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Time Resolved MRA Revisited

Kaushik Shahir  
*Advocate Aurora Health*

Kevin C. Ball  
*Advocate Aurora Health*, kevin.ball@aah.org

Rahul Sawlani  
*Advocate Aurora Health*, rahul.sawlani@aah.org

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Time resolved MRA - Revisited

Kevin Ball D.O., Crystal Rushing R.T. (R) (MRI), Rahul Sawlani M.D., Kaushik Shahir M.D.
Background - Magnetic Resonance Angiography

• There is a growing interest using dynamic MRA within the chest as newer advances in MRI technology allow for improved image quality

• MR Angiography
  • Conventional - Single phase MRA
  • Dynamic - Time resolved MRA
    • Siemens: TWIST (Time-Resolved Imaging with Stochastic Trajectories)
    • GE: TRICKS (Time-Resolved Imaging of Contrast Kinetics)
    • Philips: 4D-TRAK (4D Time-Resolved Angiography using Keyhole)
    • Hitachi: TRAQ (Time-Resolved AcQuisition)
    • Toshiba: Freeze Frame
Applications of time resolved MRA

- Pathology resulting in abnormal hemodynamics
  - Cardiac failure
  - Shunts

- Evaluation of less commonly imaged anatomy
  - Pulmonary veins

- Contraindication to conventional imaging
  - Younger populations
  - Renal insufficiency

- Less invasive alternative to conventional angiography
Background – Time Resolved MRA

- Inherent trade-off exists between spatial resolution, temporal resolution, and signal to noise ratio
- Image contrast is determined by low frequency data near the center of K space
- Image sharpness is determined by data at the edges of K space
- Keyhole imaging focuses on the central data where contrast information is stored and not rescanning the periphery which substantially reduces acquisition times
Background – Time Resolved MRA

- Shorter acquisition times enables us to visualize flow
  - The information acquired mimics conventional angiogram

- This eliminates the need to time the acquisition for the appropriate phase
  - Missing the bolus and inadequate vascular visualization
  - Venous contamination

- Advantage
  - Dynamic evaluation of flow pattern leads to better understanding of pathophysiology
Techniques for optimizing evaluation of the pulmonary arteries

• Double dose contrast
  • 0.2 mL/kg Gadavist at 4 mL/s mixed with equal part normal saline
  • Follow by 20 mL bolus of normal saline

• Strategies to reduce temporal resolution < 4s:
  • Arms above head
  • Decrease phase field of view
  • Turn off partial fourier acceleration to improve signal to noise
    • Our institution: Partial fourier 6/8 for both phase and slice
Application: Chronic pulmonary embolism

36 y.o. female with recurrent pulmonary embolism

Perfusion defects on time resolved MRA

Ventilation perfusion correlate 2 days prior

MPR of time resolved MRA showing filling defects in pulmonary arteries
Application: Chronic pulmonary embolism
Application: Pulmonary vein thrombosis

75 y.o. male with angina undergoing coronary CT

CT showing left inferior pulmonary vein filling defect vs mixing artifact

Subsequent MPR of time resolved MRA shows pulmonary vein patency without filling defect
Application: Thoracic outlet obstruction (Arterial)

50 y.o. female with near complete occlusion of left subclavian artery on CTA chest for aneurism

Arms Up: Narrowing of subclavian arteries at thoracic outlet

Arms Down: No subclavian artery narrowing
Application: Thoracic outlet obstruction (Venous)

45 y.o. female with left upper extremity swelling found to have thrombus within the left subclavian vein

Arms Up: Narrowing of left subclavian vein at thoracic outlet

Arms Down: No narrowing of subclavian vein

CT PE showing apparent subclavian compression suggesting Paget-Schroetters Thrombosis
Application: Brachiocephaalic Occlusion

75 y.o. male with chronic left upper extremity swelling and neck vessel engorgement

Time resolved MRA showing left brachiocephalic occlusion resulting in shunting into the dural sinuses and collateral vessels
Application: Brachiocephalic Occlusion

75 y.o. male with chronic left upper extremity swelling and neck vessel engorgement
Application: Congenital Heart Disease

31 y.o. male congenitally corrected transposition of the great arteries and prior Hemi-Fontan referred for evaluation of Fontan integrity

Patent Fontan entering the right pulmonary artery only visualized at the end of the cardiac cycle

MPR showing patent Fontan
Application: Congenital Heart Disease

31 y.o. male congenitally corrected transposition of the great arteries and prior Hemi-Fontan referred for evaluation of Fontan integrity
Application: Vascular Malformation

69 y.o. female with cough and incidental mediastinal mass

CXR showing anterior mediastinal mass

Follow up CT reveals possible vascular origin
Application: Vascular Malformation

69 y.o. female with cough and incidental mediastinal mass

Time resolved MRA showing slow flow vascular malformation with contrast puddling and without feeding artery or large draining vein.
Bonus: Application beyond chest

38 y.o. female deep and superficial venous insufficiency

Time resolved MRA showing venous reflux into the left gonadal vein as well as engorged parauterine veins.
Limitations

• Tradeoff between higher temporal resolution of single phase MRA

• Time resolved MRA may not be available on all scanners

• Validation studies are needed

• Reader expertise

• Susceptibility artifact from stents, coils or other metallic objects
Future Applications

- Comprehensive evaluation for chronic thromboembolic pulmonary hypertension
  - Perfusion defects
  - Vascular mapping
  - Follow up evaluation

- Complex congenital heart disease and integrity of repairs
Conclusions

• Time-resolved MRA is a robust tool which can serve as a problem solving alternative method in day to day clinical practice

• MRA is the only non-invasive modality that can provide true broad-coverage dynamic vascular and functional imaging
References


