Ultrasound monitoring of shortwave diathermic treatment of gastrocnemius strain in a dog

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Received: 17 August 2013 / Accepted: 5 October 2013 / Published online: 24 October 2013
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Abstract Rupture of the medial head of the gastrocnemius muscle occurs when the muscle is overstretched by dorsiflexion of the ankle with the knee in full extension. Muscle ultrasound (US) is a convenient diagnostic imaging technique for visualizing normal and pathological muscle tissue as it is a non-invasive real-time examination. Muscle US can also be used in the follow-up of patients with neuromuscular disorders. The aim of this paper is to describe US monitoring of the rehabilitation process in a dog undergoing diathermy treatment (TECAR) due to rupture of the proximal medial head of the gastrocnemius muscle and to show the changes in US appearance of the muscle before, during and after rehabilitation.

Keywords Dog · Gastrocnemius · Ultrasound · Strain

Sommario La rottura del capo mediale del muscolo gastronemio si verifica quando avviene un'iperestensione del muscolo in seguito a flessione dorsale della caviglia ed estensione completa del ginocchio. L'Ecografia muscolare è un valido ausilio di diagnostica per immagini per visualizzare il tessuto muscolare sia in condizioni normali che negli stati patologici inoltre non è invasiva e può essere svolta in tempo reale. L'Ecografia muscolare può essere utilizzata anche per il follow-up di pazienti con un disturbo neuromuscolare. Scopo di questo lavoro è quello di monitorare ecograficamente la riabilitazione terapeutica in un paziente affetto da rottura della giunzione prossimale del capo mediale del muscolo gastrocnemio trattato con terapia

diatermica (TECAR) e di presentare le variazioni ultrastutturali del muscolo prima, durante ed in seguito alla terapia riabilitativa.

Introduction

Ultrasound (US) imaging has a potential value in diagnostic investigation of the musculoskeletal system in small animals. US has been used in orthopedic evaluation in humans for at least 10 years, but in veterinary medicine, orthopedic US evaluation has been limited mainly to examination of equine tendons or joints. In small animals, US has also been used for describing the US anatomy of the hip and shoulder. However, in the literature, there are only a few publications reporting on US evaluation of musculoskeletal diseases in dogs. In general, US appearance of muscles is fairly distinct and can easily be discriminated from surrounding structures such as subcutaneous fat, bones, nerves and blood vessels [1, 2].

The US appearance of muscle injuries is age-related and depends on the severity of the injury. In the presence of complete muscle rupture, no muscle is visible in the injured area, which appears hypoechoic due to acute hemorrhage. The muscle stumps appear as cob-like, thickened, inhomogeneous structures which are more echoic than the surrounding tissue, and dynamic US imaging will show the gap between the muscle stumps. With increasing organization of the hematoma, echogenicity will increase. Older ruptures often appear inhomogeneous, varying from hyperechoic to anechoic, and alignment of muscle septations is visible on the US image only at a later stage. Partial muscle rupture does not cause complete loss of muscle

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mass and there is less bleeding than in complete rupture. Muscle healing can be evaluated at US imaging. Scar formation after muscle injury is characterized by a hyperechoic area with or without acoustic shadowing located between areas of relatively normal muscle tissue. Development of scar tissue depends on the extent of muscle fiber rupture. The diameter of the muscle is smaller in the injured region than in the healthy surrounding area. On the US image, fascia rupture appears as a protrusion of the muscle from the fascia. In case of fascia rupture, a hematoma is rarely detectable, and if a hematoma is present it is usually very small [3].

