MR-assisted Retrograde Drilling of Osteochondral Lesions of the Talus - A feasibility study -

C. Seebauer[1], F. Wichlas[1], J. Rump[2], J. Pinkernelle[2], I. Papanikolaou[3], T. Jung[1], S. Chopra[4], U. Teichgräber[2], and H. J. Bail[1]

[1]Center for Muskuloskeletal Surgery, Charité, Berlin, Berlin, Germany, [2]Department of Radiology, Charité, Berlin, Berlin, Germany, [3]Central Interdisciplinary Endoscopy Unit, Charité, Berlin, Berlin, Germany, [4]Department of Surgery, Charité, Berlin, Berlin, Germany

Introduction:

Osteochondrosis dissecans (OD) is a chronic subchondral lesion potentially affecting almost every joint. The etiology still remains unclear. Vascular, traumatic, infectious and genetic causes have been discussed. While stage I (Berndt and Harty classification[6]) can spontaneously heal, the next stages require operative treatment[7]. At stage II it consists of a retrograde drilling of the subchondral lesion perforating the sclerosis zone without damaging the cartilage surface[2,5,7]. Some retrograde drilling techniques have been developed using arthroscopic drilling guides, intraoperative fluoroscopy or x-ray navigation[1,2,3,5]. However, the poor visualization under x-ray control can lead to damage of the bone and cartilage. MRI is ideally suited for the evaluation of the osteocartilaginous components of talus lesions and has proven to be useful in planning surgical procedures[8]. In the present study we propose an innovative method using a MR-compatible drilling guide for the minimal-invasive treatment of OD under MR-control.

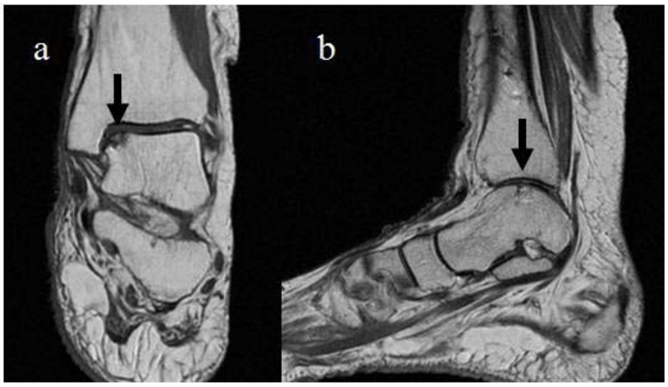

Fig. 1 T1w TSE images of a human cadaveric ankle; a: coronal, b: sagittal. The artificial osteochondral lesion is marked by the arrow.

Material and Methods:

All experiments were performed on a 1.5T Gyroscan ACS-NT (Philips Medical Systems, Best, NL). Artificial osteochondral defects were simulated in human cadaveric specimens at the medial talar dome using a 6 mm diamond bone-cutting system[4] (Fig.1a, b). For drilling we used a custom-made MR-compatible c-shaped drilling device (Fig.2a). For visualization, it was marked with Gadolinium filled tubule on its opposite ends (Fig 2a, 2b). The upper Gadolinium doped marker had a 3mm drilling-port. The first step was to orientate the image plane of a T1w TSE sequence (TR/TE: 400/18; 256×256 matrix size; FOV: 250 mm, slice thickness: 5 mm) in order to achieve the desired direction for the drilling (Fig.1a, 2b). Under repeated TSE image acquisition, the drilling device was aligned to the selected plane using the Gd-markers as a reference (Fig.2b). The two markers of the drilling guide were positioned in the direction of the osteochondral lesion of the talus (Fig.2b). The distance of the OD and the Gadolinium doped markers was measured on T1 TSE images and then marked on the drilling pin (Invivo, Schwerin, Germany). Drilling was performed under T1 GRE control by a MR-compatible drilling machine (Invivo, Schwerin, Germany) (Fig.2c).

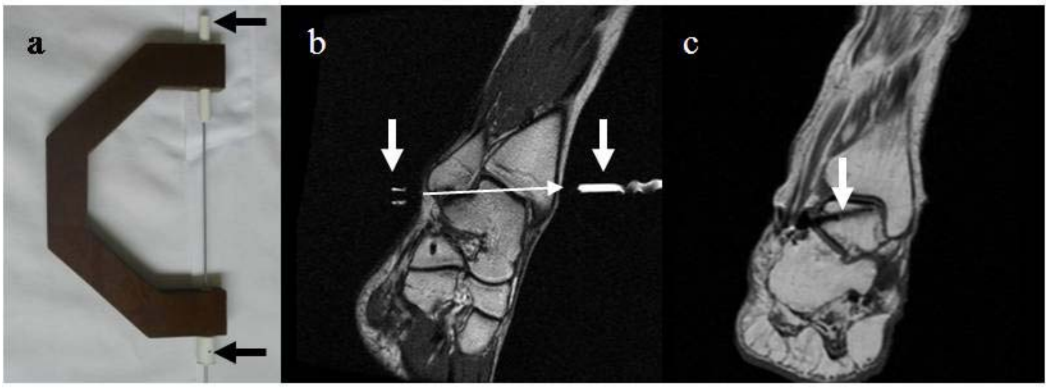

Fig. 2 a: Custom-made drilling guide with Gadolinium filled markers (arrows). b: T1w TSE (coronal) images of Gadolinium filled markers (thick arrows), direction of drilling (thin arrow) c: T1w TSE (coronal), ankle after drilling. The drilling canal is marked by the arrow.

Results:

The drilling guide alignment was easy to handle. Histological specimens showed that the artificial lesion was hit without perforating the overlying cartilage. Due to inevitable artifacts because of motion and susceptibility of the drilling machine, careful planning of the drilling depth is essential. In spite of the restricted image quality caused by the motor driven drilling machine, the described method is qualified for bone drilling. The MR-navigated retrograde drilling of OD using a passive drilling guide enabled precise drilling into the lesion without damaging the normal cartilage.

Conclusions:

Magnetic resonance imaging provides the best available information about the condition of the bone surrounding the lesion and the overlying cartilage. In conclusion, our experiment suggests that MR-navigated drilling in combination with a non invasive and MR-compatible drilling guide may provide a superior approach, compared to conventional methods. It allows percutaneously drilling in local anesthetic without opening the joint capsule and thereby reduces the risk of articular infection significantly.

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