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Case Report

Thermography Diagnosis of Medial Patellar Ligament Rupture in a Horse

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Abstract

In this report, thermography was evaluated as a portable diagnostic tool in addition to ultrasonography, which is frequently used in the diagnosis of medial patellar ligament tears in horses. Thermography revealed that the medial patellar ligament has difficulty absorbing quadriceps forces and that the cranial surface of the stifle joint shows elevated temperatures at rest. At the end of training, load sharing occurred between the cranial and caudal surfaces of the joint and the quadriceps muscle. Temperature changes captured by thermography may indicate the severity of the injury and help clinicians suspect ligament tears even without access to ultrasonography.

Keywords: Horse, Medial patellar ligament rupture, Thermography

Introduction

Injury to the stifle joint [1], the largest and most complex joint in horses, is an essential cause of hindlimb lameness, especially in performance horses [2]. The location of lesions in the joint may vary according to the level of work, discipline, and age [3]. Patellar ligaments are potential causes of orthopedic problems. Lateral patellar ligament injuries are usually trauma-related and associated with an external wound [4]. However, more rare medial patellar ligament injuries may cause locking of the joint and permanent or temporary upward fixation of the patella. This condition may require medical or surgical treatment, depending on the severity of the lesion [5].

Although ligament laxity is often implicated as the cause of lameness, desmopathy of the patellar ligaments have begun to be described in horses. In studies showing the normal and abnormal structures of the patellar ligaments ultrasonographically, diseased conditions have been reported to vary between 4-18% [4].

Injuries to this joint are challenging to diagnose, the prevalence is unclear and poses a significant problem for clinicians [6]. When the cause of lameness is the stifle joint, radiography and ultrasonography are usually used to diagnose the lesions. Without calcification in tendon/ligament lesions, tissue details are not visible on radiographs due to low contrast [7]. Although ultrasonography is a proper diagnostic method for soft tissues in the stifle joint, not all structures may be fully defined due to the complex anatomy of the joint [8]. Although techniques such as computed tomography, magnetic resonance imaging, or arthroscopy provide valuable data as diagnostic methods in joint diseases, they have disadvantages, such as being expensive, requiring special equipment, and requiring general anesthesia [9,10]. Thermography, a diagnostic method in clinical practice, enables remote determination of physiological or pathological surface temperatures without the need for restraint of animals. In veterinary medicine, this technique has been used on farm [11] and companion animals [12] since the late 1950s until today. It has many advantages over other diagnostic methods, such as being non-contact, not requiring anesthesia, no need to hold the animal, providing real-time temperatures in superficial areas, simultaneous comparisons, and easy portability [11]. As mentioned, although each diagnostic method has different advantages, multiple methods are used to make a diagnosis due to the size and complexity of the stifle joint in horses. Although previous studies have documented the use of the methods, we aimed to present ultrasonographic and thermographic data in a rare case of medial patellar ligament tear in horses, including measurement of surface temperatures. Thus, it would be valuable to include thermographic findings among the diagnostic methods to evaluate the stifle joint.

Case History

Ethical Approval

Informed consent was obtained from the animal owner to use the data obtained from the clinical examination.

Clinical Examination of the Horse

A presentation was made of an 11 years old German male jumping horse, weighing 650 kg, who was examined at the farm where he was found for constand cold lameness of the hind leg. We were informed that the horse has been training generally since the lameness started. The training program consisted of 20 min of warm-up and 20 min of galloping and jumping. Therefore, the horse presented was examined before the training, after 20 min of warm-up, and at the end of the training (after 40 min). Clinical examination, ultrasonographic, and thermographic examination were performed before training. Clinical examination and thermographic examination were again performed at 20 and 40 min. Radiographs of the stifle joint could not be taken because the X-ray equipment was not portable and could not be taken to the field.

It was learned that the horse had been lame for two months, and different medical treatments (triamcinolone acetonide ampoule, diclofenac sodium gel, and hyaluronic acid serum-intraarticular) were applied during this period. However, the horse's keeper also stated that no medication had been administered for the last two weeks. Physical examination revealed pain and tenderness in the left stifle joint. Inspection and palpation revealed no wound, crepitation, or joint swelling. Body temperature was within normal limits. During clinical examinations, it was observed that the horse's stride length was shortened at the trot, the haunch was kept at a low level, and the hoof tip rubbed the ground during stepping.

