White Paper

Application of Elastography in Dermatology

F. Alfageme Roldán

Elastography is a technique in which ultrasound is used to detect changes in tissue elasticity. An evaluation of the elasticity or rigidity could facilitate early, noninvasive monitoring and treatment of inflammatory tissue and tumors. This review will explain some of the method applications in the clinical assessment of the skin and adnexa that can provide complementary information and improve patient care.

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Elastography is a new and emergent technique that has great potential in the physical cha

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Why Elastography?

Since antiquity, palpation has played an important role in the general physical examination of patients, because it provides information about the physical characteristics of tissue. Since the late 20th century, elastography has been used to support the diagnosis and treatment of several diseases, including breast tumors, thyroid disorders, and liver disease.

New developments have enabled this technology to be introduced in high-frequency transducers, making it possible to apply elastography to superficial tissue such as skin and adnexa.

The Physical Concept

When subjected to pressure, tissue will deform and tend to recover its initial shape. This tissue elasticity can be measured in the form of tissue resistance to deformation. Strain elastography is a semiquantitative method linked to a scale from 1 to 5 related to the rigidity of the structure, with 1 being soft and 5 being rigid. It's also possible to express structure rigidity in relation to the parenchyma. This quotient is known as the strain ratio.

Elastography: Best Practice

According to the EFSUMB clinical guidelines on elastography, the following recommendations should be taken into account when elastography is performed on any organ:

1. The structure should be in close proximity to the transducer (< 4 cm).
2. The structure should be nearly homogeneous.
3. When pressure is applied, there should be no slippage in the structure over deeper planes.
4. Pressure should be applied to a surface larger than the structure being examined.
5. No structures that dampen compression, such as large blood vessels, should be present.
6. The structures being examined should be completely included within the region of interest.
7. The direction of the compression force should be known.
8. The number of structures being examined should be limited.

When elastography is used on the skin, gel should not be used in the region of interest. As we can infer, the skin is an organ that adapts to the conditions in which elastography can be carried out with the appropriate technique and technology: in other words, high-frequency linear probes applied to the skin and adnexa.

Clinical Applications of Elastography

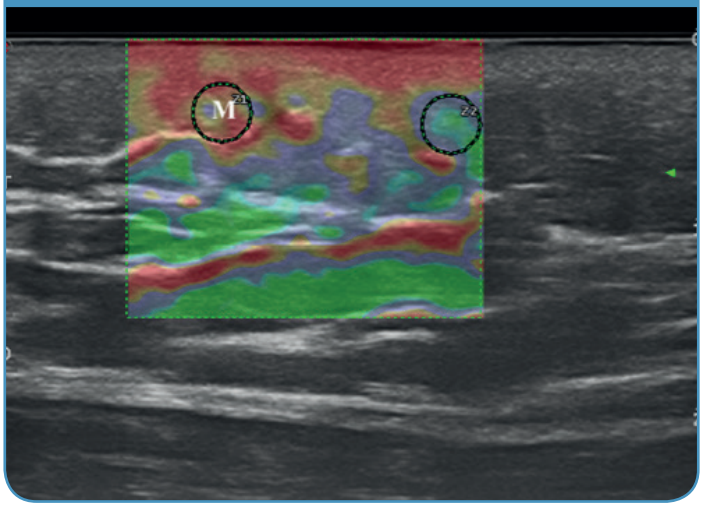
A. Inflammatory skin diseases

Inflammation affects the rigidity of the skin and adnexa structures, causing changes during the ultrasound examination in B-mode and Doppler. A study by Gaspari et al. of 50 patients who visited the emergency room for abscess drainage showed that by using elastography it was possible to observe stiff areas around the abscesses that were not visible in a B-mode ultrasound.

Another study run by DiGeso et al. aiming to determine the degree of correlation between measurements with strain elastography and B-mode ultrasound demonstrated that elastography reduces inter and intraobserver variability in the assessment of dermal thickness of the fingers in patients with systemic sclerosis.

Experimental studies on phantoms and animals have also shown that the rigidity of the surface skin increases quickly after sustained pressure, which could be an earlier marker for detecting areas at risk of ulceration.

Fig. 1 Elastography of morphea (M). An increase in rigidity can be observed in the dermal-subdermal interface of the plaque in comparison with the surrounding tissue (SR=3.4).



