

**UPOTREBA ULTRAZVUČNE DIJAGNOSTIKE I INFRACRVENE TERMOGRAFIJE U
DIJAGNOSTICI OBOLJENJA EKSTREMITETA KOD GOVEDA**

**THE USE OF ULTRASOUND DIAGNOSTICS AND INFRARED THERMOGRAPHY IN
DIAGNOSIS OF LIMB DISEASES IN CATTLE**

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SAŽETAK

Oboljenja lokomotornog sistema goveda kao što su: artritis, tendinitis, tenovaginitis, burzitis/higromi i apscesi, imaju značajnu ulogu u zdravstvenom i proizvodnom statusu životinja, jer pored toga što direktno narušavaju zdravlje životinja, uzročno-posledično dovode i do pada proizvodnje mleka, zasušivanja životinja usled potrebe lečenja, te na kraju i do trajnog isključivanja grla iz proizvodnog procesa i ekonomskog iskorišćavanja životinja. U skladu sa prethodno navedenim, može se lako zaključiti da pravovremena dijagnostika predstavlja jedan od značajnih preduslova za adekvatno lečenje obolelih životinja, a samim tim i njihovo zadržavanje u proizvodnom procesu. Cilj ovog istraživanja bio je da se ustanove prednosti i mane ultrazvučne dijagnostike i infracrvene termografije u dijagnostici oboljenja ekstremiteta kod goveda, u terenskim uslovima rada. Istraživanje je sprovedeno na komercijalnim mlekarskim farmama, na grlima sa prethodno klinički dijagnostikovanim nekim od sledećih oboljenja lokomotornog sistema: artritis, apscesi i higromi/burzitis. U skladu sa postavljenim ciljevima istraživanja, mogu se izdvojiti dva najvažnija rezultata ovog istraživanja: 1. Izvođenje infracrvene termografije predstavlja jednostavniju i bržu dijagnostičku proceduru, bez direktnog kontakta sa pregledanom životinjom, što ujedno smanjuje i nivo stresa kod životinje. Međutim, termografijom se mogu otkriti anatomske, topografske i funkcionalne promene, ali ne i tačna lokalizacija ni bliža karakterizacija samog procesa; 2. Prilikom izvođenja ultrazvučnog pregleda u evaluaciji eksudativnih oboljenja lokomotornog sistema goveda, uzimajući u obzir određene kriterijume ultrazvučnog pregleda (anatomska lokacija lezije, ehogenost prisutnih struktura, veličina lezije, osobenost ivica lezije i šupljine ispunjene eksudatom, prisustvo fenomena pretakanja i akustičnih artefakta), moguće je dobiti određene podatke o količini, vrsti i sadržaju prisutnog eksudata, te na taj način bliže okarakterisati prirodu patološkog procesa, kao i mogućnosti lečenja.

Ključne reči: krava, oboljenja ekstremiteta, ultrazvučna dijagnostika, infracrvena termografija

ABSTRACT

Diseases of the locomotor system of cattle, such as: arthritis, tendinitis, tenovaginitis, bursitis/hygromas and abscesses, have a significant role in the health and production status of animals, because in addition to directly impairing the health of animals, they cause and also lead to drop in milk production, drying off the animals due to the need for treatment, and to the permanent exclusion from the production process and economic exploitation of animals. According to all above, it could be easily concluded that right time diagnosis is one of the most important prerequisites for the adequate treatment of sick animals, and therefore their retention in the production process. The aim of this study was to establish

the advantages and disadvantages of ultrasound diagnostics and infrared thermography in the diagnosis of some locomotor diseases in cattle, in field working conditions. This study was conducted on commercial dairy farms, on cows previously clinically diagnosed with some of the following diseases of the locomotor system: arthritis, abscesses and hygromas/bursitis. According to the aim of this study, two most important results could be singled out: 1. Performing infrared thermography represents a more simple and faster diagnostic procedure, without direct contact with the examined animal, which also reduces the level of stress in the animal. However, thermography can detect anatomical, topographic and functional changes, but not the exact localization or a closer characterization of the process itself; 2. When performing an ultrasound examination in the evaluation of exudative diseases of the locomotor system of cattle, taking into account certain criteria of the ultrasound examination (anatomical location of the lesion, echogenicity of present structures, the size of the lesion, the characteristics of the edges of the lesion and the cavity filled with exudate, the presence of overflow phenomena and acoustic artifacts), it is possible to obtain certain data on the amount, type and content of the present exudate, and in this way more closely characterize the nature of the pathological process, as well as the possibilities of treatment.

