

Infrared Thermography and Ultrasonography of the Hands in Rheumatoid Arthritis Patients

Koichi Yabunaka^{1*}, Noriyuki Hayashi², Yutaka Furumitsu², Yoshiteru Ohno², Masayo Matsuzaki³, Shinichi Yamauchi⁴

¹Department of Ultrasound, Ono Memorial Hospital, Osaka, Japan, ²Department of Internal Medicine, Ono Memorial Hospital, Osaka, Japan, ³Department of Children and Women's Health, Division of Health Science, Graduate School of Medicine, Osaka University, Osaka, Japan, ⁴Department of Orthopedics, Ono Memorial Hospital, Osaka, Japan

Abstract

Ultrasonography (US) and power Doppler US (PDUS) are used worldwide for diagnosing rheumatoid arthritis (RA). Superb microvascular imaging (SMI) is a good tool for evaluating inflammatory activity. Thermal imaging is a noncontact, noninvasive procedure using skin temperature measurement. We report a case wherein the thermal and ultrasound images of the hand are compared and evaluated for inflammatory activity in patients with RA. Case: US imaging of the left hand of a 75-year-old woman with RA revealed a hypoechoic lesion of the left wrist joint. PDUS and SMI evaluated blood flow according to the blood flow at Grade 2. The temperature of the hypoechoic lesion with high blood flow was higher than that of the same location on the opposite side. This study shows that combining thermal and blood flow images may be useful for detecting inflammatory activity levels in RA patients.

Keywords: Infrared thermography, power Doppler, rheumatoid arthritis, superb microvascular imaging, ultrasonography

INTRODUCTION

Rheumatoid arthritis (RA) is a long-term autoimmune disease and the most common inflammatory disorder. Nowadays, ultrasonography (US) is used worldwide for the diagnosis of RA.^[1] US diagnostics is important as it supplies some additional data regarding the development of RA at an early stage, as well as information about disease activity. Power Doppler US (PDUS) is a particularly good tool for evaluating the inflammatory activity of joints in RA.^[2] A sonogram postprocessing technique was used to suppress received signal clutter (Superb Microvascular Imaging® [SMI]; Toshiba Medical Systems, Tokyo, Japan). SMI clearly visualizes the low-velocity microvascular blood flow of subcutaneous tissue.^[3] On the other hand, infrared (IR) thermography is becoming increasingly utilized in many medical specialties, as it is able to measure body surface temperatures in a noncontact, noninvasive procedure.^[4] IR thermography has been used as an effective tool for quantifying inflammation in the hand joints of RA patients.^[4] However, there is little information regarding the comparative evaluation of thermal images and ultrasound images (B-mode and blood flow images) in RA

patients. We report a case in which thermal and ultrasound images of the hand in RA patients are compared and evaluated for inflammatory activity.

Ultrasound and infrared thermography acquisition procedure

IR thermography examination was first performed using a thermal imaging camera (FLEX F50 Inc., Japan) with patients in a sitting position. The sonographic examination was performed immediately after thermal images were obtained. US diagnostic equipment (Canon Medical, Ltd., Tokyo, Japan) was used with linear-array (12 MHz) transducers. An ambient temperature of 25°C ± 1°C and a constant humidity of 50% ± 10% were maintained in a standardized control room.

B-mode imaging was used to assess the grade of synovitis on a scale of 0–3, with synovial inflammatory activity scores assessed as follows: 0 = Absent, i.e., no joint capsule

Address for correspondence: Dr. Koichi Yabunaka, 1-326-10 Minamihorie, Nishiku-ku, Osaka 550-0015, Japan. E-mail: yabuchanrt@yahoo.co.jp

Received: 07-08-2020 Revised: 08-09-2020 Accepted: 08-10-2020 Available Online: 09-01-2021

Access this article online

Quick Response Code:



Website:
www.jmuonline.org

DOI:
10.4103/JMU.JMU_113_20

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How to cite this article: Yabunaka K, Hayashi N, Furumitsu Y, Ohno Y, Matsuzaki M, Yamauchi S. Infrared thermography and ultrasonography of the hands in rheumatoid arthritis patients. *J Med Ultrasound* 2021;29:212-4.

