# Magnetic Resonance Angiography (MRA) of the lower extremities with Parallel Imaging (PI): comparison of different PI acceleration factors and different coils at 3.0 Tesla

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**Introduction:** Precondition for imaging of the peripheral vasculature is high spatial resolution. DSA and CTA offer very high spatial resolution but suffer from the disadvantages of ionizing radiation and nephrotoxic contrast agents (CA) [1, 2]. The implementation of dedicated matrix-coils and parallel imaging (PI) in MRI as well as high field strength offer the possibility of high spatial resolution MR angiography. Aim of the study was to evaluate the advantages of a dedicated peripheral angio array coil in terms of SNR gain, acceleration of data acquisition and increasing spatial resolution.

**Material & Methods:** 15 healthy volunteers underwent contrast enhanced (CE) MRA of the calves at 3.0 Tesla (Tim Trio, Siemens Medical Solutions). Group A (n=5) was examined without a dedicated angiography coil but two body surface coils (BM) placed on the legs. In group B and C a dedicated peripheral angiography matrix coil (PAM) was used (**figure 1**). This coil is equipped with 36 receiver elements, 24 coil elements are sufficient to cover a FoV of 50cm. Sequence parameters of the different exams were varied to keep the acquired volume the same while increasing the spatial resolution at the best possible image quality in terms of SNR, CNR and vessel conspicuity. In Group A PI factor of two was applied, in Group B and C it was increased to PI factor of 3 and 4 respectively. SNR and CNR measurements were performed using the recently described difference method [3]. Image quality was assessed by two readers in terms of vessel conspicuity (good, moderate, poor), venous contamination and occurrence of artefacts (absent, mild, major). To compare the acceleration of data acquisition the acquisition time / voxel was calculated.

**Results:** Spatial resolution could be increased to 0.9x0.9x0.9mm$^3$ at a PI factor of 4 within 23s acquisition time. Due to the application of a dedicated angiography matrix coil SNR and CNR could be increased despite acceleration image acquisition (**table 1**). In none of the exams disturbing venous enhancement or artefacts occurred, in 78% of all exams vessel conspicuity was rated as excellent (**figure 2**). Inter reader agreement was excellent with kappa values between 0.65 and 1. Acquisition time / voxel could be significantly shortened from 0.0019ms / voxel at PI 2 to 0.0009ms / voxel at PI 4 (**table 2**).

**Conclusion:** The implementation of dedicated matrix coils for peripheral MR angiography at 3.0 Tesla offers the possibility to further increase spatial resolution. In combination with PI it is possible to shorten acquisition time while increasing image quality in terms of vessel conspicuity, SNR and CNR.

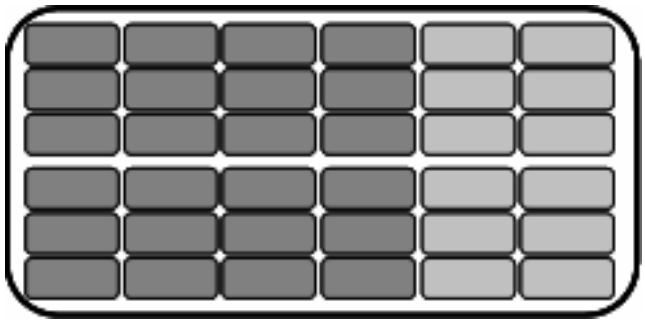

**Figure 1:** PAM with 36 receiver elements in 6 levels. Each level consist of 2 clusters, each cluster consist of 3 elements. This allows for PI factor up to 4. 4 levels or 24 elements respectively are sufficient to cover a field of view of 50cm.

**Figure 2:** Examples of the different exams. PI factor 2 and BM (left), PI factor 3 and PAM (middle) and PI factor 4 and PAM (right). BM is not sufficient to cover the entire calf and foot. Spatial resolution increases to 0.9x0.9x0.9mm$^3$ at PI 4.

| | SNRartery | SNRmuscle | CNR | Noise |
|---|---|---|---|---|
| PAT 2 | 71,57 | 17,98 | 53,59 | 5,80 |
| PAT 3 | 84,66 | 13,75 | 70,91 | 7,37 |
| PAT 4 | 46,41 | 9,77 | 36,64 | 11,64 |

**Table1:** SNR values in an arterial vessel as well as in adjacent muscle tissue. Due to the inhomogeneous distribution of noise when applying parallel acquisition techniques (PAT), noise can not be measured but has to be calculated. This was done with the difference method where the standard deviation of signal in the difference image of two datasets acquired before CA application is taken as noise.

| | acq.time [s] | voxels | acq.time/voxel [ms] |
|---|---|---|---|
| PAT 2 / BM | 30 | 15728640 | 0.0019 |
| PAT 3 / PAM | 22 | 17301504 | 0.0013 |
| PAT 4 / PAM | 23 | 26836992 | 0.0009 |

**Table 2:** Different acquisition times, number of voxels and acquisition time / voxel for the three exams. Total acquisition time for the PAT 4 exam is slightly longer than PAT 3 exam but the acquisition time / voxel is significantly shorter at PAT 4.

*1. Green, D. and D. Parker, CTA and MRA: visualization without catheterization. Semin Ultrasound CT MR, 2003. 24(4): p. 185-91.*

*2. Gregor, M., et al., Peripheral run-off CE-MRA with a 1.0 molar gadolinium chelate (Gadovist) with intraarterial DSA comparison. Acad Radiol, 2002. 9 Suppl 2: p. S398-400.*

*3. Reeder, S.B., et al., Practical approaches to the evaluation of signal-to-noise ratio performance with parallel imaging: application with cardiac imaging and a 32-channel cardiac coil. Magn Reson Med, 2005. 54(3): p. 748-54.*