Key words: cow, locomotor diseases, ultrasonography, infrared thermography

INTRODUCTION

Some diseases and disorders of locomotor system in cattle such as: bursitis, hygromas, abscesses and arthritis, are characterized by extensive soft tissue swelling and presence of inflammatory exudation (1,2). Those diseases, with the nature of their pathoanatomical and pathophysiological processes, could lead to drop in milk production, drying off the animals due to the need for treatment, to the permanent exclusion from the production process and economic exploitation of animals (3). According to all mentioned above, it could be easily concluded that right time diagnosis is one of the most important conditions for the adequate treatment of sick animals, and therefore their retention in the production process.

Ultrasonography is one of the most useful diagnostic tools for evaluation of diseases of locomotor system in cattle which are characterized by soft tissue swelling and accumulation of exudate. Ultrasound allows the evaluation of echogenicity of the content, extent of effusion, type of the border of the lesion, cavity and swelling, presence of flow phenomena and presence of ultrasound artefacts (1,2,4,5). According to these criteria, ultrasonography provides certain information about the nature of the content in the affected area, especially for fluid and semisolid masses, but it cannot definitively characterize the composition of the content and the type of effusion by itself (1,2). Definitive answer about the type of effusion and its characteristics is provided by obtaining samples by

centesis and laboratory analysis of aspirated fluid (1,2,6-9).

Infrared thermography (IRT) finds its application primarily in the diagnosis of diseases of the locomotor system (primarily diseases of the distal parts of the extremities - arthritis and diseases of the paws), then in the diagnosis of diseases of the udder and skin (10,11,12,13). With development of inflammatory processes, the body's defense mechanisms are activated, and those processes are manifested by the movement of heat through the tissue, greater blood flow and increased temperature of the surface (11,12,13). These changes in temperature of the body surface (skin surface) are detected by IRT camera, and according to their different presentations, those changes could indicate different stages of inflammatory processes.

The aim of this study was to establish the advantages and disadvantages of ultrasound diagnostics and infrared thermography in the diagnosis of some locomotor diseases in cattle, in field working conditions.

MATERIALS AND METHODS

During our mobile clinic work, in the period between 2014 and 2016, 50 cows with superficial swellings on their limbs were observed by ultrasound examination. After ultrasound examination was done, samples of effusions were collected by centesis and sent for laboratory analysis of aspirated fluid. Clinical and orthopaedic examinations were performed to identify "the region of interest" for ultrasound examination. It was found

that 4 of 50 cows had swellings on their hind limbs at the femoral region, and 46 of 50 cows had swellings at the carpal or tarsal region. Before ultrasound examination was conducted, the skin over the affected area was clipped and shaved. Ultrasound examination was conducted with an ultrasound machine (*Esaote Pie Medical®*, *Netherlands*) using an 8 MHz linear transducer, in real-time. Presence of flow phenomena and echogenicity of the content were evaluated. Four ultrasound images were taken for every case of swelling and analyzed by using image analyzer software ImageJ (*National Institutes of Health, Bethesda, Maryland, USA*). Values of pixel distribution within the grayscale (0 = black, 255 = white), which present values of mean echogenicity (ME), were determined for every ultrasound image in that part which present a liquid content of effusion. These values were quantified by randomly selecting 10 circles with a size of 15 pixels on every ultrasound image (*Fig. 1*). Average values of ME were determined for every case of swelling. Fluid sampling was performed after clinical and ultrasound examination. Before centesis, the skin was disinfected with 10% povidone-iodine solution. The fluids were obtained using a syringe and EDTA vacutainers, stored in a portable fridge and analyzed in the laboratory within 4 h. Next laboratory findings were measured and analyzed: Concentration of total proteins (Tp), concentration of glucose (Glc), concentration of uric acid, number of leukocytes (Le), percentage of neutrophils (Ne), number of erythrocytes (Er), specific weight, viscosity, colour, clarity and Gram stain. Concentration of Tp, Glc and uric acid were measured using Analyzer A15 (*Biosystems S.A., Barcelona, Spain*). Number of Le and Er were analyzed using ADVIA 120 haematology system (*Siemens, Germany*).

