Technical Considerations of the Dermatologic Ultrasound Examination

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Contents

2.1 Technical Considerations

2.1.1 Basic Requirements

- A multichannel color Doppler ultrasound machine with variable high-frequency probes working with an upper range ≥15 MHz.
- An operator trained in ultrasound imaging and dermatologic conditions [1–8].

2.1.2 Sedation

For children less than 4 years old, sedation with chloral hydrate is recommended, using a dosage of 50 mg/kg, which can be repeated 30 min later if there is no effect with the first dose. This sedation is used because any movement or crying of the child can generate noise acoustic artifacts on the screen and alter the detection of the patterns of vascularity and peak systolic velocities [1–5]. Although in some cases the diagnosis can be made without sedation, the monitoring of the lesion may become difficult because data on vascularity may be unreliable or hard to interpret. In our experience, this dosage of chloral hydrate is safe for children and allows the necessary time (approximately 20–40 min) to examine the child in a quiet environment. This could be particularly important for facial lesions such as those in the nasal, periocular, or perioral regions, where naturally the child may tend to move and where the anatomical information can be critical for the right selection of treatment.

Melatonin, with a dosage according to age, can also be used. Melatonin produces a more superficial type of sleep, so it is not recommended for facial lesions [8].

The parents or guardian should sign an informed consent before the administration of medication. A modified Aldrete score, with measures of consciousness, activity, respiration, circulation (blood pressure), and oxygen saturation, may be used for monitoring the child [9]. A pulse oximeter is needed

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for this purpose. The child should be monitored during the sedation period and discharged only when he or she is fully awake (Aldrete modified score ≥9) [1–9].

2.1.3 Alternatives to Sedation

Sedation can be replaced in newborns by breastfeeding, or in older children by the coordination of the time of the ultrasound examination with the usual time of the child's nap. In some cases, deprivation of sleep the night before or of the usual nap before the examination can help to induce sleep for the examination more quickly. These require a good communication and coordination with supportive parents or guardians.

Some very quiet children may not need sedation; this should be evaluated case-by-case, considering the site of the lesion. These quiet children are allowed to have bottles with milk or juice during the examination if this does not interfere with the site of the lesion.

For older children, the use of media such as cartoons or movie clips in smartphones or tablets can help to keep the child quiet and distracted during the examination.

2.2 Advantages and Limitations of Dermatologic Ultrasound Examinations

2.2.1 Advantages

- Good balance of resolution and penetration (0.1–60 mm depth) with the same high-frequency probe
- Resolution: 100 μm/pixel axial and 90 μm/pixel, considering an upper frequency range of 15–18 MHz
- Real-time examination
- Good definition of the skin layers and deeper structures
- Morphology of the lesion and surrounding tissues
- Qualitative and quantitative analysis of blood flow
- No effects from radiation or confinement to a reduced space
- No adverse reactions to contrast medium

2.2.2 Current Limitations

- Lesions that measure <0.1 mm
- Epidermal-only location
- Pigments such as melanin

2.3 Recommended Protocol and Guidelines for Dermatologic Ultrasound Examinations

2.3.1 Recommended Setting of the Ultrasound Machine

- Focal point in the first 3 cm (upper part of the screen)
- A low pulse repetition frequency (PRF) and wall filter
- Color gain under the noise threshold
- If necessary, use of power Doppler or echo-angiogram applications to improve the detection of slow flow
- Panoramic views for observing large lesions
- Three-dimensional (3D) reconstructions are optional but can improve the understanding of the images by clinicians not involved in the imaging [1–8].

Tip Create and save a setting for dermatologic ultrasound studies on your machine, with the support of the application specialist of the brand that you are using. Having this setting can save time and improve the definition and sensitivity of the vascularity in the ultrasound examinations.

