Quantitative imaging characterization of benign and malignant pheochromocytomas: comparison between iodine-131 mibg uptake and magnetic resonance signal intensity ratios

Poster No.: C-0623
Congress: ECR 2012
Type: Scientific Exhibit
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Keywords: Nuclear medicine conventional, MR-Functional imaging, Nuclear medicine, Kidney, Diagnostic procedure, Endocrine disorders
DOI: 10.1594/ecr2012/C-0623

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Purpose

To compare metaiodobenzylguanidine (MIBG) uptake and magnetic resonance (MR) signal intensity ratio in differentiating benign and malignant disease in patients with pheochromocytoma or paraganglioma.
Eighteen patients (9 men and 9 women, mean age 37 ± 8 years) with pheochromocytoma (n = 14) or paraganglioma (n = 4) underwent MR imaging and MIBG scintigraphy. In all patients, the diagnosis was confirmed by cytology and/or post-surgical histology and patients were divided according to the presence of benign (n = 10) or malignant (n = 8) disease. Tumors were considered benign when detected only in anatomic sites where chromaffin tissue is typically located (i.e. adrenals or sympathetic and parasympathetic paraganglia). Conversely, tumors were considered malignant when detected in anatomic sites where chromaffin tissue is not represented (i.e. lymph nodes, liver, lungs, and bone) or when capsule infiltration and vascular invasion were found. MR imaging studies were performed with a 1.5 Tesla superconducting magnet scanner (Magnetom, Siemens Medical Systems, Hoffman Estates, IL). A conventional turbo spin echo (TSE) technique was used to obtain 5 mm contiguous three-dimensional sections of the abdomen. T1-weighted images (TR/TE = 600/15 msec) and T2-weighted images (TR/TE = 2000/15-90 msec) were obtained. T1-weighted images were also acquired after the intravenous administration of gadolinium-DTPA (0.2 ml/kg of weight body, Magnevist, Schering) using dynamic multi-phase acquisition. The tumor size was measured as maximal diameter (cm). For quantitative analysis, the signal intensity ratio (i.e. ratio between absolute signal intensity of tumor lesion and that of liver, fat, muscle, and image background) was measured on T1 and T2-weighted images using region of interest analysis. For MIBG scintigraphy, before tracer injection, iodine thyroid uptake was blocked with a saturated solution of potassium iodide (200 mg per day orally, starting before tracer administration and continuing for 8 days). Iodine-131 MIBG (37 MBq) was administered intravenously. Anterior and posterior whole-body imaging and abdominal spot views were obtained 24, 48, and 72 hours after tracer injection using a dual head rotating gamma camera (E.CAM, Siemens Medical Systems, Hoffman Estates, IL) with a high-energy collimator and a 20% window centered at 364 Kev. MIBG uptake was visually and quantitatively assessed in anatomic sites where tumor lesions were detected on MR images. At visual analysis, tracer activity was considered abnormal when it was greater than blood pool as well as surrounding background activity and when no similar uptake was observed on the contra-lateral side on all series of images. MIBG uptake was graded as mild, moderate, or intense. For quantitative analysis, MIBG uptake was evaluated on 48 hours images using a photographic densitometer (X-Rite Company, MI) for measuring optical density (OD). OD was measured in lesion and in adjacent or contra-lateral normal tissue using region of interest analysis. To obtain background correction, the intensity ratio of MIBG tumor uptake (tumor lesion OD/normal tissue OD) was calculated for each lesion.
Results

Among the 10 patients with benign disease, 8 had pheochromocytoma and 2 paraganglioma; while among the 8 patients with malignant disease, 6 had pheochromocytoma and 2 paraganglioma. In patients with benign disease, a total of 12 lesions were found. In patients with malignant disease, a total of 16 lesions were detected and the majority (75%) of these patients showed lymph nodes or bone involvement. At visual analysis, MR imaging and MIBG scintigraphy detected all tumor lesions. At quantitative analysis, MIBG uptake intensity ratio was significantly higher in malignant compared to benign lesions (5.2 ± 2.4 vs. 2.9 ± 1.4, \( P < 0.01 \)). On the contrary, at MR imaging no significant difference in tumor size and signal intensity ratio between malignant and benign lesions was observed. Figures 1 and 2 show MIBG uptake and MR signal intensity in patients with benign and malignant pheochromocytoma, respectively. Figure 3 shows the values of MIBG uptake in benign and malignant lesions.
Fig. 1: (A) Patient with a large (4 cm) benign pheochromocytoma of the left side; posterior abdomen view 48 hours after iodine-131 MIBG administration shows a round area of mild tracer uptake in the left adrenal bed (IR = 1.7) (black arrows); normal diffuse tracer uptake is present in the liver and heart. (B) Patient with a bilobated malignant pheochromocytoma of the left side with para-aortic lymph node involvement; posterior abdomen view 48 hours after iodine-131 MIBG administration shows an irregular area of intense tracer uptake in the left adrenal bed both in the main tumor (IR = 13) and in metastatic lymph node (IR = 9.7) (black arrows).

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Fig. 2: (A) Patient with a benign pheochromocytoma of the right side; MR T2-weighted axial view with fat-suppression shows a regular and homogeneous tumor mass with high signal intensity in the right adrenal bed. (B) Patient with a malignant pheochromocytoma of the right side; MR T2-weighted axial view with fat-suppression shows a bilobated and non-homogeneous tumor mass with high signal intensity in the right adrenal bed with liver involvement; a cystic renal lesion of the superior pole is detected on the right side.

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Fig. 3: MIBG uptake intensity ratio (IR) in benign and malignant lesions.

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Conclusion

The main finding of this study is that quantitative analysis of MIBG uptake may differentiate between benign and malignant pheochromocytoma and paraganglioma, while MR signal intensity ratio is not useful for this purpose. In fact, MIBG uptake, measured as tumor lesion OD, was significantly higher in malignant lesions compared to benign disease; conversely, signal intensity ratio by MR imaging was not different between benign and malignant tumors. The higher MIBG uptake observed in malignant lesions could reflect major tumor storage of cathecolamines compared to benign lesions.
References


