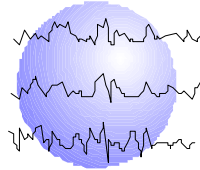


# **NEUROPSYCHOLOGICAL OUTCOME OF DOMINANT FRONTAL TOPECTOMY IN CHILDREN AND ADOLESCENTS**

Ann Hempel, PhD  
Gail L. Risse, PhD  
Michael D. Frost, MD  
Frank J. Ritter, MD



This paper has been prepared specifically for:  
American Epilepsy Society Annual Meeting  
Philadelphia, PA  
November 30 – December 5, 2001  
Please consider this information to be preliminary findings.

Minnesota Epilepsy Group, P.A.<sup>®</sup>  
225 Smith Avenue N., Suite 201  
St. Paul, MN 55102  
Phone: (651) 241-5290  
Fax: (651) 241-5248

## **ABSTRACT**

**RATIONALE:** Adult studies suggest that dominant frontal topectomy (DFT) results in diminished language functions, including verbal fluency and verbal reasoning. This study was aimed at assessing cognitive outcome following DFT in a pediatric epilepsy population.

**METHODS:** Patients included eight children and adolescents ranging in age from 7 to 16 years (mean = 12) at the time of surgery. Six evidenced cryptogenic epilepsy and two experienced seizures secondary to low grade tumor. In four patients with cryptogenic seizures, the frontal region anterior to language was resected, and in two patients resection spared the inferior frontal gyrus and frontal pole. Surgery was limited to tumor resection in one patient. In the second tumor patient surgery also involved multiple subpial transection (MST) over language cortex and resection of the epileptogenic region anterior to the language area. All patients underwent cortical mapping of language and motor areas via stimulation of a subdural electrode array prior to resection. Patients underwent neuropsychological testing prior to and four to 13 months following DFT (mean = 9 months). Changes in confrontation naming, verbal fluency, verbal intelligence, and problem solving were analyzed.

**RESULTS:** Both tumor patients evidenced stable or improved verbal IQ, verbal fluency, and problem-solving post-operatively; one experienced a mild (.5 SD) decline in confrontation naming. A 1-2 SD decline in verbal fluency was noted in five of six patients with cryptogenic epilepsy. A 1-2 SD decline was noted on at least one of two indices of problem solving in two of these patients. Two cryptogenic seizure patients evidenced mild decline in VIQ and two displayed decline in confrontation naming. By parent report, cryptogenic seizure patients who experienced decreased problem-solving on formal testing were nonetheless described as having improved self-awareness or social judgment postoperatively. No patient was reported by parents to have experienced an adverse behavioral change.

**CONCLUSION:** Neuropsychological outcome in pediatric patients is similar to that observed in adults. Diminished verbal fluency and, less frequently, diminished problem-solving, confrontation naming and verbal IQ, were observed primarily in patients undergoing extensive frontal topectomy for cryptogenic epilepsy. Patients undergoing resection for tumor removal experienced minimal cognitive changes and often improved verbal functioning, even in the patient who underwent MST and extensive frontal topectomy of the epileptogenic region. Parent report suggests that improved seizure control may result in nonspecific improvements in mental efficiency and social behavior that may offset mild declines in executive abilities and language observed on formal testing. There was not a significant relationship between postoperative seizure frequency/medications and cognitive/psychosocial outcome.

[Epilepsia 42 Suppl. 7:160 \(Abst. 2.181\), 2001](#)

## **INTRODUCTION**

Epilepsy surgery involving tailored focal cortical resection of the dominant frontal lobe has the potential to significantly improve seizure control in an important subgroup of patients with intractable epilepsy. However, few data are available on the cognitive and psychosocial outcomes of patients who undergo this procedure, and even fewer data are available on cognitive and psychosocial outcomes in pediatric patients. Available data suggest that adult patients who undergo dominant frontal topectomy (DFT) may experience diminished verbal fluency postoperatively, whether resections are limited to tumor removal (2) or extend to the orbitofrontal region in cryptogenic seizure patients (3). A degree of decline in verbal reasoning has been observed in DFT patients who experienced transient aphasia following tumor resection involving the premotor/SMA. A slight decline in problem-solving and cognitive flexibility was only infrequently observed in an adult DFT sample (3). Farnham et al (1) reported that approximately 50% of adult patients experienced increased emotionality following either dominant or nondominant frontal topectomy, regardless of size of resection or preoperative executive functioning. The present study examined the outcome of pediatric DFT patients with respect to frontal/executive functions and language functions that are, at least in part, subserved by the dominant frontal region. This study also investigated the psychosocial outcome of pediatric DFT patients.

## **METHODS**

Patients included eight children and adolescents (3 male, 5 female) ages 7-16 years at the time of surgery who underwent dominant frontal topectomy (DFT). General patient information is presented in Table 1. Six patients evidenced cryptogenic seizures and two experienced seizures associated with low grade tumor. Full scale IQ at the time of preoperative testing ranged from 65-94 (mean = 80.4). With the exception of the youngest patient, who displayed bilateral language representation, all patients were found to be left hemisphere dominant for language on intracarotid amobarbital procedure. Patients underwent a comprehensive cognitive test battery pre- and postoperatively. Prior to surgery, six patients held a diagnosis of ADHD and one displayed clear ADHD features, although the diagnosis could not be confirmed. All patients underwent cortical mapping of language and motor areas via stimulation of a subdural electrode array prior to resection.

