

**Ultrasound-guided percutaneous treatment of muscle hematomas in athletes**

Trattamento percutaneo ecoguidato degli ematomi muscolari nello sportivo

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**SUMMARY**

Muscle lesions, a frequent event in sport, often cause hematomas. In fact, both in the traumatic direct injuries, as in American football, and in the traumatic indirect ones, as in strength sports, lesions interesting leg’s muscles cause intra- and extramuscular hematomas. A diagnosis in a short time, allow us to evaluate the lesion rank and plan a surgery approach. Authors present high resolution ultrasound (HRSU) as a new diagnostic method for this kind of lesion. It allows us to confirm clinic diagnosis, define the lesion’s areas and follow-up. Moreover, HRSU has an important role in therapy, promoting in real time the blood’s aspiration from lesion’s area. Three phases after trauma, destruction, reparation and remodelling, represent three particular moments corresponding to hematoma’s formation, fagocitosis, and regeneration of fibres with the final solution of reorganization and reabsorption of scars. Authors present their cases of sportsmen submitted to HRSU of hematic effusion interposed in the lesion and following aspiration that, in the light of the results obtained, is the most appropriate method for functionality recovery time reduction and return to competitions.

**KEY WORDS**

Multiple trauma - Hematoma - Ultrasonography - Muscles, therapy.

**RIASSUNTO**

Le lesioni muscolari, evenienza particolarmente frequente in ambito sportivo, sono spesso responsabili della formazione di ematomi. Infatti, sia nelle lesioni da trauma diretto, come si verificano nel football americano, sia nelle lesioni da trauma indiretto, come avviene negli sport di potenza, le lesioni distrattive che interessano sia i muscoli flessori che i muscoli addutori degli arti inferiori, esistono formando ematomi intramuscolari ed extramuscolari. Poche un diagnosi si in tempi brevi ci consente di valutare il grado di lesione e capire il tipo di terapia chirurgica da approcciare. Gli autori presentano l’ecografia ad alta risoluzione (high resolution ultrasonography, HRSU) come una nuova metodica diagnostica di tale lesione: essa consente la verifica della diagnosi clinica, definisce l’estensione dell’area lesionata, il follow-up; inoltre, l’HRSU può svolgere un importante ruolo nella terapia favorendo in real time l’aspirazione della raccolta ematica nella sede di lesione. Le tre fasi che si susseguono dopo il trauma e cioè la distruzione, la riparazione e il rimodellamento, rappresentano tre momenti particolari che corrispondono alla formazione dell’ematoma, alla fagocitosi e alla rigenerazione delle fibre con un momento finale che comprende la riorganizzazione e il riassorbimento delle cicatrici. Gli autori propongono la loro casistica di sportivi sottoposti a HRSU del versamento ematico interposto nella lesione, e la successiva aspirazione, che, alla luce dei risultati ottenuti si ritiene sia quella più idonea alla riduzione dei tempi di recupero della “funzione” e al ritorno alla attività sportiva agonistica.

**Parole chiave:** Trauma multiplo - Ematoma - Ecografia - Muscoli, trattamento.
Muscle lesions are a frequent form of sports injury and are reported with an incidence ranging between 10-55% of cases.1 Lesions may be categorized as direct or indirect, depending on the injury mechanism. In direct injuries the affected muscle is suddenly compressed by a blunt force, as happens in contact sports, such as the American football. In indirect injuries (strain injuries) the affected muscle is subject to strenuous eccentric contraction or excessive hyperextension, as happens in strength or acceleration sports, such as light athletics. The muscles most susceptible to these injuries are the flexor and abductor leg muscles. Strains are graded into three categories. Partial ruptures (2nd degree lesions) and complete ruptures (3rd degree lesions) result in the formation of intra- and/or extramuscular hematomas (in the event of the anatomic interruption of the fascia).2-6 The healing process of strain injuries is slow and often incomplete, leading to reduced contractile strength and a high frequency of new lesions in the trauma area; this generally leads to the suspension of the athlete’s activities. The diagnosis is based on medical history and on clinical and instrumental tests (X-ray, ultrasound 2-6 and magnetic resonance 3-5). Treatment is essential to guarantee restored muscle function. The indications for surgery are complete rupture and lesion in a muscle with few or no agonists, the indications for non-invasive treatment have not yet been clearly established.1,7-9 In animal studies, it has been shown that, by drawing the stumps of the lesion together, suture of the muscle injury has been shown that, by drawing the stumps of the muscle flaps closer together, and accelerating healing.10 Based on this finding, authors undertook a prospective study to evaluate the efficacy of ultrasound-guided treatment to drain the blood between the stumps of the muscle lesion in a group of athletes, in order to draw the muscle flaps closer together and accelerate healing.