2.3.2 Suggested Protocol

- *Phase 1* Conversation with the patient, retrieval of the history, and visual inspection and palpation of the lesional and perilesional areas with the lights of the room turned on or in a well-illuminated room.
- *Phase 2* Turn off or lower the light of the room in a way that the lesional area can still be detected. Position the lesion close to the operator and the probe, and add a copious amount of gel in the lesional and perilesional regions.
- *Phase 3* Use the setting in the machine previously set for the dermatologic ultrasound examination.
- *Phase 4* The ultrasound machine study includes three steps (Figs. 2.1 and 2.2) [1–8, 10]:
  - *Step 1: Grey scale sweep* in at least two perpendicular axes that include the lesion and perilesional tissues (Fig. 2.3). Comparison with the contralateral side may support the examination. In inflammatory diseases, detection of the transitional zone between the normal and abnormal skin is recommended.

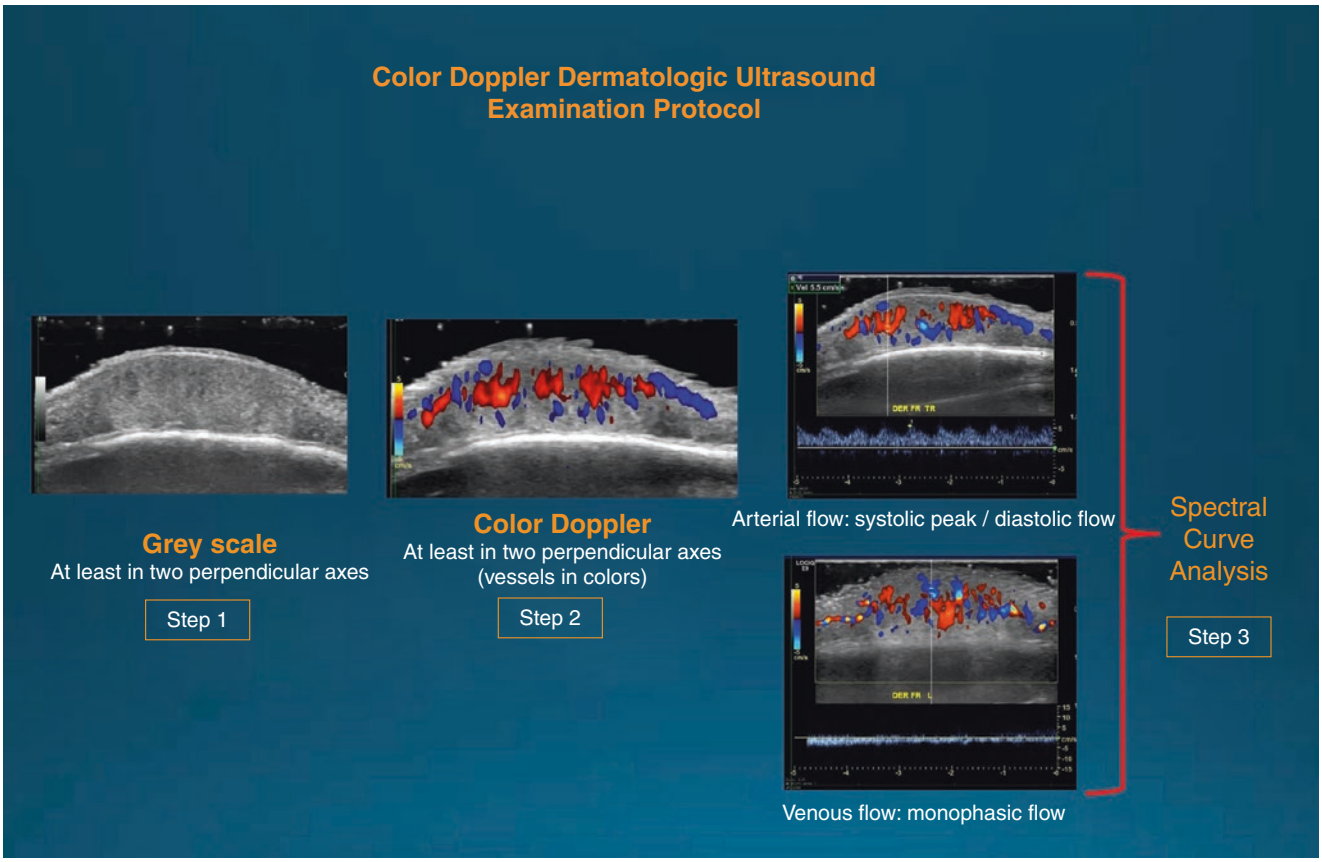

Fig. 2.1 Color Doppler dermatologic ultrasound examination protocol. Notice that Color Doppler is a must for dermatologic ultrasound examinations.

