ABSTRACT

Head–neck vascular anomalies (HNVAs) are congenital aberrancies of vascular development; clinical appearance of which depends on their depth and phase of growth. The diagnosis of haemangiomas or vascular malformations is most often a clinical one; imaging plays a pivotal role in the diagnosis of more challenging cases and in planning the therapeutic approach that may consist of pharmacological embolization, sclerotherapy or surgery. Doppler ultrasonography is the first imaging modality used to characterize maxillofacial superficial lesions and their haemodynamic conditions; but Doppler ultrasonography is not able to depict the real extension and, most importantly, the vascular anatomy of complex HNVAs. Contrast CT may provide further information by identifying calcifications and in demonstrating involvement of major vessels after contrast injection, but they use considerable X-ray dosages (avoidable especially in young patients). MRI and MR angiography (MRA) represent the best diagnostic tools to demonstrate, respectively, soft-tissue components and relationships with nearby structures and to provide useful information on HNVA feeding vessels. Time-resolved imaging of contrast kinetics (TRICKS) is a recently introduced keyhole technique that improves
temporal resolution with respect to contrast-enhanced MRA technique; by this, one can obtain dynamic images during the arterial, capillary and venous phases. This review provides an insight into this technique.

INTRODUCTION
Head–neck vascular anomalies (HNVAs) are congenital aberrancies of vascular development; their clinical appearance depends on their depth and phase of growth.\[1\]

Imaging plays a pivotal role in the diagnosis of more challenging cases and in planning the therapeutic approach.\[2\]

Magnetic resonance angiography (MRA) is an application of magnetic resonance imaging (MRI) that provides visualization of blood flow, as well as images of normal and diseased blood vessels.\[3\]

Arteriovenous malformations (AVMs) are congenital vascular malformations that result from defects involving the vessels of both arterial and venous origins, resulting in a meshwork of primitive reticular networks of dysplastic minute vessels termed “nidus”

The overall prevalence of vascular malformations is estimated to be 1.5% in population. They require treatment mainly because: Tendency to enlarge, pain, deformity, arterial steal phenomenon, ulceration, haemorrhage, impaired function.\[4-6\]

Need for imaging Head and Neck Vascular Anomalies
Depending on the appearance of head and neck vascular anomaly on the magnetic resonance angiographic image:
1. Small nidus and single arterial Feeder of arteriovenous malformation: Sclerotherapy
2. Large nidus and single arterial feeder of arteriovenous malformations: Embolization
3. Large nidus and multiple arterial feeders of arteriovenous malformations: Sclerotherapy and embolization.\[8\]

Previous Imaging Modalities
Digital Substraction Angiography
permits visualization of the arterial feeders, nidus, and venous drainage of AVMs of head and neck with high spatial and temporal resolution.
Unfortunately, DSA is relatively expensive, time consuming, with risk of vascular injury and exposure to ionizing radiation.\cite{6,7}

**Computed Tomography Angiography**

Improved temporal resolution as well as spatial resolution in the scanning direction, bolus tracking techniques and high iodine delivery rate protocols have optimized vascular enhancement in CTA.\cite{9,10}

However, CTA examinations are high radiation-dose studies and carry a risk of contrast-induced nephrotoxicity. Motion and beam hardening artifacts are still concerns.\cite{7,10}

Doppler ultrasonography is the first imaging modality used to characterize maxillofacial superficial lesions and their haemodynamic conditions; despite this, Doppler ultrasonography is not able to depict the real extension and, most importantly, the vascular anatomy.\cite{11}

**MR angiography**

- A Magnetic resonance imaging technique used to visualize the blood vessels.
- Contrast-enhanced MRA accentuated the signal from inflowing blood via the T1 shortening effect of gadolinium, resulting in improved MRA.
- Although contrast-enhanced MRA may distinguish arterial from venous components of the vascular anomaly, the exam can be technically challenging due to the variability of contrast arrival.\cite{12,13}

**TRICKS MRA**

In 1996 an MR angiographic technique, referred to as 3D TRICKS (3D time-resolved imaging of contrast kinetics) has been developed by Korosec FR. et al.\cite{14}

Time resolved imaging of contrast kinetics (TRICKS) MR angiography (MRA) is an approach of contrast enhanced MRA that acquires multiple 3D volumes during the passage of contrast agent bolus that can capture the dynamic filling of the arteries and veins similar to DSA in which the center of k-space is oversampled, whereas higher k-space is under sampled.\cite{13,15}

**Why TRICKS ?**

- Rather than sampling all spatial data for each time frame, TRICKS uses an algorithm to sample lower spatial frequencies more often than higher spatial frequencies, and estimates
missing data by linear interpolation of values from shared data across time frames. This improves the temporal resolution.

