Acceleration of Recovery of Muscle Injuries through Massage Based Therapies

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Abstract: Repair of injured skeletal muscle is an area that continues to present a challenge for sport medicine researchers due, in part, to complete muscle recovery being compromised by development of fibrosis leading to loss of function and susceptibility to reinjury. This study was carried out on 20 players affected with muscle injuries. Massage therapies was tested together with therapeutic exercises. Treatments was administered on injured players, they were divided into experimental and control groups (n = 10 each).Blood samples were withdrawn from both groups before and after therapeutic exercise only or plus massage based therapies. Pain data was recorded together with creatine phosphokinase and b-fibroblast growth factor (b-FGF) and cortisol were estimated using spectrophotometer and Elisa technique. Determination of performed tests: vertical jump, pain score, isometric strength of the leg extensors using standard leg press dynamometer and shuttle run test over 30 m. course, to run 6 times between markers placed four meters apart. Results indicated significant changes between experimental and control groups for the benefit of experimental one in different parameters. In conclusion, therapeutic exercises in combination with massage based therapies might have a potential role in muscle healing.
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Key words: Massage therapies, therapeutic exercises, pain score creatine phosphokinase, b-fibroblast growth factor, cortisol.

1. Introduction:

Skeletal muscle injuries are the most common sports related injuries and a major concern in sports medicine. To minimize the disability and aid full functional recovery after muscle damage, current clinical trials include rest, ice, compression and elevation (Rice), suturing, immobilization and exercise ***(McKeever PE, Camelo-Piragua S, Dowling J. (2012); Moyer AL, Wagner KR. (2011))***.

However, many athletes who have severely injured muscle through laceration, strains and contusion cannot get complete recovery.

Muscle has good healing potential because of relatively well vascularized than other soft tissues like tendon or ligament. However, complete recovery from the injury is compromised by the formation of fibroblastic scar tissue and insufficient muscle cell regeneration ***(Huard J, Li Y, Fu FH. (2002); Gharaibeh B, Chun-Lansinger Y, Hagen T. (2012))***. Fibrosis at the repairing site also has a direct effect on the muscle continuity, affecting the development of muscle fibers, connective tissue, nerves, and blood vessels across the repair site ***(Valentin JE, Turner NJ, Cilbert TW, Badylak SF. (2010); Bedair HS, Jarthikeyan T, Quinteri A, Li Y, Huard J. (2008); MacDonald EM, Cohn RD (2012))***.

Useful strategies to enhance skeletal muscle repair through increased vascularization may include exercise, electrical stimulation and potentially, massage therapy. Based on recent studies showing an accelerated recovery of muscle function through massage-based therapies, as this treatment modality offers a practical and non invasive form of therapy for skeletal muscle injuries. Therefore, innovative approaches that enhance muscle recovery and healing from intense exercise as well as traumatic injuries are of critical importance. Therefore, the effectiveness of massage-based therapies plus therapeutic exercises were determined so as to accelerate the recovery of muscle injuries.

The aim of the study is to evaluate the efficiency of therapeutic exercises and massage-based therapies for healing contusion of the quadriceps muscle with pain in the anterior thigh in the least possible time.

Hypothesis:

1. There are a positive effect of the therapeutic exercises of the parameters studied.
2. There are a positive effect of the therapeutic exercises plus massage therapies of the parameters studied.
3. There are difference between the two groups for the sake of the experimental group (massage therapies + therapeutic exercises)

2.Materials and Methods

The researcher used the experimental method for its suitability to the aim of the study by using two groups affected by contusion of the quadriceps muscle (20 patients). They were diagnosed by a specialist and the injuries of the two legs were dismissed. All of the patients were assigned to rehabilitation at El Agoza Army rehabilitation center.

Table (1): Basic Analysis of the control and experimental groups:

Parameters	*Control n = 10*	*Experimental n = 10*	*Significant*
Age (year)	24.4 ± 3.4	23.6 ± 4.2	0.94
Height (cm)	171.4 ± 2.2	170.6 ± 1.9	0.75
Weight (kg)	69.5 ± 3.9	68.3 ± 4.1	0.58

There was non significant differences in table (1). $P < 0.05$

Instrumentation:

1. Visual pain score.
2. Spectrophotometer.
3. Elisa.
4. Polyetheline tubes + cotton, spirit, syringes 5ml.
5. Anticoagulant (EDTA).
6. Kit for cortisol, CPK.
7. Kit for b-fibroblast growth factor.
8. Dynamometer
9. Shuttle run test over 30 m. Course.