distension; 1 = Mild, i.e., slight hypoechoic or anechoic image in the joint capsule; 2 = moderate, i.e., joint capsule elevation; and 3 = Severe, i.e., important joint capsule distension. Blood flow images were characterized as 0 = Absent with no blood flow signal; 1 = Mild with one blood flow signal; 2 = Moderate with two or three blood flow signals, i.e., an intraarticular flow of <50%; and 3 = Severe, i.e., an intraarticular flow of >50%.^[5]

CASE REPORT

This case describes a 75-year-old woman who had her first rheumatology appointment in 1991. She was maintained on the medications prednisolone and tacrolimus from 2013 to present. However, she complained of pain and stiffness in her left hand. Her 28-joint disease activity score was 3.73. US imaging revealed a hypoechoic lesion (thickened layer of the synovial membrane) of the left wrist joint on both sides of the distal ulna (ulnocarpal joint) and radius (radiocarpal joint). B-mode image showed a hypoechoic lesion with distal ulna at Grade 3 [Figure 1a] and distal radius at Grade 2 [Figure 1d]. PDUS evaluated blood flow according to the blood flow at Grade 2 [Figure 1b and e]. Moreover, SMI revealed the blood flow signal of the microvasculature inside the same lesion at Grade 2 [Figure 1c and f]. Thermal images of bilateral wrist joints and hands revealed that the temperature of the left hand was higher than that of the right hand [Figure 2a]. The hypoechoic lesion with high blood flow (distal ulna side: 33.8°C; distal radius side: 34.6°C) had a higher temperature than the same location on the opposite side (distal ulna side: 31.5°C; distal radius side: 32.4°C) [Figure 2b and c]. The hypoechoic lesion with high blood flow had a skin surface temperature on the dorsal side of the left hand of 31.7°C–35.6°C, whereas the

opposite side had a skin surface temperature in the range of 30.0°C–32.9°C. Furthermore, US imaging revealed a Grade-1 hypoechoic lesion left to the 2nd and 3rd proximal interphalangeal joint without a blood flow signal. However, the other joints were normal.

DISCUSSION

This case study demonstrated the use of thermal and blood flow images of the hand for evaluating inflammatory activity in RA patients. This technique provided new information, especially regarding the amount of perfusion in the hypoechoic lesion by blood flow images, as well as revealed high skin temperatures via IR thermography. As shown in these preliminary results, combining thermal and blood flow images may support the diagnosis of the level of inflammatory activity in RA patients because it is a noninvasive and straightforward method that can provide real-time observation at a low cost^[6]. Magnetic resonance imaging is not easily accessible.^[7]

PDUS is a useful tool for assessing inflammatory disease activity.^[8] However, PDUS is subject to blooming effects from vessel signals, as well as color noise and clutter artifacts resulting from the Doppler signals.^[9] In this patient with RA, SMI clearly demonstrated the microvasculature of the hypoechoic lesion. Clinically, SMI may be suitable for assessing low-velocity microvascular flow in a hypoechoic lesion and may have a greater sensitivity than PDUS for small vessels.

Borojević *et al.* reported that the mean value of the skin surface temperature of the dorsal side of hands observed in RA patients was 24.8°C–36.5°C and that of healthy participants

