Original Article

905nm Laser Diode and Platelet-rich plasma in the Treatment of the Second-degree Hamstring tear

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ABSTRACT

Muscle injuries are common in football fields and are responsible for most days lost in the competition. A major part of muscle injuries is the result of excessive tension and load on muscles that occur during cutting, sprinting or jumping. These injuries often affect the myotendinous junction of superficial muscles extend across two joints, including the gastrocnemius, semitendinosus, and rectus femoris muscles. Recovery of injured muscles is usually slow and causes pathomechanical aspects, which are different from the original mechanical properties of the affected muscle. The valuable aim of rehabilitation is fast recovery with minimal risk of injury recurrence. Hamstrings muscle strains are among the most common injuries in sport. **Purpose:** The aim of the present study was to compare the effects of 905nm laser diode and plasma-rich platelets on the recovery of hamstrings tear. **Subjects:** Thirty male athletes diagnosed as grade II hamstrings tear with age range of 20-35 years. **Methods:** The players were distributed into two groups. The 1st group (A) consisted of 15 patients with a mean age of 27.20±3.71 who received platelet-rich plasma (PRP). The 2nd group (B) consisted of 15 patients with the mean age of 27.10±3.70 who received laser treatment, applied 3 times/week starting from the second day for 2 weeks with the irradiation beam of 60 sec/point at the dose of 1 J/cm². The treatment was given as follows; in group (A) PRP was injected in the second day after injury; in group (B) laser was applied 3 times/week, starting from the 2nd day after injury for two weeks. Before and after treatment, patients were evaluated for muscle healing and pain. **Results:** There was not any significant difference between the 2 groups while there were significant differences within each group. **Conclusion:** There were not any significant differences between 905nm laser diode therapy and platelet-rich plasma on the recovery of hamstrings tear.

Keywords: laser, Platelet-rich plasma, Hamstrings tear

Introduction

Muscular injuries account for 30-50% of all sport's injuries,[1] 15% of which are related to the hamstrings strains.[2] Hamstring injuries commonly happen in endurance sports, soccer, rugby, hockey, and football, which is related to the explosive and decelerating needs associated with such sports.[3, 4] The clear diagnosis of muscle injury and severity grading of muscle injury is usually made through a clinical examination and tests. Ultrasonography scanning is usually recommended as one of the best methods for confirming the diagnosis of muscle injury and grading of severity.[5]

Traditional conservative treatments including corticosteroid injections, NSAIDs, and physiotherapy have all been reported inconsistently to have successful outcomes.[6, 7] Despite the prevalence of muscle injury, there is no specific management protocol till now, but it typically involves conservative treatment focusing on strength, flexibility, and neuromuscular risk factors and deficits for hamstring injury through electrotherapy, medical massage, mobility, US, therapeutic

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exercise, PRICE, polarized light, low-level laser, and pharmacological interventions (i.e. NSAIDs).[8] Despite the presence of these treatment varieties, hamstring tears have the highest recurrence rate in all injuries. It is suggested that almost one-third of hamstring tears that affect the college athletes are recurrent [9] A health research in 2015 investigating hamstring injuries in 25 National Collegiate Athletic Association sports expressed higher hamstring injury rates in men than women for soccer, baseball, softball, and athletics. Many investigations support this opinion and recommend that decreased flexibility in men leads to higher hamstring injury rates.

Platelet-rich plasma (PRP) is used in medicine since 1970 [10] in which the plasma rich in platelet is collected from the same person's blood because the platelet concentration in PRP is around 5 times higher or more than that in normal blood. PRP is prepared by centrifuging blood with adding substance such as sodium citrate as anticoagulants, this centrifuging leads to separation of the blood to 3 definite layers in the test tube: layer containing Platelet Poor Plasma (PPP), layer with PRP, and red blood cells' layer.[10, 11] Blood platelets are formed through megakaryocyte in the bone marrow and are nonnuclear. The normal blood platelet count average is 200,000-400,000/ml. Platelets contain these particles [10]: alpha granules - containing thrombospondin, fibrinogen, and growth factors; delta granules - containing adenosine diphosphate (ADP), adenosine triphosphate (ATP), pyrophosphate, ionized calcium, and serotonin, and lambda - lysosomes containing lysosomal enzymes. It is important to confirm that PRP shots in the present are not banned in sports competitions related to the World Anti-Doping Agency (WADA) instructions.[12] Intramuscular PRP injections were restricted by the WADA until 2010, but the ban was lifted in 2011.[13]

Low-Level Laser Therapy (LLLT) is a famous modality that is useful in managing different musculoskeletal conditions.[14] It effectively reduces the post-injury inflammatory phase, stimulates new capillarization, and enhances granulation tissue formation and healing. The effects of Low-Level Laser Therapy are based on the absorption of light photons by chromophores, which generate a series of interactions in cellular metabolism.[15] The effects of PRP on muscle strain injuries are still not clear and further research is still needed to support its use in strain injuries treatment.[16] Therefore, this study has been conducted to determine whether low-level laser diode and PRP can affect recovery after the second-grade hamstrings tear.

