A neurosurgeon’s view: Outcome after RF-ablation for mTLE

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A B S T R A C T

We reviewed the current RF-ablation technique for mTLE and complications relating to the procedure. RF-ablation of the amygdalohippocampal complex (AHC) is a stereotactic technique, performed under local anesthesia, which achieved long-term seizure-free clinical seizure outcomes in 71% of mTLE patients. Occipital access is used and thermolesions are made from a single trajectory in the long axis of the AHC. RF-ablation has shown a low complication rate and clinical seizure outcomes seem to be comparable with open surgical techniques.

1. History of stereotactic RF-ablation for mTLE

The concept of stereotactic lesioning of the amygdalohippocampal complex (AHC) was introduced by Talairach more than half a century ago (Talairach et al., 1974, 1958) and originally the lesion was created by brachytherapy (Talairach and Szikla, 1965). Stereotactic RF-ablation via the occipital approach along the long axis of the hippocampus with a single trajectory using a side string electrode was published 4 decades ago (Nádvorník et al., 1975; Vladyka, 1978). Vladyka (1978), who was inspired by Talairach’s interstitial brachytherapy, performed longitudinal RF-ablation of the AHC in a group of 38 patients by 18–22 segmental coagulations, which created a fused lesion 10 mm wide and 25–30 mm long. In all patients, an invasive stereo-EEG was performed prior to the lesioning and intracerebral electrodes were inserted via the occipital approach along the long axis of the hippocampus. After the procedure, the electrodes remained in place for several days to evaluate the EEG effect of the procedure. In a group of 22 patients treated with this technique and followed for at least 2 years, 50% were seizure free, 32% significantly improved and in 18% no effect was observed. They recorded the following complications: 1 bleeding, 2 abscesses, 1 hemiparesis and 1 homonymous hemianopsia.

In 1997 Blume et al. published the results of stereotactic RF-ablation of the AHC in 14 patients using a different technique. They made discrete lesions in the amygdala and anterior hippocampus in the first 5 patients and confluent lesions in these structures in the subsequent 9 patients. They used steel electrodes and a lateral temporal approach for the lesioning. A temporal burr hole was placed over the middle temporal gyrus and the electrode was advanced to each target through a single cortical puncture and was angled anteriorly and posteriorly to reach the target sites. During a median 17-month follow-up, 6 of the 14 patients were seizure-free, 4 patients had fewer and milder seizures after surgery and in 4 patients the procedure failed. In 1999, Parent and Blume upgraded this method in a group of 19 patients, 10 of whom had a favourable seizure outcome; however, only 2 patients were seizure-free. The only observed complication was a small asymptomatic temporal lobe hematoma in one patient.

Stereotactic treatment for epilepsy is not limited only for purposes of mTLE, but also for purposes of other focal epilepsy diagnosis. Stereotactic EEG (SEEG) guided thermocoagulations as a palliative treatment of nonoperable partial epilepsies are widely used in some epilepsy centres (Catenoix et al., 2008).

