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Effects of a Comprehensive Physical Therapy Program on Functional Performance Profile in Young Men with a History of Osgood Schlatter Disease

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Abstract:

Purpose: was to assess functional performance in adolescents with a history of Osgood-Schlatter disease using a developed rating scale before and after application of a comprehensive therapeutic program.

Methods: Fifty individuals diagnosed with a history of OSD participated in this study. The study sample randomly into two groups of equal number (A and B). Group (A) received shock wave therapy in addition two conventional physical therapy. Group B received the same conventional physical therapy conducted to the group (A). Sessions executed three times a week for two months.

Results: In the present study, both groups demonstrated significant improvement of the measured subscales over an eight week periods; however experimental group demonstrated better improvement in score of "physical examination" than the control group; while other variables improved with the same level.

Conclusion: The suggested physiotherapy protocol improved function in subjects with history of OSD and provided a rational for the clinical use of shock wave therapy.

Key words: Physical Therapy, Functional performance, Osgood Schlatter Disease.

1. Introduction:

Osgood- Schlatter disease (OSD) is common in growing adolescents due to an inflammation of the area just below the knee as the tendon from the kneecap attaches to the shinbone causes of knee pain. Excessive loading of the knee during periods of rapid skeletal growth rate causes overuse injuries (1-6).

Quadriceps contraction possess much stress on tibial tuberosity particularly following an adolescent growth spurt which is activity-dependent, so boys are more liable than in girls (1-5,7). There are few studies assessing the treatment of OSD (7).

Hence, there is a strong necessity to assess the consequences of injuries in young men, so that protection can be in equation.

There is diversity of causes of OSD (7); a study searched whether an avulsion fracture or an injury to the patellar tendon in adolescence can precipitate OSD. They found that partial separation of bone fragments from the tibial tuberosity at the insertion site of ligamentum patellae to the tibial tuberosity (8).

Another research considered the biomechanical background assessed the relationship between limited ankle dorsiflexion

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and the cause of Morbus Osgood-Schlatter in sports-active individuals. Authors found that the quadriceps contracted eccentrically during the whole stance phase of running to the starting point of propulsion as the knee is at highest level of flexion. Moreover, compensatory mechanisms increased stress imposed upon quadriceps femoris insertion to the tuberosity of tibia such as limited ankle dorsiflexion, increased knee flexion, tibial inversion, and foot pronation during the stance phase of running **(**9).

The patellar position as a cause of OSD is controversial (10). Studying the ratio of the distance between the proximal portion of the attachment of the tendon to the tibia and the tibial tuberosity epiphysis to the distance between the line of the knee joint and the tibial tuberosity epiphysis revealed that (11). A short patellar tendon may cause OSD. Apophyseal injuries in tibial tuberosity are due to the strong pull of the quadriceps muscle results in patella Alta at the end of the growth (12). So, teenage girls and young women are more susceptible to have patellar tracking problems (1-6, 13).

A painful ossicle in the distal portion of the patellar tendon may be present (14). Therefore, focal swelling and tenderness of the tibial tuberosity can damage bone, cartilage, tendon and serous bursa **(**1**).** Awareness of growth-related conditions and the relation of musculoskeletal development together with the onset of youth-related conditions affect greatly the degree of injury protection (15). Therefore, injury prevention is of utmost importance as recurrent injuries can have severe consequences on long-term regarding future activities participation **(**16, 17**).**

Another research postulated that male skaters constitute more than 50% of injuries as a result of overuse diseases in professional skaters (18). Another research investigates both the severity and nature of injuries in academy youth football (19). OSD involves boys more than girls with a male-to-female ratio ranging from 3:1 to as high as 7:1. This difference is related to greater boys participation in sports and risk activities than girls (15, 20). Nowadays, the gender gap is narrowing as more girls become more included in sports (7).

The rate of injury among players aged sixteen years or older is close to that of adult players (21). In addition, other factors which determine the level of risk of injuries such as atmosphere condition, training program (22), ground turfs (23), and equipment (24).

