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Measurement of the skin thickness using images of high-frequency ultrasound, in newborns Version 2

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Abstract

The authors describe the skin thickness measurement, based on the analysis of images, obtained using a handheld DermaLab® USB Series ultrasound from Cortex Technology. Epidermis and dermis layers of newborns are obtained by ultrasound scanning. The procedures of the mean thickness determination are pictured.

We developed a dedicated software to provide epidermal thickness measurement (IP register BR 51 2017 000061 1). The calculation of the epidermal thickness for each line in the image array was based on the size of the pixel in the frame obtaining 356 thickness values. Using a bootstrap technique in the selected sample size with 70 lines, the software resampled the thickness values 2,000 times. From a Gaussian distribution adjustment curve to the epidermis measurement, the peak was the thickness value, and the full with a half-maximum area was the sigma error value.

Guidelines

1. The skin scanning follows the Instruction Manual of the equipment manufacturer, DERMALAB® SERIES SKINLAB USB, 20 MHz Probe,
   available in http://www.cortex.dk/dermatology/dermalab-usb-series/.
2. The newborns are evaluated inside their incubators or in an open heating crib, wherever they were taken care of to ensure minimum manipulation and stable clinical conditions.
3. Automated measurements of skin layer thickness involved the use of two different software for digital image processing:

- DermaLab® embedded software provided dermal measurements.
- For the epidermal axial dimension estimation, we developed a dedicated software in Python language available in the Health Informatics Center of Universidade Federal de Minas Gerais, Brazil: https://site.medicina.ufmg.br/cins/

Before start

Preparation of the probe.

Mounting the water barrier of the probe.

Materials

✓ double distilled water (ddH2O) by Contributed by users
✓ Gel for ultrasound by Contributed by users

Protocol

Preparation of the Ultrasound Probe

Step 1.

1. Hold the probe of the ultrasound up.
2. Inject distilled water into the probe chamber with a 10ml syringe, filling it.
3. Cover the opening of the probe with your thumb and shake it to release air bubbles.
4. Recharge the probe with water until it is full.
5. Place the plastic film of the equipment, gently under probe tip to make the seal. Note: No air bubbles should be visible, but a small bubble with an area of less than 1mm^2 is tolerated.
6. Press and adjust the black ring of the equipment down over the film and onto the tip of the probe.
7. Ensure that the ring of the probe seal does not flow from the probe when used.

8. Snap off the excess film with a quick downward movement.

9. Connect the probe at the front of the SkinLab USB main unit using the proper connector.
10. Connected the device to a power supply and to the notebook using a USB cable, where the DermaLab® SkinLab Software is ready to be used.
11. Clean the probe with cotton/gauze embedded with 70% alcohol before touch the newborn's skin.

Using the Ultrasound Probe for the Newborn Skin Scanning

Step 2.

1. Open the DermaLab Skin software in the notebook.
2. Prepare the examiner's hands with asepsis procedures.
3. Apply the ultrasound gel into the distal internal region of the newborn's forearm.
4. Spread the ultrasound gel, gently and evenly with your fingertips to make the layer as thin as possible.
5. Make circular movements with the probe under the thin layer of gel.
6. Stop the probe to scan the image in the place of the measurement.

7. Press the 'ULTRASOUND' button on the main screen.
8. Keep the probe standing under the thin gel layer.
9. Press the 'START' button to perform the image measurement and the automatic calculation of the dermal thickness.
10. Check the quality of the image. Note: A good quality of an image is one that does not present artifacts, that is, does not present excess or lack of gel, sprouting veins and nerves and that is with the epidermis and dermis as uniform as possible, without 'breaks'.
11. Scan one or more times until producing a good image, without artifacts.

Dermal Thickness Measurement

Step 3.

1. The automated value of the skin thickness is presented in the 'SKIN THICKNESS' space, on the main screen of the DermaLab® SkinLab Software. Note: the value must be different from zero.
2. Press the 'GRID' button to display the automatically detected dermal mark.

3. The distance (in micrometers) between the two red vertical lines and the intensity score of the ultrasound signal in the area covered by the red grid is shown on the screen.

4. Press the 'SAVE' button and save the chosen image with its dermal thickness, in the desired file folder.

Epidermal Thickness Measurement

Step 4.

1. We developed a dedicated software, using Python language, for Epidermal Thickness Measurement.
2. Install the software on a computer over a Linux platform.
3. Identify the ultrasound image of the skin in the button: 'Data File' in the main menu.
4. Press the 'Browse' button to search the image in the directories of the computer where it is saved.
5. Set 250 in the 'Low Threshold' field.
6. Set 255 in the 'High Threshold' field.
7. Set 2000 in the 'Low Area' field.
8. Set 50000 in the 'High Area' field.
9. Set 2000 in the 'Nresampling' field.
10. Adjust 70 in the 'Sampling Size' field.
11. Press the 'RUN' button to automatically calculate the epidermal thickness.
12. Press the 'SAVE' button to perform the histogram with the number of times each thickness appeared in the image.

Warnings

According to the Instruction Manual of the equipment manufacturer, the performance of DERMALAB® SERIES SKINLAB USB may be affected if it is being used outside the range 10°C to 35°C (50°F to 95°F).
The high-frequency ultrasound needs to be connected to a computer.