Turk. J. Vet. Anim. Sci.
2012; 36(1): 43-48

doi:10.3906/vet-1102-791

Research Article

Thermography in the assessment of equine lameness

Mehmet Alper ÇETİNKAYA [1], Alper DEMİRUTKU [2,*]

[1]Medical and Surgical Research Laboratory, Faculty of Medicine, Hacettepe University, 06100 Sıhhiye, Ankara - TURKEY

[2]Surgery Department, Veterinary Faculty, İstanbul University, 34320 Avcılar, İstanbul - TURKEY

Received: 25.02.2011

Abstract: Infrared thermography pictorially represents the surface temperature of an object. It is a noninvasive method for detecting superficial inflammation and thus can be used in lameness diagnosis. Thermography is prone to artifacts, and, consequently, this has led some people to doubt its clinical applicability. With experience and care in interpretation, thermography can be a useful method for lameness evaluation. The aim of this study was to present further clinical information about infrared thermal cameras and to compare the diagnostic yields of thermography, radiography, and ultrasonography. Forming the animal material of this study were 47 horses with lameness. The extremities of the horses were evaluated via thermal camera following clinical examination. After this procedure, radiographic and ultrasonographic images were taken for the suspected region in all cases. The level of diagnosis with these techniques was scored and a comparison of the diagnostic methods was evaluated statistically. It was found that thermography can be a useful adjunct to lameness evaluation as part of integrated clinical and other imaging methods.

Key words: Horse, lameness, thermal camera, thermography

Atlarda topallığın değerlendirilmesinde termografi

Özet: İnfrared termografi bir cismin yüzey sıcaklığını görmemizi sağlar. Bu uygulama yüzeysel enflamasyonların belirlenmesi için non-invazif bir tekniktir ve bu nedenle topallık tanısında kullanılabilir. Termografinin artefakt oluşumuna yatkın bir yöntem olması gerçeği bunun klinik olarak uygulanabilirliği konusunda bazı kişilerde şüphe doğurabilir. Ancak tecrübeli kişiler tarafından ve dikkatli bir şekilde yorumlanması ile termografi topallığın muayenesi için kullanışlı bir yöntem haline gelmektedir. Bu çalışmanın amacı infrared termal kamera ile ilgili klinik bilgi vermek ve termografi, radyografi ve ultrasonografi tekniklerinin tanısal faydalarını karşılaştırmaktır. Topallık bulgusu gösteren 47 at bu çalışmanın hayvan materyalini oluşturmuştur. Atların klinik muayenelerinden sonra termal kamera ile ekstremiteleri değerlendirildi. Bu işlemi takiben şüpheli görülen bölgelerin radyografik ve ultrasonografik görüntüleri alındı. Bu tekniklerin tanısal olarak seviyeleri skorlandırıldı ve tanısal yöntemlerin karşılaştırılması istatistiksel olarak yapıldı. Sonuç olarak topallık tanısında termografinin klinik ve diğer görüntüleme yöntemleri ile birlikte tanıya yardımcı bir yöntem olabileceği düşünüldü.

Anahtar sözcükler: At, topallık, termal kamera, termografi

* E-mail: ademirutku@yahoo.com

Introduction

Thermography is a method that transmits an object's surface temperature detected as thermal images. Rather than being an anatomical imaging method like radiography or ultrasonography, this technique is a physiological diagnostic imaging method similar to scintigraphy (1,2). Thermography is a physiological diagnostic imaging method that acquires information about the nervous system, vascular system, muscles, and skeleton, as well as normal and abnormal functions of a local inflammatory process or period. With its ability to detect the location and degree of lesions, or functional diseases' types and the prognosis for treatment, clinical thermography contributes to the making of a proper diagnosis and the establishment of appropriate treatment. By suggesting the most efficient therapeutic choice, it also supports the clinician in making a better evaluation of the disease (1,3,4).

The use of thermography in veterinary medicine became a well-known and widely used method, especially in sport/race horse medicine, in the last 20 years (5). Thermography is used as a complementary method with ultrasonography and scintigraphy for diagnosing lameness and back pain (6,7), Horner's syndrome (8), osteoarthritis (9), superficial digital flexor tendinitis (10,11), and stress fractures and navicular diseases (11-13). Higher success rates are obtained in the therapy of these diseases when thermography is used in addition to radiography, ultrasonography, and scintigraphy (1,3,4,14).