2. Current technique of stereotactic RF-ablation of AHC

Preoperatively each patient underwent a routine presurgical examination which included long-term video-EEG monitoring, MRI in dedicated epilepsy protocol, fluoro-deoxyglucose positron emission tomography (FDG PET), neuropsychological testing and Wada test (Vojtěch et al., 2015). The technique (Liscak et al., 2010) currently used at our center is based on the principles previously published by Vladyka (1978). Stereotactic procedures are carried out under local anaesthesia and mild sedation. MRI is performed after a stereotactic frame has been attached to the patient’s head with an indicator box. For stereotactic neuronavigation, post-gadolinium 3D T1 WI is used. Post-gadolinium MRI imaging is necessary not only to visualize the anatomy of the AHC but also to trace the vessels along the trajectory of the probe, which must be avoided during the procedure to prevent hemorrhage. The surgical procedure is planned using Surgi Plan (Elekta Instruments,
Thermo-coagulation of the AHC is tailored to the individual anatomy of the patient, SEEG guiding is not used during the operation. First, the single trajectory along the long axis of the hippocampus is planned. The entry point is placed in the occipital region and the target point of the trajectory is placed in the amygdala, making maximal efforts to avoid the ependymal surface of the ventricle. A circle of hair is shaved occipitally. Then a percutaneous drill-hole is made under local anesthesia using a drill with the diameter of 3.2 mm with the patient in a semi-sitting position and the dura mater is penetrated with the coagulating tip of the probe. Stereotactic RF procedure is carried out by string electrode with a 10 mm bold active tip; this type of the tip is able to produce more than one lesion in one segment. The individual lesion is made when the string tip is exerted from the guiding tube to its side, reaching 8 mm lateral to the long axis of the probe and heated for 60 s to the desired temperature 75°C or 88°C (depending on the technical parameters of the probe — the two versions of electrodes with different thicknesses of the string tip were used). When thermo-coagulation is accomplished, the active tip is retracted, the electrode is rotated by 45° according to the treatment plan and the tip is again exerted to create another lesion. Usually 2–4 lesions are made in each segment. After lesioning is complete in one segment, the tip is retracted and the probe withdrawn by 5 mm to the position of the next segment. Thermo-coagulation is usually performed on 8 segments 5 mm apart and most commonly 25 lesions are made. The entire procedure, from the attachment of the stereotactic frame, through MRI and the operation itself, to removing the frame takes approximately 2 h. After the procedure patients are hospitalized for 3–5 days in a standard neurological ward.

According to an MRI taken 3–5 days after stereotactic surgery, thermocoagulative necrosis affects nearly the whole AHC, which is surrounded by a mild perifocal vasogenic edema (Malikova et al., 2009) — Fig. 1. The mass effect of these lesions is minimal. None of our patients required corticosteroid therapy after operation. One year after surgery an irregular pseudocyst developed in the AHC, which caused its partial destruction, entorhinal and perirhinal cortices included (Malikova et al., 2011). The extent of the RF-ablation of the AHC represents about a 50–60% volume reduction of the target structures.

### 3. Clinical outcomes

We have repeatedly analyzed short term and long term clinical seizure outcomes (Malikova et al., 2014; Vojtěch et al., 2014) and the results of our technique were completely comparable with open surgical approaches (Téllez-Zenteno et al., 2005). We evaluated long-term clinical seizure outcome (mean 5.3 years) in 61 patients; 71% of subjects were seizure-free, 10% of them were evaluated as Engel II and in 20% the treatment failed (Vojtěch et al., 2014).

### 4. Surgical complications

Sixty-three patients have been treated since 2004 and no mortality was mentioned, the only permanent neurological deficit after therapy was 2 cases of upper quadrantanopia. MRI follow-ups 3–5 days after surgery revealed 4 small intracranial hematomas, 3 of them without clinical manifestation that resolved spontaneously. One caused acute hydrocephalus and was treated by temporary ventricular drainage and resolved without sequelae. After RF-ablation of the AHC we performed open epilepsy surgery and re-RF ablation in 2 and 2 patients, respectively (8%). There were 2 cases of meningitis which required antibiotic treatment. Subsequently, a bolus of antibiotics has been administrated before the procedure and following this practice there have been no more cases of meningitis. One patient suffered from transitory anamn. Only 2 patients suffered upper quadrantanopia. In 6 patients, psychiatric disorders developed and 1 patient committed suicide due to postoperative depression (Liscak et al., 2010; Malikova et al., 2014; Vojtěch et al., 2014).

### 5. Discussion

According to our experience RF-ablation of the AHC using the technique described by Liscak et al. (2010) in the treatment of mTLE is a safe stereotactic operation with comparable long-term clinical seizure outcomes to open surgical approaches (Malikova et al., 2014). Above describe technique is tailored according to individual anatomy of patients; SEEG guiding is not performed during the operation, since we do not consider it as necessary. In case of mTLE anatomical landmarks of AHC, which is responsible for seizures generating, are sufficiently defined on MRI scans. Diagnosis of mTLE was suggested according to
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