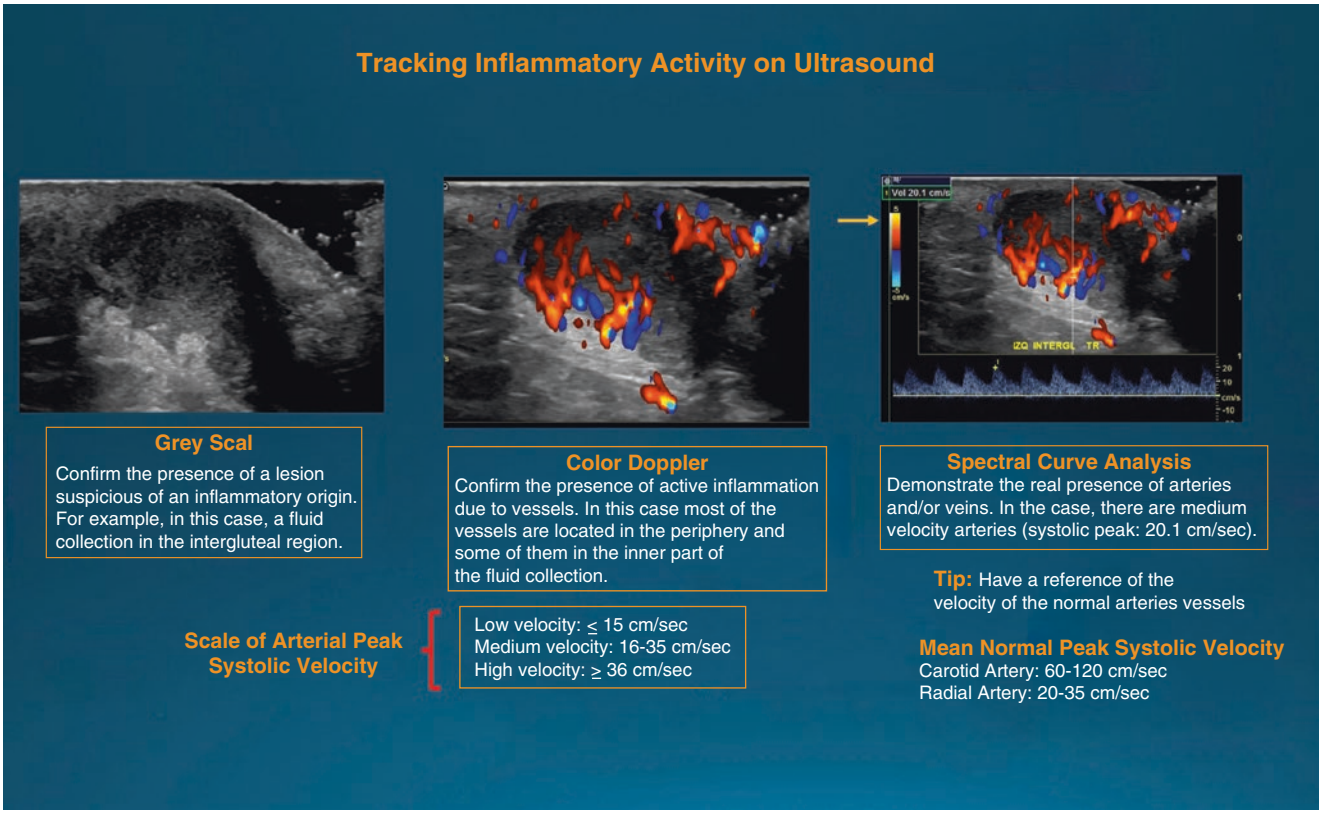

Fig. 2.2 Ultrasound tracking of activity protocol in inflammatory dermatologic diseases. An approximate average of the normal arterial peak systolic velocity of the large and middle-size arteries and a grading of peak systolic velocities are provided as references.