This technique is prone to artifacts; therefore, thermography has led some people to doubt its clinical applicability. With experience and care in application and interpretation, thermography can be a useful method for lameness evaluation, and when carefully evaluated by experienced researchers, thermography may be accepted as a feasible method for lameness diagnosis. The aim of this study was to provide further information about the diagnostic yields of thermography, radiography, and ultrasonography.

Materials and methods

The subjects of the study were 47 horses suffering from lameness (Table 1). Extremities were inspected during walk and trot. Suspected regions were then evaluated via palpation to determine any pain or sensitivity.

Suspected anatomical areas of the horses according to clinical examinations were imaged via infrared thermal camera (FLIR P45, FLIR Systems Inc., Wilsonville, OR, USA), and these images were evaluated via computer software (ThermaCAM QuickReport©, FLIR Systems) to assess temperature differences. Following this procedure, radiographic and/or ultrasonographic images were taken of the suspected areas in all cases and were evaluated.

The anatomical areas were cleaned and external dirt was removed before starting thermographic assessment. Horses were taken into a closed clinic environment without air currents, away from sunlight, in order to prevent artifact formation during the thermographic procedure; horses were kept in this environment for about 15-20 min so that their temperatures could adapt. Comparative thermography was applied between both 2 fore- and/or hindlimbs and images were taken from the cranial, caudal, and lateral sides. A second thermographic examination was conducted within 30 min in case the obtained findings left any doubts or did not correlate with clinical findings. When findings were still discordant following the second examination, the clinical examination and thermography were repeated after waiting 1 h.

Suspected regions were also evaluated radiographically and ultrasonographically. An X-ray device (AJEX140H, AJEX Meditech, Ltd., Kyunggi-do, Korea) was held in position to obtain anterioposterior, lateromedial views of the suspected regions. Following this procedure, the region was prepared for ultrasonographic assessment (Scanner 200, PIE Medical, Maastricht, the Netherlands). Regional hair was clipped and cleaned. An ultrasonic gel was applied and the region was evaluated with a 7.5-MHz linear probe.

Cases were classified according to the problems that caused the lameness. Thermography, radiography, and ultrasonography results were scored from 0 to 3 for their diagnostic values (Table 1). We organized our data as dependent groups because this study was a comparison of the 3 diagnostic methods. Therefore, the nonparametric dependent Friedman test was used to evaluate the diagnostic values of thermography, radiography, and ultrasonography.

Results

The mean age of the horses was about 10 years; 23 of the horses were mares, 20 were geldings, and 4 were stallions. All horses displayed different degrees of lameness and/or reluctance to exercise or use their extremities, and pain on palpation.

Based on history and the clinical, thermographic, radiographic, and ultrasonographic examinations, 6 horses were detected as suffering from lumbago, and the remaining horses had extremity problems: acute joint effusion in 21 cases (Figure 1), acute tendonitis in 7 cases, chronic tendonitis in 4 cases, joint effusion and tendonitis in 3 cases (Figure 2), connective tissue infection in 5 cases (Figure 3), and hip-joint osteoarthritis in 1 case (Table 1). In these cases, increased superficial temperature was determined in the suspected areas during thermographic examinations; radiographic and ultrasonographic assessments confirmed the problem and appropriate therapy was applied.

The computer software of the infrared thermal camera showed increased local temperature, by 0.5-1.5 °C, between the compared normal and suspected regions for acute cases. However, in chronic cases, no local temperature differences were detected via infrared thermal camera. The scoring of diagnostic methods revealed that thermal imaging of the suspected regions of acute cases helped the diagnosis in all cases but was not useful for chronic cases. Radiography was also a useful method for the diagnosis of lameness but did not help for the diagnosis of lumbago; furthermore, some cases of