B. Skin tumors

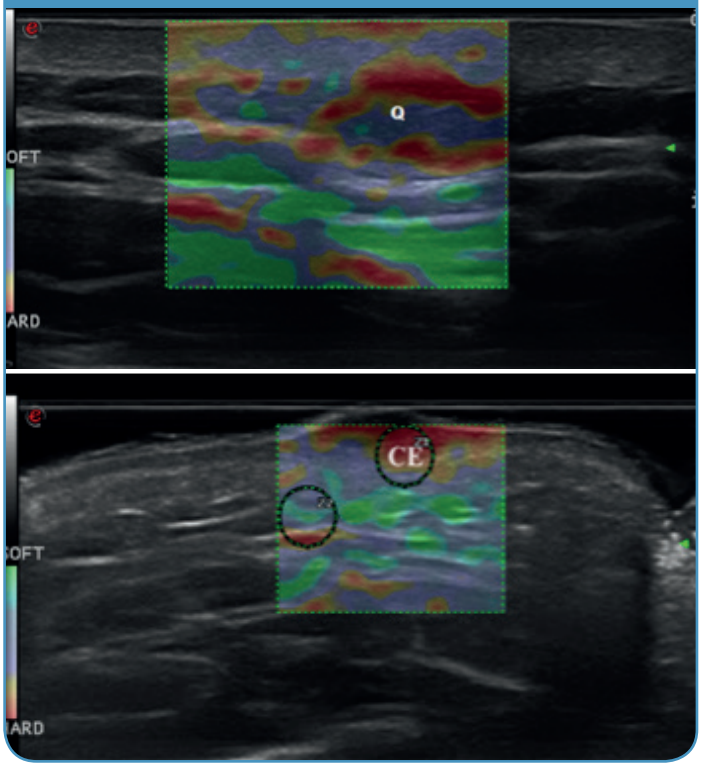
The most widely investigated application in elastography of skin tumors is differentiation between benign and malignant tumors. In tumors, the mechanical properties of the tissue are generally altered in a way that allows the tumor to be differentiated from adjacent healthy tissue.

I. Benign and malignant skin tumors

Benign subcutaneous tumors have a recognizable appearance in B-mode ultrasound and in doubtful cases elastography could play a useful role in a differential diagnosis. Park et al. used the technique to differentiate between inflamed and unruptured epidermal cysts, where an unruptured cyst was shown to be stiffer than an inflamed cyst.

Elastography shows that malignant skin tumors are stiffer than the surrounding tissue. In a pilot study run by Botar et al., 42 melanomas in 39 patients were studied using the technology and color Doppler ultrasound to assess vascularization. The melanomas were hypervascularized and had multiple vascular pedicles, and elastography showed that the lesions were stiffer than the adjacent skin. The lesions with the highest degree of vascularization displayed the greatest stiffness.

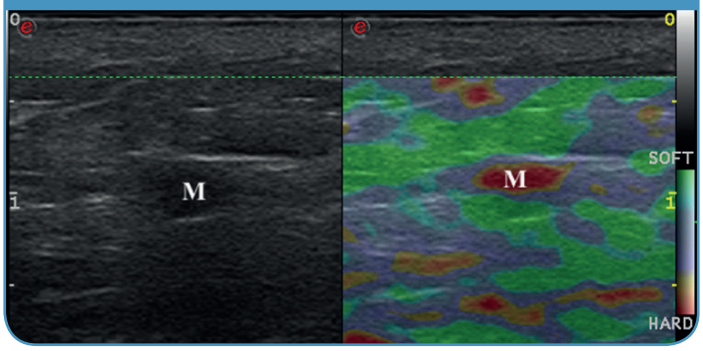
Fig. 2 A, Strain elastography of a cyst (Q). B, Squamous cell carcinoma of the cheek (CE). The SR=2.36 indicates that the lesion is stiffer than the adjacent subcutaneous cellular tissue.



II. Lymph node enlargement

Lymph nodes have an elastic structure in which the cortex tends to be less rigid than the capsule and the hilum. To assess the stiffness of lymph nodes, elastography is used to classify nodes into 4 or 5 categories, according to the proportion of areas of rigidity they present. Benign enlarged nodes generally tend to be soft, whereas malignant nodes tend to be stiffer.

Fig. 3 Lymph node metastasis of a melanoma where the complete rigidity of the lesion and the lack of soft areas is visible.



Conclusion

- Elastography is a new and emergent technique that has great potential in the physical characterization of tissues in the skin and adnexa.
- In specific cases such as melanoma, early detection is crucial. Hinz et al. found that, in addition to conventional B-mode sonography, elastography combined with color Doppler sonography increased sensitivity in the detection of metastatic disease in clinically suspicious enlarged lymph nodes from 80.9% to 95.2%, but found no increase in specificity (76.2%).
- The technology offers complementary and synergistic information in the assessment of cutaneous tissues. This information can lead to a better diagnosis and improve patient care.

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