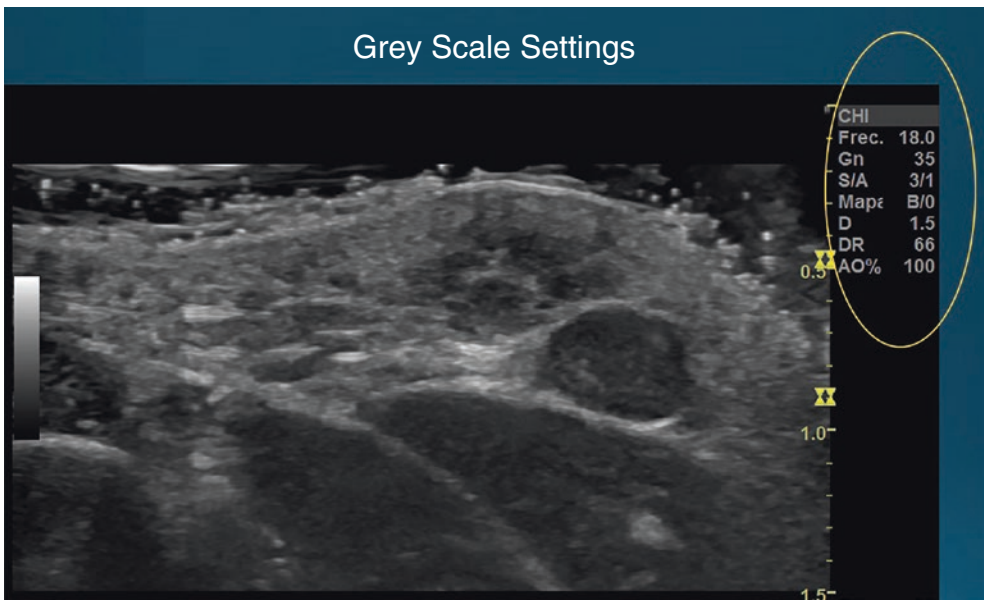

Fig. 2.3 An example of grey scale setting for dermatologic ultrasound studies.

– *Step 2: Color Doppler qualitative analysis of the vascularity patterns* of the lesional and perilesional tissue (Fig. 2.4). Detection of the thickness of the vessels (mm) and the registration of at least three representative vessels per axis (longitudinal and transverse) are strongly recommended. Please note that usage of color Doppler is mandatory in dermatologic ultrasound examinations.
– *Step 3. Color Doppler quantitative analysis of the blood flow through spectral curve analysis* of the lesional and perilesional vessels allows the detection of the type (arterial or venous) and the velocity of the flow (cm/sec). The analysis of at least three spectral curves in each axis (longitudinal and transverse) is suggested. Depending on the size and amount of vascularity, six curves per axis (longitudinal and transverse) may be needed in vascular lesions. Analysis of the origin and path of the feeding vessels can support the diagnosis of vascular lesions.

2.3.3 Protocol Tips

- *Skin Ultrasound Examination*: Include the transitional zone (i.e., the border between normal and abnormal tissue) and compare the appearance of the lesional area *versus* a normal area and/or the contralateral side.
- *Nail Ultrasound Examination*: The ultrasound sweep includes the ungual and periungual regions (medial and lateral; radial and ulnar; proximal and distal).
- *Scalp Ultrasound Examination*: For a better definition of the hair follicles, displace the hair tracts and align the axis of the probe with the major axis of the hair follicles.