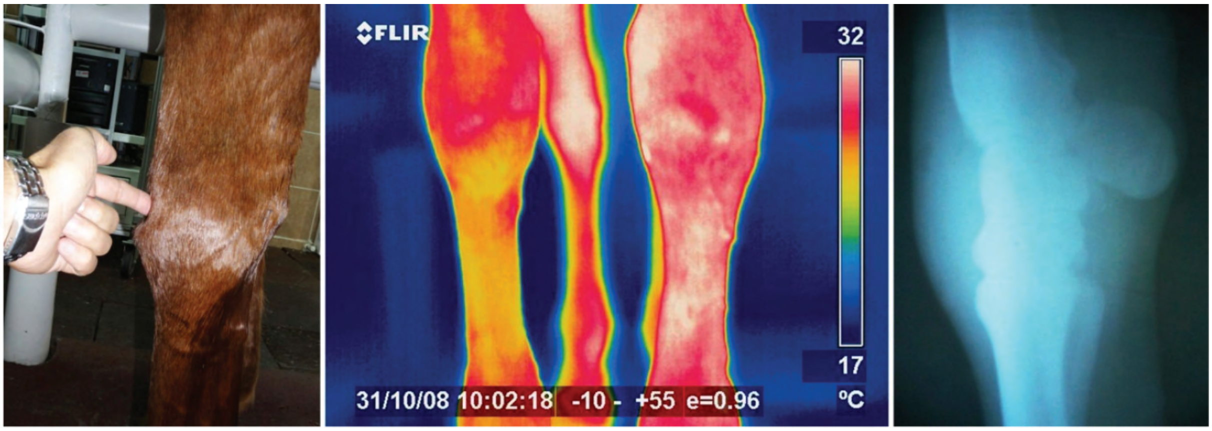

Figure 1. Clinical, thermographic, and radiographic appearance of a horse with carpal joint effusion after exercise.

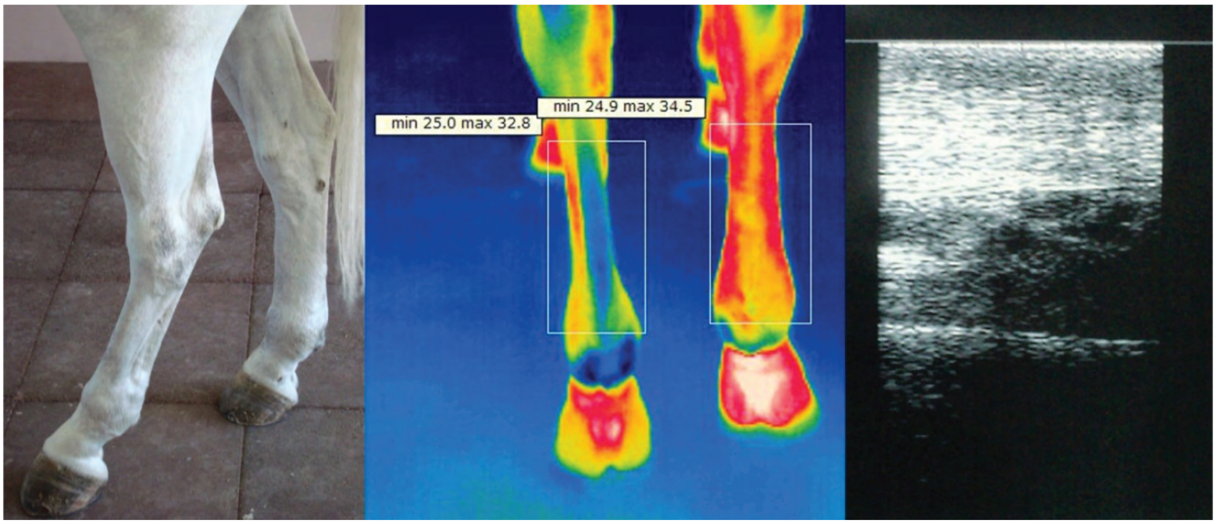

Figure 2. Clinical, thermographic, and ultrasonographic images of a horse with acute flexor tendinitis.

Figure 3. Thermal image of connective tissue inflammation possibly resulting from a superficial wound on the lateral aspect of the tarsal joint (white arrows) and radiographic image of the affected area.

tendonitis were unable to be diagnosed or difficult to diagnosis. Additionally, ultrasonographic imaging of the suspected regions was useful for joint effusion and tendonitis cases, but not useful for diagnosis of lumbago, connective tissue infection, or hip-joint osteoarthritis cases.

The nonparametric dependent Friedman test was applied to the scored data, and statistical significance was set at $P < 0.05$ when comparing the 3 different methods. When statistical results were examined (Table 2), there was a significant difference between the 3 diagnostic methods ($P = 0.00003$). Samples were also compared statistically according to each lesion group: the joint effusion group ($P = 0.00197$), tendonitis group ($P = 0.00447$), lumbago group ($P = 0.00248$), and connective tissue infection group ($P = 0.00674$) had significant differences, but the joint effusion and tendonitis group had no significance ($P = 0.13534$). No group was formed with the hip-joint osteoarthritis case.