The gastrocnemius muscle is divided into a lateral and a medial head, which are covered by strong tendons and infiltrated by tendon strands. Both heads arise out of a large tendon from the lateral and medial supracondylar tuberosity of the femur and they enclose a large sesamoid bone that articulates with the corresponding condyle. The medial and lateral heads fuse distally to form a tendon which attaches to the tuber calcanei. The lateral head of the superficially located gastrocnemius muscle almost completely encloses the superficial digital flexor tendon, which originates from the femur and attaches to the medial phalanx of the digits. The main function of the gastrocnemius muscle is to cause extension of the tarsus, but this muscle also flexes the knee in the non-weight-bearing state resulting in action throughout the stance phase and during walk, trot or gallop. Injury to the origin of the gastrocnemius muscle in dogs includes total or partial avulsion of the lateral or medial head with or without prior trauma. Affected dogs present with high-grade lameness sometimes associated with plantigrade stance. Distal displacement of the corresponding sesamoid bone of the gastrocnemius head is usually apparent on radiographs [4].

The patients are usually injured when performing active plantar flexion of the foot with simultaneous active contraction and passive stretching of the gastrocnemius. In human medicine, US is used as the primary imaging technique for evaluating patients affected by this clinical condition, but only two cases of dogs in which this muscle injury was treated with US rehabilitation therapy are reported in Veterinary and Comparative Orthopaedics and Traumatology (VCOT) 2009 [5]. We propose to use shortwave diathermy rehabilitation in dogs with this muscle disorder and describe our experience with this treatment, the US findings and correlation between clinical symptoms and US follow-up findings in patients affected by rupture of the proximal musculotendinous junction of the medial head of the gastrocnemius muscle.

The purpose of this study is to demonstrate the US findings in rupture of the medial head of the gastrocnemius muscle in a dog and to describe the healing process during treatment, according to a new protocol involving shortwave diathermy.

Case history

A 4-year-old male German hound, an active hunting dog, body weight 34 kg, presented with acute onset of right posterior limb lameness. The dog had been treated with anti-inflammatory medication (carprofen 4 mg/kg), but presented no significant improvement of the clinical signs. Orthopedic examination of the right femorotibial joint revealed signs of moderate pain on joint extension and severe pain on palpation of the mediolateral femur, especially when pressure was applied to on the lateral fabella. Radiographic examination of the stifle joint did not reveal any abnormality. The lateral fabella was well demarcated. US imaging was performed and showed normal stifle joint and normal menisci. Distal to the medial fabella, the gastrocnemius muscle presented hypoechoic areas suggesting edema, hematoma and partial rupture. The dog was administered carprofen 4 mg/kg once a day for 2 days and then 2 mg/kg once a day for the following 5 days. Short-wave diathermy was carried out twice a week for a period of 1 month. US was performed on the day before the first application of shortwave diathermy using a GE Logiq P5 Pro US machine and a 5–10 MHz convex probe, and after five and ten shortwave diathermy applications. During the 1-month treatment period, the dog showed continuous improvement. No visible lameness was detected after the treatment, and no pain was evident at extension of the stifle joint and palpation of the medial distal femur.

Before shortwave diathermy, US longitudinal scan showed hyperechoic muscle fibres with hypoechoic areas suggesting edema, hematoma and partial muscle rupture of the lateral head of the gastrocnemius muscle (Fig. 1). After five shortwave diathermy applications, the muscle appeared less hypoechoic due to reabsorption of the hematoma (Fig. 2). After completed therapy, the muscle

Fig. 1 US diagnosis of gastrocnemius muscle tear

Fig. 2 US imaging after five shortwave diathermy applications

Fig. 3 US imaging after ten shortwave diathermy applications

Fig. 4 Healthy gastrocnemius muscle (*left*) and gastrocnemius muscle strain after therapy (*right*)

showed normal echogenicity, although slightly hyperechoic compared to clinical standards (Figs. 3 and 4). US evaluation after five and ten shortwave diathermy applications showed normal muscles and partial edema reabsorption.