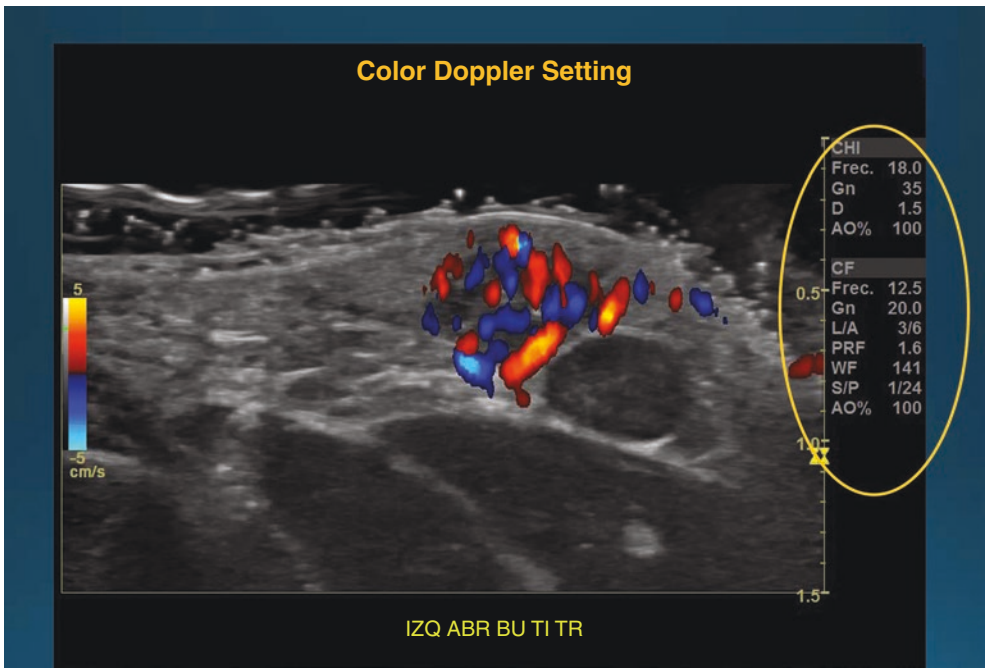

Fig. 2.4 An example of color Doppler setting for dermatologic ultrasound studies.

2.4 Reporting of Dermatologic Ultrasound Examinations

A formal report is always recommended. Besides the usual information on identification, date, referring physician, technique, and brief history, provision of the following data is suggested [8]:

- Origin of the lesion (dermatologic vs non-dermatologic; endogenous vs exogenous)
- Anatomical location (layers involved)
- Nature of the lesion: cystic, solid, mixed
- Relevant acoustic artifacts that support the diagnosis
- Diameters in all axes
- Vascularity: presence, type (arterial or venous), thickness, and maximum peak systolic velocity of the arterial vessels
- Surrounding relevant anatomical structures
- Phase: In hemangiomas, the description of the phase (proliferative, partial or total regression) is suggested.
- Activity: In inflammatory diseases, a description of the ultrasonographic phase of activity is needed (active or inactive). A sonographic scoring (SOS) can be reported for some conditions such as SOS-Acne or SOS-HS (sonographic scoring of hidradenitis suppurativa).
- Assessment of benignancy versus malignancy: Provision of the sonographic signs that favour a benign or malignant ultrasound appearance of the lesion.
- A formal ultrasound impression at the end of the report is suggested, which can suggest a presumptive diagnosis. If the sonographic pattern is not typical, some potential differential diagnoses can be described (ideally, no more than three).

Note Figures 2.5, 2.6, and 2.7 illustrate technical problems that may occur in reporting dermatologic lesions if the examination is performed by a non-trained operator or with the use of a non-recommended machine or the wrong frequency. Thus, following the published guidelines for performing dermatologic ultrasound studies is strongly recommended [8, 10].

