PoleStar® System Related Abstracts


The aim of this study was to demonstrate the usefulness of PoleStar in glioma surgery. Placement of the patients took between 8 and 90 minutes (mean, 33 min). Although longer positioning times were necessary in the first few cases, with more experience, positioning of the patients became less time consuming.

Intraoperative image quality was sufficient for navigation and resection control in both high- and low-grade tumors. Primarily enhancing tumors were best detected on T1-weighted imaging, whereas FLAIR sequences proved best for nonenhancing tumors. In all patients with primarily enhancing tumors, iMRI reliably showed contrast-enhancing tumors before and during resection, with good image quality. In patients with non-enhancing tumors FLAIR-sequenced imaging demonstrated clear tumor borders, even in cases of macroscopically invisible tumors. Intraoperative detection of residual tumor led to further resection and tumor reduction in almost every second surgical procedure.

Intraoperative resection control led to further tumor resection in 12 (28.6%) of 42 patients with contrast-enhancing tumors and in 10 (47.6%) of 21 patients with noncontrast-enhancing tumors.

Of the 30 patients with contrast-enhancing tumors for whom full resection was planned, intraoperative imaging revealed residual tumor in 27% cases which led to additional resection increasing the number of patients for which full resection was planned and achieved from 73% to 100%, confirmed by both PoleStar and postoperative diagnostic imaging.

Of the 12 patients with contrast-enhancing tumors for whom partial resection was intended, intraoperative imaging enabled additional resection in 33% of cases.

Of the 9 patients with non-enhancing tumors for whom full resection was planned, intraoperative imaging revealed residual tumor in 22% cases which led to additional resection increasing the number of patients for which full resection was planned and achieved from 78% to 100%, confirmed by PoleStar imaging. In one patient additional tumor was found in postoperative diagnostic scans.

Of the 12 patients with non-enhancing tumors for whom partial resection was intended, intraoperative imaging enabled additional resection in 67% of cases. In one case the extent of the remaining tumor on the postoperative diagnostic scan was larger than on the PoleStar scan.

Reviewer Comments Summary:
Christopher Nimsky, Erlangen, Germany: "In 22 of 63 patients, intraoperative imaging led to an extended resection. This rate of 35% corresponds well with previous published studies on effects resulting from use of intraoperative MRI (iMRI), applying various low- and high-field systems, and confirms that immediate intraoperative quality control has a significant impact on the extent of resection."

Walter A. Hall, Syracuse, New York: “These results are comparable to those that are reported with 1.5-T high-field iMRI systems and confirm that neurosurgeons are notoriously inaccurate in estimating the volume of residual disease. As more and more institutions are moving toward higher-field intraoperative systems, this group has nicely demonstrated that there is still a place for low-field MRI systems despite their lower image quality and longer scanning times compared with high-field systems. In selection of an iMRI system for any individual site, one must take into consideration the
primary use of the system, i.e., whether it is to be diagnostic or therapeutic, and the amount of available capital within the institution to invest in such a major expenditure.”


This article from Shanghai presents 55 cases performed with PoleStar between March 2006 and December 2007.

“Prior to 2006, thousands of patients with pituitary adenomas were treated via a transsphenoidal approach at Shanghai Huashan Hospital. The extent of tumor resection was determined mainly on the basis of a surgeon’s individual experience under a microscope, which often results in unpredictable residual tumors.”

“The total numbers of iMRI acquisition sessions varied between 2 and 5 (average, 2.7).”… “In our experience, the operating time was prolonged for an average of 1.8 hours due to additional intraoperative imaging. However, this additional time was justified by more precise tumor resections, which could potentially prevent or delay a second procedure or adjuvant treatment for patients.” …

“Intraoperative imaging revealed residual tumor and guided extended tumor resection in 17 of 55 cases (31%). As a result, the percentage of gross total removal of macroadenomas increased from 58.2% to 83.6%.”