Exercise therapy assists sportsmen to avoid muscle weakness of the affected leg (25) although some sufferers may experience discomfort in kneeling and activity of daily living (26, 27). Warm up exercises is important to balance muscle size, function, and ligaments. Regular stretching before and after exercises can help prevent injury (28-30).

Recent training programs concentrated on exhaustive repetition of stereotyped gestures on long term planning as the more difficult the task the greater the necessity for repetition, aiming for qualitative advancement of execution **(**1, 31) as a result, and increased risk of overuses injuries proceeds (28).

Extracorporeal Shockwave Therapy (ESWT) is a novel therapeutic method producing non-focused shockwaves. The convex side of the transducer head transmits burst pulses as a radial energy (32) elevating tissue pressure.

Shockwave therapy (SWT) reduces pain through overstimulation of pain transmission nerves, hyper stimulation analgesia, or local production of pain-inhibiting substance. Higher level of (SWT) enhances metabolic processes, blood flow, and stimulates the body's self-repair (33).

The purpose of this study was to assess functional performance in adolescents with a history of Osgood-Schlatter disease using a developed rating scale before and after application of a comprehensive therapeutic program.

2. Patients and Methods:

2.1. Study participants and recruitment criteria:

Fifty individuals diagnosed with a history of OSD participated in this study. Subjects suffered from knee pain due to Osgood-Schlatter disease aged between 17 and 21 years old. Subjects excluded if they had bleeding disorders, local malignancy, fever, tumors, people with cardiac pacemakers or with any metallic implants , abnormal skin sensation ,obvious deformity, history of knee surgery or knee trauma ,excessive weakness joint injection

within 4 weeks of the study, inadequate communication skills & unable to comply with exercise protocol. The study sample randomly into two groups of equal number (A and B). Group (A) received shock wave therapy in addition two conventional physical therapy. Group B received the same conventional physical therapy conducted to the group (A). Sessions executed three times a week for two months.

Each patient signed a consent form after explaining the scope, objectives, and value of this endeavor. Patients randomly assigned into conventional physical therapy alone or conventional physical therapy and shock wave therapy groups.

2.2. Instrumentation

2.2.1. Instruments for Evaluation

A universal goniometer to evaluate knee range of motion (ROM) it consists of:

1) Degrees circle - Fixed arm, correlates with the movable arm and fulcrum 360 degrees.
2) Ordinary tape measure: to measure thigh girth at different levels (7.5cm, 15cm). Flexible, 150 cm long - Marked with 1/10 cm.
3) The rating instruments (Appendices I).

A modified one hundred points rating scale. This scale is based upon five variables (symptoms, functional tests, clinical examination, performance tests and manual muscle testing). The basic grading scale breaks down into four categories: Excellent=90-100; Good=80-89; Fair=70-79 and Poor=69 or below

2.2.2.Instruments For treatment:

The "Shock Master" producing shock waves (**Figure 1**) is a low to medium-energy range, and it is a radial shock wave delivery system that its approved for distribution and use in the United States by the Food and Drug Administration (FDA).

2.3.1.Procedures of the study

Treatment procedure and the exercise regimen administered to all patients with full demonstration. Each participant given an exercise compliance sheet containing exercise figures and tables to record frequency and repetitions of each exercise. Participants dropped from the study for less than 80% compliance. All measured variables taken on the same day and at the same time, before they had stretching for that day and taken before treatment, post 8 weeks of treatment. Exercise protocol for both groups: Isometric exercises for Quadriceps (three items) and Hamstrings (one item) with 10 seconds hold, 20 repetitions (=1set), 3 sets each. Hip Abductor dynamic strengthening exercises, 3 sets (1 set=20 repetitions) for with 1 kg weight. Free ROM exercises 10 repetitions. Hot water fomentation once per day for 15 minutes for all groups. All patients advised to wear knee caps while in weight bearing positions such as standing and walking. Postural & ergonomic care.

