Tips for robust motion correction in liver imaging using MultiVane

Application Tip

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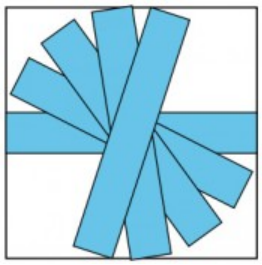
Single shot breath hold techniques for liver imaging often have relatively low resolution and SNR. Multishot techniques allow use of higher spatial resolution, but multishot TSE with respiratory triggering may suffer from ghosting artifacts due to motion. MultiVane can be added to reduce the ghosting, thus making multishot liver imaging more robust.

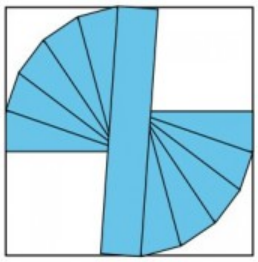
In MultiVane, data acquisition is performed in "blades" in k-space. In-plane motion will affect the low frequencies in the center of k-space and can thus be detected and corrected for each blade, resulting in reduced motion effects in the images.

Tip 1: Setting the MultiVane percentage

The MultiVane percentage (MV%) controls the number of MultiVane rotating blades in k-space. This parameter is similar to NSA in its effect on scan time and SNR. Applying a MV% of 100 will result in the same scan time as a Cartesian scan.



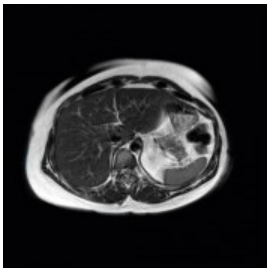
MV% = 100% provides scan time similar to a Cartesian scan.



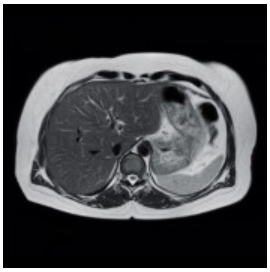
MV% ≈ 157% provides full k-space coverage.

When the MV% is set too low, streaking artifacts will be seen in the image. Select a higher value to decrease streaking artifacts.

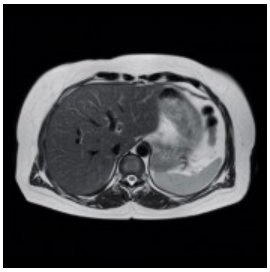
Ingenia 1.5T example *Click on an image to enlarge*



MV% 160
1 shot/blade, 2:16 min.
If MV% is too low, SNR is low and streaking artifacts are visible.



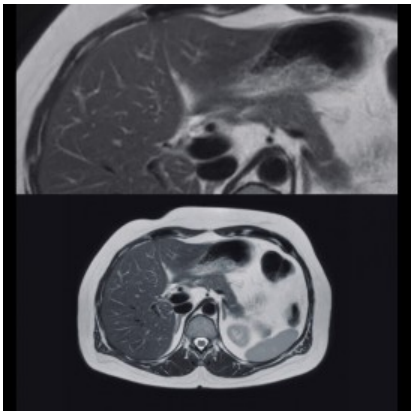
MV% 240
1 shot/blade, 2:36 min.
Good SNR and reduced artifacts.



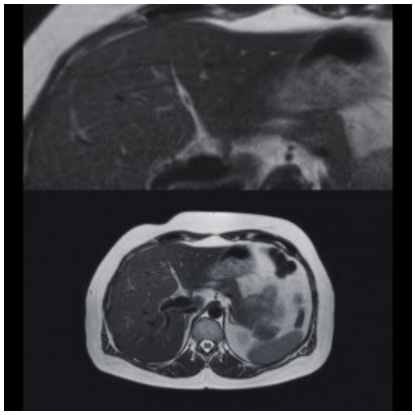
MV% 320
1 shot/blade, 3:24 min.
SNR is good, but image more blurred, scan time long.

Tip 2: Shots per blade and TSE factor

These parameters control the number of turbo shots that together form one blade. For liver imaging, setting the number of shots per blade to 1 is a good choice, because with more shots per blade, motion effects may appear within a blade.

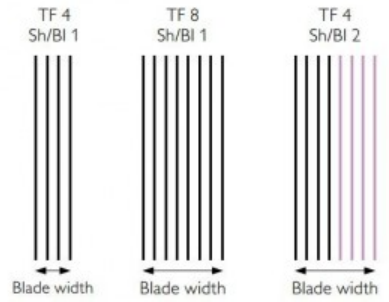


MV% 240, 1 shot/blade, 2:36 min.
1 shot per blade provides good image quality. Ingenia 1.5T



MV% 240, 3 shot/blade, 3:57 min.
With 3 shots per blade motion artifacts and some RL shading are visible. Ingenia 1.5T

The TSE factor should be high enough to allow adequate motion correction. A rule of thumb is to choose a TSE factor that is about 8% of matrix size, e.g. matrix 400 with TSE factor 32.

