Characterisation and Biopsy of Soft-Tissue Sarcoma using PET and Interventional MR

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Introduction

Although biopsy and histological examination remains the 'gold standard' for tumour diagnosis and classification, the accuracy of such procedures is compromised by tumour heterogeneity. Soft-tissue sarcomas (STS) are a heterogeneous group of masses where core needle biopsy is considered particularly inaccurate [1] and a more invasive excisional approach is preferred. We present a method for PET and MR guided core biopsy that allows accurate sampling of PET indicated regions and direct comparison of PET and histology findings for validation of novel PET tracers, such as hypoxia markers.

Methods

In an ongoing study, four patients with suspected STS underwent a three-step procedure:

1. PET Imaging: A semi-quantative map of tumour glucose metabolism was acquired with a dedicated PET system following the administration of ^{18}F-fluorodeoxyglucose (FDG). The following week, scans with ^{15}O-labelled water to measure blood flow and ^{18}F-fluoromisonidazole (FMISO) to quantify tissue hypoxia were also performed. Anatomical MR scans (1T Siemens Magneton) were acquired on each occasion.

2. PET/MR Image Registration: PET images were registered with MR scans using external markers and a rigid-body transform. In STS, this provides a more accurate method of image alignment than image-content based algorithms [2]. A non-rigid MR to MR transform was then determined using an automated algorithm and used to align PET data (Figure 1). This allowed regional comparison of PET tracer uptake.

3. iMR Biopsy: Prior to core biopsy, patients received an infusion of the histological hypoxia marker pimonidazole. The biopsy procedure was carried out in an XMR suite equiped with a 1.5T Philips Intera scanner. Patients were imaged with a localising grid taped over the volume of interest and the biopsy site was determined with visual reference to this 'gridded MR' and fused PET/MR images. The biopsy was carried out on the scanner bed using an MR compatible, semi-automatic biopsy gun and trocar (Daum GmbH). The trocar was imaged in place and imaging of biopsy needle tracks was attempted. Biopsy sites were accurately mapped back in to PET image space, using iMR to MR registration,to allow comparison of PET and histological findings.

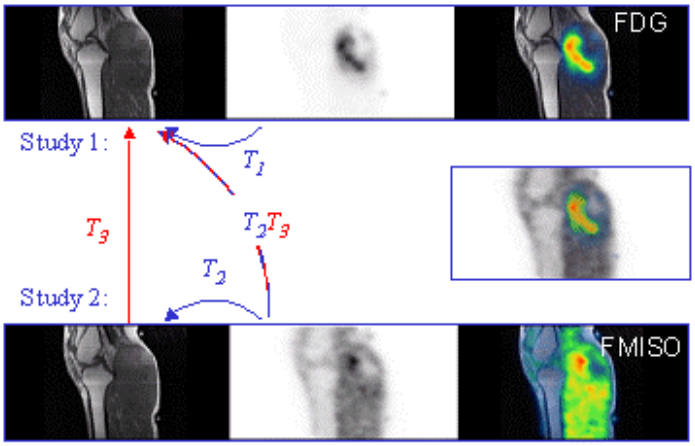

Figure 1. Registration of PET and MR

Results and Discussion

Estimated registration accuracy was MR-MR 2-3mm, PET-MR 5-6mm and PET-PET 6-7mm. Biopsy tracks were hard to visualise but biopsy site could be inferred from the position of the trocar. In 2 patients the technique confirmed a diagnosis of STS, other patients were confirmed with lymphoma and neurofibroma. Figure 2 demonstrates the technique in STS behind the knee. Here increased FDG and FMISO uptake agreed with histology findings at the same site. The registration of PET with interventional MR images may be simplified with the availability of PET/CT in place of dedicated PET and MR scanning.

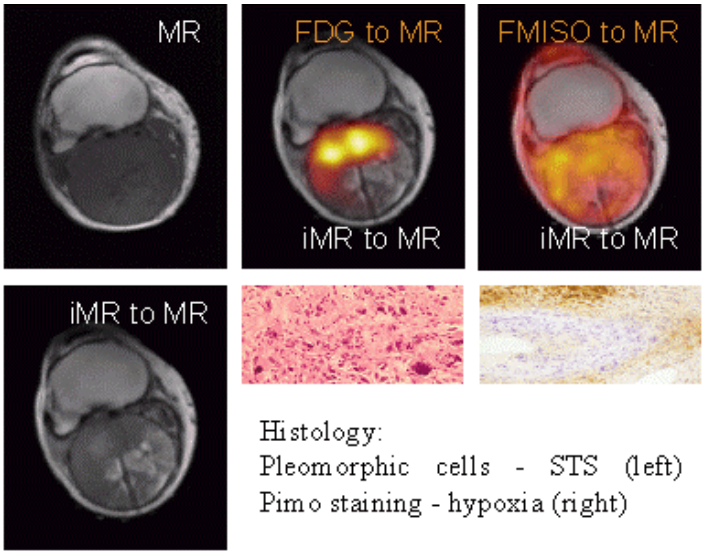

Figure 2. MR, iMR and PET aligned with tumour histology

Conclusion

This technique allows targeting of specific areas of high-grade soft-tissue sarcoma during PET/MR guided biopsy for histological comparison with three PET tracers.

In the future, this technique may be useful in the development of novel PET tracers and the study of other tumour types.

References

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