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Honoring Philips’ ambition of no compromise imaging, University of Bonn clinicians led by radiologist Nuschin Morakkabati-Spitz, and in collaboration with Philips clinical scientist Jürgen Gieseke, have developed two techniques for Achieva 3.0T pelvis imaging: an ultra-fast method and a high resolution technique. Evaluating these ultra-fast (six times faster) and high-resolution techniques in clinical studies of the female pelvis has proven the effectiveness of these approaches, which have been integrated to ExamCards at the University of Bonn and are in routine clinical use.

“Imaging at 3.0T affords tremendous potential both in scanning speed and in the diagnostic capabilities that high spatial resolution provides,” says Nuschin Morakkabati-Spitz, M.D., radiologist at the University of Bonn, which performs approximately 10 pelvic MRIs (males and females) per week. “In imaging the female pelvis in particular, the ability to perform high-resolution studies will greatly assist in staging of gynecological tumors. Similarly, speed in scanning the female pelvis is critical in the reduction of patient-induced motion artifacts and also in improving throughput.”

Dr. Morakkabati-Spitz, in collaboration with University of Bonn-based Philips clinical scientist Dr. Jürgen Gieseke, sought to exploit their Achieva 3.0T system’s capabilities to develop both ultra-fast and high-resolution MRI methods for pelvic imaging. The efficient SAR management with a combination of optimized SENSE factor and refocusing flip angle is key to enable effective use of pulse sequences that use very high TSE factors. These high TSE factor sequences – such as T2-weighted TSE sequences – incur relatively high RF energy deposition due to the large number of 180° refocusing pulses they employ.

**High-resolution 3.0T technique also features speed**

Dr. Morakkabati-Spitz and Dr. Gieseke began in 2003 to develop and optimize methods for high resolution studies of the female pelvis. The T2-weighted 3T-HR

**Ovarian mass**

Routine ultrasonography in a 43-year-old female showed an ovarian mass. SP revealed an ovarian mass with two different tissue components. Based on the presence of fat, an ovarian dermoid was suspected. The fast sequence (39 sec.) confirmed this. Image quality is better with the fast sequence due to the absence of motion artifacts, and spatial resolution of a SP is maintained while scan time is drastically reduced (6x). Surgery confirmed the diagnosis of an ovarian dermoid.
technique builds on their initial 3.0T T2-weighted sequence by combining it with SENSE – which shortens the echo train length – and reducing the refocusing flip angle (180° to 75°, using flip angle sweep [FAS] along the echotrain), resulting in sharply reduced RF power. Compensatory fine-tuning of TR, TE, NSA, and halfscan optimize the 3T-HR technique.

“The spatial resolution of 3T-HR is 3.6 times higher than our initial 3.0T protocol yet the 4:03-minute scan time is identical,” Dr. Gieseke notes.

Between August 2003 and September 2004, in the first study ever of very high spatial resolution 3.0T MRI of the female pelvis, Bonn’s 3T-HR (800 x 1024 matrix, 0.45 x 0.46 x 4 mm voxels) sequence was compared with a 3.0T standard protocol in a prospective trial of 23 patients with gynecological disorders.1

According to clinicians, the “delineation and detectability of small anatomical details, such as small potential ovarian cysts or small vessels was rated superior with 3T-HR in all pelvic MR studies.”1

“We also detected small lesions, such as myomas and a lymph node metastasis and in one case were able to exclude invasion of a potential tumor into the vagina,” Dr. Morakkabati-Spitz notes.

Since the completion of this trial, Dr. Morakkabati-Spitz has studied an additional 100 patients using 3T-HR. At the University of Bonn, the 3T-HR sequence is now routinely used in the pelvic ExamCard when there is a known or suspected cancerous lesion – about 50% of patients undergoing pelvic MRI scans.

“This ultra-fast sequence should be the baseline sequence for all patients undergoing pelvic MRI.”