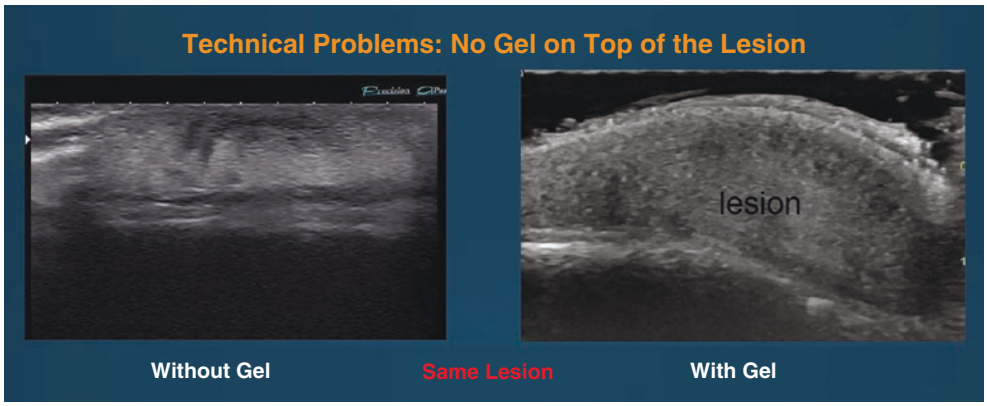

Fig. 2.5 Technical problems related to gel. A comparison of the ultrasound image of the same lesion without and with gel. A copious amount of gel on top of the lesion provides a better-defined image, including the surface.

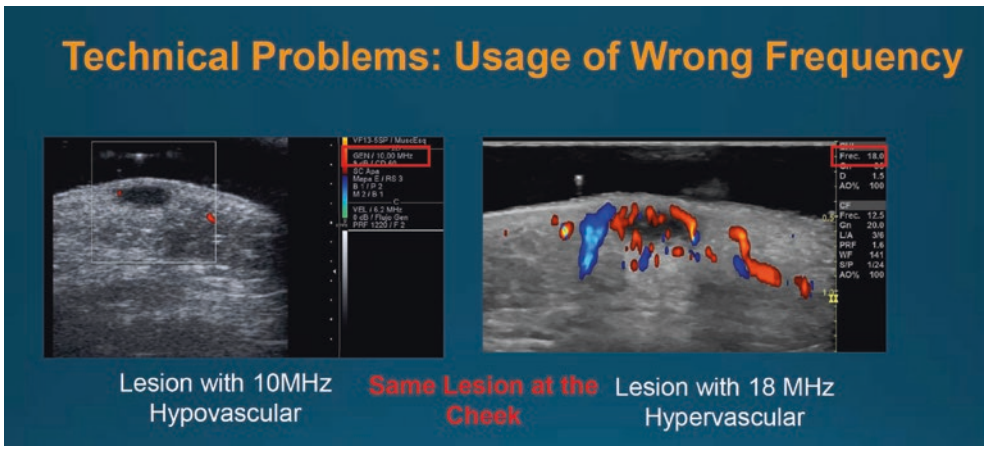

Fig. 2.6 Technical problems related to the frequency. A comparison of the detection of vascularity of the same lesion using 10 MHz and 18 MHz probes. The usage of variable-frequency probes working with upper-frequency ranges ≥15 MHz is recommended; otherwise, the sensitivity of the detection of the blood flow in superficial layers is limited.

