Effectual of Thermographic Diagnosis at Equine Medial Patellar Ligament Tear

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Abstract

Different techniques are used in the diagnosis of medial patellar ligament tear in horses along with ultrasonography, which is frequently used. This study investigates the use of thermography, a non-invasive, cost-effective and portable diagnostic tool, in a rare case of medial patellar ligament tear in horses. An 11-year-old German jumping horse with hindlimb lameness was examined before and after training using clinical evaluation, ultrasonography, and thermography. Temperature changes in different anatomical regions differed with the activity level of the horse. The cranial surface of the stifle joint showed elevated temperatures at rest, signifying the medial patellar ligament’s struggle to absorb quadriceps forces. As the horse trained, temperatures on the cranial and lateral surfaces increased, indicating increased loading. After rigorous training, load-sharing occurred between the cranial and caudal surfaces of the joint and the quadriceps muscle. Temperature changes on specific joint surfaces and the quadriceps muscle, as captured by thermography, can indicate injury severity and help clinicians suspect ligament tears even without access to ultrasonography. This study is among the first to explore medial patellar ligament tears and suggests the potential of thermography as a diagnostic method in equine stifle joint injuries. However, this research marks a promising step towards improved equine diagnostics, particularly in field conditions where other diagnostic methods may be impractical.

Introduction

Injury to the stifle joint (Sullins 2002), the largest and most complex joint in horses, is an important cause of hindlimb lameness, especially in performance horses (Denoix 2004). The location of lesions in the joint may vary according to the level of work, discipline and age of the horse (Egenvall et al. 2013). Patellar ligaments are potential causes of orthopedic problems. Lateral patellar ligament injuries are usually trauma-related and associated with an external wound (Gottlieb et al. 2016). 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 (Kallings 2021).

Although ligament laxity is often implicated as the cause of lameness, desmotopies 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% (Gottlieb et al. 2016; Hoaglund et al. 2019; Van der Vekens et al. 2011).

Injuries to this joint are difficult to diagnose, the prevalence is unclear and poses a significant problem for clinicians (Flynn and Whitcomb 2002). When the cause of lameness is the stifle joint, radiography and ultrasonography are usually used to diagnose the lesions. Unless there is calcification in tendon/ligament lesions, tissue details are not clearly visible on radiographs due to low contrast (Laverty 1991). Although ultrasonography is a useful diagnostic method for soft tissues in the stifle joint, not all structures may be fully defined due to the complex anatomy of the joint (Barrett 2012). Although methods 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 (Nelson et al. 2016; Frisbie et al. 2014). Thermography, which has taken its place as 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 and companion animals 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 (Hilsberg 2000).
As mentioned, although each diagnostic method has different advantages, more than one method is 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, to the authors’ knowledge there is no use of thermography as a
diagnostic method for medial patellar ligament tears. Therefore, we aimed to present ultrasonographic and
thermographic data in a rare case of medial patellar ligament tear in horses. Thus, it would be valuable to
include thermographic findings among the diagnostic methods to evaluate the stifle joint.

Case History

A presentation was made of an 11-year-old German jumping horse weighing 650, which was examined at the
farm where it was found due to hindlimb lameness. We were informed that the horse has been training
normally since the lameness started. The training program consisted of 20 minutes of warm-up and 20
minutes of galloping and jumping. Therefore, the horse presented was examined before the training, after 20
minutes of warm-up and after 40 minutes at the end of the training. Clinical examination, ultrasonographic
and thermographic examination were performed before training. Clinical examination and thermographic
examination were performed at 20 and 40 minutes. 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.

Clinical finding

It was learned that the horse had been lame for two months and different medical treatments were applied
during this period. Physical examination revealed pain and tenderness in the left stifle joint. 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.

Ultrasonographic examination

Horse underwent 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.

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 cranioproximal 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 (Figure 1).

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 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 ligament tear was diagnosed (Figure 2).