Materials and methods

In compliance with the rules of the Helsinki Declaration, athletes involved in competitive sports with a clinical diagnosis of 2nd degree leg muscle strain and persistent hematoma, as confirmed by instrumental tests using high-resolution ultrasound (HRUS) performed approximately one week after injury, were enrolled in the prospective study.

Le lesioni muscolari sono un’evenienza traumatica frequente nella pratica sportiva, tanto da essere riportate con un’incidenza variabile tra il 10% e il 55%.1 Le lesioni possono essere distinte in dirette e indirette, in base al meccanismo traumatico. Nelle lesioni da trauma diretto il muscolo coinvolto è compreso repentinamente da una forza contundente, come accade negli sport di contatto tipo il football americano. Nelle lesioni da trauma indiretto (trauma distrattivo) il muscolo coinvolto subisce una contrazione energetica eccentrica o una eccessiva iperestensione muscolare, come negli sport di potenza o di scatto tipo l’atletica leggera. I muscoli che maggiormente subiscono tali lesioni sono i muscoli flessori e adduttori degli arti inferiori. Le lesioni distrattive sono distinte in tre gradi. Le rotture parziali (lesioni II grado) e le rotture complete (lesioni di III grado) esistono nella formazione di ematomi intramuscolari e/o extramuscolari (in caso di interruzione anatomica della fascia).2-6 Il processo di guarigione delle lesioni distrattive è lento e spesso incompleto, con riduzione della forza di contrazione e alta frequenza di nuove lesioni in sede di trauma; tutto ciò comporta per un sportivo la sospensione dell’attività. La diagnosi è anamnestica, clinica, strumentale (radiografia, ecografia 2-6, risonanza magnetica 3-5). La terapia è un elemento essenziale per garantire il ripristino della funzionalità muscolare. Le indicazioni per la terapia chirurgica sono la rottura completa e la lesione in un muscolo con pochi o nessun agonista; le indicazioni per una terapia incruenta non sono ancora chiare.1,7-9 In studi animali è stata evidenziata come la satura del difetto muscolare avvicinando i monconi della lesione consentirebbe una guarigione più precoce.10 Sulla base di questo presupposto è stata valutata in modo prospettico l’efficacia della terapia drenante ecoguidata del sangue interposto tra i monconi della lesione muscolare di alcuni atleti per favorire l’avvicinamento degli stessi lembi, e quindi la guarigione.

Materiali e metodi

Rispettando le norme della dichiarazione di Helsinki, durante 18 mesi sono stati reclutati nello studio prospettico atleti praticanti attività agonistica con diagnosi clinica di lesione muscolare distrattiva di II grado dei muscoli degli arti inferiori e persistenza di ematoma, confermate alla valutazione strumentale con l’ecografia a elevata risoluzione (HRUS) eseguita a circa una settimana dal trauma. Tutte le indagini HRUS sono state effettuate dal medesimo radiologo e con la stessa apparecchiatura Tecnos (Esaote Biomedica, Genova, Italia) dotata di una sonda lineare multifrequenza (5-12 MHz) a elevata risoluzione. I criteri di eleggibilità per l’aspirazione ecoguidata dell’ematoma muscolare sono...
All the HRUS tests were performed by the same radiologist and using the same Tecnos equipment (Esaote Biomedica, Genoa, Italy), with a multi-frequency linear high-resolution probe (5-12 MHz). The following eligibility criteria were used for ultrasound-guided aspiration of the muscle hematoma: 1) age >18 years; 2) HRUS confirmation of strain with hematoma taking account of the criteria described in the literature; 3) absence of indications for surgery.