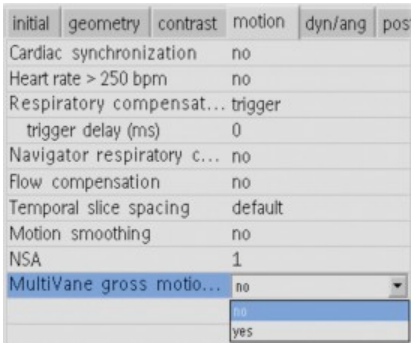


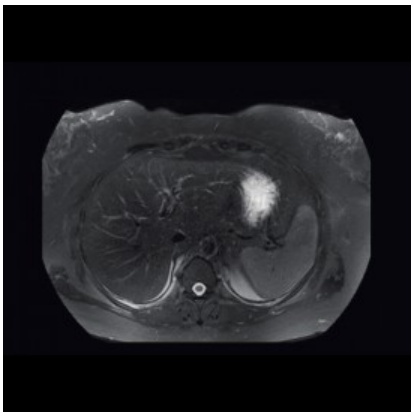
Tip 3: MultiVane gross motion correction

When a complete anatomy changes position, e.g. head movement in brain imaging, this is called gross motion. MultiVane can detect this gross, rigid motion by registering position differences between blades. Gross motion correction compensates for this gross motion. For small, non-rigid or pulsatile motion, the intrinsic characteristics of MultiVane reduce motion sensitivity to a minimum.

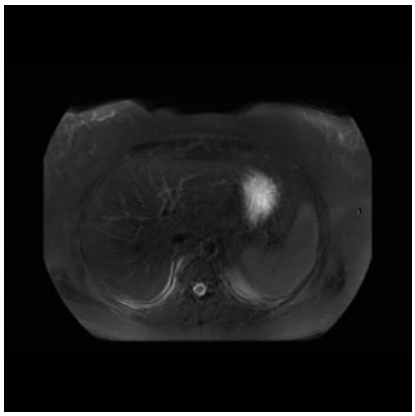
MultiVane gross motion correction = YES
This is recommended when severe motion can be expected, for instance in pediatric brain imaging.

MultiVane gross motion correction = NO
This is recommended when only the shape of the anatomy changes, for instance by pulsatile motion. Also use this when motion in the slice direction (through-plane motion) is expected, as in axial liver scanning. As MultiVane is a 2D technique, this type of motion cannot be corrected.





Gross motion correction NO
Ingenia 3.0T

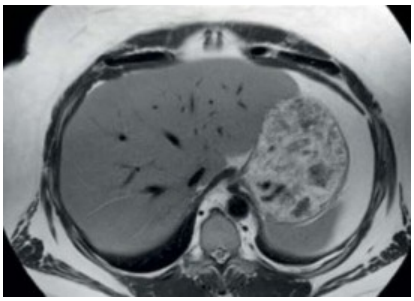


Gross motion correction YES
Ingenia 3.0T

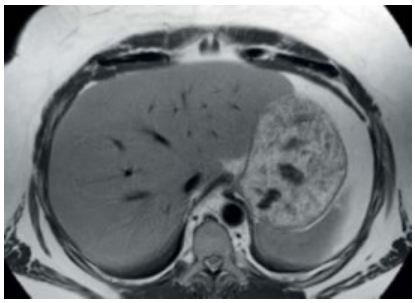
Gross motion correction NO provides best results in axial liver.

Tip 4: Setting WFS when using MultiVane

When MultiVane is used, the Water Fat Shift (WFS) direction will rotate within k-space. Minimize the WFS to minimize streaking artifacts. The larger the WFS, the larger this effect will be visible in the image.



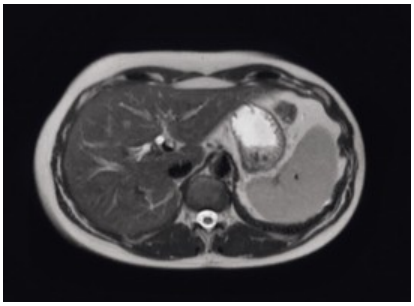
WFS = 0.3
Ingenia 1.5T



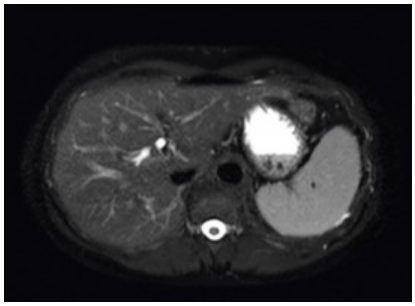
WFS = 0.56
Ingenia 1.5T

Tip 5: Comparing MultiVane on Ingenia 1.5T

The Ingenia 1.5T release 4.1.3 preset protocols include these MultiVane protocols for robust motion correction in high resolution respiratory triggered multishot scans.