- With high temporal resolution, images that coincide with contrast uptake in the area of interest can be obtained with the course of blood flow through arterial, capillary and venous phases.\[8\]

**TRICKS MRA protocol**

- Patients were examined in the supine position using head and neck phased array coil.
- Injection of contrast medium was implemented with automatic power injection in antecubital vein.
- The start of the acquisition was coincided with the start of intravenous contrast bolus injection.
- The images were reconstructed in the maximum intensity projection (MIP) and volume rendering (VR). The source and reconstructed images were transferred to a commercially available workstation (Advantage for Windows, version 4.1; GE Healthcare).\[8\]

**MACHINE SPECIFICATIONS**

1.5-T MR scanner (Signa Horizon Echo Speed, GE Healthcare), equipped with 25 mT gradient and slew rate of 70 MT/s.\[8\]

Contrast agent

- Gadopentate dimeglumine (Magnevist; Schering, Berlin, Germany).
- Dose of (0.1 mmol/kg) was injected at a flow.
- Rate of 3 mL/s followed by saline flush of 25 mL.

**IMAGE ANALYSIS**

Arteriovenous vascular malformation. Volume rendering image of TRICKS-MRA shows large nidus of tangled vessels (arrowhead) is seen in the check with feeder (long arrow) from the superficial temporal artery and venous drainage (short arrow) in the internal jugular vein.

Sagittal MIP images at different phases show the dilated arterial feeder (long arrow), nidus (arrowhead) and drained veins (short arrow). (Figure 1).\[8\]

MRI examination in another case shows a mass lesion close to the anterior margin of the right masseter muscle (Figure 2(a-c)).\[16\]
Time-resolved imaging of contrast kinetics (TRICKS) images (figure 2 (d)) document a small tissue component with an early arterial enhancement, while the majority of the lesion is characterized by a slow venous enhancement (arrows).

In TRICKS images after embolization, the residual component of haemangioma is evident (arrows).

FIGURE 1 Arteriovenous vascular malformation. (a) Volume rendering image of TRICKS-MRA shows large nidus of tangled vessels (arrowhead) is seen in the check with single arterial feeder (long arrow) from the superficial temporal artery and venous drainage (short arrow) in the internal jugular vein. (b–e) Sagittal MIP images at different phases show the dilated arterial feeder (long arrow), nidus (arrowhead) and drained veins (short arrow).
FIGURE 2 A Patient with tenderness and occasional swelling of the right cheek of about 1 month duration. MRI examination shows a mass lesion close to the anterior margin of the right masseter muscle (a–c). Time-resolved imaging of contrast kinetics (TRICKS) images (d) document a small tissue component with an early arterial enhancement, while the majority of the lesion is characterized by a slow venous enhancement (arrows). Digital subtraction radiography confirms these findings [selected angiogram of internal maxillary artery, (e)]. In TRICKS images after embolization (f), the residual component of haemangioma is evident (arrows).

The pathway designed to facilitate diagnosis using TRICKS MRA has been shown in flowchart 1.[17]

![Flowchart 1 Pathway designed to facilitate diagnosis](image)

Advantages of TRICKS[16,17]
• Provides temporal information,
• Is insensitive to variation in the shape and timing of contrast bolus,
• Has inherently high signal-to-noise,
• Can be acquired in any orientation, independent of the direction of blood flow,
• Preserves signal in regions of complex flow,
• Minimizes motion artifacts,
• Produces high-quality volume angiograms that can be reformatted or reprojected
• Allows the application of a variety of temporal postprocessing techniques.

Disadvantages of TRICK
These mainly include the high cost of the machine, its availability and also the spatial resolution is compromised with TRICKS.[16]

CONCLUSION
TRICKS-MRA is a reliable tool for evaluation of AVMs of head and neck with respect to arterial feeders, nidus size and venous drainage.
Dynamic MRA in the form of TRICKS is a newly available imaging modality with great potential for improving the evaluation and management of patients with head and neck vascular anomalies.[8]

REFERENCES