Criteria for exclusion included the presence of: 1) infections or dermatological pathologies in the needle insertion site; 2) major clotting disorders; 3) hemolymphoproliferative diseases; 4) neoplasms close to the strain or at a distance.

The ultrasound-guided aspiration procedure was performed by a team of two doctors: the first, a radiologist, performed HRUS, while the other inserted the aspiration needle using a manual technique. The skin was disinfected and the field prepared using sterile cloths, according to the method described by Jacobs; the ultrasound probe was covered with a probe cover; the site of the lesion was verified, excluding the presence of critical structures (blood vessels, nerves) along the presumed course of the needle; local anesthesia was performed by injecting 0.6 mL of mepivacaine chloride (carbocaine 3%, AstraZeneca, Milan, Italy) as an injectable solution; an 11-cm long, 20 G needle is inserted using HRUS guidance; the hematoma is aspirated by connecting the needle to a 10-cc Luer-lock syringe until it is fully evacuated.

A compressive bandage was then applied, and patients received physical treatment (cryotherapy and physio-kinesiotherapy); they were reassessed at weekly intervals using HRUS until fully recovered (Figures 1, 2).

Results

A total of 18 patients, all professional football players, were referred to our attention with a clinical diagnosis of 2nd degree muscle strain. HRUS confirmed the presumed diagnosis in 15 patients and classified three patients as presenting a 1st degree strain. The 15 patients were all males with a mean age of 26 years (age range 18-32). The site of the muscle lesion was the myotendinous junction of the medial gemellus in five patients, the rectus femoris in three patients, the semimembranosus in three patients, and...
the biceps femoris in two patients and the long adductor in two patients. The right side was affected in nine patients, and the left in six. The mean diameter of the hematoma was 6.8 cm, with a range of 2-10 cm. The mean quantity of blood drained was 8 cc, with a range of 2-20 cc. The clinical and instrumental assessments showed instrumental healing and functional recovery of the lesions to the medial gemellus within an average of 14 days, and to the other muscle lesions within seven days of aspiration treatment.