3. How to overcome the limitations to determine the resection margin of pituitary tumours with low-field intra-operative MRI during trans-sphenoidal surgery: usefulness of Gadolinium-soaked cotton pledgets  J. Y. Ahn, J. Y. Jung, J. Kim, K. S. Lee, S. H. Kim

The group from Seoul reports: “Overall, among the 51 patients with intended complete tumour removal, iMRI revealed definite tumour remnants or suspicious findings in 13 patients (25.5%), leading to an extended resection and allowing completion of the resection in 10 patients. There was an increased rate of complete tumour removal from 74.5% (38 out of 51) to 94.1% (48 out of 51).”


The group from Frankfurt reports: “The mean time for patient positioning was 25.6 ± 8 minutes (minimum, 15 min; maximum, 35 min). An average of 5.4 ±1.5 scan-sessions were performed in each patient … Pure iMRI scan time accounted for an additional 24.4 ± 9.2 minutes. … The use of iMRI did not compromise the intraoperative workflow. However, total anesthesia time (246.0 ± 50.7 versus 163.4 ± 41.2 min) and operation time (116.9 ± 43.9 versus 78.2 ± 33.0 min) was significantly prolonged in patients with iMRI resection control compared with that for patients who underwent procedures without the use of an iMRI system”. … “In seven patients (17.5%), iMRI resection control showed accessible residual tumors leading to further resection. After tumor resection, the final iMRI scan documented adequate decompression of the optic pathway in all patients.”

In reviewer comments Dr. Paolo Capabianca, who is the proponent of endoscopic trasnssphenoidal approach writes: “As endoscopic pituitary surgeons, we could argue that endoscopic intrasellar exploration could be sufficient to detect any tumor remnants.” … “Under these conditions, in which an increased risk of leaving suprasellar remnants is expected, especially if the suprasellar cistern falls down in an asymmetric way, a low-field intraoperative MRI (iMRI) system such as the PoleStar N20 could really be useful. Widespread use of these systems is even more desirable, considering the continuous development and expansion of extended transsphenoidal approaches not only for
adenomas involving the sellar and suprasellar areas but also for different lesions, i.e., meningiomas and craniopharyngiomas, that arise in many regions all around the sella.”

Dr. Peter Black who is considered the “father of iMRI” adds: “In 17.5% of the patients presented here, residual tumor not recognized initially was safely removed. The only downside of this was a 1-hour longer surgery time, an apparently small price to pay. Like all iMRI systems, the PoleStar provides a convenient method for assessing precisely what has been done in surgery; it is also very convenient to use.”

5. Intraoperative magnetic resonance imaging-guided transsphenoidal surgery for giant pituitary adenomas Fabian Baumann & Christoph Schmid & René-Ludwig Bernays Neurosurg Rev, Published online: 13 October 2009.

The article describes six cases of giant pituitary adenoma (≥40mm in diameter) operated with the help of PoleStar. The article reports a much higher total resection rate of 66% (between 27.9% and 40% according to literature), accompanied by at least as favorable endocrinological outcome and symptom control as with conventional pituitary surgery. The authors conclude that “We believe these favorable outcomes are supported by the use of intraoperative imaging, which serves as an intraoperative quality control to resection and to preservation of surrounding structures beyond that of the operating microscope or endoscope. This intraoperative information translates into more radical resections that may lead to fewer severe complications, fewer additional procedures (such as transcranial complementary operations, hormonal replacement therapy, radiotherapy), and to reduction of overall costs of therapy of this difficult group of patients.”

In reviewer comments Dr. Hans Landolt, PoleStar from Aarau writes: “In contrast to the literature about giant pituitary adenomas operated without iMRI, this small series show excellent results. Beside the surgical competence of the senior author, his use of actualized intraoperative imaging helped decisively to attack tumor remnants specifically according to the new images. Any pituitary surgeon will be surprised to see nonsuspected tumor remnants using an iMRI. To visualize and to be able to remove it during the same procedure are undisutable advantages especially in giant sellar tumors. Also, for smaller tumors iMRI helps to raise learning curves dramatically, allowing an immediate feedback of the aims achieved after each surgical step. The time needed for iMRI is irrelevant compared to the advantages offered, as we also experienced in Aarau since 2006. For transsphenoidal surgeons, an iMRI will become soon the golden standard as soon as larger series will be published.”

