Case Report

Color Doppler Ultrasonography to Evaluate Hypoechoic Areas in Pressure Ulcers: A Report of Two Cases

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Abstract

Ultrasound (US) is frequently used for evaluating inflammation of subcutaneous tissue caused by pressure ulcers (PUs), but color Doppler mode (CDM) helps to better identify inflammatory edema in subcutaneous fat and necrotic tissue in PUs. We report two cases where inflammatory edema in subcutaneous fat and necrotic tissue in PUs are identified using small US equipment with CDM. Case 1 – An 82-year-old male presented with cerebral infarction and a Category III PU in the sacral region. B-mode gray-scale US imaging (B-mode imaging) revealed a thickened layer of subcutaneous fat with fat lobules and homogeneous cobblestone appearance with fluid accumulation within the echo-free space. CDM did not identify any color signal (CS) in hypoechoic areas. Case 2 – A 29-year-old female presented with cytopenia and decreased renal function with a Category IV PU with undermining in the coccyx region. B-mode imaging distinguished the necrotic tissue, indicating a diffuse hypoechoic area with no layers, unclear borders, and uneven gray level (cloud-like image) in the subcutaneous fat. Similar B-mode imaging findings were obtained in inflammatory edema with cobblestone appearance. CDM did not detect a CS in the hypoechoic areas but confirmed peripheral hypervascularity. CDM imaging identified inflammatory edema in the subcutaneous fat and necrotic tissue in PUs. Specifically, CDM may better evaluate early-stage PUs with necrotic tissue by distinguishing necrosis from intense inflammatory edema.

Keywords: Color Doppler mode, pressure ulcers, ultrasonography

Introduction

Newer, high-frequency ultrasound (US) probes can be used to evaluate inflammation of subcutaneous tissue caused by a pressure ulcer (PUs). US is used most frequently for this evaluation because it is noninvasive, widely available, rapid, and relatively inexpensive. In contrast, visual examination and palpation techniques cannot detect deep-tissue injury.[1] Previous studies have reported the benefit of B-mode gray-scale US imaging (B-mode imaging) for diagnosing early-stage PUs and for predicting prognosis.[2-4] In particular, a diffuse hypoechoic area with no layers, unclear borders, and uneven gray level (cloud-like image) strongly suggests deep-tissue abscess.[5] However, inexperienced operators have difficulty assessing B-mode images of PUs with unusual morphology because of the variability in the images of hypoechoic areas. For example, the B-mode image is similar to intense inflammatory edema and diffuse abscess as both appear as a cloud-like sign. Previously, we found that advanced US diagnostic equipment with clutter suppression imaging clearly revealed the microvascularity of granulation tissue, which appeared hypoechoic areas.[6] Although the large size of advanced US equipment is not suitable for daily wound-care rounds, small US equipment with color Doppler mode (CDM) capability may be a useful bedside tool.

We present two cases where small US equipment with CDM identified inflammatory edema in the subcutaneous fat and necrotic tissue in PUs.

Ultrasound scanning technique

Sagittal images, supplemented by transverse and oblique views of the ulcer and its underlying structures, were obtained in overlapping planes, with the patient in the lateral position.

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After B-mode imaging sonographic examination, we obtained CDM images. US diagnostic equipment (Hitachi Aloka Medical, Ltd., Tokyo, Japan) was used with linear-array (5–18 MHz) transducers, and we maintained constant levels of gain and tissue depth for later quantitative image analysis. At this hospital, patients with PUs or signs of tissue damage undergo wound assessment using the DESIGN tool,[7] which is the PU assessment tool generally used in Japan, and weekly high-resolution US. The interior of the undermined region and the wound surface was filled with hydrocolloid gel and protected by polyurethane film dressing material. US was performed once a week when the dermatologist evaluated each wound case.

Case Reports

Case 1: Inflammatory edema in subcutaneous fat

An 85-year-old male with cerebral infarction who had been bedridden presented to our hospital. He also had a Category III PU in the sacral region. The hospital's PU team managed his care during his in-hospital stay of 7 weeks, and the patient was followed until discharge from the hospital. Sonographic images and photograph (width, 25 mm; length, 53 mm; and DESIGN-R score, 19 points) of the first examination 3 weeks after admission are shown in Figure 1a-c. B-mode imaging revealed a thickened subcutaneous layer of fat with fat lobules with homogeneous cobblestone appearance and fluid accumulation in the echo-free space [Figure 1b]. CDM did not detect any color signal (CS) in the hypoechoic areas; CS appears as a prominent blooming effect and color noise [Figure 1c]. Sonographic images and photograph of the patient after 1 week are shown in Figure 1d-f. B-mode imaging showed decrease in fat edema after 1 week and no detected CS [Figures 1e and f].