Discussion

Medical thermography is a technique that noninvasively measures the temperature diffused by an object and translates this measurement as an image. Infrared thermography displays the superficial body temperature in order to detect inflamed tissue. This technique, which helps to evaluate inflammatory changes noninvasively, is especially useful for lameness diagnosis in horses and to localize lesions (1,3,4). In our study, infrared thermography facilitated the finding of the region(s) of temperature differences. In the past, superficial body temperature changes were evaluated via manual palpation; this approach is still employed. However, the evaluation of both superficial body temperature changes and the detection of whether the temperature of one limb is increased or not compared to the other limb differ from one person to another; manual palpation is a quite difficult procedure to handle. In addition, despite the fact that an increase of 1 °C in temperature easily helps detect the localization of a lesion via thermography, it is not usually well assessed via palpation. Thermography is an examination method that should be used on this level for problems' early diagnosis, especially in combination with other diagnostic imaging methods.

In human medicine, thermography is generally performed when environmental conditions are under control, which is generally impossible to achieve in veterinary medicine. Situations to be controlled are the patient's and the thermal camera's movements, incoming radiant energy, environmental temperature, artifacts caused by dirt and wetness in the area, and the type of thermographic camera (2,4). In this study, the artifacts that we detected during thermography occurred because the horses had been brought in after a cold shower-bath following exercise, or due to dirt on the extremities. This was avoided by letting the horse wait for some time to allow it to adapt to the environmental temperature, and by prior thorough cleaning.

Table 1. Scoring of diagnostic methods.

Case no.	Problem	Ther.	Rad.	Ultr.	Case no.	Problem	Ther.	Rad.	Ultr.
1	(a) JE; t, m - tph	3	2	3	**25**	(c) Ten; Fl - flx	0	1	3
2	(a) JE; c, m - cph	3	2	2	**26**	(a) Ten; Fl - flx	3	1	3
3	(a) JE; m - tph	3	3	3	**27**	(a) Ten; Fl - flx	3	1	3
4	(a) JE; m -cph	2	3	3	**28**	(c) Ten; Fl - flx	0	2	3
5	(a) JE; (b) c	3	3	3	**29**	(a) Ten; Fl - flx	3	1	3
6	(a) JE; c, m - cph	3	2	3	**30**	(a) Ten; Fl - flx	3	0	2
7	(a) JE; m -cph	3	3	3	**31**	(a) Ten; (b) Fl - flx	2	0	3
8	(a) JE; c	3	3	3	**32**	(c) Ten; (b) Fl - flx	0	2	3
9	(a) JE; c	3	3	3	**33**	(a) Ten; Hl -flx	3	0	3
10	(a) JE; c	2	2	3	**34**	(c) Ten; Hl -flx	0	2	3
11	(a) JE; m - cph	3	3	3	**35**	(a) Ten; Hl -flx	3	0	3
12	(a) JE; c, m - cph	3	2	3	**36**	Lumbago	3	0	0
13	(a) JE; m - cph	3	3	3	**37**	Lumbago	3	0	0
14	(a) JE; m - tph	3	2	3	**38**	Lumbago	3	0	0
15	(a) JE; m - cph	3	3	3	**39**	Lumbago	3	0	0
16	(a) JE; m - cph	2	2	3	**40**	Lumbago	3	0	0
17	(a) JE; c	3	1	3	**41**	Lumbago	3	0	0
18	(a) JE; c	3	2	2	**42**	Con.tis.inf.; “distal to t”	3	2	0
19	(a) JE; c	3	2	3	**43**	Con.tis.inf.; “distal to c”	3	2	0
20	(a) JE; m - cph	3	2	2	**44**	Con.tis.inf.; “between t and m - tph”	3	2	0
21	(a) JE; c	3	2	3	**45**	Con.tis.inf.; “between t and m - tph”	3	2	0
22	(a) JE, (a) Ten; t, m - tph; Hl - flx	3	3	3	**46**	Con.tis.inf.; “distal to elbow”	3	2	0
23	(a) JE, (a)Ten; m - tph; Hl - flx	3	2	3	**47**	(c) Hip osteoart.	0	3	0
24	(a) JE, (a)Ten; m - cph; Fl - flx	3	2	3					

Scoring: 0 = unable to be diagnosed; 1 = difficult to diagnose; 2 = easy to diagnose; 3 = very easy to diagnose.
Ther.: thermographic, Rad.: radiographic, Ultr.: ultrasonographic; (a) acute, (c) chronic, (b) bilateral; JE: joint effusion, Ten: tendonitis, c: carpal, t: tarsal, m - cph: metacarpophalangeal, m - tph: metatarsophalangeal, Fl - flx: forelimb flexor tendon, Hl - flx: hindlimb flexor tendon, osteoart.: osteoarthritis, Con.tis.inf.: connective tissue infection.