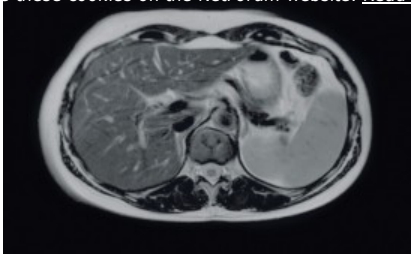


T2W - Breath hold, single shot

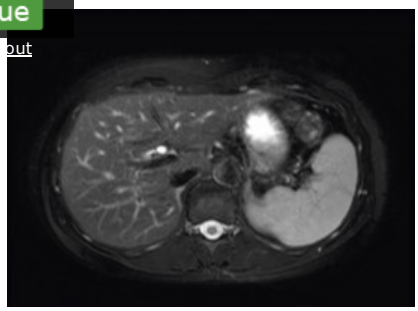


T2 SPAIR - Breath hold, single shot

With single shot the resolution is low and images are not sharp.

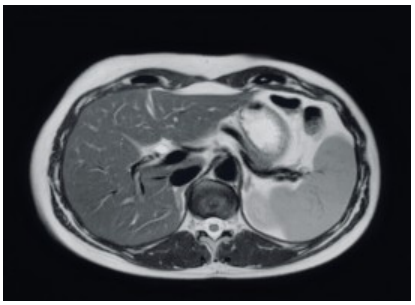


T2W - Respiratory triggered, multishot

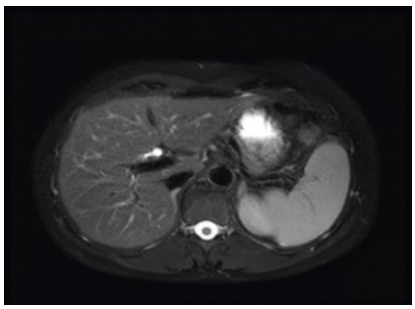


T2 SPAIR - Resp triggered, multishot

The multishot images look blurred and motion artifacts are visible.



T2W - MultiVane
Respiratory triggered, multishot



T2 SPAIR - MultiVane
Respiratory triggered, multishot

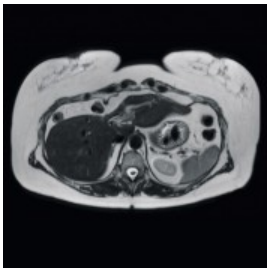
MultiVane with multishot produces sharp images withut motion artifacts.

Note that MultiVane can also be used without external motion compensation.

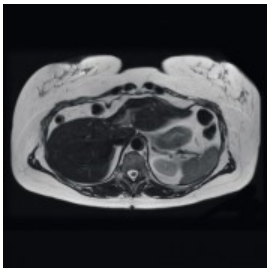
Tip 6: Comparing MultiVane on Ingenia 3.0T

The higher 3.0T field strength influences the use of MultiVane in several ways. Scan times tend to be longer as SAR is higher at 3.0T, and the method is more sensitive to B0 variations within the blades. Therefore, the MultiVane percentage at 3.0T is usually set higher than at 1.5T, the TSE factor is also set higher for good motion correction and scan time reduction. Because of the sensitivity for B0 variation, B0 shimming is recommended.

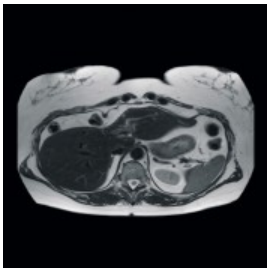
Click on an image to enlarge it



T2W



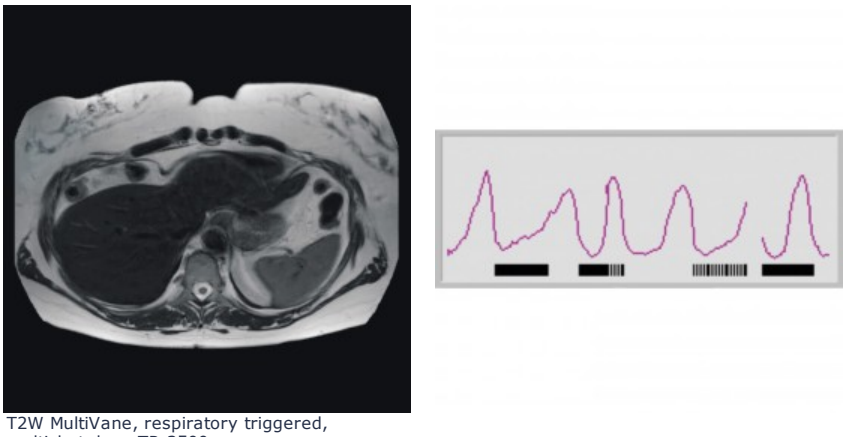
T2W



T2W

In general, motion correction is robust at 3.0T, even when long TRs are used. This is illustrated in

In general, motion correction is robust at 3.0T, even when long TRs are used. This is illustrated in this example below. Although the TSE shot is during the breathing cycle, the resulting images show no motion artifacts.



T2W MultiVane, respiratory triggered, multishot, long TR 3500 ms