Material and Methods:

The present study aimed at investigating the effects of low-level 905nm laser diode versus PRP injection on the healing of the 2nd-degree hamstring tear in professional athletes. 30 male professional athletes with the age range of 20-35 years and the second-degree hamstring tear were included in the study. All players were assessed clinically and sonographically at baseline and after 2 weeks. Grading of the hamstring injury was determined by a diagnostic ultrasound to confirm the diagnosis using the grading, which was suggested by Peetrons (2002)[17] (Table 1). Players were randomly divided into 2 groups, with 15 patients in each group as follows: **Group (A)**; PRP was injected in the second day after injury. **Group (B):** Laser was applied 3 times/week starting from the second day after injury for 2 weeks.

Table 1: Grades of muscle strain injuries by ultrasound

Grade	Ultrasound findings
0	No ultrasound features seen.
1	Muscle edema only.
2 a	Partial tears of muscle fibers, disruption involving <33%.
2b	Partial tears of muscle fibers, disruption involving ≥33-66%
2c	Partial tears of muscle fibers, disruption involving ≥ 66 - 99%
3	Complete tear of the muscle.

Inclusion criteria also included athletes with the 2nd-degree hamstring tear diagnosed clinically and sonographically, the injury either in musculotendinous junction or muscle bulk and the injury is acute and at one level. Athletes with a recurrent hamstring muscle injury, tendon injuries, and diseases affecting the healing process (e.g. diabetes Mellitus, thyroid disease), and blood diseases affecting platelets were excluded. Outcome measures were healing assessment (intramuscular edema and injury size) by ultrasonography and pain, which was assessed by the visual analogue scale (VAS). Instrumentations used for treatment included: PRP: The blood was collected from the arm veins of players. Then the autologous PRP was separated from the whole blood using centrifuge 800D with spaces for four blood tubes. PRP was obtained from a 20mL autologous venous blood sample, which was taken from the antecubital vein. The blood was poured into test tubes containing sodium citrate and then centrifuged at 2500 rpm for 6 min. The blood was separated into 2 layers: a red bottom layer containing red blood cells, and the plasma layer. Then it was centrifuged again for 6 min at the same rpm; that gave a pink middle layer containing PRP; and a yellow top layer containing PPP. Then, the pink plasma layer (PRP) was drawn from the test tubes by using a micropipette and was ready to use. The injection site was identified by both clinical palpation and ultrasonography. PRP was injected on the second day after injury. **Laser diode:** A laser device (EME, Italy) was used at a wavelength of 905 nm in the study. It is a monodiodic contact laser device with a probe of 25 mW, patients who received laser treatment were applied 3 times/week starting from the second day for 2 weeks with irradiation beam of 60 sec/point at a dose of 1 J/cm².

Results:

Prior to analysis, all data were screened for completeness. The collected data were organized, tabulated, and statistically analyzed. The results are interpreted as mean±SD, maximum, minimum, percent, and number. Kolmogorov-Smirnov test was utilized to assess the normality of distribution for tested variables before treatment. The comparison between different variables in both groups was performed using (t-test) for 2 independent measures of two different samples. A computer program (SPSS) was used for data analysis. P-value ≤ 0.05 was considered significant.

Population characteristics: Table 2 represents the physical characteristics of the participants in both groups (A and B) before joining the study. Statistically, there was a non-significant difference (p>0.05) between the groups before treatment in age, weight, and height.

Table 2: characteristics of both groups.

	Group A (n= 15)	Group B (n= 15)	t value	P value
Age	27.20 ± 3.71 ys	27.10 ± 3.70	0.068	0.934 (NS)
Height	176.8 ± 6.88 cm	175.80 ± 7.71	0.051	0.950 (NS)
Weight	70.80 ± 7.28 Kg	69.00 ± 8.68	0.175	0.840 (NS)

Table 3 represents t values of pain and the percentage of improvement in both pre- and post-treatment groups. There was not any significant difference between groups (p> 0.05).

Table 3: Comparison between mean values of pain in both groups.

	Group A (n= 15)	Group B (n= 15)	t value	P value
Pre	6.18 (5.20-8.10)	5.96 (4.30-7.50)	0.761	0.227 (NS)
Post	0.91 (0.00-3.10)	0.71 (0.00-2.60)	0.658	0.257 (NS)
Mean diff.	5.21	5.11	0.3037	0.381 (NS)
% of improvement	85%	88%		

Table 4 represents the t-values of intramuscular edema of two treatment groups. No significant difference was found between the groups.

Table 4: Comparison between the mean values of intramuscular edema

	Group A (n= 15)	Group B (n= 15)	t value	P value
Pre	2.0 (1.0-3.0)	2.0 (1.0-3.0)	0.002	0.999 (NS)
Post	0.50 (0.0-1.0)	0.0 (0.0-2.0)	1.308	0.520 (NS)

Table 5 represents the t-values of injury size, which was healed and the percentage of improvement. There was not any significant difference between the groups.