Thermographic Examination

Thermography measures the surface temperature of any object with a temperature above absolute zero [11], and as shown in *Fig 1*, hot spots are seen in red-white and cold spots in blue. Along with the initial clinical examination, thermographic images were taken at 20 and 40 min of training. Temperature changes were recorded on the left quadriceps muscle and cranial, lateral, and caudal surface of the left stifle joint *(Fig. 1)*. Three measurements were taken at each mentioned site and statistically analyzed.

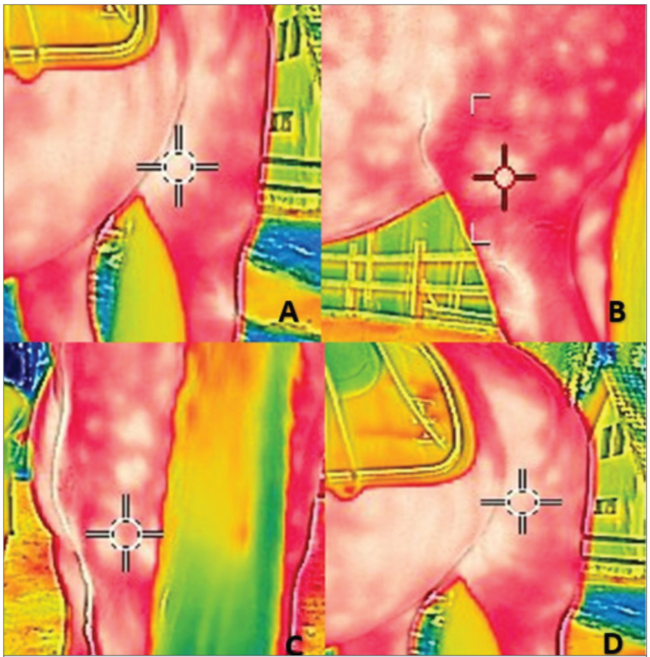

Fig 1. Surfaces from which thermographic images are taken. **A:** Cranial surface of the stifle joint, **B:** Lateral surface of the stifle joint, **C:** Caudal surface of the stifle joint, **D:** Quadriceps muscle

The emissivity value for subjects was 0.93, and all images were taken at the same distance (2 m) [13]. Temperature measurements from the regions shown in *Fig. 1* were analyzed with one-way ANOVA. The values were reported as means with standard deviation and subjected to analysis using SPSS 17.0 software (SPSS Inc., Chicago, IL, USA). The statistical analyses were conducted at a significance level of $P<0.05$.

According to the results of the analysis, it was found that the temperature in the cranial surface of the stifle joint before training was significantly higher than in the other regions. When the anatomical regions were compared at 20 min of training, the highest temperature was found on the lateral surface of the stifle joint, followed by the cranial surface. The caudal surface of the stifle joint and the quadriceps muscle had statistically the lowest temperature, and these two regions were not different. At 40 min of training, the temperatures of the cranial surface of the stifle joint and quadriceps muscle were not significantly different. Still, they had significantly higher temperatures than the other two anatomical regions. Time-dependent changes in temperature measurements are shown in *Table 1*.

While the temperature changes from the anatomical regions according to time were in this way, statistical analysis was also performed according to the anatomical regions. Although the temperatures on the cranial surface of the stifle joint increased at 20 and 40 min, the difference between the pre-training and 20 min measurements was insignificant. However, there was a significant increase in the 40th min measurements compared to pre-training

Table 1. Temperature measurement values taken from anatomical regions according to time

Anatomical Regions	Before Training	20th Min. of Training	40th Min. of Training	P-Value
Cranial Surface of Stifle	33.57±0.15^{b}	33.80±0.10^{b}	36.47±0.25^{a}	<0.001
The Lateral Surface of the Stifle	32.67±0.15^{b}	34.67±0.15^{a}	34.73±0.21^{a}	<0.001
The Caudal Surface of the Stifle	32.83±0.06^{c}	33.23±0.15^{b}	34.73±0.06^{a}	<0.001
Quadriceps Muscle	32.80±0.10^{c}	33.17±0.15^{b}	36.63±0.15^{a}	<0.001