Thermographic examination
Along with the initial clinical examination, thermographic images were taken at 20 and 40 minutes of training. Temperature changes were recorded on the left quadriceps muscle and cranial, lateral, and caudal surface of the left stifle joint. (Figure 3). Three measurements were taken at each of the mentioned sites and statistically analyzed. The emissivity value for subjects was 0.93 and all images were taken at the same distance (2 meters)(Pezeshki et al. 2011)

**Analysis of thermographic temperatures**

Temperature measurements taken from the regions shown in Figure 3 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 study employed one-way analysis of variance (ANOVA). 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 the other regions. When the anatomical regions were compared at 20 minutes of training, the highest temperature was found on the cranial 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 from each other. At 40 minutes of training, the temperatures of the cranial surface of the stifle joint and quadriceps muscle were not significantly different from each other, but 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 minutes, the difference between the pre-training and 20 minute measurements was not significant. However, there was a significant increase in the 40th minute measurements compared to both pre-training and 20th minute. Although there was no significant difference in the temperatures on the lateral surface of the stifle joint between the 20th and 40th minute 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 and this increase was significant. (Table 2).

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

<table>
<thead>
<tr>
<th>Region</th>
<th>Before Training</th>
<th>20th min. of training</th>
<th>40th min. of training</th>
<th>P -value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cranial surface of stifle</td>
<td>33.57±0.15b</td>
<td>33.80±0.10b</td>
<td>36.47±0.25a</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Lateral surface of stifle</td>
<td>32.66±0.15b</td>
<td>34.67±0.15a</td>
<td>34.73±0.21a</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Caudal surface of stifle</td>
<td>32.83±0.06c</td>
<td>33.23±0.15b</td>
<td>34.73±0.06a</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Quadriceps muscle</td>
<td>32.80±0.10c</td>
<td>33.17±0.15b</td>
<td>36.63±0.15a</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

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

**Table 2:** Temperature measurement values according to anatomical regions.

<table>
<thead>
<tr>
<th>Region</th>
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<th>40th min. of training</th>
<th>40th min. of training</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cranial surface of stifle</td>
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<tr>
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Data presented mean±SD (n=3). Different superscripts shows significantly differences (p<0.05)
Discussion

Diseases related to the stifle joint are an important cause of hindlimb lameness in horses (Sullins 2002). Although injuries of the joint are commonly reported in the literature, diagnosis is difficult for clinicians working in the field (Flynn and Whitcomb 2002). Although ultrasonography and radiography are often used for diagnosis, the disadvantage is that radiography has a loss of detail for lesions in soft tissues (Laverty 1991). 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 (Barrett et al. 2012). 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 to identify 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 minutes 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. (Frazer et al. 2019) In the example study, it is understood how high the strength of the patellar structures and the quadriceps muscle must be in order 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 in which we detected a medial patellar ligament tear by ultrasonography, we thought that ligament tear should be suspected by thermographic temperature measurement under field conditions. In this sense, thermographic data can provide important data. We think that 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 at 20 and 40 minutes into the training. Examination at 20 minutes 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 from each other. 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. (Fu et al. 2010; Steinmann et al. 2020) This may be the reason 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 and other tissues may no longer be able to meet this load. This can explain the temperature rise. If the training was continued, we encountered different findings thermographically. At 40 minutes, the highest temperature was again on the cranial surface of the joint, similar to the situation before training, but this time the temperature of the quadriceps muscle had also increased. Although these two anatomical regions had high temperatures, they were not statistically different from each other. When we examined the change of the anatomical regions according to time, we found that there was no difference between the temperature of the cranial surface of the joint before training and the temperature at 20 minutes, while there was a significant increase at 40 minutes. In the quadriceps muscle, we found a steady increase over time. In the study by Frazer and colleagues (2019), it was stated that the patellar structures and especially the quadriceps muscle were under a lot of load with the galloping of the horse as previously mentioned. After 20 minutes of training, he galloped and jumped obstacles in accordance with his daily training until 40 minutes 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. Whereas, we found that although the temperature on the lateral surface of the joint increased in the 20th and 40th minutes compared to the pre-training period, there was no difference between them.
In conclusion, interesting data were recorded in this case report. To the best of the authors’ knowledge, the number of studies reporting cases of medial patellar tear is small and there are no studies reporting the temperature of the articular surfaces and quadriceps muscle in these cases. In this sense, our case report provides important data. When all our data are evaluated together, 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 minutes 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. We are aware that more cases are needed to confirm these results. However, our results are the first results for medial patellar ligament tears. In addition, we would like to emphasize that ultrasonography is very useful for diagnosis in the absence of portable X-rays for clinicians working in the field. Even in the absence of ultrasonography, thermographic images can be obtained to at least suspect ligament tears. Thermography can provide important findings as an diagnostic method.

Figure Legens

**Figure 1:** The heterogeneous structure of the quadriceps muscle and echogenicity increases are indicated by the yellow star.

**Figure 2:** 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)

**Figure 3:** 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

References


