KORTA, Karolina, BIEŃKO, Marta, MARCHAJ, Magdalena, BIEŃKO, Mateusz, PUTRA, Anna, KRÓL, Tomasz, TOBOREK, Michalina, NIEDZIELA, Natalia, MACIĄG, Maria and BEDNARZ, Karolina. Quadriceps Crush Contusion in Athletes: The Effectiveness of Orthobiologic Treatment with Platet-Rich Plasma (PRP). Quality in Sport. 2024;28:55120. eISSN 2450-3118.
https://dx.doi.org/10.12775/QS.2024.28.55120
https://apcz.umk.pl/QS/article/view/55120

The journal has been 20 points in the Ministry of Higher Education and Science of Poland parametric evaluation. Annex to the announcement of the Minister of Higher Education and Science of 05.01.2024. No. 32553.
Has a Journal's Unique Identifier: 201398. Scientific disciplines assigned: Economics and finance (Field of social sciences); Management and Quality Sciences (Field of social sciences).
Punkty Ministerialne z 2019 - aktualny rok 20 punktów. Załącznik do komunikatu Ministra Szkolnictwa Wyższego i Nauki z dnia 05.01.2024 r. Lp. 32553. Posiada Unikatowy Identyfikator Czasopisma: 201398.
Przypisane dyscypliny naukowe: Ekonomia i finanse (Dziedzina nauk społecznych); Nauki o zarządzaniu i jakości (Dziedzina nauk społecznych).

The authors declare that there is no conflict of interests regarding the publication of this paper.
Received: 12.09.2024. Revised: 07.10.2024. Accepted: 20.10.2024. Published: 25.10.2024.

Quadriceps Crush Contusion in Athletes: The Effectiveness of Orthobiologic Treatment with Platet-Rich Plasma (PRP)

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Abstract

Introduction: Quadriceps contusion is a common injury in contact sports like football, rugby, and basketball, resulting from a direct blow to the anterior thigh. This causes muscle damage, bleeding, and inflammation. While often considered minor, poor management can lead to complications, delayed recovery, and impaired athletic performance.

Purpose: The purpose of this review is to evaluate the effectiveness and the role of orthobiologic treatments such as PRP in enhancing healing and functional recovery for a swift return to sport.

Summary: Quadriceps contusion, resulting from direct trauma to the quadriceps muscle group, leads to hematoma formation and varying degrees of injury severity. Diagnosis is primarily clinical, often supported by ultrasound and MRI to assess the extent of muscle damage. Treatment is typically non-operative, involving rest, ice, compression, physical therapy, and a gradual return to activity. One significant complication is myositis ossificans, characterized by abnormal bone formation within the muscle, which can cause chronic pain and restricted movement. Recent advances, such as ultrasound-guided platelet-rich plasma (PRP) injections, offer promising results by enhancing healing, relieving pain, and accelerating functional recovery. PRP therapy, particularly popular among athletes, promotes tissue repair by stimulating cell regeneration and reducing inflammation, helping speed up recovery and potentially lowering the risk of complications like myositis ossificans. Although preliminary evidence supports the effectiveness of PRP in helping athletes return to play sooner, more research is needed to validate its full impact on musculoskeletal injuries. Continued exploration of nonoperative treatment and rehabilitation protocols is also necessary to ensure optimal outcomes. Preventive strategies, including the use of protective gear and conditioning exercises to strengthen muscles, are critical in reducing the risk of injury and enhancing athletic performance.

Keywords: Quadriceps contusion; platelet-rich plasma; musculoskeletal injury; contact sports; myositis ossificans; regenerative therapies;

1. Introduction

Quadriceps contusion is a prevalent musculoskeletal injury, particularly among athletes engaged in contact sports such as football, rugby, and basketball. These types of sports often involve high-speed collisions, falls, and other physical contacts that put athletes at a higher risk of sustaining blunt force trauma to the muscles. The injury occurs due to a direct impact on the anterior thigh, which leads to damage of the muscle fibers, disruption of small blood vessels, and a subsequent inflammatory response aimed at initiating the healing process (1, 2). Although quadriceps contusions are frequently perceived as minor injuries, their seemingly benign nature can be deceptive. Inadequate

or improper management can lead to a cascade of complications that may not only prolong the recovery process but also significantly impair athletic performance. This impairment can manifest as reduced muscle strength, limited range of motion, and chronic pain, all of which can hinder an athlete's ability to return to their previous level of competition (3, 4).

