Assessment of Parallel Acquisition Techniques in Adrenal MR Imaging: Does Increased Temporal Resolution Significantly Improve Visualization of Adrenal Lesions?

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Purpose: To compare conventional radiofrequency coil reception and parallel coil array acquisition methods (e.g., SMASH, GRAPPA) and to evaluate the relationship of temporal resolution on image quality in adrenal gland imaging.

Material and Methods: Using a 1.5T MR (Magnetom Sonata, Siemens, Erlangen, Germany) scanner, conventionally acquired and parallel sampled T_2 weighted Turbo Spin Echo sequences were applied in ten healthy volunteers and ten patients with adrenal gland lesions. The imaging protocol consisted of: conventional (TR/TE 4730/125 ms; FA 150º; ETL 29, NSA 1; AT 25 s), parallel (TR/TE 4090/125 ms; FA 150º; ETL 29, NSA **1**; AT 12 s), and parallel (TR/TE 4090/125 ms; FA 150º; ETL 29, NA **2**; AT 24 s) SMASH techniques with generalized autocalibration employed in T_2 weighted Turbo Spin Echo sequences with 5 mm slice thickness and 1.6 mm in – plane resolution. The parallel acquisition was performed with an acceleration factor of 2. For image analysis, the contrast-to-noise ratios (CNR) of each image were calculated in the region of the adrenal gland. The severity of breathing motion and aliasing artifact, as well as overall image quality, were rated on a five point scale by trained radiologists. A Differential Receiver Operating Characteristic (DROC) analysis was performed by two independent investigators.

Results: Adrenal gland findings included adenomas, metastasis, and hemorrhages. Acceleration (x 2) of a conventional TSE sequence for adrenal tissue characterization via parallel imaging with a single acquisition, led to: a) an increase in diagnostic power (DROC 0.362), b) a significant improvement in overall image quality ($p_{Volunteers} = 0.017$, $p_{Patients} = 0.042$), and c) reduction of breathing motion artifact ($p_{Patients} = 0.012$) in patients when compared to non-parallel acquisitions. These were obtained while simultaneously improving the temporal resolution and marginally increasing tissue contrast. If further improvement of image quality and significant increase of contrast are required parallel imaging with a doubled number of signal averages allowed image improvement over conventional imaging (DROC 0.303), ($p_{Volunteers} = 0.045$, $p_{Patients} = 0.022$) while maintaining the same temporal resolution.

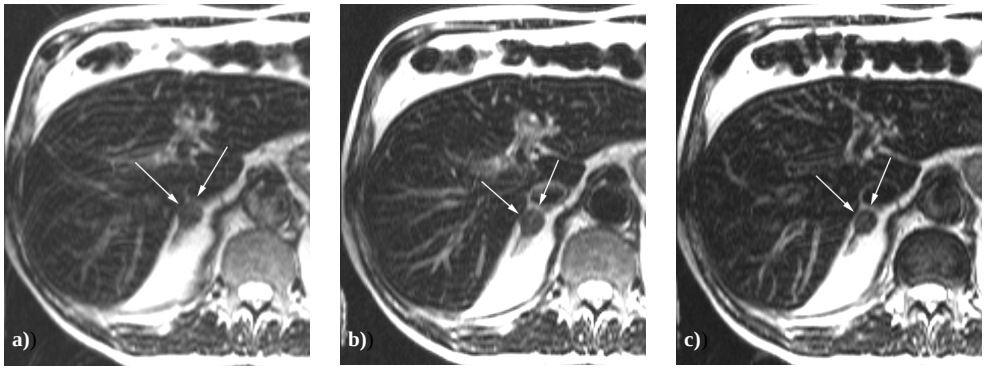

Figure 1**: Adrenal imaging obtained in a 76 – year – old patient with bilateral adenomas. **(a)** Conventional Turbo Spin Echo (TSE) sequence insufficiently visualizing adrenal morphology and anatomical borders. **(b)** Parallel accelerated TSE sequence with single acquisition and improved temporal resolution allowing delineation of surrounding periadrenal fat. **(c)** Parallel accelerated TSE sequence with a doubled number of signal averages also visualizes the periadrenal fat and furthermore enhances the adrenal contrast. Note the reduction of breathing motion artifact in **(b)** and **(c)** compared to **(a)

Conclusion: The widespread application of cross–sectional imaging techniques has led to an increase in visualization of adrenal masses, which are common incidental findings. This incidental detection then requires further diagnostic characterization, particularly since the adrenal gland is a common site of metastasis. Breathing motion artifacts and long acquisition times are crucial limitations of adrenal MR imaging, exacerbated by the need to compare corresponding slices of multiple phases in combination with the subdiaphragmal anatomical location of the adrenal glands. In our investigation, acceleration of sequences employed for adrenal tissue characterization via parallel acquisition strategies lead to a significant increase in diagnostic image quality by significantly reducing breathing motion artifacts without sacrificing image contrast-to-noise ratio (Fig. 1). While other applications of parallel imaging continue to be debated, we conclude that T2w TSE acquisitions with a parallel imaging acceleration of 2 should be routinely employed for adrenal imaging in the future.