BRAINLAB

Patient Safety on intraoperative MR Imaging in a two room solution setup for intraoperative and diagnostic imaging.

As early as 1997 the first clinical publications showed the clinical benefits of using intra-operative Magnetic Resonance Imaging: “Intra-operative MRI can be expected to increase the degree and accuracy of resection”[1] [2]. Other studies have looked at post-operative MRI imaging and indicate that intra-operative MRI would have had an influence on the clinical outcome[3] [4]. All recent studies concur that post-operative patient outcome/condition is dependent on the extent and success of tumor resection[5] [6] [7].

Initial installations of intra-operative MRI systems were dominated by lower field scanners (<= 0.5 Tesla). While these first solutions facilitated overcoming the issue of “brainshift” with updated intra-operative images, the surgical technique had to adapt immensely to the new intra-operative imaging capabilities. As a result, early iMRI systems have seen relatively low utilization.

More recent studies indicate that diagnostic high-field scanners have a positive impact on intra-operative use due to the increased image quality and the spectrum of sequences [8] and that the recent development of advanced MR sequences will open a new chapter of intraoperative MRI [9].

The initial Brainsuite concept, created 9 years ago, focused only on high field iMRI within the operating room with an emphasis on an optimal workflow for the surgical team. Today, after the early adopter phase, it has become even more crucial to create efficient and effective procedure workflows in order to achieve a high utilization of the technology.

In order to achieve a faster amortization of the investment in a high-field scanner and to utilize its capabilities more efficiently, many hospitals are trying a combined approach using MRI for diagnostic purposes and for intra-operative imaging. This scenario presented the next challenge for Brainlab and its partners.

There are two ways to achieve an OR/DR room configuration appropriate for intra-operative imaging as well as diagnostic scanning. The first is to move the scanner to the patient, which due to room construction and logistical issues has proven to be resource intensive and expensive. The second is to move the patient to the scanner, which provides more flexibility and cost effective treatment of patients. Furthermore, moving the patient has not been questioned to be unsafe, as there are many workflows currently in existence in the hospital setting that require patient transport to the diagnostic department (i.e. stereotactic patients are pinned in a stereotactic head ring while being transported from the operating room to the scanner). Additionally, in so called “two-room iMRI solutions” the distance between OR and scanner room is typically only a few meters.

Other questions have been raised about the potential for infection when using a dual use diagnostic scanner that requires patient transport.

[1] BLACK PM, Development and implementation of intraoperative magnetic resonance imaging and its neurosurgical applications. Neurosurgery. 1997 Oct;41(4):831-42; discussion 842-5.

[2] WIRTZ CR, Image-guided neurosurgery with intraoperative MRI: update of frameless stereotaxy and radicality control. Stereotact Funct Neurosurg. 1997;68(1-4 Pt 1):39-43.

[3] ALBERT, Early postoperative magnetic resonance imaging after resection of malignant glioma: objective evaluation of residual tumor and its influence on regrowth and prognosis, 1994 , Neurosurgery, 34, 45-60

[4] AMMIRATI, Effect of the extent of surgical resection on survival and quality of life in patients with supratentorial glioblastomas and anaplastic astrocytomas, 1987, Neurosurgery 21, 201-206

[5] SENFT, Intraoperative MRI guidance and extent of resection in glioma surgery: a randomised, controlled trial, 2011, The Lancet Oncology

[6] NIMSKY C., Correlation of the extent of tumor volume resection and patient survival in surgery of glioblastoma multiforme with high-field intraoperative MRI guidance., 2011, Neuro Oncol. [Epub]

[7] BERGER M., Glioma extent of resection and its impact on patient outcome, 2008, Neurosurgery 62(4):753-64;

[8] NIMSKY C.; Preliminary experience in glioma surgery with intraoperative high-field MRI. Acta Neurochir Suppl. 2003;88:21-9.

[9] SCHMIDT T., Lows and Highs: 15 years of development in intraoperative Magnetic Resonance Imaging”, Acta Neurochir Suppl. 2011;109:145-9.

