PET/MRI fusion studies provide important information that may change decisions regarding surgical therapy for patients with thyroid cancer

Seiboth L, Van Nostrand D, Wartofsky L, Ousman Y, Jonklaas J, Butler C, Atkins F, Burman K. Utility of PET/neck MRI digital fusion images in the management of recurrent or persistent thyroid cancer. Thyroid 2008;18:103-11,

SUMMARY

BACKGROUND Serum thyroglobulin levels and neck ultrasound examinations comprise the mainstay of diagnostic follow-up studies in low risk patients who clinically appear free of disease. However, patients with more serious disease usually require a variety of imaging studies to identify the site and extent of metastatic tumor. Positron-emission tomography (PET) scanning is one such study that is being increasingly used with computed tomography (CT) or magnetic resonance imaging (MRI) to produce images that provide both anatomic and metabolic information. This study assesses the clinical utility of coregistered (fused) images of PET and MRI in patients with thyroid cancer.

METHODS The study subjects comprised 34 patients with thyroid cancer who had undergone PET and MRI imaging for thyroid cancer at some point during their follow-up. Of this group, 31 (91%) had papillary thyroid cancer and one had medullary thyroid cancer, all of which were initially treated with total or near-total thyroidectomy. During follow-up, patients routinely had serum thyrotropin (TSH), free thyroxine (FT_4), and serum thyroglobulin (Tg) measurements, except for the patient with medullary thyroid cancer, who had serum calcitonin measurements. In addition to neck ultrasound exams, each patient routinely had ^{18}fluorodeoxyglucose (FDG)–PET and gadolinium MRI scans that were subsequently digitally fused. The individual PET scanning and MRI were usually performed on the same day or not more than 5 months apart, but most were performed within 2 weeks of each other. A radiologist and nuclear medicine physician first independently reviewed each patient's MRI and PET scan, and after the PET/MRI fusion studies were generated, they were collaboratively interpreted. As part of the study, and prior to the PET/MRI coregistration, four endocrinologists who were unaware of the results of the fusion studies each retrospectively and individually reviewed the patient charts to make a clinical assessment and theoretical treatment plan. After this was accomplished, each endocrinologist was individually provided the results of the PET/MRI studies. With these new images, each endocrinologist made a revised clinical assessment and treatment plan and then categorized the PET/MRI information into three groups: (1) new information that altered the treatment plan, (2) new information that confirmed the initial proposed treatment plan, or (3) no new information. Two statistical analyses were done. The first combined the two positive responses into a single score and compared it with a response that did not provide new information. The second statistical test determined the extent of agreement among the four endocrinologists.

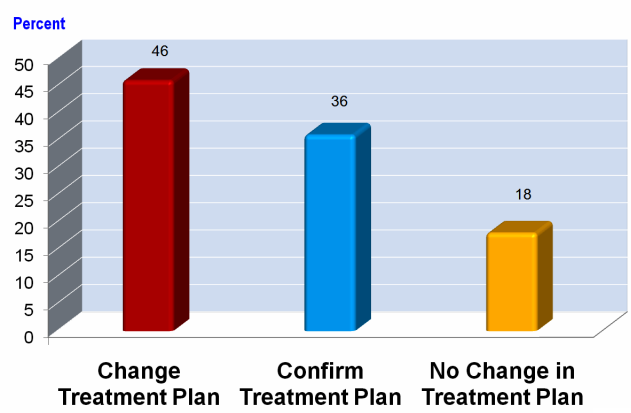

Figure 1. PET/MRI fusion provided additional information that altered the treatment plan in 46% of the cases, confirmed the treatment plan in 36%, and provided no additional information in 18%.

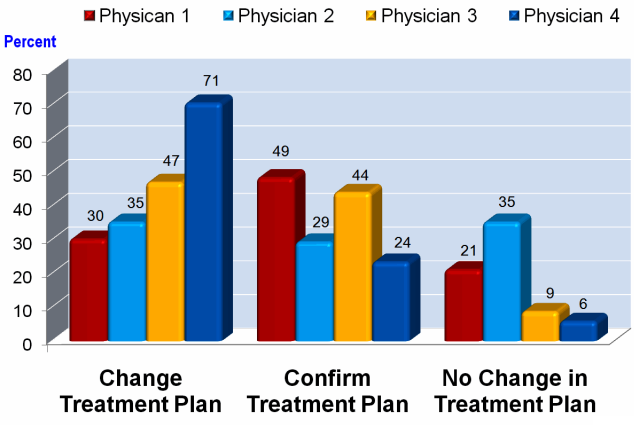

Figure 2. The Individual physician responses to new data on PET/MRI fusion studies are shown as the percent of study patients for whom the PET/MRI studies affected each endocrinologist's treatment plan. When the reviewer's response was neutral (did not gain new information) the coefficient of agreement was low (0.035±0.114, P>0.4) but when the reviewers' responses were positive (gained new information that altered or confirmed treatment), the coefficient of agreement was high (0.796±0.078, P<0.001) and overall agreement was high (0.663±0.055, P<0.001).

RESULTS Of the 34 study subjects, 23 (68%) were female and the mean age (± SD) was 43.8±12.5 years (range, 15 to 65). The patients had had a mean of 1.7±0.6 past surgeries, and 29 (85%) had received at least one radioiodine (^{131}I) treatment 6 months to 24 years prior to this study, receiving an average of 331.8±320.2 mCi (range, 129 to 1046) of ^{131}I. In addition, 18 (58%) patients had positive neck ultrasound examinations, 13 (38%) had positive CT scans, 26 (82%) had positive MRIs, and 30 (85%) had detectable serum Tg levels that averaged 95.2±439.5 ng/ml (range, <0.5 to >2500). The PET/MRI fusion studies provided additional information that altered the treatment plan in 16 patients (46%) and confirmed the proposed treatment plan in 12 (36%) and provided no additional information in 6 (18%). The endocrinologists agreed more often than they disagreed about the impact of the new PET/MRI information (Figure 1). The first statistical analysis was inconclusive for a neutral response by the reviewers concerning the PET/MRI information; however, there was strong overall agreement between the reviewers for a positive response (Figure 2).

CONCLUSION PET/MRI studies provide structural and functional information that may change the surgery plan in patients with persistent thyroid cancer.

COMMENTARY

This preliminary study suggests that ^{18}FDG-PET/MRI fusion studies may have a useful place in the management of thyroid carcinoma. This is not surprising, since it is widely held that ^{18}FDG-PET/CT plays a major role in the management of differentiated thyroid carcinoma, providing important restaging information by identifying the location and magnitude of occult tumor metastases (1) while providing a powerful means of estimating prognosis in patients with extensive disease (2). Several studies now suggest that ^{124}I-PET/CT may be superior to ^{18}FDG-PET/CT in tumor restaging (3). The study by Seiboth et al. suggests that ^{18}FDG-PET/MRI fusion studies are superior to ^{18}FDG-PET or CT alone and to neck ultrasonography, and is potentially capable of changing the treatment plans for patients with aggressive disease. It is not yet clear which of the perturbations of PET fusion will eventually become the most widely used, or whether there will be unique indications for these different tests. Still, fusing PET with MRI offers some interesting advantages, such as reducing total-body radiation and finding tumor in locations that typically are best identified by MRI such as brain and spinal metastases. The next level of studies should compare PET/CT with PET/MRI. The Seiboth study underscores the major clinical advantage gained by fusing PET and MR images that potentially can provide important information. This study is likely to spark further studies of PET/MRI in patients with thyroid cancer.

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References

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