The Use of Image Guidance in Minimally Invasive Pituitary Surgery

Samip N. Patel, MD[1], Fernando L. Vale, MD[2], Tapan A. Padhya, MD[1]
[1]Department of Otolaryngology - Head and Neck Surgery, [2]Department of Neurosurgery
University of South Florida College of Medicine, Tampa, Florida

ABSTRACT

INTRODUCTION: Transsphenoidal pituitary surgery has become the favored approach for pituitary tumor resection. Traditionally, fluoroscopy has been the standard for intraoperative guidance during the transnasal approach, however the role of BrainLAB VectorVision (BrainLAB, Feldkirchen, Germany) neuronavigational system has increased.
OBJECTIVE: 1. Evaluate the utility of performing transnasal transsphenoidal pituitary surgery with computer-assisted image guidance; 2. Examine the efficacy of BrainLAB versus fluoroscopy.
METHODS: We conducted a retrospective review of patients who underwent pituitary surgery between September 1998 and September 2008. One hundred twenty one consecutive patients were examined. Inclusion criteria were patients treated by the same single surgeon at the same institution undergoing transnasal transsphenoidal pituitary surgery. Nineteen patients were treated using intraoperative fluoroscopy. Forty eight patients were treated using BrainLAB VectorVision neuronavigational system. Three patients were treated using both fluoroscopy and BrainLAB image guidance.
RESULTS: The average preparation (min) for fluoroscopy and BrainLAB was 70.3 and 67.3 (p = 0.3299), respectively. The average surgical time (min) for fluoroscopy and BrainLAB was 131 and 107.9 (p = 0.0079), respectively. Results were also analyzed for various other parameters such as associated complications, age, and diagnosis.
DISCUSSION: BrainLAB provides a three-dimensional image to the surgeon, allowing for greater visual accuracy and surgical precision. In addition, it allows for a faster and more cost effective procedure without the radiation exposure and need for extra personnel.

CONTACT

Samip N. Patel, MD
Department of Otolaryngology-HNS
Email: spatel8@health.usf.edu
Phone: 813.340.0550

INTRODUCTION

Surgical approaches to the pituitary gland have evolved tremendously over the 20th century. More recently, the transsphenoidal approach has been the mainstay for pituitary surgery for the past forty years with the standard sublabial transseptal transsphenoidal route. Now, minimally invasive pituitary surgery (MIPS) has revolutionized pituitary surgery by providing a safer, faster, more precise, and cost effective technique.

Traditionally, the transsphenoidal approach has relied upon *intraoperative fluoroscopy* for localization and confirmation. We use the computer-based *BrainLAB VectorVision* (BrainLAB, Feldkirchen, Germany) to compare image guidance applications in minimally invasive pituitary surgery. ***The objective of this report is to discuss our results in patients undergoing transnasal transsphenoidal pituitary surgery, to evaluate the utility of computer-assisted image guidance, and to evaluate the efficacy of fluoroscopy versus BrainLAB image guidance.***

METHODS AND MATERIALS

Patient Selection
The project was reviewed and approved by the institutional review board (IRB) of the University of South Florida and the Office of Clinical Research at Tampa General Hospital. A retrospective chart review was conducted assessing patients undergoing minimally invasive pituitary surgery by a single neurosurgeon and coauthor (F.L.V) at the University of South Florida College of Medicine between September 1998 and September 2008.. These patients also underwent surgery performed by the senior author (T.A.P.)

One hundred twenty one consecutive patients were examined. The inclusion criteria were patients treated by the same single neurosurgeon at the same institution undergoing transnasal transsphenoidal pituitary surgery. Therefore based upon our cohort group and this inclusion criteria, a sample size of 70 was obtained.

IMAGE GUIDANCE

Preoperative Imaging
Patients underwent preoperative non-contrasted computed tomography *(CT) scanning of the sinus and skull base with BrainLAB protocol, which calls for fine-cut (1-2mm cuts) axial CT scan.*

Neuronavigational System
BrainLAB system, windows base operating system, is a two-camera system in which infrared light is emitted by transmitters installed near the receiving cameras and is reflected by suitable objects (markers). These reflections are detected and used by the computer to establish both the positional coordinates of the patient's head and also the position of surgical instruments.

RESULTS

One hundred twenty one consecutive patients underwent image guided minimally invasive pituitary surgery, of which 70 were included in the study based upon inclusion criteria. ***Nineteen cases (27%, mean age 44.2) involved fluoroscopy, 48 cases (69%, mean age 54.5) involved BrainLAB, and 3 cases (4%, mean age 36.3) involved both fluoroscopy and BrainLAB.*** The patients are significantly older in the BrainLAB group (p = 0.0208). There was overwhelming *preponderance of macroadenoma* as pathologic diagnosis in BrainLAB group with 40 (83%) versus the fluoroscopy group with 9 (47%) (p = 0.0028).

Figure 1. C-Arm Fluoroscopy.

Figure 2. BrainLAB.

		Fluoroscopy	BrainLAB	p-value
Age	mean	44.2	54.5	0.0208
	SD	19.4	14.7	
Gender	Female	10	28	0.7861
	Male	9	20	
Race	White	15	35	0.8141
	American African	1	6	
	Hispanic	3	7	
	Craniopharyngioma	1	1	
Diagnosis	Cystic adenoma	5	4	0.0028*
	Macroadenoma	9	40	
	Microadenoma	3	1	
	Rathke Cleft Cyst	1	2	
Preparation Time (minutes)	Mean	70.3	67.3	0.3299
	SD	27.8	13	
Surgery Time (minutes)	Mean	131	107.9	0.0079*
	SD	37.7	33.3	
Adverse Event	No	7	30	0.2630
	Yes	12	18	

Table 1. Multivariate Analysis.