Data presented mean±SD (n=3). Different superscripts show significantly differences (P<0.05)

Table 2. Temperature measurement values according to anatomical regions

Measurement Time	Cranial Surface of Stifle	The Lateral Surface of the Stifle	The Caudal Surface of the Stifle	Quadriceps Muscle	P-Value
Before training	33.57±0.15^{a}	32.67±0.15^{b}	32.83±0.06^{b}	32.80±0.10^{b}	<0.001
20th min. of training	33.80±0.10^{b}	34.67±0.15^{a}	33.23±0.15^{c}	33.17±0.15^{c}	<0.001
40th min. of tTraining	36.47±0.25^{a}	34.73±0.21^{b}	34.73±0.06^{b}	36.63±0.15^{a}	<0.001

Data presented mean±SD (n=3). Different superscripts show significantly differences (P<0.05)

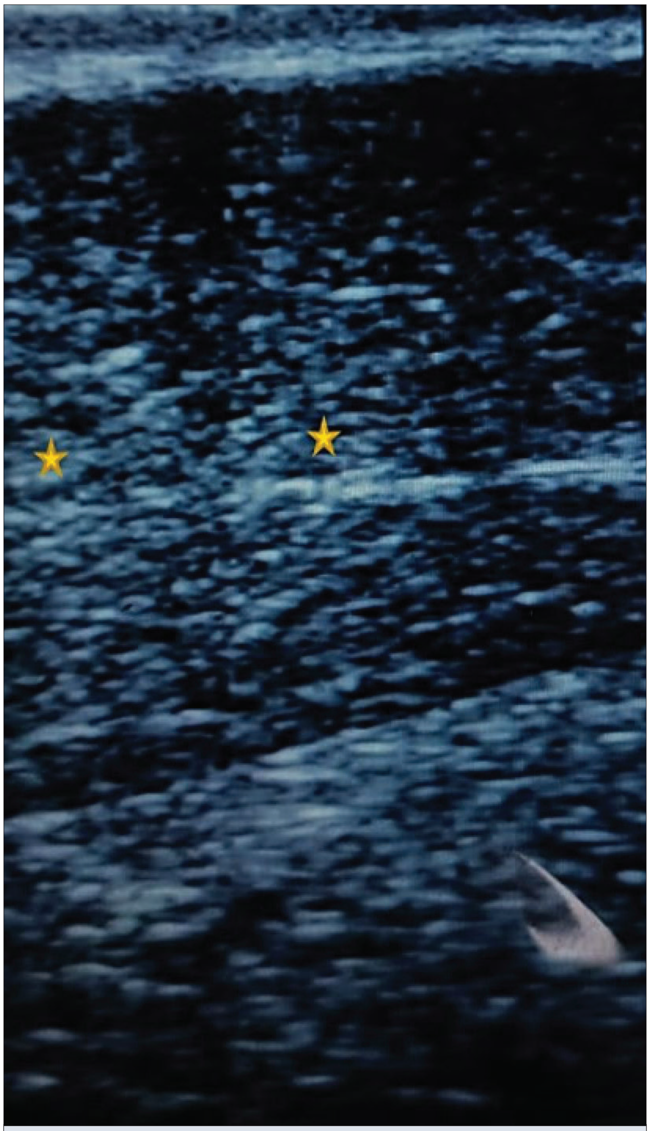

Fig 2. The yellow stars indicates the heterogeneous structure of the quadriceps muscle and echogenicity increases

and 20th min. Although there was no significant difference in the temperatures on the lateral surface of the stifle joint between the 20th and 40th min measurements, these measurements were significantly higher than the temperatures before training. In the analysis of temperature measurements taken from the caudal surface of the stifle joint and quadriceps muscle, it was determined that the temperatures gradually increased over time, which was significant (*Table 2*).

