Williams, F. N., Herndon, D. N., & Jeschke, M. G. (2009). The hypermetabolic response to burn injury and interventions to modify this response. Clinics in Plastic Surgery, 36(4), 583–596.

Yao, J., Meng, M., Yang, S., Li, F., Robert, M., Liu, C., Liu, L., Yuan, X., Fang, Z., & Lou, Q. (2018). Effect of aerobic and resistance exercise on liver enzyme and blood lipids in Chinese patients with non-alcoholic fatty liver disease: A randomized controlled trial. International Journal of Clinical and Experimental Medicine, 11(5), 4867–4874.

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