Table 2. Friedman ANOVA test results for samples (3 different diagnostic methods) according to each lesion group.

Lesion group	**N**	**df**	**P**
JE	21	2	0.00197
JE + Ten	3	2	**0.13534**
Ten	11	2	0.00447
Lum	6	2	0.00248
CTI	5	2	0.00674
All lesions	47	2	0.00003

JE: joint effusion, Ten: tendonitis, Lum: lumbago, CTI: connective tissue infection; N: number of samples, df: differentiation factor. Significance was set at $P < 0.05$ when comparing the 3 different methods.

It can be quite difficult to determine the situation when the temperature difference of the suspected extremity is vague on the thermal camera screen. Comparing the temperature differences via computer software makes the vague differences clear and facilitates the diagnosis and the therapy.

Thermography is used as a complementary method for diagnosing lameness. It has high success rates for the diagnosis and therapy of diseases when it is used in addition to radiography, ultrasonography, and scintigraphy (1,3,4,14). In this study, the scoring of the diagnostic methods revealed that thermography was useful for the diagnosis of lameness, except in chronic situations. This was probably due to the fact that superficial temperatures had become normal in chronic lameness. On the other hand, as mentioned in previous studies, we obtained successful diagnoses with thermography in conjunction with ultrasonography and radiography.

In this study, it was observed that there were statistically significant differences in all lesions and lesion groups, except 1 group (joint effusion and tendonitis group; P = 0.13534). This was probably due to the fact that there were only a few cases within this group.

In conclusion, thermographic examination is an important method that can assist in the making of a diagnosis when evaluated with other diagnostic imaging methods and clinical examinations, rather than being an independent and alternative technique. Artifacts expected to occur should be taken into consideration before thermographic examination is conducted, and an appropriate environment and patient preparation should be guaranteed.

References

1. Bathe, A.P.: Thermography. In: Floyd, A.E., Mansmann, R.A., Eds. Equine Podiatry. 1st edn., Saunders, St. Louis. 2007; 167-170.
2. Turner, T.A.: Thermography as an aid to the clinical lameness evaluation. Vet. Clin. North Am. Equine Pract., 1991; 7: 311-338.
3. Eddy, A.L., Van Hoogmoed, L.M., Snyder, J.R.: The role of thermography in the management of equine lameness. Vet. J., 2001; 162: 166-167.
4. Turner, T.A.: Diagnostic thermography. Vet. Clin. North Am. Equine Pract., 2001; 17: 5-113.
5. Stromberg, B.: Thermography in veterinary medicine. Bibl. Radiol., 1975; 43: 231-236.
6. Graf von Schweinitz, D.: Thermographic diagnostics in equine back pain. Vet. Clin. North Am. Equine Pract., 1999; 15: 161-177.
7. Tunley, B.V., Henson, F.M.: Reliability and repeatability of thermographic examination and the normal thermographic image of the thoracolumbar region in the horse. Equine Vet. J., 2004; 36: 306-312.
8. Purohit, R.C., McCoy, M.D., Bergfeld, W.A. 3rd: Thermographic diagnosis of Horner's syndrome in the horse. Am. J. Vet. Res., 1980; 41: 1180-1182.
9. Vaden, M.F., Purohit, R.C., McCoy, M.D., Vaughan, J.T.: Thermography: a technique for subclinical diagnosis of osteoarthritis. Am. J. Vet. Res., 1980; 41: 1175-1279.
10. Marr, C.M.: Microwave thermography: a non-invasive technique for investigation of injury of the superficial digital flexor tendon in the horse. Equine Vet. J., 1992; 24: 269-273.
11. Simon, E.L., Gaughan, E.M., Epp, T., Spire, M.: Influence of exercise on thermographically determined surface temperatures of thoracic and pelvic limbs in horses. J. Am. Vet. Med. Assoc., 2006; 229: 1940-1944.
12. Purohit, R.C., McCoy, M.D.: Thermography in the diagnosis of inflammatory processes in the horse. Am. J. Vet. Res., 1980; 41: 1167-1174.
13. Turner, T.A., Fessler, J.F., Lamp, M., Pearce, J.A., Geddes, L.A.: Thermographic evaluation of horses with podotrochlosis. Am. J. Vet. Res., 1983; 44: 535-539.
14. Ringer, S.K., Lischer, C.J., Ueltschi, G.: Assessment of scintigraphic and thermographic changes after focused extracorporeal shock wave therapy on the origin of the suspensory ligament and the fourth metatarsal bone in horses without lameness. Am. J. Vet. Res., 2005; 66: 1836-1842.