Ultrasonographic Examination

The horse underwent an ultrasonographic examination of the stifle using an ultrasound machine (Mindray Digital Ultrasonic Diagnostic Imaging System DP-20 Vet, China) with a variable frequency (7-10 MHz) linear transducer. The horse was not sedated, and the hair was not clipped because he was being used for training. Machine parameters were adjusted as necessary to improve image quality. A stand-off pad was not used. Ultrasonography of the stifle joint was performed because pain and tenderness were detected in the left stifle joint on physical examination.

The bony structures, ligaments, and quadriceps muscle were evaluated in transverse and sagittal views of the left stifle joint in normal posture. By placing a probe cranio-proximal to the quadriceps muscles, images towards the tibia were controlled.

It was determined that the quadriceps muscle had a heterogeneous structure, and there were increases in echogenicity at some points (*Fig. 2*).

It was noted that the medial and lateral trochleae were smooth. In the transverse plane, the intermediate patellar ligament was found to have an oval appearance and homogeneous echogenicity. The lateral patellar ligament

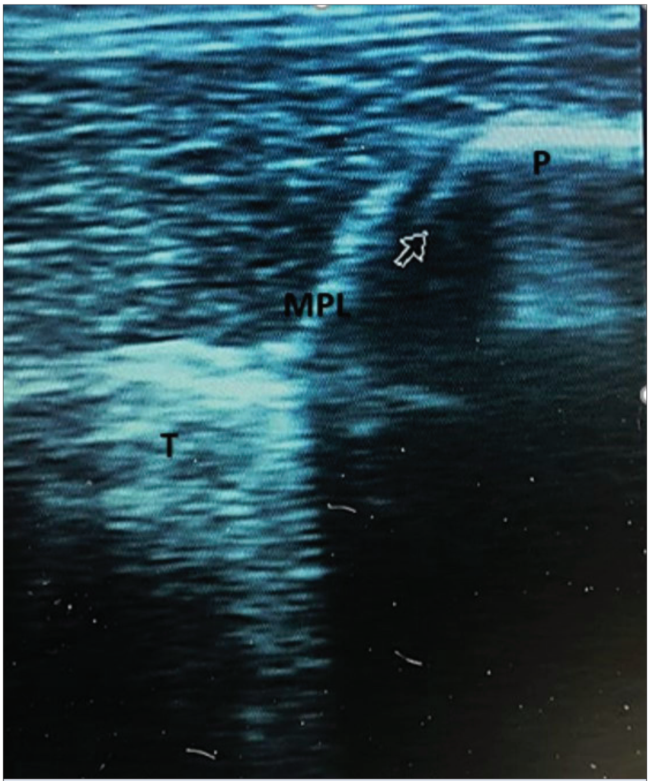

Fig 3. Ultrasonographic image of the medial patellar ligament. It is seen that the ligament is interrupted in the area indicated by the arrow (P: Patella, T: Tibia, MPL: Medial Patellar Ligament)

was evaluated by following the tibial tuberosity, but no irregular areas disrupting homogeneity were identified. In the examination of the medial patellar ligament, it was determined that the ligament was interrupted at the patella level in the transverse section, and an anechogenic area was formed in this area. And a ligament tear was diagnosed *(Fig. 3)*.