2. Etiology and Pathophysiology

Quadriceps contusion typically results from a direct blow or trauma to the quadriceps muscle group, which comprises four muscles: the rectus femoris, vastus lateralis, vastus medialis, and vastus intermedius. Each of these muscles plays a crucial role in the extension of the knee and the stabilization of the patella, making them particularly vulnerable during high-impact activities (5, 6). The force of the impact disrupts the continuity of the muscle fibers and leads to the rupture of surrounding blood vessels. This rupture results in the accumulation of blood within the muscle tissue, forming a hematoma. The hematoma contributes to local inflammation, pain, and swelling, all of which are characteristic symptoms of quadriceps contusion (7). The extent of the injury can vary significantly depending on the force of the impact, the exact location of the trauma, and the individual's muscle condition prior to the injury.

Quadriceps contusions are graded based on the severity of the injury, which is determined primarily by the degree of knee flexion that the patient can achieve without pain. This grading system is crucial for guiding treatment and predicting the likely course of recovery:

- Grade I (Mild): This grade is characterized by the ability to bend the knee more than 120°. Patients with a mild contusion typically experience only slight discomfort and may notice a small area of bruising or swelling (1, 8). Despite the mild nature of this injury, it is important to manage it properly to prevent exacerbation.

- Grade II (Moderate): In this grade, knee flexion is limited to between 90° and 120°. Patients often report moderate pain and swelling, with a noticeable reduction in the range of motion. Bruising may be more pronounced, and the affected area is often

tender to the touch (1, 8). This grade of contusion usually requires a longer period of rest and rehabilitation.

- Grade III (Severe): The most severe grade, where the injured individual is unable to bend the leg beyond 90°. This limitation is usually accompanied by significant pain, extensive bruising, and swelling. The hematoma in these cases is often large and may lead to complications such as myositis ossificans if not properly managed (1, 8).

3. Clinical Presentation and Diagnosis

Patients with quadriceps contusion typically present with swelling, pain, and a limited range of knee motion, all of which are direct consequences of the initial trauma and the body's inflammatory response (9). The pain is usually exacerbated by movements that involve the knee or the quadriceps muscle, such as walking, squatting, or attempting to bend the knee. Swelling occurs due to the accumulation of blood and other fluids in the injured area, which can also lead to a visible enlargement of the thigh. As the injury progresses, bruising may become apparent, often manifesting as a deep purple or blue discoloration of the skin, particularly in the later stages of the injury when blood from the hematoma begins to break down (10). The range of motion in the knee joint may be significantly reduced due to both pain and swelling, with patients often unable to fully extend or flex their knee (1, 11). This limitation in movement can interfere with daily activities and athletic performance, highlighting the need for prompt and effective treatment.

The diagnosis of quadriceps contusion is primarily clinical, based on the patient's history of trauma and the findings from a thorough physical examination (12). During the examination, the clinician assesses the extent of pain, swelling, bruising, and the range of motion in the affected leg. Palpation of the injured area may reveal tenderness and firmness consistent with the presence of a hematoma. In some cases, particularly when the diagnosis is unclear or when complications are suspected, imaging studies are utilized. Ultrasound can be used to visualize the extent of muscle damage, identify the size and location of the hematoma, and assess for any associated injuries such as muscle tears or deep vein thrombosis (5, 12). Magnetic resonance imaging (MRI) offers a more detailed view, allowing for the assessment of soft tissue injuries, the degree of

muscle fiber disruption, and the exclusion of more severe injuries such as femur fractures or tendon ruptures (13).

4. Myositis Ossificans

One of the most significant complications of quadriceps contusion is myositis ossificans, a condition characterized by the abnormal formation of bone tissue within the muscle. This condition is particularly concerning because it can lead to chronic pain, significant reduction in the range of motion, and long-term functional impairment (1, 16). Early signs of myositis ossificans include persistent pain that does not improve with standard treatment, ongoing swelling, and a progressively worsening reduction in knee mobility. These symptoms often prompt further investigation, as the condition can be mistaken for other post-injury issues such as a deep hematoma or scar tissue formation (17, 18). The diagnosis is confirmed through radiographs, which reveal heterotopic ossification—bone formation in soft tissue that is not normally mineralized (19, 21). Early detection and appropriate management are essential to prevent the progression of myositis ossificans and to mitigate its impact on the patient's long-term recovery.

5. Conservative Management

The management of quadriceps contusion focuses on alleviating symptoms, reducing inflammation, and preventing complications that could prolong recovery or lead to chronic issues (10). Treatment of quadriceps contusion is usually non-operative and consists of a carefully phased approach, tailored to the severity of the injury. The first phase, known as the acute phase (Phase I), occurs within the first 48 hours post-injury. During this phase, the primary goals are to control hemorrhage, reduce swelling, and alleviate pain. This is achieved through rest, ice application, and compression, often supplemented with elevation of the injured leg (1, 14). The use of non-steroidal anti-inflammatory drugs (NSAIDs) may also be recommended to manage pain and reduce inflammation.