General iMRI Abstracts


“From April 2002 to June 2003, 182 neurosurgical procedures were performed with a 1.5-T magnetic resonance system.”… “Surgical procedures were influenced by iMRI in 36.2% of operations, and surgery was continued to remove residual tumor. Additional further resection significantly reduced the percentage of final tumor volume compared with first iMRI scan. Percentages of final tumor volume also were significantly reduced in both low-grade and high-grade gliomas.”


“The purpose of this study was to test the hypothesis that intraoperative MR imaging increases the extent of tumor resection, thus improving surgical results in patients with high-grade gliomas.”… “Intraoperative MR imaging showed residual enhancing tumor in 22 cases (53.7%).” … “In 17 of the 22 cases in which residual tumor was seen, surgery was continued.”
8. Intraoperative High-Field Magnetic Resonance Imaging in Transsphenoidal Surgery of Hormonally Inactive Pituitary Macroadenomas  Christopher Nimsky, M.D., Boris von Keller, M.D., Oliver Ganslandt, M.D., Rudolf Faehlbusch, M.D.  *Neurosurgery 59:105-114, 2006*

“Among the 85 patients in whom complete tumor removal was intended preoperatively, intraoperative imaging revealed definite tumor remnants or suspicious findings in 36 (42%) patients. Imaging led to an extended resection in 29 (34%) patients of this group. Among them, resection could be completed in 21. This increased the rate of complete tumor removal from 58% (49 out of 85) to 82% (70 out of 85). In the group of patients with intended partial removal (n = 21), resection was extended in 38% (eight out of 21) because of intraoperative imaging.”

9. Intraoperative Magnetic Resonance Imaging to Determine the Extent of Resection of Pituitary Macroadenomas during Transsphenoidal Microsurgery  Robert J. Bohinski, M.D., Ph.D., Ronald E. Warnick, M.D., Mary F. Gaskill-Shipley, M.D., Mario Zuccarello, M.D., Harry R. van Loveren, M.D., Donald W. Kormos, Ph.D., John M. Tew, Jr., M.D.  *Neurosurgery, Vol. 49, No. 5, November 2001*

“In the … 29 patients, initial iMRI demonstrated that the endpoint for extent of resection had been achieved in only 10 patients (34%) after an initial resection attempt, whereas 19 patients (66%) still had unacceptable residual tumor. All 19 of these latter patients underwent re-exploration. Ultimately, re-exploration resulted in the achievement of the planned endpoint for extent of resection in all of the 29 completed transsphenoidal explorations.”


Dr. Hatiboglu et al. from the M.D. Anderson Cancer Center working with the BrainSUITE system report: “Forty- six patients underwent resection using iMRI guidance, with iMRI being used to evaluate the extent of resection in 44 patients and for reregistration in 2 patients. Surgery was terminated after iMRI in 23 patients (52%) because gross total resection was achieved or because of residual tumor infiltration in an eloquent brain region. Twenty- one patients (47%) underwent additional resection of residual tumor after iMRI. For enhancing gliomas, the median extent of resection increased significantly from 84% to 99% with additional tumor removal after iMRI. For nonenhancing gliomas, the median extent of resection increased (from 63% to 80%) with additional tumor removal after iMRI, but not significantly, owing to the small sample size (7 patients). Overall, the extent of resection increased from 76% to 96%. Gross total resection was achieved after additional tumor removal after iMRI in 15 of 21 patients (71%). Overall, 29 patients (65%) experienced gross total resection, and in 15 (52%), this was achieved with the contribution of iMRI.”

