GE Healthcare

Phase contrast MR imaging and time resolved MR angiography TRICKS

Velocity-encoded Phase contrast cine MR imaging is becoming the technique of choice for the clinical evaluation of aortic coarctation for anatomic delineation and functional assessment of hemodynamic obstruction. The gated MR signal data acquired throughout the cardiac cycle can be segmented into multiple time-resolved (cine) images for depiction of the circulating blood flow within the thoracic aorta. Accurate quantitation of key hemodynamic parameters such as flow velocity, flow volume, and pressure gradients across the coarctation is performed to aid in preoperative planning and post-interventional monitoring.

Velocity-encoded cine MR imaging also may be applicable for the detection of recurrent stenosis after stent placement or angioplasty. Pressure gradient greater than 20 mmHg across aortic coarctation is considered clinically significant as in this case.

The advantage of this technique is the ability to visualize moving anatomy with high spatial resolution and providing hemodynamic information without the use of contrast agents.

Use of Phase contrast MR Imaging

& time resolved MR angiography TRICKS in restenosis of coarctation of aorta along with aortic pseudoaneurysm

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"Phase contrast MR imaging and time resolved angiography TRICKS helps in visualizing pseudoaneurysm and congenital defects like coarctation of aorta"

Patient history

A 66-year-old known hypertensive male (poorly controlled on β-blocker and ARB) presented with history of progressive dyspnea and bilateral pedal edema of 20 days duration.

Past history

- K/C/O congenital coarctation of aorta
- Resection with end-to-end anastomosis done in childhood
- No history of any other medical/surgical illness
- No family history of IHD/ coarctation

Physical examination

- Afebrile; P-84/min; BP-145/90 mmHg; Respiratory rate–22/min
- Bilateral pedal edema present
- Visible pulsations in the suprasternal notch. S1 S2 – Normal
- Auscultation revealed diminished breath sounds in infrascapular region bilaterally

imagination at work

Investigation

Routine plain CT thorax revealed mild bilateral pleural effusion with tortuous thoracic aorta showing suspicious out pouching in aortic arch. Cardiac MR was performed. FIESTA and spin echo multiplanar images were acquired.

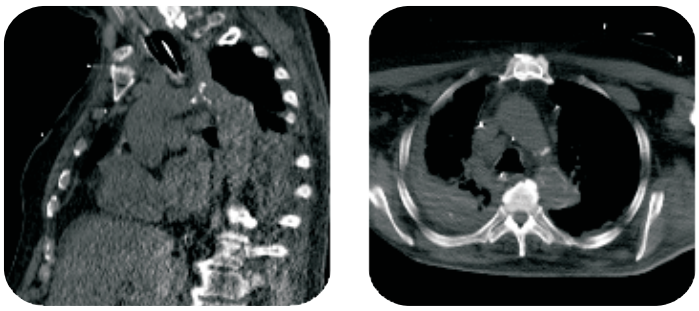


Fig. 1: CT images

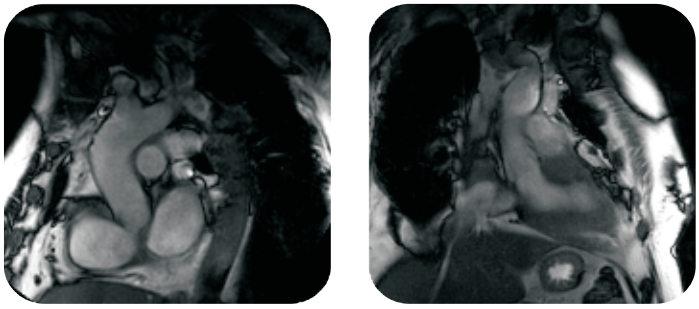
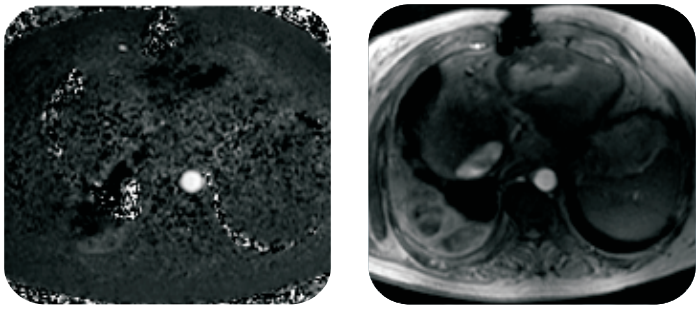