Descriptive statistic values based on average ME values and distribution of frequency for average ME values were calculated. The correlation between average ME values and descriptive characteristics of the effusions such as viscosity (very viscous, viscous, sero-viscous, serous), colour (milky yellow, yellow, red), clarity (blurry, blurred, slightly cloudy, clear) and Gram stain (presence of bacteria, absence of bacteria), was tested using χ^2 test and $2 \times k$ contingency tables, so the significance of difference in the proportion of cows that have certain characteristics of effusions in the groups based on average ME values above and under the median value determined by descriptive statistics has been

investigated. All statistical analyses were performed with Statistica (*TIBCO Software Inc., USA*) and Microsoft Office Excel 2007 (*Microsoft Corporation, USA*).

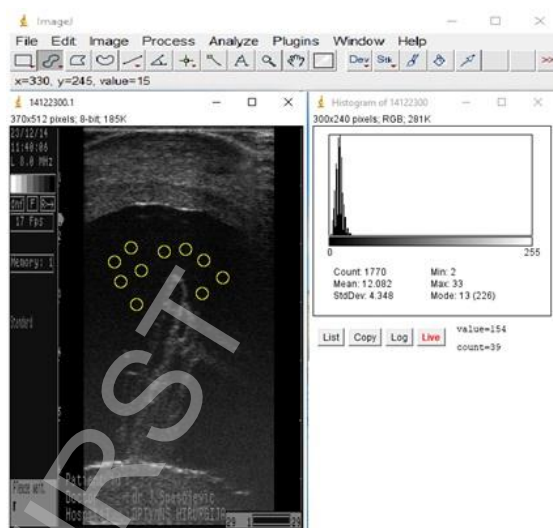


Figure 1. Determination of mean echogenicity (ME)

During our mobile clinic work, in the period July – November 2023., three cows with suspected arthritis and significant clinical findings of pain and swellings were examined by infrared thermography (IRT). IRT was conducted by infrared camera Testo 865 (*Testo, Bangkok, Thailand*). Suspected areas were recorded in 1-1,5 m distance between clinician and animals.

RESULTS

According to the aim of this paperwork, here are presented results of descriptive statistic values based on average ME values and distribution of frequency for average ME (*Table 1* and *Fig. 2*). For the purpose of field condition work, in this paperwork are presented results of correlation between average ME values and descriptive characteristics of the effusions such as viscosity (very viscous, viscous, sero-viscous, serous), colour (milky yellow, yellow, red), clarity (blurry, blurred, slightly cloudy, clear) and Gram stain (presence of bacteria, absence of bacteria) (*Table 2*). The results in *Table 2*. showed that there is a significant difference in the proportion of cows with certain characteristics of effusions in function of that whether the average ME values were high or low. In cows, in which higher average ME values were found, very viscous and viscous consistency, milky yellow color, and poor transparency (blurry) of the

effusions dominated and in a large proportion of the samples there was presence of bacteria. On the other hand, in cows with lower average ME values of ultrasound findings, serous, yellow color, and cloudy or clear effusions dominated, and also absence of bacteria in a large portion of the samples.

In Table 3. And Fig. 3-5 are presented results of clinical and IRT results of three examined cows.

Table 1. Descriptive statistic values based on average ME values

Variable	Descriptive Statistics									
	N	Mean	Median	Min	Max	Lower Quartil	Upper Quartil	Std. Dev.	Skewness	Kurtosis
Mean Echogenicity (ME)	50	13,02	9	5,6	34,62	7	14	8,95	1,51	0,86

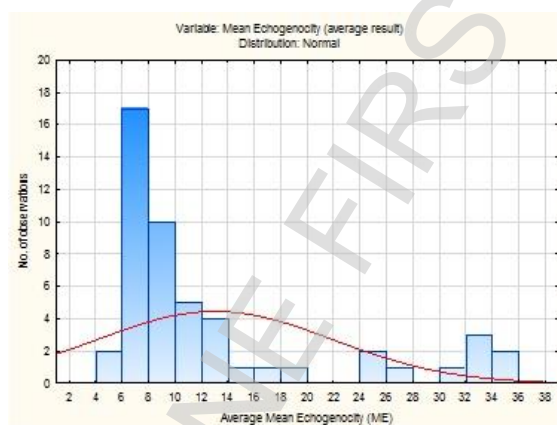


Figure 2. Distribution of frequency for average ME values

Table 2. Connection between ME value and physical characteristic and presence of bacterial cell in exudate