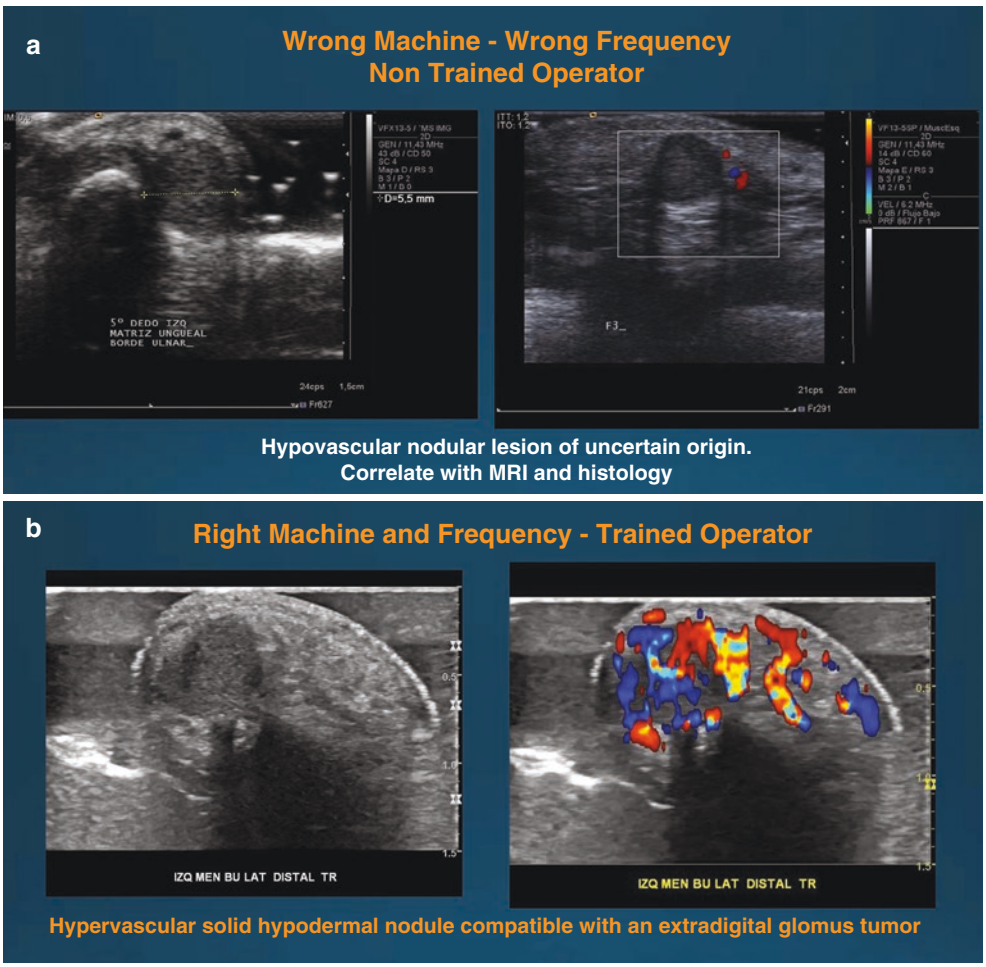

Fig. 2.7 Technical problems related to the device, frequency, and training of the operator. (**a**) The report from an examination using the wrong machine, wrong frequency, and a non-trained operator shows a hypovascular nodule of uncertain origin, suggesting a correlation with other imaging modalities and histology. (**b**) A report on the same lesion examined using the right machine, right frequency, and a trained operator shows a hypervascular solid hypodermal nodule suggestive of glomus tumor.

2.5 Tips for the Dermatologic Ultrasound Examination

- Work in a room where the lights can be turned on and off easily.
- Some ultrasound machines include a warmer for the bottle of gel; a baby-bottle warmer may also be used for warming the gel. Before applying the gel to a child, it is suggested to test the temperature of the gel in your hand.
- Clean the probes with a non-alcohol solution. (Ask the manufacturer for recommendations for your device.)
- When dealing with open wounds, sterile gel and a cover for the probe (for example, a sterile glove or a cover for laparoscopic surgery equipment) may help.
- A cover for the probe is also needed for lesions that involve mucosal areas.
- The operator can often stabilize his or her hand by using the little finger for support (Figs. 2.8 and 2.9).
- To examine the hands or toes, warm water or saline can be used instead of gel.
- When studying the ear pinna, cover the external meatus with a piece of cotton, in order to decrease the entrance of gel, which may be uncomfortable for the patient (Fig. 2.10).
- When examining a child, ask the parents or someone from your team for support in order to maintain the position of the child (Fig. 2.11).
- A pad or towel can be used for examining the nail of the thumbs, which allows comparison with the contralateral side and stabilizes the position of these fingers (Fig. 2.12).
- For observing the scalp, displacement of the hair tracts is needed (Fig. 2.13).

Fig. 2.8 Skin ultrasound examination. The recommended position of the fingers during the dermatologic ultrasound examination of the skin. Notice that the little finger supports and stabilizes the position of the hand of the operator. Observe the amount of gel needed for the study.

Fig. 2.9 Nail ultrasound examination. The recommended position of the fingers during the dermatologic ultrasound examination of the nail. The little finger helps to stabilize the position of the hand of the operator. Notice the amount of gel needed for the study.