Case 2: Necrotic tissue

A 29-year-old female was admitted to the hospital with cytopenia and decreased renal function. She was under observation for 18 months after stem cell transplantation for aplastic anemia. She also had a Category IV PU with undermining in the coccyx region. The hospital's PU team managed the patient's PU care in hospital for 18 weeks. The patient was followed until home discharge from the hospital. Sonographic images and photograph (width, 7 mm; length, 15 mm; and DESIGN-R score, 30 points) of the first examination 3 weeks after admission are shown in Figure 2a-c. B-mode imaging identified the necrotic tissue showing a diffuse hypoechoic area with no layers, unclear borders, and uneven gray level (cloud-like image) in the subcutaneous fat [Figure 2b]. Similar B-mode imaging findings were obtained in the inflammatory edema with cobblestone appearance. CDM did not reveal CS in the hypoechoic areas but confirmed peripheral hypervascularity [Figure 2c]. Sonographic images and photograph of the 1-week follow-up examination are shown in Figure 2d-f. B-mode imaging showed more clearly the hypoechoic areas. In addition, CDM did not detect CS in the hypoechoic areas [Figure 2e], but CS did confirm peripheral hypervascularity more clearly [Figure 2f].

Discussion

The authors have presented two cases where CDM identified inflammatory edema in subcutaneous fat and necrotic tissue in PUs. B-mode imaging alone made it difficult to accurately evaluate hypoechoic area (cloud-like image or the inflammatory edema with cobblestone appearance); however, CDM was able to verify inflammatory edema in the subcutaneous fat and necrotic tissue in PUs. Specifically, it was possible to distinguish intense inflammatory edema from diffuse necrotic tissue abscess with cloud-like sign, using CDM.

When no CS is detected in inflammatory edema in subcutaneous fat, anatomically, there are no blood vessels of adequate

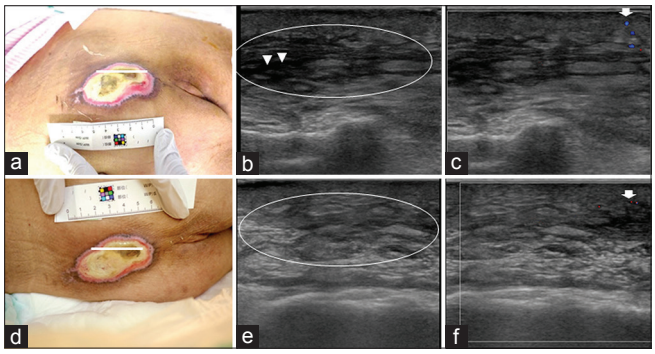

Figure 1: Sonographic images and photograph at baseline (the first examination; upper images) and after 1 week (lower images). (a and d) Photos of the Category III PU are in the sacral region. (b) B-mode image showing a thickened subcutaneous fat layer with fat lobules providing a homogeneous cobblestone appearance (circle) with fluid collection in the echo-free space (arrowhead). (e) B-mode image showing reduced fat edema. (c and f) Color Doppler mode did not detect a color signal in the hypoechoic areas and color noise (arrows). White line = observation point of ultrasonography

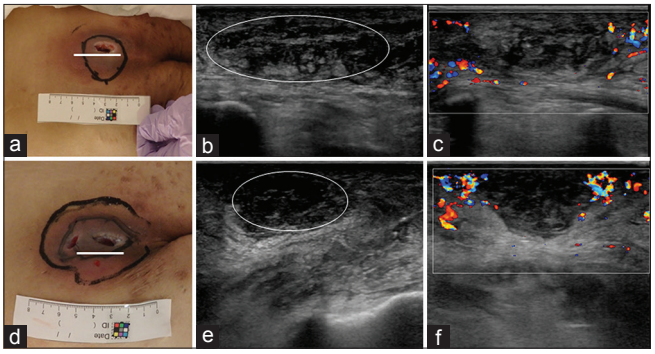

Figure 2: Sonographic images and photograph at baseline (the first examination; upper images) and after 1 week (lower images). (a and d) Photos of the category IV PU with undermining in the coccyx region. (b) B-mode image of the necrotic tissue showing a diffuse hypoechoic area with cloud-like image in the subcutaneous fat (circle). (e) B-mode image more clearly showing the hypoechoic areas (circle). (c and f) Color Doppler mode did not detect a color signal in the hypoechoic areas, but a color signal did confirm peripheral hypervascularity. White line = observation point of ultrasonography

thickness for detection by CDM. In contrast, previous studies report that in abscess formation, highly vascularized connective tissue surrounds the necrotic area, and this can be detected by CDM.[8,9] Color Doppler sonographic images of soft-tissue abscess reveal increased vasculature in the abscess wall.[10] In this study, B-mode images were similar for necrotic tissue and inflammatory edema at baseline (the first examination); however, CDM revealed increased vascularity around the periphery of the abscess after 3 weeks. CDM may better evaluate early-stage PUs with necrotic tissue by distinguishing necrosis from intense inflammatory edema.

In this study, we did not evaluate vascularity in the two cases of hypoechoic area in the PUs using Power Doppler sonography with clutter suppression technique (Superb Microvascular Imaging®; Toshiba Medical Systems, Tokyo, Japan).[6,10] Clutter suppression imaging clearly visualizes the microvascularity of granulation tissue. However, CDM detected a CS with the smaller US equipment used in this study, which is more suitable for daily wound-care rounds. Because PUs often occur at the surface, point-of-care US is now being used as a bedside tool, and smaller US equipment provides sufficient diagnostic information to manage patients safely.[11,12]

Conclusion

CDM imaging identified inflammatory edema in the subcutaneous fat and necrotic tissue in PUs. Specifically, CDM may better evaluate early-stage PUs with necrotic tissue by distinguishing necrosis from intense inflammatory edema.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Nil

Conflicts of interest

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