Real-time guidance and thermal monitoring of interstitial laser ablation of osteoid osteomas in an open high-field MRI

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**Purpose:**
Apart from radiofrequency ablation (1), laser ablation has been successfully applied in the treatment of osteoid osteoma (Oo) under CT guidance (2). Only one publication has described MRI guidance of treating this tumor in an open low-field scanner at 0.23 T and thermal monitoring was not yet proven to be feasible (3). We prospectively determined the feasibility and technical features of open high-field MR imaging in the guidance of interstitial laser ablation (ILA) of Oo.

**Materials and Methods:**
5 patients with typical clinical and imaging findings suggesting osteoid osteoma underwent ILA in an open high-field MRI scanner (1.0 T, Panorama HFO, Philips Healthcare, NL) (Fig. 1). A fluoroscopic T1-w Turbo Spin Echo (TSE) sequence (TE/TR 5.7/200ms; TF 7; fa 90°; res. 1.5x1.5x5mm; scan duration 3s) was used for interactive lesion localization, instrument guidance, drilling (bone biopsy set, Invivo, Germany) and positioning of the laser fiber (600 μm, Frank Optic Products, Germany). Thermal ablation with an Nd:YAG laser (1064nm, Fibertom medilas, Dornier MedTech, Germany) was conducted via the biopsy canal. A Gradient Echo (GRE) sequence (TR/TE 4.3/2ms; fa 27°; res. 2.8x2.8x4mm) with an image update every 4.5s was investigated for the monitoring of laser tissue effects at 2-3 Watt based on T1 effects and Proton Resonance Frequency phase mapping (PRF).

**Results:**
All lesions were successfully localized, targeted, and treated under MR fluoroscopy and thermometry (Fig. 2). Laser effects could be monitored online in all cases. The color-coded technique (PRF) was found to be valuable in addition to conventional magnitude images (T1) (Fig. 3). No complications occurred. All the patients were symptom free at 2-5 months follow-up.

**Discussion:**
The open high-field MRI scanner (Fig. 1), provided good patient access, high-quality imaging for lesion localization and instrument guidance (Fig. 2), online temperature monitoring during treatment (Fig. 3), and postprocedural imaging to rule out missed nidal tissue (Fig. 5), resulting in a ‘‘one-stop-shop’’ intervention. Other authors have reported on similar strategies in low-field open MRI (0.23 T) (3), however, online monitoring of the temperature spread within the tissue had not been approved. Generally, high-field devices are more suitable for thermal monitoring due to improved SNR. With the use of an open high-field scanner at 1.0 T, we can now provide high-quality imaging with improved resolution. We have shown the feasibility of temperature calculation with phase images and a color-coded subtraction technique for quantitative thermometry in vivo (4). The GRE sequence used, has a short echo time and proved to be useful in monitoring thermal tissue changes at the needle tip. A short TE was preferred over a longer TE, since the needle artifact increases with longer TE.

**Conclusion:**
MR guidance and thermal monitoring of ILA of osteoid osteomas is feasible in an open high-field MRI. Rapid image updates with fast TSE and GRE sequence designs are one step towards a safer procedure.

**References:**