Fig. 2: 2 D Fiesta images of aortic arch revealed significant stenosis in aortic arch just distal to the origin of left subclavian artery along with pseudoaneurysm in distal aortic arch

Phase contrast MR imaging

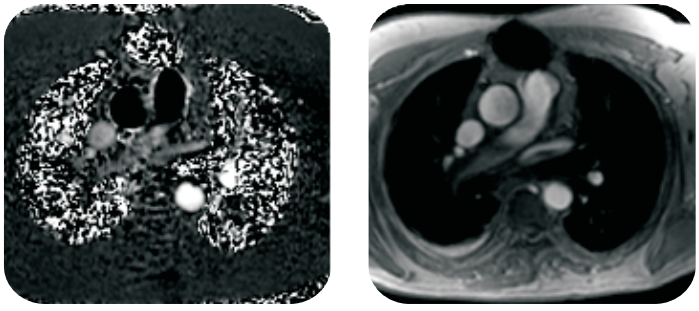
Phase contrast MR imaging perpendicular to direction of flow in various parts of thoracic aorta was performed after applying appropriate Venc to avoid aliasing. The images were obtained in multiple phases across the cardiac cycle.

a



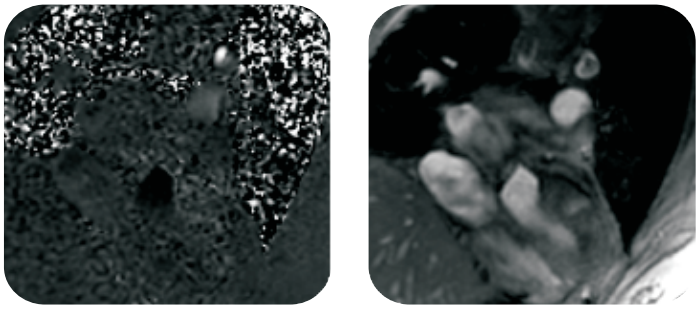
Phase (left) and Magnitude (right) Images of flow analysis (Aorta at diaphragmatic level)

b



Phase (left) and Magnitude (right) Images of flow analysis (Ascending aorta and aorta distal to aneurysm)

c

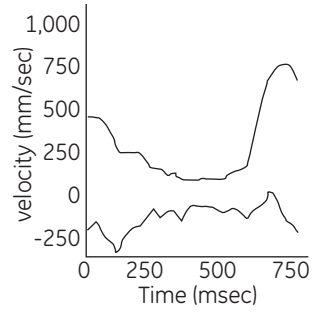


Phase (left) and Magnitude (right) Images of flow analysis (Aorta distal to stenosis)

Fig. 3: Phase (left) and magnitude (right) images of flow analysis a) Aorta at diaphragmatic level; b) Ascending aorta and aorta distal to the aneurysm; c) Aorta distal to stenosis

Peak velocity and pressure gradient across these levels were calculated. It revealed increased flow volume with high peak systolic velocity across stenosis approximately 260 cm/sec with a pressure gradient of 27 mmHg.

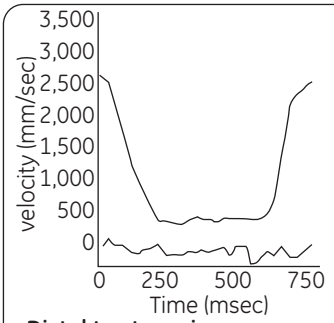
AREA	PEAK SYSTOLIC VELOCITY (cm/s)	4 x velocity^2 (m/s^2)	PRESSURE GRADIENT (mmHg)
ASCENDING AORTA	74.6	4 x 0.55	2.22
DISTAL TO STENOSIS	260.4	4 x 6.67	27.04
DISTAL TO ANEURYSM	65.3	4 x 0.43	1.70
AORTA (diaphragmatic level)	58.3	4 x 0.34	1.36



Ascending Aorta

Peak Positive Velocity (cm/sec)	74.6
Peak Negative Velocity (cm...	-36.9
Flow (ml/beat)	57
Positive Pixel Flow (ml/beat)	68.6
Negative Pixel Flow (ml/bea..	-11.6