Figure (1): Shock wave therapy for a residual OSD left knee

2.3.2. Precautions:

Patients were advised to avoid crossed leg sitting, squatting & restrictions in use of stairs. Patients advised to repeat the same exercise protocol at home. The treatment executed using the Shock Master for group A through applying SWT with a coupling gel to minimize the loss of shock waves at the interface between applicator tip and skin. The applicator (hand-piece) was pressed upon treatment area with application pressure categorized as "medium". As the patient adjusted to the shockwave-induced pain, the applied energy increased during the treatment. Each

patient received 2000 shock/session, energy flux density 0.18mJ/mm2, energy level 2-4, pulse rate 160/min., 6Hz).

Data analysis:

To avoid a type II error, a preliminary power analysis [power (1−α error P) = 0.85, α = 0.05, effect size = 0.87, with a two-tailed for a comparison of 2 independent groups] determined a sample size of 25 for each group. This effect size was calculated according after a pilot study of 10 individuals considering the pain level as a primary outcome. For comparing subjects' characteristics between both groups t-test conducted. Then, normal distribution of data checked using the Shapiro-Wilk test for all variables, Hence Levene's test applied for detecting homogeneity of variances between groups. Mixed MANOVA performed to compare within and between groups for effects of treatment on symptoms, functional tests, clinical examination, performance tests between group A and group B as between group comparison and between pre and post treatment in each group as within group comparison

3. Results:

3.1. Subject characteristics:

The mean values of age for group A (19.7 ± 1.23) and for group B (19.6 ± 1.21).

3.2. Effect of treatment on Symptoms, functional tests, clinical examination, performance tests, manual muscle testing and summation:

Mixed MANOVA for variables composing the developed rating scale revealed that; there was no significant interaction of treatment and time (Wilks' Lambda = 0.77; F (6, 43) = 2.11, p = 0.07, η^2 = 0.22). There was a significant main effect of time (Wilks' Lambda = 0.32; F (6, 43) = 14.94, p = 0.0001, η^2 = 0.67). There was no significant main effect of treatment (Wilks' Lambda = 0.84; F (6, 43) = 1.28, p = 0.28, η^2 = 0.15). There was no significant difference between group A and group B in all variables pre-treatment (p > 0.05) (**table 1**); while post treatment revealed a significant increase in clinical examination of group A compared with that of group B (p = 0.001).

However, there was no significant difference in symptoms, functional tests, performance tests, manual muscle testing and summation between groups (p > 0.05). However, both groups showed significant increase in score post treatment compared with that pretreatment (p > 0.05).

Table (1): Symptoms, functional tests, clinical examination, performance tests, manual muscle testing and summation pre and post treatment in group A and B.

	Pre treatment			Post treatment				
	Group A	Group B		Group A	Group B		Repeated measures (Group A)	Repeated measures (Group B)
	X̄±SD	X̄±SD	p value	X̄±SD	X̄±SD	p value	p value	p value
Symptoms	16.36 ± 1.89	16.72 ± 1.69	0.48	18.08 ± 1.28	18.2 ± 1.6	0.77	0.0001*	0.0001*
Functional tests	16.32 ± 1.79	15.96 ± 1.56	0.45	17.72 ± 1.62	17.48 ± 1.32	0.56	0.٠001*	0.٠001*
Clinical examination	11.6 ± 1.38	11.64 ± 1.07	0.91	13.24 ± 0.92	12.28 ± 1.02	0.001*	0.٠001*	0.٠2*
Performance tests	10.76 ± 1.53	11.12 ± 1.42	0.39	12.32 ± 1.18	12.04 ± 1.33	0.43	0.٠001*	0.٠02*
Manual muscle testing	26 ± 1.91	26.12 ± 1.76	0.81	28.2 ± 1.68	27.76 ± 1.61	0.35	0.٠001*	0.٠001*
Summation	81.04 ± 6.45	81.48 ± 5.78	0.8	89.64 ± 4.48	87.64 ± 5.02	0.14	0.٠001*	0.٠001*

X̄, mean; SD, standard deviation; p-value, level of significance; * Significant

Grades before treatment (group A); excellent 2 patients, good 13 patients, fair 8 patients, poor 2 patients, for (group B); excellent one patient, good 17 patients and fair 7 patients. While after treatment; (group A); excellent 17 patients, good 8 patients; for (group B); excellent 11 patients, good 13 patients. Grades before treatment (group A); excellent 2 patients, good 13 patients, fair 8 patients, poor 2 patients, for (group B); excellent one patient, good 17 patients and fair 7 patients. While after treatment; (group A); excellent 17 patients, good 8 patients; for (group B); excellent 11 patients, good 13 patients (**Table 2**).

