Cost-Effectiveness of Intraoperative-MRI Methods for Stereotactic Laser Amygdalohippocampotomy

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Introduction

Conventional frame-based targeting systems for Stereotactic Laser Amygdalohippocampotomy (SLAH) requires multiple patient transfers between OR and MRI suites, allowing greater susceptibility to error in lesion targeting. Intraoperative MRI (iMRI) targeting systems (Clearpoint®, MRI Interventions) obviate the need for intraoperative transfers, but may be associated with additional costs. We therefore undertook a short-term economic evaluation of laser ablation procedures performed with the iMRI targeting system compared to conventional alternatives.

Methods

45 patient encounters were reviewed, including the 15 most recent of 3 groups: SLAH cases using the ClearPoint system, SLAH cases using the CRW frame, and open surgery cases. One-way MANOVA determined differences between groups for Total Cost incurred by the hospital. Costs were stratified by category. Significant multivariate effects were defined at alpha=0.05. Bonferroni alpha correction defined significant univariate effects ($p<0.0038$).

Table 1 - Patient Characteristics

Table 1: Patient Characteristics

	CP (n=13)*	CRW (n= 14)*	Open Surgery (n=15)
Mean Age	40.54 (sd = 15.65)	44.5 (sd = 19.09)	42.87 (sd = 14.13)
Sex			
Male	7	3	9
Female	6	11	6
Age at Seizure Onset	14 (sd = 10.38)	15.14 (sd = 10.38)	28.8 (sd = 14.13)
Diagnosis			
MTLE	13	11	13
Cavernoma (temporal lobe)		2	2
ETLE		1	
Side of Procedure			
Right	7	6	7
Left	6	8	8
N reoperations to achieve seizure freedom	3 23%	6 43%	– –

*3 total patients from initial 45 censored from analysis for lack of requisite data.

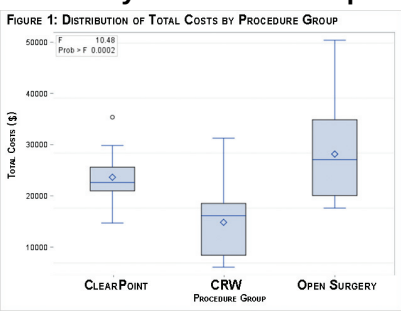
Table 2 - Differences in Mean Cost

Table 2: Difference Between Mean Costs for Significant Univariate Effects

	ClearPoint - CRW			ClearPoint - Open Surgery			CRW - Open Surgery		
	Mean Difference	99.62% CL Lower	Upper	Mean Difference	99.62% CL Lower	Upper	Mean Difference	99.62% CL Lower	Upper
Total Charge	31,773	5,550	57,996	16,990	-8,809	42,788	-14,783	-40,084	10,517
Total Costs	8,204	-1,221	17,630	-4,219	-13,493	5,054	-12,424	-21,518	-3,330
Fixed Costs	3,364	-4,991	11,719	-7,073	-15,292	1,147	-10,437	-18,497	-2,376
OR/Anesthesia Time	6,165	3,504	8,826	-1,327	-3,945	1,291	-7,492	-10,060	-4,924
Hospitalization Costs	-526	-3,604	2,553	-5,900	-8,929	-2,872	-5,375	-8,345	-2,405
Test Costs	-549	-1,164	66	-1,325	-1,930	-720	-776	-1,369	-182
Misc Costs	13	-121	146	141	10	272	129	0	257
Length of Stay*	0	-1	1	-4	-6	-2	-3	-6	1

*Absolute difference in length of stay rounded to nearest whole day; All other values in table represent absolute differences in cost in USD ($). CL = confidence limits at Bonferroni alpha correction of critical p=0.0038.

Figure 1 - Distribution of Total Cost by Procedure Group



Results

Significant differences were found for Total Costs ($F[2,38]=10.48$, $p=0.0002$), OR/Anesthesia Time ($F[2,38]=54.90$, $p<0.0001$), Hospitalization and Test Costs ($p<0.0001$). Differences in Total Cost comparing ClearPoint with CRW (99.62% CI: [-$1,221 , $17,630]), and ClearPoint with Open surgery (-$13,493 , $5,054) were not significantly different. ClearPoint OR/Anesthesia Time costs were $6,165 ($3,604 , $8,826) more than CRW. Hospitalization costs were higher for Open Surgery than ClearPoint or CRW ($p<0.0001$) which were not significantly different from each other ($p=0.675$). No differences were found for Medication or Procedure Costs. 43% of CRW patients required additional operations to achieve seizure freedom, versus only 23% among ClearPoint patients.

Learning Objectives

- Recognize the key advantages of iMRI methods in the context of laser ablative procedures
- Appreciate important differences in the relative economic burden of each of the three surgical approaches discussed
- Identify key areas for potential cost reduction and future quality improvement

Conclusions

Relative to open surgery, minimally invasive approaches offer measurable reductions in cost. Total Cost of ClearPoint likely falls between that of the comparators. OR/Anesthesia Time costs account for >75% of the total cost difference, representing a 5 hour difference in procedure length. Additionally, ClearPoint was associated with fewer reoperations. The ClearPoint iMRI targeting system is an economically sound alternative to established targeting methods and open surgery.

References

1.Willie JT, Laxpati NG, Drane DL, et al. Real-time magnetic resonance-guided stereotactic laser amygdalohippocampotomy for mesial temporal lobe epilepsy. Neurosurgery. 2014;74(6):569-584; discussion 584-585. **2.**Curry DJ, Gowda A, McNichols RJ, Wilfong AA: MR-guided stereotactic laser ablation of epileptogenic foci in children. Epilepsy Behav 24:408–414, 2012 **3.**Carpentier A, McNichols RJ, Stafford RJ, Itzcovitz J, Guichard J-P, Reizine D, et al: Real-time magnetic resonance-guided laser thermal therapy for focal metastatic brain tumors. Neurosurgery 63:ONS21-28-29, 2008 **4.**Alexander E III, Moriarty TM, Kikinis R, Black P, Jolesz FM. The present and future role of intraoperative MRI in neurosurgical procedures. Stereotact Funct Neurosurg. 1997;68(1-4 pt 1):10–17. **5.**Hall WA, Liu H, Martin AJ, Maxwell RE, Truwit CL. Brain biopsy sampling by using prospective stereotaxis and a trajectory guide. J Neurosurg. 2001;94(1):67–71. **6.**De Salles AA, Frighetto L, Behnke E, et al.. Functional neurosurgery in the MRI environment. Minim Invasive Neurosurg. 2004;47(5):284–289. **7.**Larson PS, Starr PA, Bates G, Tansey L, Richardson RM, Martin AJ. An optimized system for interventional magnetic resonance imaging-guided stereotactic surgery: preliminary evaluation of targeting accuracy. Neurosurgery. 2012;70(1 Suppl Operative):95-103; discussion 103. **8.**Starr PA, Martin AJ, Larson PS. Implantation of deep brain stimulator electrodes using interventional MRI. Neurosurg Clin N Am. 2009;20(2):193–203. **9.**Ostrem JL, Ziman N, Galifianakis NB, et al. Clinical outcomes using ClearPoint interventional MRI for deep brain stimulation lead placement in Parkinson's disease. J Neurosurg. 2016;124(4):908-916. **10.**Starr PA, Markun LC, Larson PS, Volz MM, Martin AJ, Ostrem JL. Interventional MRI-guided deep brain stimulation in pediatric dystonia: first experience with the ClearPoint system. J Neurosurg Pediatr. 2014;14(4):400-408.