Imaging	Residual Tumor	CSF Leak	Diabetes Insipidus	Cavernous Sinus Hemorrhage
Fluoroscopy	32%	21%	21%	5%
BrainLAB	12.5%	27%	4%	0%

Table 2. Adverse Events.

RESULTS

Although there was a *reduction in mean preparation time* in the BrainLAB group (67.3 minutes) versus the fluoroscopy group (70.3 minutes), univariate analysis shows this difference in preparation time was not significant between the two groups (p = 0.6577). However, *surgery time is significantly shorter* in the BrainLAB group (107.9 minutes) than in the fluoroscopy group (131 minutes) with a p-value = 0.0079.

Multivariate analysis (Table 1) shows that after controlling for types of diagnosis and age, ***surgery time is significantly shorter (Figure 6) in the BrainLAB group than in the fluoroscopy group (p = 0.0079).***

The *rate of adverse events (Figure 27)* does appear to be higher in the *fluoroscopy group at 63%* compared to *37% in the BrainLAB group.*

Figure 3. Z-Touch Laser.

Figure 4. Pointer.

Figure 5. Reference Star.

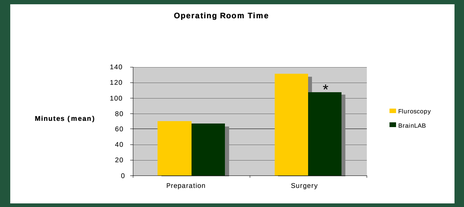

Figure 6. Operating Room Time.

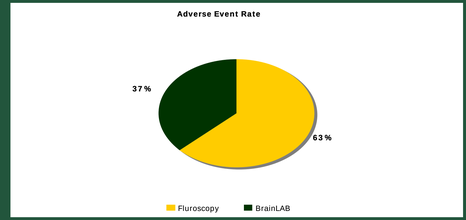

Figure 7. Adverse Event Rate.

DISCUSSION

Compared to fluoroscopy, ***BrainLAB provides 3-D continuous, real-time imaging***. This obviates the need of intraoperative radiological personnel required for the C-arm fluoroscopy machine. In addition, by eliminating fluoroscopy from the procedure, radiation risks to the surgeon, staff and patient are reduced. Furthermore, clinical and cadaveric studies have verified the reliability, reproducibility and accuracy of various computer-based systems.

Our results indicate that ***BrainLAB reduces overall operating room time***. Mean preparation time was reduced from 70.3 minutes, fluoroscopy, to 67.3 minutes, BrainLAB (p = 0.6577 univariate analysis, p = 0.3299 multivariate analysis). In addition, ***operative time was significantly reduced from 131 minutes, fluoroscopy, to 107.9 minutes, BrainLAB (p = 0.0165 univariate analysis, p = 0.0079 multivariate analysis).*** Also, our ***overall rate of adverse events approached near significance (p = 0.0507 univariate analysis) with a higher proportion allocated to the fluoroscopy***. A breakdown of events showed that there was reduced rate of residual tumor, diabetes insipidus and vascular events with BrainLAB.

CONCLUSIONS

BrainLAB provides a three-dimensional image to the surgeon, allowing for greater visual accuracy and surgical precision. In addition, it is a practical technologically advanced tool, allowing for a faster and more cost effective procedure without the radiation exposure and need for extra personnel. As an outcome, we now use BrainLAB exclusively in our endoscopic approach to the sphenoid in pituitary surgery.

REFERENCES

1. Senior BA, Ebert CS, Bednarski KK, et al. Minimally invasive pituitary surgery. *The Laryngoscope*. 118:1842-55, 2008.
2. Ledderose GJ, Stelter K, Leunig A, et al. Surface laser registration in ENT-surgery: accuracy in the paranasal sinuses--a cadaveric study. *Rhinology*. 45:281 -5, 2007.
3. Stelter K, Andratschke M, Leunig A, et al. Computer-assisted surgery of the paranasal sinuses: technical and clinical experience with 368 patients, using the Vector Vision Compact system. *The Journal of Laryngology and Otology*. 120:1026 -32, 2006.
4. Greenfield JP, Howard BM, Huang C, et al. Endoscopic endonasal transsphenoidal surgery using a skull reference array and laser surface scanning. *Minim Invasive Neurosurg*. 51:244-6, 2008.
5. Asthagiri AR, Laws ER, Jane JA. Image guidance in pituitary surgery-a modern approach. *Pituitary Surgery*. 34:46-63, 2006.
6. Charalampaki P, Reisch R, Ayad A, et al. Image-guided endonasal transsphenoidal microsurgical treatment of recurrent microadenomas of the pituitary gland. *Minim Invasive Neurosurg*. 49: 93-7, 2006
7. Nauer CB, Eichenberger A, Dubach P, et al. CT radiation dose for computer-assisted endoscopic sinus surgery: dose survey and determination of dose-reduction limits. *Am J Neuroradiol*. 30:617-22, 2009.
8. Elias WJ, Chadduck JB, Alden TD, et al. Frameless stereotaxy for transsphenoidal surgery. *Neurosurgery*. 45:271, 1999.