Exudate characteristics	Category	Number of cows according to average ME values		χ^2 test
		Above the median value	Under the median value	
Viscosity	very viscous	7	0	P<0.0005
	viscous	7	1	
	sero-viscous	6	7	
	serous	5	17	
Colour	milky yellow	9	0	P<0.005
	yellow	10	18	
	red	6	7	
Clarity	blurry	16	4	P<0.005
	blurred	7	10	
	slightly cloudy	2	3	
	clear	0	8	
Presence of bacteria (Gram stain)	Presence of bacteria	16	3	P<0.0005
	Absence of bacteria	9	22	

Table 3. Differences in the temperature of the same anatomical areas on adjacent extremities in 3 different COWS

Number	Anatomical region	The difference in temperament with the neighboring limb measured by a thermal imaging camera	Clinical findings – methods of inspection and palpation	Differential diagnosis
1. Fig. 3	Tarsal joint of right limb	2,6 °C	Moderate swelling on the lateral and medial side of the tarsal joint, with present skin damage.	Tarsal arthritis and tarsal hygroma
2. Fig. 4	Crown of hoof of front right leg	7,7 °C	Temperate swelling in the area of the crown of the hoof, palpation is extremely painful. Inability to lean/extremely difficult to lean on an extremity. When standing up, the animal transfers its entire weight to the adjacent limb.	Hoof arthritis, arthritis of the crown joint
3. Fig. 5	Carpal joint of left limb	1,1 °C	Painless swelling with the inability to manually determine the difference in temperature between adjacent extremities. Fluctuation phenomenon present.	Carpal arthritis and carpal hygroma

