Hybrid ultrasound imaging techniques (fusion imaging)

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Abstract

Visualization of tumor angiogenesis can facilitate non-invasive evaluation of tumor vascular characteristics to supplement the conventional diagnostic imaging goals of depicting tumor location, size, and morphology. Hybrid imaging techniques combine anatomic [ultrasound, computed tomography (CT), and/or magnetic resonance imaging (MRI)] and molecular (single photon emission CT and positron emission tomography) imaging modalities. One example is real-time virtual sonography, which combines ultrasound (grayscale, colour Doppler, or dynamic contrast harmonic imaging) with contrast-enhanced CT/MRI. The benefits of fusion imaging include an increased diagnostic confidence, direct comparison of the lesions using different imaging modalities, more precise monitoring of interventional procedures, and reduced radiation exposure.

Key Words: Hybrid imaging, Real time virtual sonography, Angiogenesis, Focal liver lesions.

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Introduction

Conventional cross-sectional imaging technique [**ultrasound**, computed tomography (CT), magnetic resonance (MR), etc.] have important roles in noninvasive diagnosis, and in tumor treatment strategies. The techniques employed have different working principles, consequently complementing each other with respect to the information obtained. The combination (fusion) of two imaging techniques was developed in recent years, defining the so- called “hybrid techniques” or “fusion imaging”. Combinations of anatomical imaging techniques (ultrasound with CT or MR imaging), as well as associations between anatomical (CT or MR imaging) and molecular (SPECT or PET) imaging modalities are currently used in clinical practice.

fusion imaging:

One example of fusion imaging is real-time virtual sonography (RVS), a technique that enables the display of an ultrasound B mode image and CT or MR images in real-time (Kawasoe,2007). The system includes a magnetic positioning sensor fixed on the convex-shaped probe of the ultrasound scanner, for the creation of images with identical cross-sections in real-time. This is done according to the position and the angle of the probe in relation to previously acquired CT and MR volume data. To be compatible with the RVS module, CT examination must meet certain requirements: (1) the volume data must be archived in the DICOM format; (2) the slice thickness should be 3 mm or less and image reconstruction the same; and (3) the CT scan area must include the xiphoid process.

To display virtual images, it is necessary to transfer the CT or MR data to the ultrasound

machine) Sandulescu,2009). The magnetic positioning sensor unit is carefully assembled, based on the position of orientation marks.

CLILINICAL APPLICATIONS:

The founding principles of combining the ultrasound image and the CT/MR images were based on several observations. In recent years, frequent imaging investigations led to the discovery of small focal liver lesions, which can be treated locally by ultrasound-guided radiofrequency ablation (RFA) or other ablation techniques. However, ultrasound exams are cannot always identify isoechoic tumors, tumors recurring locally in areas treated with lipiodol following transarterial chemoembolization (TACE), or tumors recurring in areas treated previously by RFA or percutaneous ethanol injection (PEI) procedures (Kawasoe, 2007). In addition, in ultrasound examinations, there are a few dead angles and it is difficult to examine the whole liver, especially in obese patients. Nodules that are poorly identified on ultrasound are clearly visible on CT/MR. However, interventional treatment is easier to perform under ultrasound-guidance, while the exposure to increased doses of radiation is also avoided. Thus, real-time virtual sonography combines the imaging advantages of both techniques. Several studies have already proved the feasibility of the RVS module, especially for percutaneous RFA of poorly visible or unidentifiable focal liver lesions during B-mode sonography (Minami et al.2007).

LIMITS:

RVS cannot be used in patients if CT/MR is contraindicated (patients with known contrast medium allergies, renal failure, or metallic implants). Another limitation of RVS is that the technique does not always show the best synchronization between ultrasound and CT/MR images, although the discrepancy can be adjusted with careful visualization of neighboring portal and hepatic veins in most cases(Sandulescu, 2008). The use of the RVS module does prolong the examination time; therefore, the clinical impact, in terms of improved decision making, should be further assessed. The technique adds the costs of CT/MR to the costs of the contrast-enhanced ultrasound exam; thus the cost-effectiveness of this approach must be evaluated in future studies (Bruix J, 2005) .

Recommendations:

The benefits of fusion imaging include an increased diagnostic confidence, direct comparison of the lesions using different imaging modalities, more precise monitoring of interventional procedures, and reduced radiation exposure. The theories and applications of these ultrasound combined hybrid and innovative techniques as well as their advantages and limitations are compared, and further perspectives are proposed. This provides new insights into advances in ultrasound combined techniques and their application at research, educational.

Conclusion:

In conclusion, hybrid ultrasound imaging techniques now play a pivotal role in diagnosis, staging, and follow-up during treatment. During local ablation of focal liver lesions hybrid ultrasound imaging allows better control of the procedure and less radiation exposure.

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