Cervical carcinoma
A 39-year-old female presented with clinical suspicion of cervical carcinoma. MRI was performed for preoperative tumor staging. SP showed a cervical carcinoma with parametrial infiltration (FIGO IIB). This was confirmed with the high spatial resolution sequence HR. The scan time of HR is identical to SP at 4:03 min., while spatial resolution increases by a factor of three. The higher spatial resolution enables depiction of small anatomic details such as fine septae and small vessels.
3.0T sequence,” she observes. “The data so far indicate that higher spatial resolution at 3.0T leads to more clinically relevant information that should be especially valuable in staging pelvic cancers.”

**0:39 is new scan time benchmark for routine pelvic MRI**

With the success of the 3T-HR technique, Bonn radiologists and Dr. Gieseke sought to harness elements of that method to create a 3.0T sequence that afforded much greater speed while maintaining the spatial resolution of their initial 3.0T protocol. The new ultra-fast technique – 3T-FAST – is based on a single-shot TSE sequence and combined with Halfscan, SENSE factor 3 and 75° refocusing flip angle. The 3T-FAST scan time is reduced to 39 seconds or six times faster than 3T-SP with a scan time of 4:03 min.

“With this speed, you could increase patient throughput, particularly in outpatient departments, enhance the ability to obtain useable studies of uncooperative patients and minimize physiological motion artifacts due to breathing and peristalsis,” Dr. Morakkabati-Spitz says. “Alternatively, you could use the time-savings to obtain additional views.”

In an as yet unpublished study, Dr. Morakkabati-Spitz also concluded that it is unnecessary to use i.v. n-butyl-scopolamine to halt peristaltic motion, because 3T-FAST’s speed freezes motion.2 “This is an advantage for patients with contra-indications for the anti-peristaltic drug,” she observes.

**3T-FAST replaces initial 3.0T protocol for all pelvic imaging**

Beyond throughput and patient preparation issues, Bonn clinicians compared 3T-FAST and the existing 3.0T protocol in a 33-patient study (in press) conducted from May to September 2004 to confirm the

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**Abdominal mass**

52-year-old female patient presented with a palpable abdominal mass. SP revealed a huge cystic pelvic mass. Due to the absence of motion artifacts, the internal architecture was better delineated with the fast sequence (39 sec. scan time, right), which revealed even more internal septations. Surgery revealed ovarian cancer.
ability to use high speed and also high spatial resolution, and to demonstrate 3T-FAST’s clinical potential in depicting pelvic anatomy and possible gynecological disorders. “Because 3T-FAST is six times faster than our original 3.0T protocol, respiratory and peristaltic motion artifacts were drastically reduced,” she says.

In general, all small anatomic details and possible gynecological disorders that were visualized with the existing 3.0T protocol also could be effectively viewed with the 3T-FAST protocol.  

Interestingly, 3T-FAST demonstrated higher tissue contrast with respect to fluids, she says, noting that the fast technique provided higher contrast between urine and muscle, and between possible lesions and fluids. “This didn’t interfere with image interpretation,” Dr. Morakkabati-Spitz says. “On the contrary, this attribute might be helpful in patients with subtle fluid collections, such as ascites, in patients with ovarian cancer, for example.”

According to Dr. Morakkabati-Spitz, 3T-FAST truly offers no compromises – and the University of Bonn has backed up its opinion of the technique by replacing its initial 3.0T standard protocol with 3T-FAST for all pelvic imaging MRI indications – both for male and female patients.

“There are no contraindications for using 3T-FAST,” she says. “It provides very high image quality, and motion is frozen – you don’t need n-butyl-scopolamine. Additionally, image interpretation is familiar compared to the initial 3.0T protocol and 1.5T protocol. This ultra-fast sequence should be the baseline sequence for all patients undergoing pelvic MRI.”

References


Ovarian tumor

A 20-year-old female patient presented with abdominal pain. Ultrasonography revealed a pelvic mass. The SP confirmed a pelvic mass, the origin of which still remained uncertain. The high spatial resolution sequence enabled depiction of small ovarian cysts – thereby identifying the right ovary and a feeding vessel connecting the mass and the right ovary. Surgery confirmed a granulosa cell tumor of the right ovary.