Table 5: Comparison between mean values of the injury size of both groups

	Group A (n= 15)	Group B (n= 15)	t value	P value
Pre	31.0 (16.0-98.0)	33.93 (16.0-78.0)	-0.412	0.341 (NS)
Post	3.0 (0.0-21.0)	3.73 (0.0-24.0)	- 0.33	0.373 (NS)
Mean diff.	28.00	30.20	-0.433	0.334 (NS)
% of improvement	90.322	89.007		

Discussion

The results of the present investigation revealed that there was not any significant difference between using laser and PRP in both groups. The use of the laser diode and PRP showed improvement in recovery after hamstring strain in athletes including healing and function. Although there was improvement within all groups, no significant difference was observed between groups but the results showed improvement in both groups.

Results of the current research about healing are consistent with the results of Renno et al., 2011,[14] who made a research for the comparison of the effects of LLLT and low-intensity pulsed ultrasound (US) on injured skeletal muscles and found the proper effect of laser on healing. In addition, Demidova et al., 2007 and Ga′ et al., 2006 [18, 19] stated that Low Laser can reduce the inflammation and accelerate tissue repair in rats.

Ferreira et al., 2005 [20] found in a study that irradiation with 2.5 J/cm^2 Helium-Neon laser works as a pain killer and has edema reducing effect when the laser is applied at the 1st, 2nd, and 3rd hours after the administration of carrageenan into the rat paw. The 632.8-nm wavelength was effective for pain relief in O.A.,[21, 22] indicating that the Helium-Neon low-level laser therapy could also be suitable for this study. Methods of doses application and drug administration used during this research were those documented as the best for reducing the response of carrageenan-induced edema into the rat paw.[23] Acute inflammatory pain starts with the excitation of the nociceptor (e.g., fast and direct depolarization followed by spike activity and the induction of the action potential) induced by noxious stimuli. The hyperalgesia caused by tissue injury can be considered as changes in the recruitment of "silent" nociceptors, responsiveness of the nociceptors, and transduction sensitivity. This modulation involves complex interactions among many substances derived from damaged tissue, immunocompetent cells, the vasculature, sympathetic terminals, and the nociceptors themselves.[24, 25]

A study by Manduca and Straub (2017) [26] stated that there are needs for more studies to be applied to the effects of PRP as an alternative management choice for the hamstring injury. Nowadays, while no side effects have been noticed, PRP injections cannot be valuable for hamstring injuries in comparison to rehabilitation protocols alone because of the evidence limitations and contradiction in their study.

Zanon et al., (2016) [27] found in a study on footballers that the management of acute hamstring injuries with local injections of PRP at the site of injury is appropriate, easy to apply, and not risky. There is a reduction in the occurrence of re-injuries in the short term. Platelet-rich plasma injection helps to promote a stable muscle scar that shows no recent injuries. There was no confirmation about the faster recovery effect of muscle treated with PRP compared to untreated muscles.

Guillodo et al., 2015 stated that in athletes with grade III acute hamstring injuries, a single local PRP injection could not reduce the time to return to play at the pre-injury level.[28]

A meta-analysis by Pas et al., 2015 [29] demonstrated superior efficacy for adding lengthening exercises, but not for PRP injections, which contradicts our study results. Sharifi et al., (2014) [30] established a study to evaluate the effects of LLLT or PRP as a single choice of treatment or using both in combination in the healing process of Achilles tendons in rabbits. They applied weekly PRP injection for a group for 3 weeks, and LLLT with parameters (power: 100 mW, Wave Length: 650 nm, Area: 1 cm^2, Time: 1 min) for fifteen following days and in the combined method both of the treatments were applied. Histopathological criteria like inflammatory reactions, collagen formation, and adhesion formation were measured; the data proved that the treatment of rabbits with platelet-rich plasma or Low-Level Laser Therapy alone has a clear significant advantage superior to untreated animals but there was not any significant difference between them.

This result is in agreement with this study as good recovery was found in PRP and LLLT groups but without significant differences between them.

This study is limited to a relatively small sample size; the study applied only to 30 players from the same club to limit them for the program and to control them. Moreover, they were in the same circumstances, in order not to interfere with the results.

The results of a study conducted by Sharifi et al. showed that the combination of both treatments, PRP and LLLT has more efficacy than individual use of each treatment, which contradicts with our result in the combined method that showed no significant differences between the group with combined treatment and other groups. This may be due to different parameters of LLLT, triple injection of PRP, or the application on animals, which may have a higher response than humans. Therefore, we believe that there is a need for more research on a larger sample size that may show the superiority of a treatment method over another.

conclution

We concluded that there was no significant difference between low-level 905nm laser diode and platelet-rich plasma in the treatment of hamstring strain in athletes. Also, all treatments showed significant differences within each group.

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