In the subacute phase (Phase II), which typically lasts up to 7 days, the focus shifts to restoring movement and preventing stiffness. This phase includes physical therapy exercises aimed at gradually increasing knee flexion and improving range of motion. Gentle massage may also be introduced to help disperse the hematoma and improve circulation in the affected area (1, 5, 7, 14, 15).

The final phase, known as functional rehabilitation (Phase III), begins once the acute symptoms have subsided and involves a gradual return to sport-specific activities. This phase is critical for restoring full muscle strength, flexibility, and coordination before the athlete is cleared to return to full participation in sports (1, 5, 7, 14, 15).

6. Recent Advances

Recent advances in the management of quadriceps contusion have introduced novel therapies that aim to accelerate healing and enhance recovery outcomes. Among these, regenerative therapies such as platelet-rich plasma (PRP) injections and stem cell therapy have gained significant attention in the sports medicine community. PRP therapy involves the injection of a concentrated solution of platelets, derived from the patient's own blood, into the injured area. Platelets contain growth factors that can stimulate tissue repair, reduce inflammation, and promote faster recovery (22, 23, 24). Stem cell therapy, although still in the experimental stages for many applications, holds promise for regenerating damaged muscle tissue and improving healing outcomes by introducing undifferentiated cells capable of developing into new muscle fibers (22, 23, 24).

Additionally, there is growing interest in the use of cryotherapy and laser therapy as adjunct treatments. Cryotherapy, which involves the application of extreme cold to the injured area, can help reduce inflammation and pain, while laser therapy uses focused light to stimulate cellular repair processes and reduce oxidative stress in the damaged tissue (25, 26, 27, 28, 29). These therapies, although still under investigation, represent promising avenues for improving the management of quadriceps contusion and reducing the risk of complications.

7. Prognosis and Return to Play

The prognosis for quadriceps contusion largely depends on the severity of the injury and the effectiveness of the management strategies employed. In general, most mild to moderate contusions resolve within 2-4 weeks with appropriate treatment, allowing the athlete to return to play without significant long-term consequences (9). However, severe contusions may require a longer recovery period, particularly if complications such as myositis ossificans develop (5, 7, 30). During the recovery process, careful monitoring of the injury is essential to ensure that the patient is progressing appropriately and that there are no signs of delayed healing or secondary issues. Return to play should be based on the complete resolution of symptoms, the restoration of full range of motion, and the recovery of muscle strength to pre-injury levels. This ensures that the athlete can perform at their highest level without risking further injury or recurrence of the contusion (1, 5, 31).

8. Prevention

Preventing quadriceps contusion involves the use of protective gear, proper training techniques, and conditioning exercises that enhance muscle strength and flexibility. Protective gear, such as padded shorts or thigh guards, can help absorb the impact of blows and reduce the risk of muscle damage (5, 14). Conditioning exercises aimed at strengthening the quadriceps and improving flexibility can also play a crucial role in injury prevention. Regular stretching, strength training, and dynamic warm-up routines can help prepare the muscles for the demands of contact sports and reduce the likelihood of injury. Additionally, athletes should be educated on the importance of avoiding high-risk activities during periods of muscle fatigue, as tired muscles are more susceptible to injury. Coaches and trainers should emphasize the need for adequate rest and recovery, as well as the importance of maintaining proper technique during training and competition (5, 14).

9. Conclusion

Quadriceps contusion, resulting from direct trauma to the quadriceps muscle group, leads to hematoma formation and varying degrees of injury severity. Diagnosis is primarily clinical, often supported by ultrasound and MRI to assess the extent of muscle damage. Treatment is typically non-operative, involving rest, ice, compression, physical therapy, and a gradual return to activity. One significant complication is myositis ossificans, characterized by abnormal bone formation within the muscle, which can cause chronic pain and restricted movement. Recent advances, such as ultrasound-guided platelet-rich plasma (PRP) injections, offer promising results by enhancing healing, relieving pain, and accelerating functional recovery. PRP therapy, particularly popular among athletes, promotes tissue repair by stimulating cell regeneration and reducing inflammation, helping speed up recovery and potentially lowering the risk of complications like myositis ossificans. Although preliminary evidence supports the effectiveness of PRP in helping athletes return to play sooner, more research is needed to validate its full impact on musculoskeletal injuries. Continued exploration of nonoperative treatment and rehabilitation protocols is also necessary to ensure optimal outcomes. Preventive strategies, including the use of protective gear and conditioning exercises to strengthen muscles, are critical in reducing the risk of injury and enhancing athletic performance.

Disclosure:

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All authors have read and agreed with the published version of the manuscript.

Funding statement: No funding was received.
Conflict of interest: The authors declare no conflict of interest.
Statement of institutional review board: Not applicable.
Statement of informed consent: Not applicable.
Data availability statement: Not applicable.

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