US localisation of abnormal findings in neck PETCT or scintiscan: a preliminary experience with 3D and 2D virtual navigation (VN) and bodymap technology (BMT) vs cognitive approach

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Purpose

US is considered the modality of choice for neck soft-tissue examination, image guided neck interventional procedure and in particular FNA or core biopsies. Even if standard B-mode US examinations can be integrated with advanced imaging techniques such as color-Doppler, contrast-enhanced ultrasound and elastosonography, tissue characterization by US still relies mainly on morphological characteristics. On the other hand, Scintiscan, PETCT and MRI can provide valuable specific functional information which is useful for detecting pathologies. In particular, while Scintiscan is commonly used in the diagnostic work-up of thyroid and parathyroid disease, whole body PET-CT scan, CT and MRI can frequently detect, even incidentally, abnormal findings in the soft tissue of the neck [1-2-3-4].

Either way, clinicians are often most interested in US confirmation and US features and, ultimately, in the histological characterization by US guided FNA or core needle biopsy.

Usually, a cognitive approach is used for creating an alignment between a US scan and functional images, and defines a correlation between US findings and functional findings. This technique is intuitive, inexpensive, and requires the operator to pinpoint the location of the suspicious lesion via functional imaging within the US images. Unfortunately, the cognitive approach is challenging and susceptible to human error as it relies on the operator's spatial cognition to accurately direct the US probe toward the target [5].

More recently, real time Virtual navigation by images fusion techniques (also known as Interactive localizing techniques) has been proposed in order to spatially co-registrate a real time modality (i.e. US) with high resolution isotropic 3D CT and MRI or functional images (i.e. PET-CT and scintiscan). In this way, the operator can simultaneously use information from multiple imaging modalities to enhance diagnostic and localization capability. Image fusion can be achieved by electromagnetic (EM), optical or mechanical devices.

There are some advantages of using EM devices over optical and mechanical device:

a) The tracked device can reside out of generator sight;

b) Multiple devices can be tracked at the same time;

c) Devices can be tracked also within the patient's body without signal attenuation;

d) There are no significant limitation to operator position and movements.

These advantages make EM tracking systems more flexible, as well as making them suitable for multipurpose applications.
The main technical limitation of EM tracking systems is that the ferromagnetic environment can cause interference and distortion of magnetic coordinates. However, a new generation of EM tracking systems has reduced susceptibility to the effects of the metal hardware [6-7-8].

Other possible drawbacks are the necessity of expensive dedicated images-fusion hardware and software, and the difficulty of obtaining a precise image fusion considering the anatomical distortion that can be induced by patient movements as well as physiological changes, or simply by the US probe itself.

The aim of our study is to report a preliminary clinical experience using 3D VN and 2D navigation with BMT for US localization of abnormal findings in neck PET-CT or scintiscan.
Methods and materials

For the present study a MyLabTwice ultrasound scanner equipped with an electromagnetic (EM) tracking system, 2D navigation with BodyMap and 3D Virtual Navigator hardware and software, was used (ESAOTE, Italy).

BodyMap is an EM tracked technology for 2D Navigation, that combines US with pre-acquired 2D DICOM images, used to show the real-time position of the US probe with respect to any secondary images, such as scintiscan. While the probe is moving, showing the real-time ultrasound frames, the probe position (indicated by a green circle) is automatically over-imposed on the reference DICOM image (Fig 1).

Virtual Navigator is a technology for 3D fusion imaging procedures allowed by the same hardware of BodyMap. By moving the transducer, real-time US scans of the neck is simultaneously matched with the 3D multiplanar reconstruction of the second modality (Fig 2).