Therapeutic exercises were carried in the following order:

- Static exercises without load.
- Static exercises with load.
- Dynamic exercise within active range of movement to the pain threshold.
- Dynamic exercise with increasing load.
- Strength exercises.
- Proprioceptive training.
- Sport specific exercises.

Massage therapies were conducted according to American Massage therapy association (http: //www.amtamassage.org). 4 days of massage were performed per week until recovery.

The visual scale of pain was numbered from 1 to 10 with 0 indicating no muscle pain and 10 indicating that the pain is too high ***(Jamie et al., 2009).***

Statistical Analysis:

Descriptive statistics include both. Means, standard deviation and T test, before and after treatments. The level of statistical significance was set at $P < 0.05$.

3. Results:

Table (1) revealed a non significant difference in the basic parameters of the age, weight, height of the control and experimental groups.

Table (2, 3) indicated the biochemical parameters creatine phosphokinase, basic fibroblast growth factor and cortisol before and after treatment in control and experimental groups. After healing the b-FGF and cortisol increased in control and experimental groups, the results were in the favor of the experimental group, while creatine kinase decreased in experimental group compared to control one.

Table (4, 5) the performed tests: vertical jump, isometric strength of the leg extensors and shuttle run test over 30m. course were all in the favour of the experimental group compared to the control group.

Table (2): Concentrations of CK, b-FGF, cortisol before and after treatments:

No. 10 *Control* *Experimental*

Variable	**Group (1)**		**Group (2)**	
	Before	**After**	**Before**	**After**
CK (μ/L)	264.4 ± 24	188.5 ± 21	271 ± 17	162 ± 15*
b-FGF (pg/ml)	12.6 ± 2.4	15.1 ± 2.5	13.1 ± 2.1	20.4 ± 1.9*
Cortisol (μg/dl)	23.2 ± 4.1	24.6 ± 3.4	23.7 ± 4.1	30.2 ± 3.2*

The level of significant $P < 0.05$

Table (3): Concentrations of CK, b-FGF, Cortisol after treatments in control and experimental groups.

n = 10

Variables	*Control*	*Experimental*
CK (μ/L)	188.5 ± 21	162 ± 15*
b-FGF (pg/ml)	15.1 ± 2.5	20.4 ± 1.9*
Cortisol (μg/dl)	24.6 ± 3.4	30.2 ± 3.2*

Sig. Level $P < 0.05$.

Table (4): Revealed performance tests pain score, vertical jump, isometric strength (leg press), shuttle rum before and after treatments: No. 10

Variable	*Control Group*		*Experimental Group*	
	Before	*After*	*Before*	*After*
Pain score (%)	71.4 ± 9.1	43.1 ± 7.4*	68.6 ± 10.1	25.1 ± 6.2*
Vertical jump (cm)	2.2 ± 10.1	2.9 ± 0.2	2.5 ± 0.12	3.4 ± 0.22*
Isometric strength (Kg)	20.2 ± 2.4	22.1 ± 1.9	20.4 ± 1.8	24.3 ± 1.6*
Shuttle run (30m/s)	5.51 ± 0.4	5.46 ± 0.32	5.47 ± 0.5	5.25 ± 0.30*

$P < 0.05$

Table (5): Performance tests pain score, vertical jump, isometric strength, shuttle run and time of healing.
n = 10

Variables	**Control**	**Experimental**
Pain score (%)	43.1 ± 7.4	25.1 ± 6.2
Vertical jump (cm)	9.9 ± 0.2	3.4 ± 0.22*
Isometric strength (Kg)	22.1 ± 1.9	24.3 ± 1.6
Shuttle run (30m/s)	5.46 ± 0.32	5.25 ± 0.30
Time of healing (day)	23.1 ± 2.2	18.6 ± 2.6

$P < 0.05$.

4. Discussion:

Biochemical changes after healing indicated a positive effect of the therapeutic exercises and a better effect when therapeutic exercises are in combination with massage therapies (Table 2, 3).

It does appear that under certain conditions, massage can reduce muscle soreness ands had significant effect on lowering plasma creatine kinase ***(Best et al., 2013).***

b-FGF modulate normal processes as angiogenesis wound healing, tissue repair and it is upregulated by in response to inflammation via mediators such as TNF, IL and nitric oxide ***(Presta, 2005; Reuss, 2003; Kardami, 2004). Hwang et al., (2013)*** reported that b-FGF accelerate muscle repair by increasing the number of regenerated myofibrils and fast twitching contraction and provide a positive microenvironment for myogenic differentiation and repair.