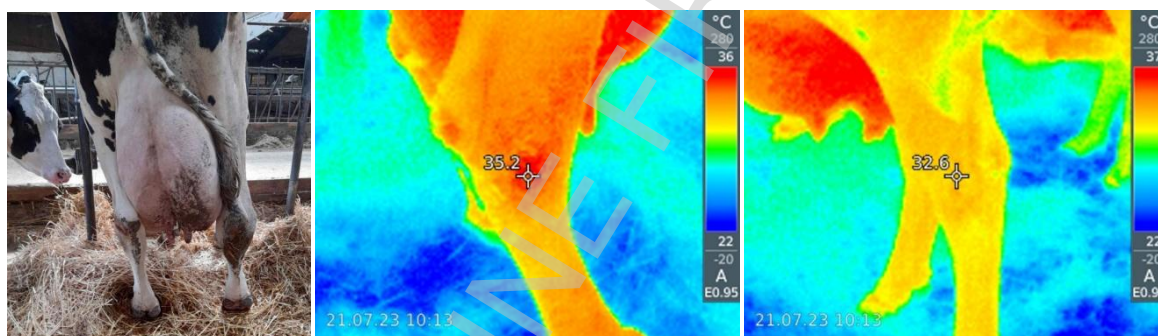


Figure 3. Tarsal arthritis – presumptive diagnosis

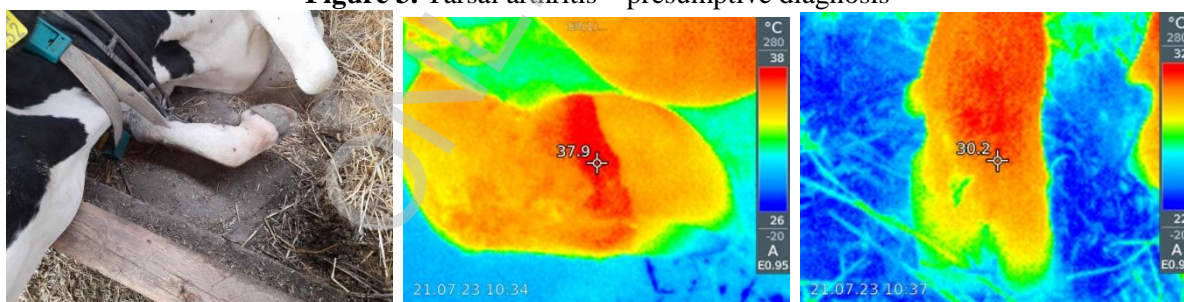


Figure 4. Swelling in region of crown of hoof of front right leg

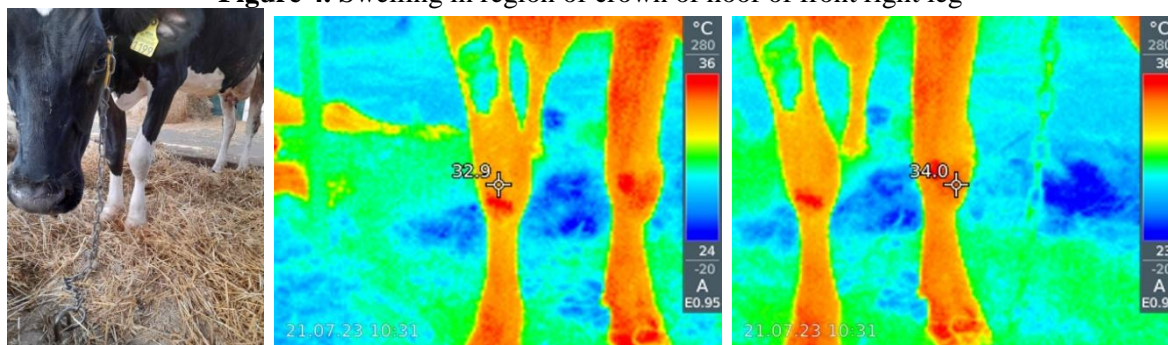


Figure 5. Swelling in region of carpal joint of left limb

DISCUSSION

Ultrasonography is non-invasive diagnostic tool, ideal for evaluation of musculoskeletal disorders and diseases such as arthritis, bursitis, hygromas and abscesses, because these diseases are frequently associated with extensive soft tissue swelling and presence inflammatory exudation (1,2).

Ultrasound examination can provide information about the type, nature, and duration of some inflammatory processes, and these information can be helpful in planning therapy protocols for mentioned diseases (1,2,14,15).

In recent studies (1,2,6-8,16), it was reported that evaluation of the echogenicity of effusions and flow phenomena in some musculoskeletal disorders and diseases, which ranges from anechoic to echoic, depend on the type and nature of its inflammatory content (serous, serofibrinous, fibrinous, purulent). In the study with cows (15), it was reported that capsule echogenicity instead of capsule thickness is a more reliable ultrasonographic parameter for determination of the duration of the inflammatory process.

It has been also mentioned that ultrasonography cannot definitely characterize the composition and type of effusion content by itself. It was recommended to perform centesis and laboratory analysis of aspirated fluid samples (1,2,5-8). Rohde et al. (17), defined some laboratory musculoskeletal disorders and diseases in cattle which are associated with extensive soft tissue swelling and inflammatory exudation. Spasojevic et al. (18) found that could be possible to correlate ME values with laboratory parameters such as concentrations of Tp and uric acid, specific weight and percentage of Ne.

Our results could be used for confirmation of clinical cases of effusions in cattle and evaluation of therapy effects. That means that those patients with higher ME values could be in higher risks to have effusions with septic process in it, and according to that, it could define a therapy protocol, evaluation and prognosis of a diagnosed diseases.

Thermography, as other clinical method used in this study, finds its application primarily in the diagnosis of diseases of the locomotor system (primarily diseases of the distal parts of the extremities - arthritis and diseases of the hoofs), then in the diagnosis of diseases of the udder and skin (10-13,19).

What is important to emphasize when performing thermography in the diagnosis of arthritis is that thermography is performed after the general part of the clinical examination (which first of all involves the performance of inspection and palpation), and before the performance of other, special methods of clinical examination, and that it is necessary to perform imaging of the same anatomical areas of adjacent limbs because the diagnosis is based on the temperature difference of the obtained results (11-13). In our study, thermography was also performed after the general part of the clinical examination. Different studies have shown that differences in temperature values of 0.5 to 1.5 °C between the affected and unaffected areas on the adjacent extremities, speak in favor of the existence of inflammatory processes, especially if there are also various clinical signs that showed existence of inflammatory processes (11,13). In our study, differences in temperature between affected and unaffected structures were significant (*Table 3*) and indicated the existence of inflammatory processes. The non-invasiveness of thermography, then the detection of minimal temperature variations by comparing thermograms of identical structures of neighboring extremities, makes thermography one of the most useful methods in early presumptive diagnosis, when changes in microcirculation and an increase in temperature of the affected structures occur, rather than clinical manifestations of the disease (10-13).

CONCLUSION

According to the results of this study, it could be concluded that IRT is more useful and faster diagnostic tool in making early presumptive diagnosis. IRT can reveal anatomical, topographic and functional changes according to changes in microcirculation, but not the exact anatomical localization of the processes themselves, nor their closer characterization. Ultrasound examination is more suitable and useful diagnostic tool which can provide more exact localization and characterization of some inflammatory processes and their content, especially processes characterized by swelling and presence of some bigger amount of inflammatory exudate.

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