The procedure was performed on 20 patients with different findings (abnormal uptake in thyroid nodules, 12; residual uptake after thyroidectomy, 3; lymph nodes pathologic uptake, 5; parathyroid pathologic uptake, 2) at Scintiscan and PETCT. Each patients was examined by three operators. Functional images were evaluated by each operator and loaded on the equipment before performing US examination. With the patient in supine position the support for magnetic generator was placed under the shoulder in order to have the generator on the left side (Fig 3). Firstly, a standard US scan was performed with the cognitive approach. The US scan was then co-registered with scintiscan or PETCT using anatomical landmarks (linear probe LA533, 5-13 MHz with magnetic sensor support) and the 2D navigation with BM (or 3D VN modality) was activated (Fig 4). US examination was then performed with the aid of navigation software. Each operator was asked about their confidence in localization with cognitive approach versus 2D navigation with BM or 3D VN. The number of successful co-registrations and the time necessary for the set-up of cognitive approach and 2D navigation with BM or 3D VN were recorded.
Fig. 1: BodyMap enables the real-time tracking of the probe with 2D Thyroid Scintiscan: on the left side is visualized the ultrasound scan and on the right side the probe position (green circle) in the secondary imaging modality (Scintiscan). The image shows different landmarks with three consistent ultrasound frames.

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Fig. 2: Virtual Navigator merges the real-time ultrasound capabilities with 3D high-resolution and functional information from other imaging modalities (such as CT). Colored targets can be marked and visualized on both imaging modalities.

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**Fig. 3:** The picture shows the magnetic generator (black arrow) on the plastic support and the magnetic sensor (white arrow) connected to the US unit (Fig a). The magnetic generator produce a spatially encoded 3D magnetic field (red arrows) that allows the system to know the position of the magnetic sensor (Fig b).

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**Fig. 4:** The images show the assembly of the linear probe with the bracket for the magnetic sensor (black arrow) and the magnetic sensor itself (white arrow).

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Results

All co-registrations were successfully carried out (Fig 5). Overall, operators reported that using 2D navigation with BM or 3D VN resulted in an increased confidence in localization of pathologic findings in 76% of the procedures with an inter-observer agreement of 97%. If only target lesions with a maximum US diameter not more than 20 mm were considered (11 cases in total) the increased confidence and inter-observer agreement were respectively 94% and 100% (Fig 6-7).

The average time required for the start-up of the cognitive approach, 3D VN and 2D BM navigation was 4 (±2), 5 (±1.5) and 2(±1) minutes respectively.
Fig. 5: BodyMap technology: real-time US scan and probe tracking on Scintiscan 2D image. A patient with ectopic thyroid nodule in thyroglossal duct.

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**Fig. 6:** US localization of abnormal activity in the left lateral cervical side on PET-CT scan. The abnormality correspond to a small lymph node in level II in a patient operated on for lung carcinoma. FNA was performed. Cytological examination revealed granulomatous lymphadenitis.

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Fig. 7: BodyMap technology: real-time US scan and probe tracking on Scintiscan 2D image in a patient with hyperparathyroidism and enlarged parathyroid gland, visible on both imaging modalities.

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Conclusion

3D VN and 2D Navigation with BM using an EM tracking system are reliable techniques. When compared with the cognitive approach, they resulted in an increased operator confidence in US localization of abnormal or pathologic functional findings on scintiscan and PETCT. Operators’ confidence further increased in the cases with challenging small lesions. Inter-observer agreement resulted to be substantial for all cases, or nearly perfect for cases with small target lesion, making the techniques robust. As regard the time required for the set-up of the navigation modality, it can appear incredibly short if compared with the cognitive approach. However, using the fusion environment, functional images could be evaluated in virtual real-time while performing US. Time was saved because the operator had no necessity of consulting the multimodality reporting PACS console. On the other hand, during the cognitive approach the operator sometimes needed repeated access to the reporting console in order to check the correct spatial alignment of US and functional images. Image fusion and virtual navigation by EM tracking are very promising tools for radiological daily practice with very-low or no impact on the standard examination setting and protocol.

During neck US, Virtual Navigator should be implemented each time a precise correlation with other imaging modalities is needed, both for diagnostic and interventional purposes (Fig 8). The solely limitation to be considered is the cost of the necessary hardware and software. However, it must be highlighted that an EM tracking system can have countless applications in a radiological environment which goes towards making its cost affordable [7]. In order to induce wider clinical use, navigation systems need to be more user-friendly and easily available. Large scale production will make further technical improvements possible such as wireless sensors, US probe and medical tools with integrated magnetic sensors and miniaturized generators [8].
Fig. 8: US-MRI fusion in a patient with a thyroglossal duct cyst. The complex structure of the cyst is better visualized on ultrasound while the deep cyst extension is better defined by MRI imaging.

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References


