The abdomen and pelvis present an ensemble of problems for MR imaging.

1. There is a problem of **contrast**; there are an almost infinite variety of disease processes that can occur in the abdomen/pelvis, and no one sequence is ideal for all.

2. There is the problem of **signal-to-noise and coverage**; evaluation of the abdomen/pelvis often requires a large field-of-view.

3. There are problems with **complex motion** arising from the heart, the vascular structures, breathing, and peristalsis.

There are now solutions for all of these problems, and MRI is assuming more of the clinical burden that has heretofore been the domain of CT.

Since there is no single sequence that is ideal for all types of pathology (either anticipated or not anticipated), multiple sequences are required. However, it is important to use the minimum number of sequences that will provide the maximum amount of information. There should be a rational reason for every sequence obtained, and the MRI examination should be tailored to the specific clinical situation (including specific clinical questions and patient's body habitus and ability to cooperate).

### T1-Weighted Sequences

**Spoiled gradient-echo (GRE)** techniques permit the entire abdomen to be scanned in a single comfortable breath-hold. This, in turn, opens up the possibility of doing dynamic contrast-enhanced scans, and by adjusting the TE, scans can be obtained with water and lipid in-phase (IP) and opposed-phase (OP). Currently, both IP and OP images through the entire abdomen or pelvis can be obtained in one breath-hold sequence. A comparison of IP and OP phase images allows one to diagnose focal and diffuse fatty infiltration of the liver, to characterize incidental lesions in the adrenal glands, and to detect the presence of fat in ovarian dermoids and other tumors that may not be apparent with other techniques.

**Fat-saturation** improves lesion-organ contrast on T1-weighted images. In early implementations, fat saturation resulted in a decrease in the number of slices obtainable per TR, and heterogeneous fat suppression through the abdomen occasionally introduced problems in interpretation. Improved local shimming and fat saturation pulses placed outside of the imaging loop (i.e. “quick fat-sat”) and **Dixon techniques**

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permit the entire abdomen/pelvis to be scanned with uniform fat suppression in a single
breath-hold.

**T2-Weighted Sequences**

*Fast SE* sequences (a.k.a. FSE or TurboSE) provide inferior liver/lesion contrast
compared with conventional SE due to magnetization transfer and other effects. Longer
echo trains may aggravate this problem, However, whatever contrast is sacrificed by
using FSE sequences is more than compensated for by an overall improvement in
image quality and a substantial savings in time. Contrast is improved and motion
artifacts are reduced with the addition of fat suppression, which can be accomplished
using STIR.

By judicious selection of imaging parameters, and by rearranging the order and manner
in which the lines of K-space are acquired, FSE T2-weighted images can be obtained in
the time frame of a breath-hold. Variations include a **single shot** version (eg. HASTE,
SSFSE). In general, the lesion-liver contrast on these images is compromised and there
may be perceptible blurring. These are most useful for (1) T2-weighted images in
patients who are not able to suspend respiration, (2) T2-weighted imaged images in an
orthogonal plane to supplement the routine sequences, and (3) imaging fluid (so called
“hydrograms”) for MRCP’s, MR urograms, etc. Hydrograms may also be obtained with a
**balanced steady state free precession (SSFP)** sequence (eg. FIESTA, true FISP)

**3D versions of T2-weighted** sequences are available. Thus far, they have been used
most commonly in the pelvis.

Because **EPI (echo-planar imaging)** is so fast and can provide images with excellent
T2-contrast, it might be able to replace slower T2W sequences for some indications,
and when used to implement **DWI (diffusion-weighted imaging)**, it may contribute
some additional diagnostic capabilities, such as lesion detection and characterization. In
the body problems with susceptibility and chemical shift, even at 3T, have been
mitigated with technical advances.

**Intravenous Contrast Agents**

Gadolinium-chelate agents improve the confidence level for lesion detection and
characterization in the abdomen and should be used in most instances. The arterial
phase is an important component of a dynamic contrast enhanced hepatic scan.
Multiphase phase imaging is also useful for evaluation of the pancreas, kidney, and
sometimes the uterus. However, for some abdominal applications, such as
determination of the presence of lipid in a known adrenal mass, and for many
gynecologic applications, they may not be as useful.

**3D-fat suppressed breath-hold T1-weighted spoiled gradient echo sequences,**
such as VIBE and LAVA, are commonly used for contrast-enhanced 1 MRI studies.
There are newer acquisition and reconstruction techniques that are starting to become
available that use some **combination of compressed sensing, parallel imaging, and
radial sampling.** These obviate the need for timing the bolus injection and even the
need for breath holding for abdominal MRI exams. As these types of techniques are refined and become commercially available, it will likely change the equation about who gets MRI and who gets CT.

REFERENCES

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