Discussion

Diseases related to the stifle joint are an important cause of hindlimb lameness in horses [1]. Although joint injuries are commonly reported in the literature, diagnosis is difficult for clinicians working in the field [6]. Although ultrasonography and radiography are often used for diagnosis, the disadvantage is that radiography lacks detail for lesions in soft tissues [7]. In addition, as in our case report, the fact that the radiography device is not portable also limits the clinicians in the field. Ultrasonography is used more in field studies because it can easily take images from soft tissues in different sections [8]. Although radiographs could not be obtained in the present case, ultrasonographic and thermographic images that can be used in field conditions were evaluated. The most important aim was identifying abnormalities in the lameness case clinically localized to the stifle joint. A diagnosis of medial patellar ligament tear was made with both ultrasound images and evaluation of superficial temperatures. In addition to being able to visualize the ligament tear, the temperature changes in this area also gave us important information. The horse's condition before training and the temperatures taken at 20 and 40 min into training were significantly different. At rest, the highest temperature was detected on the cranial surface of the stifle joint. Although the loads on joints and muscles have not been studied on live horses, a force of 8000 N was applied to analyze the load on the genu joint of a galloping horse in biomechanical studies. The strength of the patellar ligaments to withstand this load is 300 MPa. In the study that obtained these data, 1000 N proximal patellar tension was applied to represent the quadriceps force [14]. In the example study, it is understood how high the strength of the patellar structures and the quadriceps muscle must be to meet the load on the stifle joint. In the case we presented, we interpreted the high temperature of the cranial surface of the joint even in the resting state as the medial patellar ligament could not fully absorb the load and tried to counteract the quadriceps force coming from the dorsal side with the structures on the cranial surface of the joint. In the case we detected a medial patellar ligament tear by ultrasonography, we thought a ligament tear should be suspected by thermographic temperature measurement under field conditions. In this sense, thermographic data can provide essential data. We believe the joint and the surrounding structures were under more load because the patient was a jumping horse. In the meantime, the patient's anamnesis showed that he continued to train, so thermal images were taken 20 and 40 min into the training. Examination at 20 min revealed that the highest temperature was lateral to the stifle joint. The cranial surface ranked second, while the caudal surface and quadriceps muscle, which had the lowest temperature, did not differ. Several studies have suggested that the initiating factor of pathological processes is the inadequate ability of the tissues to cope with the mechanical load applied to the tendons [15,16]. This may be why the highest temperature before training is only on the cranial surface, whereas with training, the highest temperature is on the lateral surface. Because the load has gradually increased, other tissues may no longer be able to meet this load. This can explain the temperature rise. If the training were continued, we would encounter different findings thermographically. At 40 min, the highest temperature was again on the cranial surface of the joint, similar to the situation before training. However, this time, the temperature of the quadriceps muscle had also increased. Although these two anatomical regions had high temperatures, they were not statistically different. When we examined the change of the anatomical regions according to time, we found no difference between the temperature of the cranial surface of the joint before training and the temperature at 20 min. In comparison, there was a significant increase at

40 min. In the quadriceps muscle, we detected a steady increase in temperature over time. In the study by Frazer and colleagues [14], it was stated that the patellar structures, especially the quadriceps muscle, were under much load with the horse's galloping, as previously mentioned. After 20 min of training, he galloped and jumped obstacles in his daily training until 40 min were completed. In parallel with the literature, we think that the cranial surface of the joint and the quadriceps muscle temperature increased as the medial patellar ligament could not meet the load with more load on the leg. We found that although the temperature on the lateral surface of the joint increased in the 20th and 40th min compared to the pre-training period, there was no difference between them.

In conclusion, our case report provides valuable data for the diagnosis of medial patellar tear and the temperature of the articular surfaces and quadriceps muscle. When all our data are evaluated, we think that in medial patellar ligament tears, the temperature increases only on the cranial surface of the stifle joint at rest due to increased load; after 20 min of warm-up, the cranial surface and lateral surface are also under load, and when the training is terminated, this load is shared between the cranial, caudal surface of the joint and the quadriceps muscles. We can say that the lateral surface of the joint is under less load after galloping and jumping hurdles compared to other anatomical regions. The temperature differences identified in the case report, combined with clinical and ultrasonographic examination, indicated a pathology. Veterinarians working in the field should also evaluate superficial temperatures in this way. More cases are needed to confirm these results. In addition, we would like to emphasize that ultrasonography is very useful for diagnosis without portable X-rays for clinicians working in the field. In addition, a ligament tear can be suspected by determining temperature increases by thermographic examination. Thermography can provide significant findings as a diagnostic method.

Availability of Data and Materials

The data that support the findings of this case report are available from the corresponding author (E. Dogan) upon reasonable request.

Acknowledgments

We want to thank the authorities and staff of the horse farm for allowing us to collect data for this case.

Competing Interests

The authors declared that there is no conflict of interest.

Author Contributions

Clinical, ultrasonographic and thermographic examination was done by ED, OD and ABD. ED analyzed and interpreted the data. ED, OD, ABD wrote the paper. Authors submitted the article together.

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