Discussion

Muscle trauma pathology is relatively frequent and is the cause of temporary disability leading to the athlete’s inability to train for a period between one and several months. Strains are more frequent in sports that involve rapid and sudden eccentric muscle contractions; this means that soccer players are potentially at risk. During matches, they are subject to repeated sprinting, kicking and jumping movements, sometimes for more than 90 minutes. The skeletal muscle is essentially made up of muscle fibres providing the contractile function, and connective tissues that provide support. While bone tissue heals through repair, muscle lesions heal through regeneration. The healing of any muscle lesion, which always involves three phases (destruction, fibrochinesiterapia) and is followed by functional recovery, can be monitored using instrumental techniques such as magnetic resonance imaging (MRI). The ultrasound-guided aspiration of muscle hematomas has been shown to be an effective treatment for muscle trauma, as it allows a quicker return to training and a faster recovery of muscle function. In this study, all patients treated with ultrasound-guided aspiration of muscle hematomas showed instrumental healing and functional recovery within an average of 14 days to the medial gemellus and within seven days to the other muscle lesions. The mean diameter of the hematoma was 6.8 cm, with a range of 2-10 cm, and the mean quantity of blood drained was 8 cc, with a range of 2-20 cc. The clinical and instrumental assessments showed instrumental healing and functional recovery of the lesions to the medial gemellus within an average of 14 days, and to the other muscle lesions within seven days of aspiration treatment.
tion, repair and remodelling) is linked to factors such as the size of the lesion, the vascular network and oxygenation. The destruction phase is characterised by the rupture and necrosis of the muscle fibres, lesions to blood vessels, formation of the hematoma between the lesion stumps, and cellular inflammatory reaction. The repair phase involves phagocytosis of the necrotic tissue, regeneration of muscle fibres, formation of the fibrous scar tissue and development of a new capillary network. During the remodelling phase, new muscle is created followed by the reorganisation and reabsorption of scar tissue and the recovery of function. By analysing the formation of fibrous scar tissue, it was found that immediately after the rupture of the muscle fibres, the hematoma fills the defect and granulation tissue – which consists of a network of fibrin and fibronectin that supports and anchors the fibroblasts – is developed. The greater the size of the lesion, the greater the tendency to form more extensive scar tissues. The formation of fibrous scar tissue is very important initially because it provides support for the regeneration of muscle fibres; later, however, it acts as a considerable impediment to the recovery of function, because it alters normal muscle architecture. Fibrosis formation process is similar to normal wound healing, but unlike the latter the absence of termination and resolution phases leads to uncontrolled fibrotic activity. Various authors have affirmed that the development of fibrosis prevents complete healing and full functional recovery. Moreover, the altered muscle architecture caused by fibrous scar tissue increases the likelihood of new lesions. Immediately after injury, the treatment of choice to reduce the extent of hematoma entails application of the RICE principle: 1) Rest: prevents diastasis of the lesion stumps; 2) Ice: lowers intramuscular temperature to 3-7 °C, reducing intramuscular blood flow by 50%; 3) Compression: reduces blood flow; 4) Elevation of the affected limb: reduces hydrostatic pressure and consequently the interstitial transudation of liquids. Some recent animal studies have shown that suture of the muscle injury reduces the distance between the stumps, allowing faster healing and preventing the formation of extensive fibrotic scar tissue. Using the mouse study as a model, it was found that one month after injury the tectonic strength of the sutured muscle was 81% of the control muscle, while the strength of the untreated muscles was 81% of the control muscle. However, in human cases, the strength of the sutured muscle was 81% of the control muscle. Therefore, the treatment of choice to reduce the distance between the lesion stumps; 2) Ice: lowers intramuscular temperature to 3-7 °C, reducing intramuscular blood flow by 50%.
ed muscle was 35%; the strength of immobilised muscle was 18%.¹⁸

HRUS was defined by Dodd in 1996 as “the undiscovered jewel of interventional radiology”,¹⁹ it plays an important role in both diagnostics and therapy. HRUS is the elite method of diagnosis for myotendinous lesions: it allows the clinical diagnosis to be verified, defines the extent of the injured area, and can be used to check follow-up. Moreover, HRUS can play an important role in the treatment by allowing real-time aspiration of the hematoma at the site of lesion. Various authors have hinted at the possibility of using ultrasound-guided drainage but none have ever assessed the real efficacy of the aspiration procedure in relation to prognosis and, in particular, to recovery times and the patient’s return to sporting activities. The use of the ultrasound guided aspiration procedure reduces the quantity of blood separating the lesion stumps, thereby preventing the onset of extensive fibrous scar tissue that alters the architecture of the injured muscle. In authors’ experience, ultrasound-guided drainage resulted in faster recovery times in all patients with complete functional recovery on average within one month of injury, a period that is much shorter than that taken by other forms of treatment to guarantee functional recovery. This study had three limits: 1) results were not compared to a control group undergoing conservative treatment, but the average recovery times reported in the literature were used as standard; 2) the assessment of the efficacy of symptomatological and functional results was based solely on subjective criteria; 3) the limited population treated in the study does not give adequate statistical validity to the results.

Conclusions

In conclusion, in the light of this experience, the use of HRUS to drain muscle hematomas allows a marked reduction in recovery times and prevents the development of widespread areas of fibrotic scar tissue, that lead to alterations of normal muscle structure and, therefore, impede the achievement of a perfect sporting performance.

References/Bibliografia