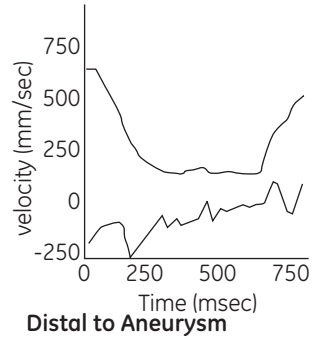
Summary: Ascending Aorta



Distal to stenosis

Peak Positive Velocity (cm/sec)	260.4
Peak Negative Velocity (cm...	-42.9
Flow (ml/beat)	40.5
Positive Pixel Flow (ml/beat)	42.3
Negative Pixel Flow (ml/bea..	-1.7

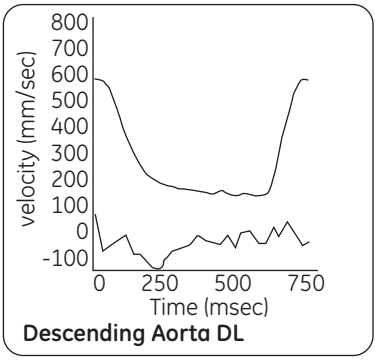
Summary: Distal to stenosis



Distal to Aneurysm

Peak Positive Velocity (cm/sec)	65.3
Peak Negative Velocity (cm...	-28.6
Flow (ml/beat)	40.7
Positive Pixel Flow (ml/beat)	42.7
Negative Pixel Flow (ml/bea..	-1.9

Summary: Distal to Aneurysm



Peak Positive Velocity (cm/sec)	58.3
Peak Negative Velocity (cm...	-14.6
Flow (ml/beat)	39.6
Positive Pixel Flow (ml/beat)	40.1
Negative Pixel Flow (ml/bea..	-0.4

Summary: Descending Aorta DL

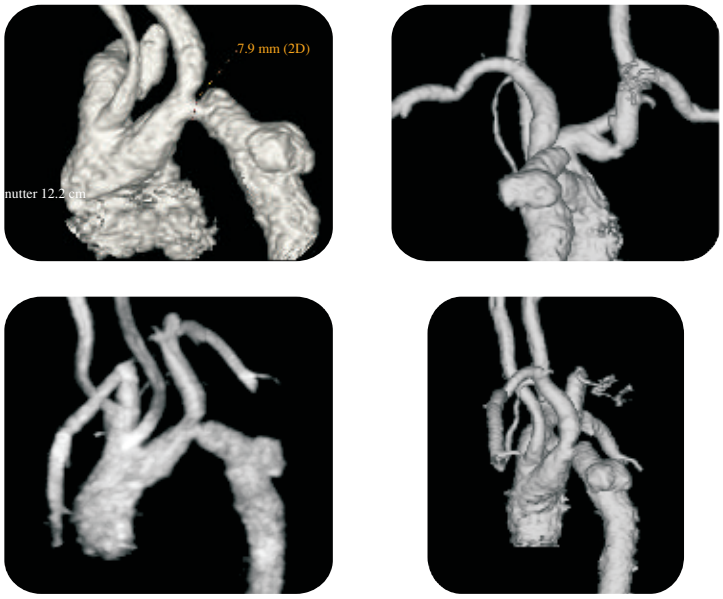


Fig. 4: TRICKS images of the aortic arch

Time resolved MRA (TRICKS) was also performed by injecting 10 ml bolus of intravenous gadolinium contrast. It revealed focal narrowing in region of aortic arch just distal to origin of left subclavian artery. Diameter of aorta in the region of stenosis was 7.9 mm. An outpouching from the aorta of 1.8 x 1.6 cm suggestive of pseudoaneurysm was observed in the distal aortic arch, 3 cm distal to the stenosis..

Treatment

Coarcted segment was resected totally and an end to end anastomosis of aorta was performed in the standard manner.

Image courtesy to Max Superspeciality Hospital, Saket, New Delhi

Conclusion

Thus Velocity-encoded Phase contrast cine imaging of thoracic aorta is useful in accurate quantitation of key hemodynamic parameters such as flow velocity, flow volume, and pressure gradients across the coarctation. This is useful to aid in preoperative planning and also post-interventional monitoring without the need of invasive angiogram. In our case, it revealed a significant pressure gradient across coarctation of 27mmHg and increased flow volume with high peak systolic velocity across coarctation of approximately 260 cm/sec.

Furthermore, morphologic information was added with use of TRICKS which revealed a pseudoaneurysm in the distal aortic arch, 3 cm distal to the stenosis.

Time resolved MR angiography TRICKS proved particularly useful in our case as the arterial arrival time was uncertain and patient was free-breathing .

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