11. First intraoperative, shared-resource, ultra-high-field 3-Tesla magnetic resonance imaging system and its application in low-grade glioma resection  M. Necmettin Pamir, M.D., Koray Özduman, M.D., Alp Dinçer, M.D., Erdem Yıldız, M.D., Selçuk Peker, M.D., and M. Memet Özek, M.D.  *J Neurosurg / May 29, 2009*

The authors describe a shared-resource facility that “houses a 3-T Siemens Trio system and consists of interconnected but independent MR imaging and surgical suites. Neurosurgery is performed using regular ferromagnetic equipment, and a patient can be transferred to the ioMR imaging system within 1.5 minutes by using a floating table. The ioMR imaging protocol takes < 10 minutes including the transfer, and the authors obtain very high–resolution T2-weighted MR images without the use of intravenous contrast.” “Since the facility became operational in June 2004, 56 LGG resections have been performed using ioMR imaging, and > 19,000 outpatient MR imaging procedures have been conducted. First-look MR imaging studies led to further resection attempts in 37.5% of cases as well as a 32.3% increase in the number of gross-total resections.”

“A twin neurosurgical magnetic resonance imaging (MRI) suite with 3-T intraoperative MRI (iMRI) was developed to be available to neurosurgeons for iMRI and for independent use by radiologists.” The operating table is motorized, enabling transfer of the patient into the MRI system. These two areas can function independently, allowing the MRI area to be used for nonsurgical cases.”…Twenty-six iMRI examinations were performed, 3 immediately before surgical incision, 9 during surgery (operative field partially closed), and 14 immediately postsurgery (operative field fully closed but patient still anesthetized and draped).”…Twenty-three iMRI examinations took an average of 78 ± 20 minutes to perform. In three patients, iMRI led to further tumor resection because removable residual tumor was identified. Complete tumor resection was achieved in 15 of the 18 cases.”

Value of a More Complete Resection Abstracts


“Microsurgical resection remains a critical therapeutic modality for all gliomas. However, there remains no general consensus in the literature regarding the role of extent of resection (EOR) in improving patient outcome. With the exception of World Health Organization (WHO) Grade I tumors, gliomas are difficult to cure with surgery alone, and the majority of patients will experience some form of tumor recurrence. Patients with glioblastomas have median survival rates of 12.2 to 18.2 months, whereas those with anaplastic astrocytomas can expect to survive 41 months on average. Low-grade gliomas carry a better prognosis, although the vast majority of patients eventually die of their disease; 5-year survival percentages range from 42 to 92% in the literature. For all gliomas, the identification of universally applicable prognostic factors and treatment options remains a great challenge.” …

“Although the importance of glioma resection in obtaining tissue diagnosis and alleviating symptoms is clear, a lack of Class I evidence prevents similar certainty in assessing the influence of EOR. In fact, despite significant advances in brain tumor imaging and intraoperative technology during the past 15 years, the effect of glioma resection in extending tumor-free progression and patient survival remains unknown.” The authors reviewed every major clinical publication since 1990 on the role of extent of resection in glioma outcome. They concluded that: “Despite persistent limitations in the quality of data, mounting evidence suggests that more extensive surgical resection is associated with longer life expectancy for both low- and high-grade gliomas.”


“The prognostic role of extent of resection (EOR) of low-grade gliomas (LGGs) is a major controversy. We designed a retrospective study to assess the influence of EOR on long-term outcomes of LGGs.”…Conclusion: “Improved outcome among adult patients with hemispheric low-grade gliomas is predicted by greater extent of resection.”

In this article a group from the John Hopkins School of Medicine reviewed the patient records for 170 patients with supratentorial low grade gliomas operated on in their institution between 1996 and 2007 to measure overall survival, progression-free survival and malignant degeneration-free survival (conversion to high-grade glioma). Their conclusion was that “Gross total resection was associated with a delay in tumor progression and malignant degeneration as well as improved overall survival independent of age, degree of disability, histological subtype, or revision versus primary resection. Gross total resection should be safely attempted when not limited by eloquent cortex.”