Two patients with cryptogenic seizures underwent DFT involving the region anterior to the precentral gyrus, sparing the inferior frontal gyrus and frontal pole. One of these patients also underwent anterior 2/3 corpus callosotomy and suffered a stroke inferior and medial to the area resected. Two cryptogenic seizure patients underwent nearly complete resection extending from just anterior to the precentral gyrus to the frontal pole, and two of these patients also underwent anterior 2/3 corpus callosotomy.

One tumor patient underwent tumor resection only involving the region of the superior and middle frontal gyri. The second tumor patient had previously undergone partial tumor resection at another facility. Her second surgery involved resection of residual tumor, resection of the frontal pole, and multiple subpial transection (MST) over the frontal language area.

Patients underwent follow-up neuropsychological testing 4 - 13 months postoperatively (mean = 8.75 months). Parents were also asked to report any observed changes in cognitive or behavioral functioning. Parent observations and patients' postoperative performance on measures of language functions and problem-solving were examined in relation to extent of resection and postoperative changes in AEDs and seizure frequency. Test variables included the verbal subtests of the Wechsler Intelligence Scale for Children - Third Edition, Controlled Oral Word Association Test (COWAT), Boston Naming Test (BNT), and Wisconsin Card Sorting Test (WCST). In the youngest patient (patient 8), verbal fluency was assessed with the McCarthy Verbal Fluency subtest, and problem-solving was assessed with the NEPSY Tower subtest.

## **RESULTS**

Pre- and postoperative test scores are presented in Table 2. With the exception of the NEPSY Tower scores, which are presented as scaled scores (mean = 10, SD = 3), test results are presented in the form of standard scores (mean = 100, SD = 15).

All patients experienced significantly improved seizure control. Patient 2 continued to experience multiple seizures per week, and seizure frequency in two patients (patients 7 and 8) decreased from multiple seizures per day to no more than several per week that occur exclusively during sleep. The remaining patients achieved complete or nearly complete seizure control.

Both tumor patients, even patient 3 (who underwent MST and extensive frontal topectomy and was maintained on the same AEDs at follow-up) evidenced stable or improved functioning overall. A slight decline (.5 SD) in confrontation naming was noted in the patient with tumor resection only. Neither patient was observed by parents to have experienced other than stable or improved cognitive and behavioral functioning postoperatively.

Patient 6, who experienced a stroke in the region proximal to the resected area, displayed increased perseverative errors on the WCST and diminished verbal fluency (VF). This patient's mother reported increased word-finding difficulties. Four of the five other patients who underwent frontal topectomy for cryptogenic seizures also experienced  $\geq 1$  SD decline in VF. Patient 2, who underwent the largest resection and continued to experience frequent seizures postoperatively, evidenced  $\geq 1$  SD declines on all language measures, including VIQ. Parents also

reported increased word-finding difficulties in this individual. Of the remaining four cryptogenic seizure patients, one displayed a .5 SD decline in VIQ, and one displayed a 1 SD decline in confrontation naming. Postoperative language functioning by parent report was stable or slightly improved in three of these four individuals. Problem-solving was stable or improved in all but two cryptogenic seizure patients; however, parents reported improved abstract thinking in one of these patients and improved social judgment in the other patient.

All but one ADHD patient continued to experience significant ADHD symptoms, although none displayed exacerbation of these symptoms postoperatively. By parent report, none of the patients evidenced an adverse change in emotional or behavioral functioning postoperatively. Several were described by parents as more alert, happy, and/or mentally efficient.

## **DISCUSSION**

Children and adolescents who undergo DFT often experience mild or greater decline in verbal fluency, as has been observed in adult patients, and may also experience a degree of decline in problem-solving, word retrieval, and/or verbal IQ. However, most patients are observed by parents to be functioning as well as or better than they did preoperatively with respect to psychosocial adjustment, mental efficiency, and language. This suggests that generally subtle declines on formal testing may be offset by positive effects of improved seizure control. The patient experiencing the greatest decline in language was also the patient who underwent the most extensive resection, raising the possibility that close proximity of the resected area to language areas identified during cortical mapping may be a factor in language outcome. Because the postoperative interval was relatively brief (less than one year in most patients), it is unclear whether further improvement may be forthcoming.

## **CONCLUSIONS**

1. Children and adolescents who undergo DFT appear to experience a similar neuropsychological outcome as adults, in particular, diminished verbal fluency.
2. Declines in verbal fluency and generally mild declines in VIQ, confrontation naming, or problem-solving on formal testing may be inconsistent with parent report of stable or improved postoperative functioning, suggesting the practical implications of test findings may be limited.
3. Cognitive outcome may be more favorable in those undergoing DFT for tumor resection.