Table 2. Grade pre and post treatment in group A and B

Grade	Pre treatment	Post treatment	
	Median	Median	P-value
Group A	4	4	0.34
Group B	4	5	0.004
P-value	0.61	0.0001	

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4. Discussion:

The current research aimed at assessing the efficacy of a comprehensive therapeutic program in individuals with a history of Osgood-Schlatter disease. Ross et al. studied 25 students whose OSD had been diagnosed on average 7.6 years earlier and compared them to 25 students as a control group. They speculated that 88% of subjects with a history of OSD experienced anterior knee pain with sporting activity **(**6).

Moreover, they scored significantly (P < 0.00001) less on both the ADL activities and sports activity scales of the Knee Outcome Survey. Although all students had a full sharing in their required athletic and military training activities, individuals with a history of OSD experienced marked limitations in running, jumping, cutting, or pivoting performance.

In the present study, both groups demonstrated significant improvement of the measured subscales over an eight week periods; however experimental group demonstrated better improvement in score of "physical examination" than the control group; while other variables improved with the same level. Energy generated from bursts of ESWT spread in tissues together with exercise program relieves painful area in the experimental group compared to exercise program alone in the control group. Also, stimulation of cellular repair suppressed the inflammatory responses at the cell membrane level diminishing pain level and increasing range of motion. SWT might enhance articular tissue regeneration as a result of the release of fibroblast growth factor, ILGF-I, and TGF-β1 (34).

Warm up exercises before physical sports were crucial to balance muscle size, ligaments, and function. Regular stretching before and after exercises could help guarding injury. Exhaustive repetition of stereo-typed exercises on long term aimed for qualitative advancement which meant that the more difficult the task the greater the necessity for repetition So, there was a susceptibility of increased risk of overuse injuries. Stretching the hamstrings and calf muscles enhanced blood flow and broke down the pain- spasm-pain cycle. Strengthening the muscles could improve the shock absorption mechanism and help stabilize the knee joint (35).

Study results agreed with the findings of Deyle et al. Who revealed that the conventional physical therapy was effective in increasing ROM through improving flexibility and muscles power (36).

Study results disagreed with the findings of Gundog et al. who reported no significant difference in pain on the baseline data. Pain reduction might refer to the effect modalities other than ESWT used to relieve pain and reduction of muscle spasm (37) ; while Bobbert et al. rendered improvement to the increase in sensory responses through excretion of endorphins which could affect the pain gate mechanism (38).

There was a paucity of studies evaluating rating scales and how these instruments perform over time (39-42). The developed scale was not validated to any other corresponding functional scales. In addition, It will be better to assess function through two subgroups one subgroup represents the time before epiphyseal plate growth (adolescence) and the other subgroup represents after growth (adulthood) to precisely judge function.

5. Conclusion:

The suggested physiotherapy protocol improved function in subjects with history of OSD and provided a rational for the clinical use of shock wave therapy.

Limitations of the study:

One of the limitations that can be considered on the future research is the double blinding design to eliminate any biasing in selecting patient group. Providing large sample size of participants can be considered in future research. Finally, it would be better to apply current interventions on athletic populations for future research in whom the OSD is considered high.

Author's contributions:

Both authors were fully involved in drafting this article and approved the submission of the final version for publication.

Ethical approval:

Ethical approval was obtained from the scientific research ethical committee in faculty of physical therapy, Beni-Suef University (No.: BSUPT01/21/2015).

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Declaration of competing interest:

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