# Use of Intraoperative MRI for Treatment of Pediatric Neuropathology

**Stephen G HUSHEK**[1], Lori Russell[2], Neil Hoerter[2], Robert Moser[2], Christopher B Shields[3], Todd W Vitaz[3], Thomas M Moriarty[3]

[1]Norton HealthCare, 200 Chestnut Street, Louisville, KY USA; [2]Norton Hospital, ; [3]University of Louisville, School of Medicine, ;

**Introduction**

The emergence of intraoperative MRI has opened new doors for the treatment of pediatric neuropathology. Applied to tumor resection, this technology will hopefully improve the surgeon´s ability to obtain a complete resection while minimizing damage to surrounding neural structures. Applied to cysts, the interactive image guidance capability combined with intraoperative imaging allows the surgeons to perform true frameless stereotactic procedures.

**Methods**

We performed 35 procedures on 31 patients in our intraoperative MRI unit (Signa SP, GE Medical Systems, Milwaukee WI). Our iMRI center is attached to our main operating facilities and connected to our children´s hospital. All procedures were performed within the magnet bore. Standard surgical positioning techniques were utilized depending on lesion location. The average patient age was 5.4 with a range of 3weeks-19 years.

RAS Targeting: We developed a technique to expedite identification of residual tumor or stereotactic targets using the optical tracking system (Flashpoint™, Image Guided Tech. Inc., Boulder Co.) integrated into the scanner. The optical tracking system operates by detecting the location of a handpiece equipped with infrared LEDs and communicating its position to the scanner. The scanner is then able to acquire images in a variety of planes centered at the tip of the instrument and annotate the images with a graphic overlay to show the position of the handpiece.

The technique begins by determining the coordinates of the target from a high quality, multi-slice acquisition (typically T1 post contrast in the case of residual tumor, FLAIR or T2 in the case of a cyst). The patient coordinates (right/left, anterior/posterior, superior/inferior) are converted to magnet XYZ coordinates and entered into the Locator Device Simulator, which simulates the optical tracking handpieces used for interactive imaging. The coordinates are communicated to the scanner and the image acquisition is "frozen". In the frozen mode the scanner repetitively acquires images centered at a fixed coordinate, regardless of subsequent handpiece positions, but the handpiece position annotation is continuously updated on the image. A large crosshair is superimposed on the target coordinates at the center of the image to provide a reference for the surgeon. The simulator is then disabled and the tracking system once again connected to the surgeon´s handpiece while the image acquisition continues at the target coordinates. The small crosshair representing the current position of the handpiece is updated 4 times per second. The surgeon then moves the handpiece to align the small crosshair with the large crosshair and when the two are aligned the surgeon knows the targeted tissue is under the handpiece tip.

The exact same technique is used for cyst catheter placement, with the difference being that the targeting is during the trajectory planning phase to align the catheter path with the center of the cyst. Images are acquired while the ventricular catheter with a titanium stylet is inserted to observe its path to the cyst and check for any cyst deformation when the catheter hits it.

The technique provides the essential capability of a surgical navigation workstation without the additional expense. This targeting technique is faster than normal interactive scanning because the target remains on the screen the entire time and the rapid updates of the current position graphic allow the surgeon to align the handpiece with the target in real-time.

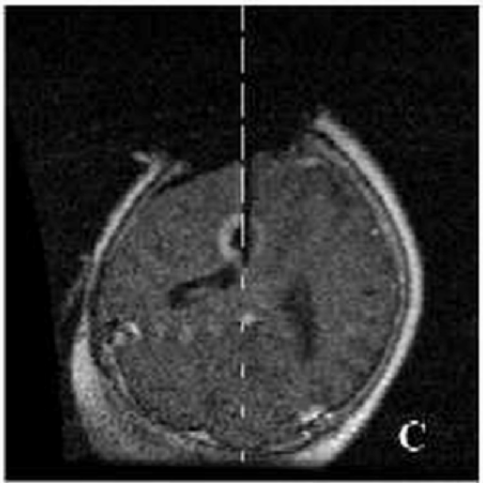
**Results**

There were no infectious, hemorrhagic or neurological complications. Gross total tumor removal was obtained both by visual inspection and MRI imaging in all patients undergoing resection. Three of the eight catheter placements showed cyst deformation that would have prevented cyst penetration without intraoperative imaging. Average postoperative length of stay following craniotomy was less than three days.

**Discussion**

Intraoperative MRI is an extremely useful tool for the treatment of pediatric neuropathology. Intraoperative imaging helps surgeons navigate through eloquent areas of the brain and maximizes tumor resection at the time of the primary procedure. It has also increased the armamentarium of minimally invasive neurosurgery in pediatric patients, allowing true frameless stereotactic procedures to be performed. The use of such new coordinate defined tracking helps fulfill the primary benefit of iMRI technology by allowing rapid, accurate and verified catheter placement. Finally, real time imaging allows data reacquisition intraoperatively, illustrating cyst decompression and absence of hemorrhage at the time of the procedure. These advantages have yielded an absence of any neurological complications and a decrease in the length of postoperative stay in the patient population treated at our institution to date.

**References**




**IntraOperative Images Using Target Coordinates Showing Biopsy Needle at Target.**

**Neuropathological Results**

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| Patient Demographics | n=31 |
| Female/Male | 19/12 |
| Average Age | 5.4 (range 3weeks - 19 years) |
| Procedure Type: | n=35 |
| Craniotomy for Tumor Resection | 23 |
| Stereotactic Biopsy | 4 |
| Stereotactic Catheter Placement | 8 |
| Lesion Location | |
| Supratentorial | 19 |
| Infratentorial | 4 |