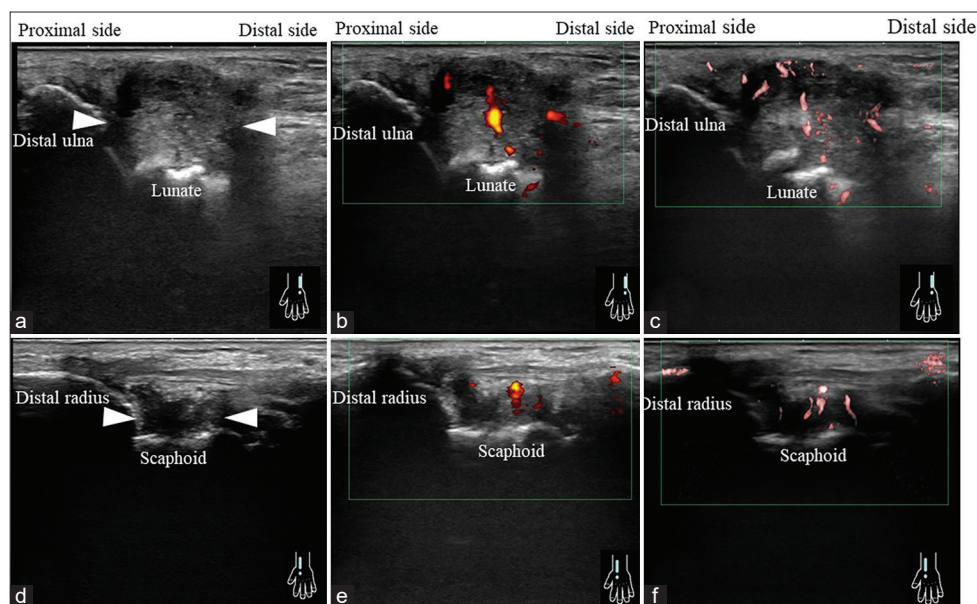


Figure 1: Ultrasonographic images showing the hypoechoic lesion in the wrist joint of a 75-year-old woman with pain in the left hand. Longitudinal scans of the distal ulna (ulnocarpal joint) and radius (the radiocarpal joint): Upper and lower images, respectively. (a and d) B-mode images indicating the thickened layer of the synovial membrane (arrowheads) (d and e) Color signal of the hypoechoic lesion using power Doppler ultrasonography (c and f) The color signal of the microvasculature in the hypoechoic lesion is stronger with superb microvascular imaging than with power Doppler ultrasonography

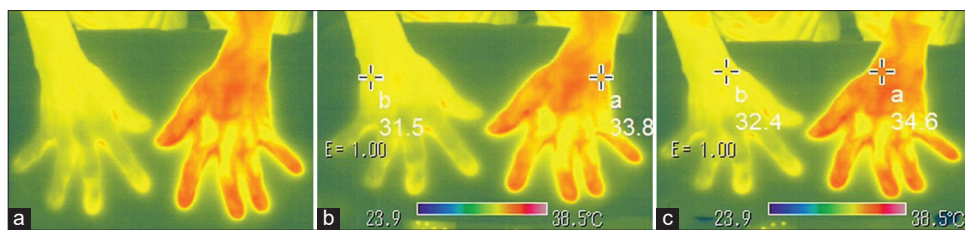


Figure 2: (a) Thermal images of bilateral wrist joints and hands revealed that the temperature of the left hand was higher than that of the right hand. (b and c) The hypoechoic lesion with high blood flow (distal ulna side: 33.8°C; distal radius side: 34.6°C) had a higher temperature than the same location on the opposite side (distal ulna side: 31.5°C; distal radius side: 32.4°C)

was 24.8°C–35.5°C.^[10] This study was similar to a previous study; the hypoechoic lesion in the left hand with pain and high blood flow had a higher temperature than the opposite side. IR thermography showed a clear temperature difference because of differences in hypoechoic lesions with blood flow. Simultaneously, in this study, the skin temperature was not proportional to the inflammatory activity score and blood flow level. In the future, it is necessary to examine a larger number of cases and clarify the relationship between skin temperature and grade of synovitis. However, this technique may focus on the site of inflammation due to RA.

The study has certain limitations that should be considered when applied to medical practice. IR thermography depends on the sensor and experimental setup. However, this procedure did not involve finger-cooling and finger-rewarming.^[6] Moreover, this study indicated the need to validate results for a large number of data.

CONCLUSION

The combination of thermal and blood flow images may support the detection of disease activity areas in RA patients.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. According to the form, the patient has provided consent for the reporting of her images and other clinical information in the journal. The patient understands that her name and initials will not be published, and due efforts will be made to conceal identity, but anonymity cannot be guaranteed.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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