The results of ***Pereira et al., (2012) and Shi et al., (2009)*** indicated that b-FGF application has a major synergistic effect for induction of vascular structure, in addition, regenerative motor nerve in remodeling muscle tissue showed a positive staining for nerve and that neural and capillary networks in remodeled tissue are essential for functional recovery of regenerative muscle ***(Anderson et al., 1995; Do et al., (2012); Yun et al., 2012).***

Hwang et al., (2013) reported that research indicates that growth factors could provide the optimum circumstance for stem cell transplantation and enhance stem cell proliferation, basic fibroblast growth factor (b-FGF) contributes to survival and differentiation of stem cells, and enhance recovery of muscle function ***(Dimario and Strohman, 1988; Beier et al., 2011)***.

This is in agreement with the result of this study, as b-FGF concentrations increased after therapeutic exercises and massage therapies leading to muscle healing and regeneration.

The mechanism of action leading to injury healing was reported by ***Liu et al., (2009)*** that injury in the periphery release stimulatory factors that cause mobilization of MSCs from bone marrow into the circulation. At the site of injury, certain molecules expressed on the endothelium causes recruitment of MSCs, where they transmigrate from blood vessels and undergo in situ maturation and intigrate in the injured tissue to bring about healing. The regulatory effect of activated fibroblast is likely to be mediated by basic fibroblast growth factor (b-FGF) as protein array analysis indicated elevated levels of (b-FGF) ***(Nedeau et al., 2008; Ito et al., 2008).***

The decreased level of creatine phosphokinase revealed after massage and therapeutic exercises (Table 3) might be due to the effect of exercise protocol and massage on reduced muscle damage. This result was in agreement with what was reported by previous findings of child and ***Donnelly (1998), Hunter and Faulkner, (1997)***.

Furthermore, the degree of damage was often a function of the trained state of the muscle and dependent on both the specific condition of exercise and the intrinsic factors related to the individual ***Brooks et al., (1995), Lieber and Friede (1993)***. ***Newton et al., (2008)*** reported that muscle damage was less for trained than untrained individuals.

Ganong (2000) reported the anti-inflammatory and antiallergic effects of cortisol, in large doses, it inhibit the inflammatory response to tissue injury.

Also it suppress manifestations of allergic disease that are due to the release of histamine from tissues.

Both of these effects require high levels of circulating cortisol and cannot be produced without producing the other manifestations of cortisol excess, large doses of cortisol inhibit ACTH secretion to the point that severe insufficiency can endangerous the problem when cortisol level decrease. Also cortisol decrease local swelling and block the systematic effects of bacterial toxins. The decreased local inflammation of prostaglandins is reduced.

The elevated cortisol concentration (Table 3) due to the effect therapeutic exercises plus massage therapies could be due to inhibition of inflammation to tissue injury as cortisol suppress manifestations of allergic conditions ***(Barret et al., 2010).***

Table (4, 5) indicated that there was a positive therapies for improving the performance tests, vertical jump, isometric strength of the extensors and shuttle run.

This was in accordance with studies of ***Vicenzino et al., (2002)*** and ***Lofnenverg et al., (2001),*** that therapeutic therapies and massage may increased muscle force working on the joints and increased range of motion and help in prevention of recurrent of injury in the future.

Also ***Verhagen et al., (2004) and Kern et al., Kelsey (1999)*** were in accordance that therapeutic exercises improve motion in different direction.

As for pain score, the therapeutic exercises and massage therapies indicated a lower pain score in case of experimental group compared to control group this was in accordance with ***Mohamed Abdel Rehim (2012),*** the decreased pain score recorded might be due to decreased inflammatory action and decreased edema due to massage therapies, also healing time decreased due to the positive action of therapeutic exercises and message therapies leading to better regenerative action ***(Almekinders, 1999; Park et al., 2011; Park et al., 2012; Dimario and Strohman, 1988; Menetrey et al., 2000)***

This was in accordance with the study results (Table 5) for time of healing as the experimental group showed a rapid healing process compared to the control group, which may be due to massage therapies which enhanced tissue repair through growth factors mainly (b-FGF) action.

Hypothesis:

1. There are a positive effect of the therapeutic exercises of the parameters studied.
2. There are a positive effect of the therapeutic exercises plus massage therapies of the parameters studied.
3. There are difference between the two groups for the sake of the experimental group.

From the discussion, it is noticed that all three hypothesis have been realized.

Conclusion:

Muscle injuries and repair is an area in sports medicine research that has not been extensively investigated and potentially massage therapy seems a very attractive and the least invasive form of therapy to improve muscle function and speed healing, one possible mechanism for this therapy enhanced tissue repair through basic fibroblast growth factor in muscle regeneration.

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3/23/2014