Introduction
Advances in MRI systems and techniques have continued to push the limits of spatial resolution and acquisition speed leading to an improvement in diagnostic accuracy and increasing MRI’s value in patient care. However, as the spatial resolution of MR images is increased the demand on patient cooperation is also increased. Sub-millimeter acquisitions are common, if not routine, and under these conditions even a slight amount of patient motion can degrade the quality of the resulting image. Further complicating the situation is that patient instruction and immobilization techniques do little to reduce the effects of physiologic motion such as peristalsis, respiration, and vascular flow. With this in mind, it’s easy to see why motion correcting and motion-insensitive MR sequences such as the new syngo BLADE technique are so vital in today’s MRI practice.

Why syngo BLADE?
Routine Turbo Spin Echo (TSE) acquisitions fill raw data space (k-space) in a rectilinear or Cartesian fashion meaning that during each TR period data lines equal to the echo train length will fill k-space from top to bottom (Fig. 1A). The center of k-space which contributes the signal and contrast characteristics of the image will only be acquired once (unless multiple averages are used) and patient motions will have a moderate to severe effect on the resulting image depending on the progress of a particular acquisition. Figure 1B demonstrates the effect patient motion will have on a brain image during a routine TSE acquisition. In this example, a volunteer was asked to move their head in a side-to-side pattern during the acquisition. The syngo BLADE sequence is derived from the radial k-space sampling concept where a set of data lines, or blades, equal to the echo train length are rotated around the center of k-space (Fig. 1C). The most important benefit of this type of sequence design is that each of the acquisition blades re-samples the center of k-space making it possible to generate a low resolution image for each one. This information can then be used to correct for patient motion at the end of the acquisition. The image in figure 1D depicts the same volunteer experiment as in figure 1B. However, in this test the syngo BLADE acquisition technique was employed to eliminate the image artifacts caused by the volunteers’ motion.

syngo BLADE in other areas of the body
An additional benefit to syngo BLADE is that since each acquisition blade must be corrected for its rotation within k-space the sampling method alone, without motion correction applied, will be significantly less sensitive to motion artifacts than a standard TSE sequence. This intrinsic feature, along with the fact that integrated Parallel Acquisition Techniques (in this case, syngo GRAPPA) can be incorporated to reduce imaging times, makes syngo BLADE a valuable tool in
all areas of the body including neuro (head and spine), abdominal and orthopedic applications. In addition, it is important to note that syngo BLADE works for all orientations, axial, sagittal and coronal.

**Abdomen and Pelvis:**
Respiration contributes only a portion of the motion artifacts in abdominal and pelvic imaging. Even in cooperative patients that are able to hold their breath well and when motion compensation techniques are employed, flow and peristaltic motion effects can degrade image quality. Furthermore, the increased spatial resolution desired in today’s clinical environment often leads to longer breath-hold durations. syngo BLADE combined with the PACE (Prospective Acquisition CorrEction) free-breathing respiratory control option provides a solution.

Figure 2A demonstrates how the PACE free-breathing technique minimizes respiratory motion effects in axial abdominal images on a patient who is not able to hold their breath. When used in conjunction with syngo BLADE (Figure 2B) motion effects from flowing structures are also minimized. Figures 2C and 2D further demonstrate how syngo BLADE reduces the effects of flow and peristalsis in special pelvic applications such as sagittal MR imaging of the colon.

**Orthopedic Applications:**
Structures of interest in orthopedic MR imaging are often very small. A slight amount of motion can make a difference in the ability to make a diagnosis especially in pediatric applications. syngo BLADE has been shown to reduce the effects of patient motion in orthopedic studies on both adult and pediatric patients.

Figures 3A and 3C depict routine coronal and axial TSE images of the wrist with a considerable amount of motion. Applying syngo BLADE leads to a noticeable improvement in image quality (Figures 3B and 3D).

**Conclusion**
One of the best tools for reducing motion artifacts in MRI is careful patient instruction and positioning. However, motion artifacts from sources such as respiration, vascular flow, peristalsis, and general movement e.g. during the pediatric examination can still negatively affect MR image quality. syngo BLADE works in all orientations and has been shown to effectively correct for motion effects in the brain, minimize physiologic motion effects in the abdomen and pelvis, and reduce motion artifacts in body and orthopedic examinations.