## **REFERENCES**

1. Farnham SJ, Risse GL, Hempel A, Moriarty GL, Penovich PE, Gates JR. Psychosocial outcome in patients after frontal lobe resection. *Epilepsia* 1998; 39(S6):224.
2. Helmstaedter C, Gleibner U, Zentner J, Elger CE. Neuropsychological consequences of epilepsy surgery in frontal lobe epilepsy. *Neuropsychologia* 1998;26(4):333-341.
3. Risse G, Mercer K, Penovich P, Moriarty G, Gates J, Fangman M. Cognitive outcome in patients undergoing surgical resection of the frontal lobe. *Neurology* 1996;46(S2):A213.

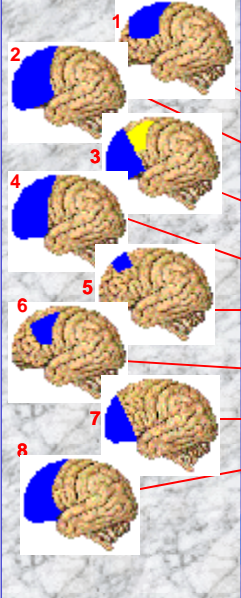
Table 1

**Patient Information**

Patient	Sex	Age of Sz onset (yrs)	Etiology	Age at surgery (yrs)	Follow-up (months)	AEDs pre-op	AEDs post-op	Sz freq pre-op	Sz freq post-op	Complications
1	F	1.1	Cryptogenic	8.2	6	CBZ, GBP	CBZ, TPM	2-5/day	None	None
2	M	6	Cryptogenic	8.7	4	CBZ	CBZ, GBP	7/week	3-4/week	None
3	F	8.1	Tumor	13.8	9	FBM, GBP, PB	FBM, GBP, PB	1/week	None	None
4	F	3.5	Cryptogenic	15	13	CBZ, LTG	CBZ, LTG	1-2/day	None	None
5	F	15.8	Tumor	16.3	9	CBZ	None	1/month	None	None
6	M	6	Cryptogenic	16.5	13	FBM, CBZ, GBP	PHT	1-2/day	Rare	Infarction inferior and mesial to area resected
7	F	6	Cryptogenic	13.1	11	LEV, PHT	LEV, OXC	2-4/day	Up to several/week	None
8	M	4	Cryptogenic	7.5	5	TGB, PHT, FBM, ZNS, LZP	OXC, PHT, ZNS	10/day	Poss. 1-2/week	None

Table 2

**Cognitive Test Data**



Patient	VIQ pre-op	VIQ Post-op	BNT pre-op	BNT post-op	WCST-cat pre-op	WCST-cat post-op	WCST-PE pre-op	WCST-PE post-op	VF pre-op	VF post-op
1	95	87	77	93	70	92	---	92	79	55
2	72	56	70	43	92	115	84	101	104	68
3	83	84	66	76	72	107	83	101	58	107
4	97	91	83	92	89	61	84	48	65	45
5	83	91	82	73	49	107	86	80	85	102
6	71	75	64	70	61	61	77	55	95	70
7	80	75	90	76	< 50	< 50	---	---	56	45
8	57	52	34	31	*	*	---	---	**80	**50

Improvement of .5 - 1 SD    Improvement of > 1 SD    Decline of .5 - 1 SD    Decline of > 1 SD

■ Area Resected  
 ■ MST

VIQ = Verbal IQ                      SD = Standard Deviation                      VF = Verbal Fluency  
 BNT = Boston Naming Test                      Cat = Categories  
 WCST = Wisconsin Card Sorting Test                      PE = Perseverative Errors

\*NEPSY Tower  
 Scaled Score = 6 (Mildly impaired) at pre-op,  
 9 (Average) at post-op

\*\*MST McCarthy Verbal Fluency

Table 3

**ADHD Status and Parent Report of Functional Outcome**

Patient	ADHD-pre	ADHD-post	Parent report of post-op functioning
1	yes	yes - mild	Less impulsive, overactive, and noncompliant. Improved social skills, though somewhat reserved. Organized and conscientious in completing schoolwork. No report of decline in speech, some increased difficulty in understanding math concepts.
2	yes	yes	Word finding difficulty. Forgetfulness that parents attribute to attention problems. Favorable response to Ritalin, but incomplete ADHD symptom control.
3	yes	yes	More assertive and outgoing in a positive way. Improved organizational skills, but inattention still somewhat problematic. Continued difficulty with "putting words together" and reading comprehension.
4	yes	yes	Increased mental efficiency, quicker wit. More aware of when she needs to ask for clarification of schoolwork. Increased confidence in social interaction.
5	yes	yes	More cheerful and upbeat. Continued ADHD-related inattention, disorganization.
6	yes	yes	Word finding problems. Behavior seems improved with maturation (e.g. improved social awareness).
7	No	No	Happier, less tired, conscientious in fulfilling responsibilities. No adverse change in behavior. Greater difficulty in understanding meaning of what she hears and reads. Mild problems with concentration and organization persist.
8	Possible	Possible	More often pesters brother, but well-behaved and productive in class. Speech articulation is clearer. No increased difficulties with quantity or ease of speech. Making greater progress academically.