Conclusions

Shortwave diathermy is a non-pharmacological management approach involving deep heating of the tissues. This treatment has been reported to have a measurable effect in patients with osteoarthritis of the knee. Shortwave diathermy increases tissue temperature and circulation and reduces pain in patients with degenerative osteoarthritis, and the effect has been well documented. However, few studies have investigated the effect of shortwave diathermy in the treatment of increased synovial sac thickness or its ability to change the inflammatory process caused by muscular avulsion or contraction. US is an inexpensive, simple-to-use and non-invasive imaging technique which has substantially evolved over the past decade. It allows direct visualization of the soft tissue structures and joint compartments, and it is easily repeatable.

Compared with the US treatment described by Mueller et al. [5], shortwave diathermy successfully decreases avulsion of the gastrocnemius muscle in half the time without immobilization of the dog. The physiological mechanisms underlying such significant changes may be linked to improved blood circulation in the epimysium membrane.

Rupture of the lateral head of the gastrocnemius muscle occurs when the muscle is overstretched by dorsiflexion of the ankle with the knee in full extension; differential diagnosis includes deep vein thrombosis or thrombophlebitis. The use of an imaging modality can allow the physician to confirm a clinical suspicion of muscle tear, exclude other diseases and assess the extension of the lesion, all of which have an influence on the choice and duration of treatment. In human medicine, US has proved successful in the evaluation of muscle trauma, including partial and complete muscle ruptures. US examination of muscle rupture is fast, easy to perform and painless. Increased echo intensity is caused by infiltration of fat and fibrous tissue. As muscle echo intensity is strongly correlated with these structural changes, quantitative muscle US is a reliable method for detecting structural muscle changes and determining the severity of the muscle disorder.

In humans, strain injury of the lateral head of the gastrocnemius muscle at the middle or proximal leg is termed “tennis leg” due to its common association with this sport. This injury usually occurs at the distal muscle tendon junction, but it can also affect the knee or occur in

association with an injury to the deep plantaris muscle. Similarly, lesions to the lateral head of the gastrocnemius muscle occur in humans in connection with injury to the posterolateral complex, and they are frequently associated with tears of the popliteus tendon, biceps tendon, and plantaris muscle. Several factors make a muscle more susceptible to strain, including extension across two joints, long fusiform shape, composition of fast contracting type II fibres and eccentric action (contracting during elongation). In eccentric contraction, the muscle fiber is forced to stretch during the initial stance phase. The gastrocnemius muscle, the hamstring muscles and the biceps brachii muscle have these characteristics and are the most frequently strained in humans. In humans, musculotendinous strain of the gastrocnemius muscle is a common racquet sport injury related to fast acceleration, sudden stops and turns. Given the differences in limb conformation among breeds, inherent biomechanical differences in joint function may be responsible for alterations in loading patterns that contribute to specific injuries or a degenerative process. Muscles crossing distal limb joints do negative (eccentric) work as they stretch to absorb energy during weight acceptance in the early stance phase, and then they typically do positive (concentric) work in the late stance phase to provide an active push-off when the foot is caudal to the more proximal joints. The muscle has an intrinsic ability to heal through myofibril regeneration if the sarcolemma cell membrane and the connective tissue sheath of the endomysium are not destroyed.

Muscle US imaging is a convenient diagnostic tool for visualizing normal and pathological muscle tissue as it is a non-invasive real-time examination. Muscle US is also useful in the follow-up of patients with neuromuscular disorders. Because of its non-invasiveness, muscle US

imaging can easily be repeated, and this makes it an ideal tool for evaluating new treatment strategies in musculoskeletal diseases [1].

In conclusion, in patients with clinically suspected rupture of the lateral head of the gastrocnemius muscle, US imaging has proved to be an easily performed, fast and safe imaging modality. The dog had an excellent outcome and resumed intended use without recurrence of lameness.

Conflict of interest Luca Lideo and Roberto Milan declare that they have no conflict of interest in relation to this paper.

Informed consent The dog's owner provided (written) informed consent to enrollment in the study and to the inclusion in this article of information and images that could potentially lead to its identification.

Human and animal studies All institutional and national guidelines for the care and use of laboratory animals were followed.

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