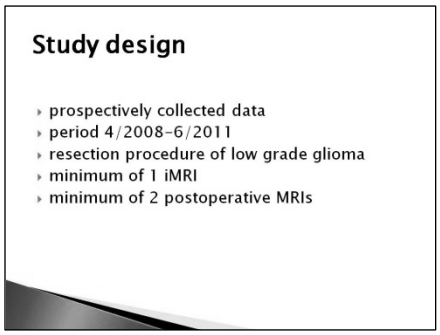
Neurosurgical literature has addressed this topic as well: " .... the operating room is pressure regulated[10], the gantry room is sterile cleaned before each procedure and the wound is sterile draped during each transfer. We have not encountered a single case of infection during the first 6 years of use. No anesthesia related problems or complications were encountered either." This same paper states: "This 3m long transfer takes an average of 1.5 min and the routine imaging paradigm another 6-8 min totaling to 10 min for each ioMRI imaging session. This new design does not cause a significant difference in the daily number of outpatient diagnostic studies nor does it block an operation theatre only for ioMRI procedures."[11]

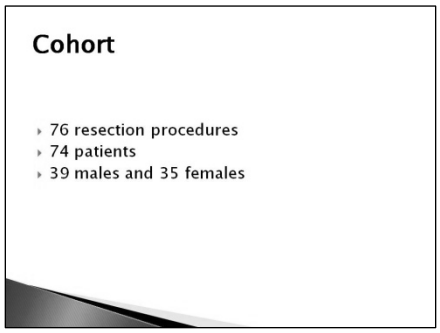
Jankovski et al. report technical issues such as MRI system failures and blocked robotic OR-tables[12] but " ... our large experience over more than 3 years confirms that ioMRI at 3.0 T is a safe and feasible technique with only minor problems."[13]

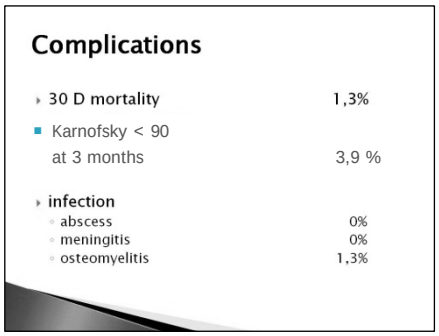
Beneš et al. summarized: "In 332 cases no medical complication with ioMRI was encountered." [14]

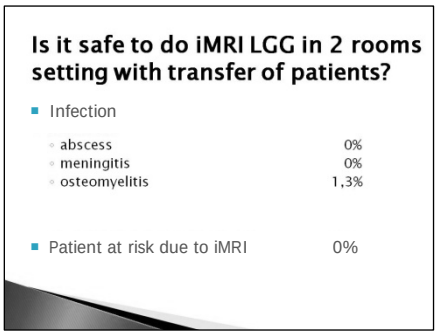
Dr. David Netuka, of the same group, which has performed 950 intra-operative MRI operations, presented in Oct 2011 at the quadrennial EANS meeting in Rome their experiences on "Intraoperative MR Imaging in low-grade Glioma Surgery":

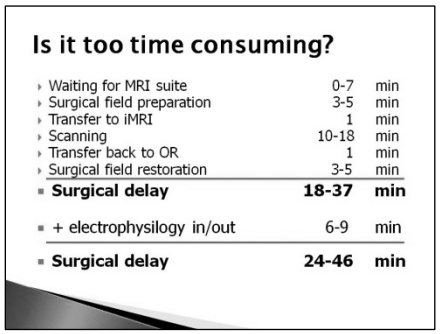
- Between April 2008 and August 2011 in this prospective study 74 patients with low grade glioma have been included.
- At minimum one intraoperative MRI scan has been acquired.
- The infection rate is not higher than conventional neurosurgical procedures. [15] [16]

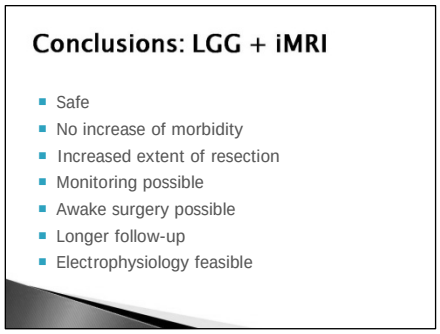












images courtesy of Dr. David Netuka, UVN Prague

[10] Remark by editor: „ Operating room is over-pressurized"
[11] PAMIR, 3 T ioMRI: the Istanbul experience. Acta Neurochir Suppl. 2011;109:131-7.
[12] Remark by editor: Maquet Wivas table is no longer available
[13] JANKOVSKI, Intraoperative magnetic resonance imaging at 3-T using a dual independent operating room-magnetic resonance imaging suite: development, feasibility, safety, and preliminary experience. Neurosurgery. 2008 Sep;63(3):412-24; discussion 424-6.
[14] BENES, Multifunctional surgical suite (MFSS) with 3.0 T iMRI: 17 months of experience. Acta Neurochir Suppl. 2011;109:145-9.
[15] GERATHY, Antibiotic prophylaxis in neurosurgery A randomized controlled trial J Neurosurg. 1984 / Vol. 60 / No. 4 / Pages 724-726
[16] LIETARD, Risk factors for neurosurgical site infections: an 18-month prospective survey, J Neurosurg 2008, 109:000–000