Fig. 2.10 Ear pinna examination. Add a piece of cotton to the external meatus in order to avoid the significant entrance of gel.

Fig. 2.11 Examination of the palm of the hand in newborns or infants. Ask the parents or someone from your team to help in maintaining the extension of the fingers.

Fig. 2.12 A pad or towel may support the positioning for the examination of the nails of the thumbs. Comparison with the contralateral side may facilitate the detection of abnormalities.

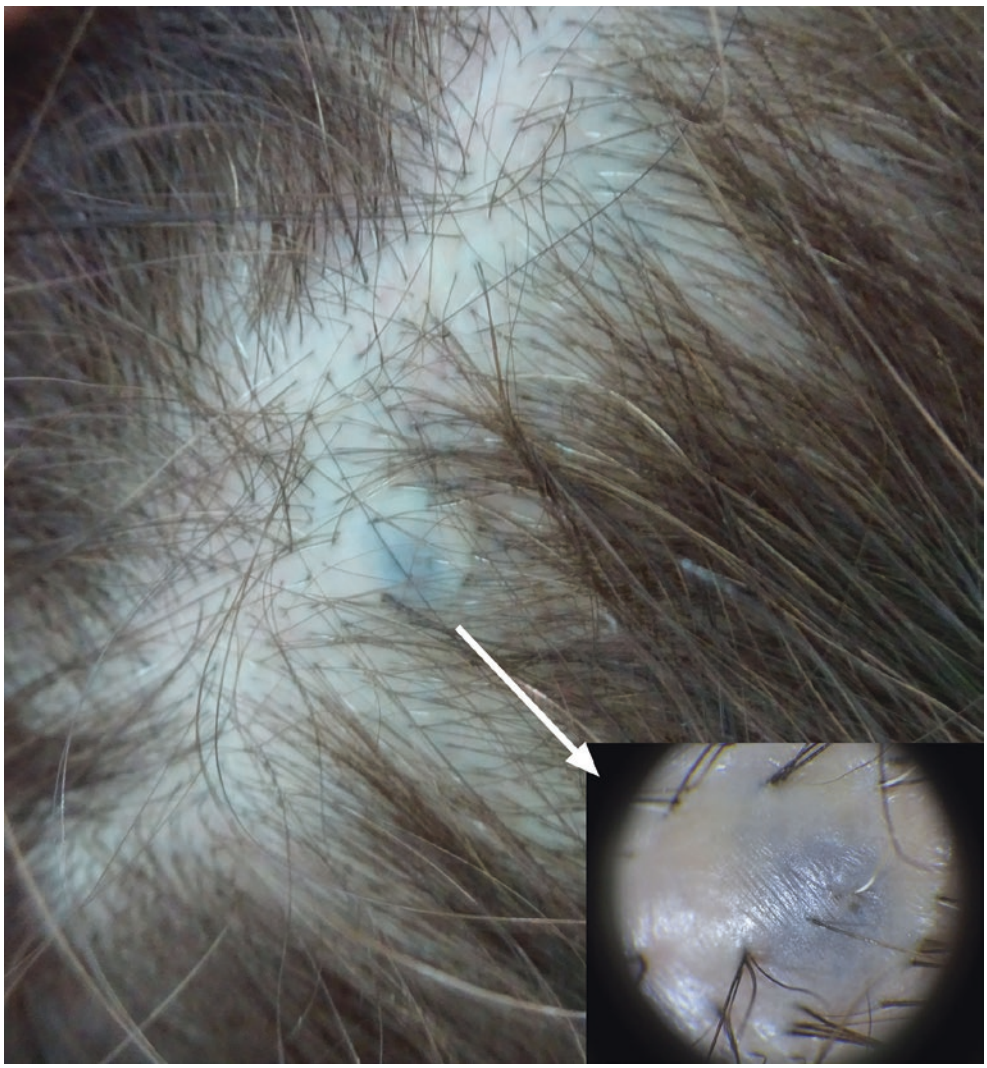

Fig. 2.13 Examination of the scalp. Displacement of the hair tracts is needed to create space for positioning of the probe and to facilitate the penetration of the soundwaves.

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