Initial clinical experience with a hybrid interventional angio-MRI system

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Introduction

The advent of fast-scan sequences on interventional MR scanners has accelerated the development of various interventional techniques using MRI[1,2]. In turn, this offers the merits of radiation-free imaging, excellent soft tissue contrast, arbitrary slice orientation and three-dimensional imaging capabilities. However, the interventional MRI techniques in use at present are mainly non-vascular techniques, with few vascular techniques having been reported[3-6]. Vascular intervention requires real-time imaging of the vascular anatomy and intravascular blood flow for road mapping, which is difficult to be acquired with MRI alone. In order to overcome this disadvantage, we combined an open-magnet interventional MR unit with a mobile C-arm, and applied this hybrid system to several vascular interventional procedures.

Materials and Methods

Hybrid System

We developed a hybrid interventional angio-MRI system, which consists of a 0.3-T open MR unit (AIRIS II, Hitachi Medical Corporation) and a mobile C-arm fluoroscopy unit (Sirius Power/C, Hitachi Medical Corporation). This system allows MR imaging and x-ray fluoroscopy/DSA in the same suite just by turning around the patient table without repositioning the patient. The mobile C-arm was located approximately four meters away from the isocenter of the magnet, and no visible distortion was seen in x-ray images. We turned off the mobile C-arm during MR scan to avoid zipper artifact and SNR decrease.

Procedures

Interventional procedures performed with this system were 1) percutaneous sclerotherapy for soft tissue vascular malformations, 2) intraarterial infusion chemotherapy for malignant tumors in the head and neck, and 3) transcatheter arterial embolization for hepatocellular carcinomas in the patients who were allergic to iodine contrast material. In percutaneous sclerotherapy, the lesion extent and distribution of the injected sclerosant were confirmed with MRI, and blood flow in the lesion was confirmed with x-ray DSA (Fig. 1). In intraarterial infusion chemotherapy, catheter was manipulated under x-ray fluoroscopy, and distribution of the injected drug was confirmed under MR fluoroscopy. In transcatheter arterial embolization, catheter manipulation and embolization were performed under x-ray fluoroscopy, and MR arterial portography (MRAP) was performed with MRI. In some cases, we performed MR digital subtraction angiography (MRDSA), and evaluated MRDSA images in comparison to x-ray DSA images.

Results

We performed 39 percutaneous sclerotherapies for 31 patients, 17 intraarterial infusion chemotherapies for 10 patients, and 3 transcatheter arterial embolizations for 3 patients. All interventional procedures were done safely without intraprocedural complications related to using our hybrid system.

With use of MRI, cross-sectional images with excellent soft tissue contrast allowed identification of exact lesion extent and/or confirmation of drug distribution. With a mobile C-arm, catheter manipulation was done safely under x-ray fluoroscopy, and enough information of blood flow was acquired. Switchover between a MR unit and a C-arm unit was performed smoothly within a minute without repositioning the patient.

MRDSA performed in some cases gave us rough information about vascular anatomy and blood flow, and made it possible to reduce the use of conventional x-ray DSA.

Discussion

MRI has exquisite soft tissue contrast, excellent three-dimensional visualization, and the ability to image in any scan plane. But, the temporal and spatial resolution provided by x-ray fluoroscopy still exceeds MR-fluoroscopy despite recent advances in MRI, though x-ray fluoroscopy has the disadvantages of ionizing radiation and the inability to produce cross-sectional images.

The system developed in the current study can take advantages of the both modalities. Initial clinical experience has demonstrated that vascular interventions performed with this system are thought to be feasible.

As we have demonstrated by performing MRDSA, vascular interventions with MRI alone will be feasible in the future[7]. However, because MRDSA is inferior to conventional x-ray DSA in the areas of spatial and temporal resolution at present, an interventional MR unit combined with a mobile C-arm unit is a helpful tool for MR-guided vascular intervention.

Conclusion

MR-guided vascular intervention is feasible with our hybrid interventional angio-MRI system. This system may have the potential to extend the application range of MR-guided interventions.

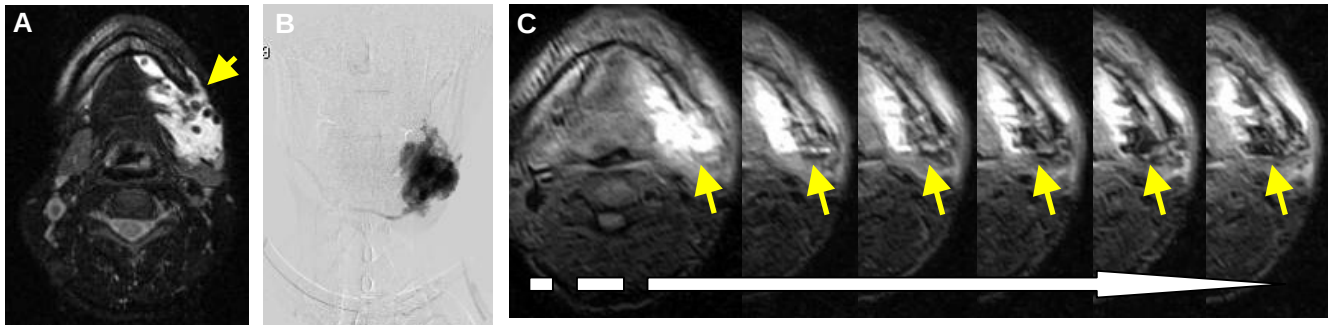

Fig. 1

A: Left submandibular vascular malformation showed hyperintensity on a T2WI image (arrow).

B: Pooling of contrast medium infused percutaneously was confirmed by x-ray DSA.

C: Finally, the mixture of sclerosing agent and 16% Gd-DTPA was injected into the lesion under T2-weighted MR fluoroscopy. The distribution of the mixture was seen as marked hypointensity (arrows).

References

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