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Standard versus tailored left temporal lobe resections: Differences in cognitive outcome?

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Abstract

This study explores differences in cognitive outcome after a standard resection (SR) or tailored (TR) in 100 patients with left temporal lobe epilepsy, controlling for extent in the three lateral gyri. Comparing preoperative to 6-month postoperative performance on a battery of intelligence, language and verbal memory tests revealed the following: a differential effect of the procedure was found for digit span, a short-term memory and attention task, the SR group showing a gain and the TR group a loss postoperatively. This could be explained by a rather large improvement of the SR group with below average resection sizes in the superior temporal gyrus (STG) (<2.8 cm), which small resections are nearly absent in TR resections. Effect of larger extent on the STG in the SR group was related to a decrease in verbal intelligence and a tendency in auditory comprehension which poses a risk in 'large' standard resections. Differences in extent of resection on the other gyri did not cause differences in effects on language functioning or verbal memory.

Conclusions: In standard anterior temporal lobe resections only (without intraoperative language mapping) up to a limit of 4.5 cm, large resections on the STG pose a risk for declining on verbal IQ and auditory comprehension. In general, tailored resections (with language mapping) result in decline on a task measuring short-term memory and attention.

Keywords: Epilepsy surgery; Anterior temporal lobectomy; Penfield procedure; Neuropsychology; Anaesthesia

1. Introduction

Anterior temporal lobectomy is a well-recognized and worldwide applied treatment of intractable epilepsy. In general, there are two main options in performing left (language-dominant) anterior temporal resections: (1) amygdalo-hippocampectomy, together with a neocortical resection without intraoperative cortical language mapping (standard resection, SR), which normally limits the resection to 3–4 cm or (2) tailored resection (TR) with electrical stimulation mapping of eloquent cortex in which the resection, in principle, is limited only by the location of language sites found with intraoperative electrical stimulation (IOES). The latter was introduced by Wilder Penfield (Penfield & Jasper, 1954) who described a wealth of elicited behaviour and sensations after electrically stimulating neo- and archicortex. This method has been extensively refined into mapping eloquent cortex (Ojemann, 1979, 1993) and is being widely applied in the last decades. At first sight there are only advantages to an operation with IOES: speech areas can be identified and thus minimize postoperative loss of function. However, the procedure is often stressful, cooperation of the patient is very important and cannot always be estimated beforehand. Therefore a group of patients who would need a larger resection cannot be operated under "Penfield conditions" and have to be offered a SR. Apart from a lessened chance of seizure freedom in this particular group it can

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be questioned if a "standard" resection also renders a "standard" chance on naming difficulties.

Reports on language deficits after SR are not conclusive. Several studies (Hermann, Wyler, & Somes, 1991; Wyler & Hermann, 1988) even suggest a positive effect on receptive language which they attributed to a greater seizure-free outcome in this group and thus a greater reduction of "neural noise". In a large group study (Hermann, Wyler, Somes, & Clement, 1994), only 7% exhibited some form of dysnomia 6 months after operation which seemed to be related to a later onset of epilepsy. Notwithstanding these positive reports, other studies found language related deficits after surgery which do remain at least one year after (Langfitt & Rausch, 1996). In this study the deficits correlate with age and postoperative interval, which might suggest that compensating mechanisms like plasticity come into effect. It should not be surprising that age also is an important factor. Early risk factors like febrile convulsions before the age of 5 seem to protect against naming decline (Hermann, Perrine et al., 1999; Saykin et al., 1995; Stafiniak et al., 1990). This phenomenon is explained by assuming a different and more widespread cerebral representation of naming after an early insult. This was confirmed in more theoretical studies (Schwarz, Pauli, & Stefan, 2005). Additionally, most of these patients have mesiotemporale sclerosis (MTS) as primary origin of their seizures which could be the main factor and explain that age is involved (Davies, Bell, Bush, Hermann et al., 1998).

Surgery under TR in general permits larger resections, which in itself could lead to decline in function. In a comparison between SR and TR, the cognitive results of SR tended to be better (Hermann & Wyler, 1988a, 1988b). A later study on the differential effects of resection with or without the superior temporal gyrus (STG) (Hermann, Perrine et al., 1999) showed significant decline in visual confrontation naming following left anterior temporal lobectomy (ATL), regardless of surgical technique. A correlation was found between decline and later age of onset and with extent of resection. Later age of onset was also found to be a related factor in a study with extraoperative language mapping (Davies, Risse, & Gates, 2005), but extent of resection was not.

Based on these findings, we hypothesized that the extent of resection under SR as well as TR might correspond to greater functional impairment and thus might be worse after TR which involves larger resections. We tested this hypothesis by assessing the effect of extent of resection in the three lateral temporal gyri under SR versus TR.

2. Methods

The 100 subjects of this retrospective study were all patients with intractable temporal lobe epilepsy enrolled in the Dutch Collaborative Epilepsy Surgery Program, a multidisciplinary working group (Presurgical Evaluation Protocols, 1993). Patients were examined between 1986 and 2004 for the possibility of resection of an epileptic focus. Area and focus side were assessed primarily by electroencephalographic recordings based on scalp electrodes and, in uncertain cases, by depth electrodes. All patients had undergone extensive MRI studies and some underwent also a PET (FDG and flumazenil). They also had intracarotid sodium amobarbital testing for assessment of cerebral dominance before surgery (Alpherts, Vermeulen, & van Veelen, 2000). Only patients that were left hemisphere dominant for speech were included. Table 1 presents the demographic and clinical characteristics of the group.

Table 1
Demographic and clinical characteristics

	Standard resection	Tailored resection ("Penfield")
n (male/female)	54 (27/27)	46 (21/25)
Age at seizure onset[a]	12.1 (8.5)[a]	12.0 (7.6)
Age at surgery	37.2 (8.3)	32.3 (9.1)[**]
Test intervals (years)		
Pre-surg.–surg.	0.9 (0.7)	0.9 (0.7)
Surg.–post-surg.	0.7 (0.3)	0.7 (0.5)
Extent of resection (cm)		
STG	2.8 (1.1)	4.0 (1.1)
MTG	3.5 (0.9)	4.4 (1.7)
ITG	3.7 (1.3)	4.7 (0.8)
Pathology		
Not abnormal	–	3
MTS exclusively	39	28
Dual pathology	3	5
Cortical dysplasia	2	–
Vascular malformation	1	1
Neoplastic	8	9
Unknown	1	–
Handedness[b]	44/9/1	42/3/1
Outcome[c]	28/13/12/1/0	28/8/5/4/1

$n = 100$.
[a] S.D.s in brackets.
[b] Numbers in category right handed/left handed/ambidexter.
[c] Numbers in category 1A, 1B-1D, 2, 3, 4 of Engel's classification scheme (Engel et al., 1993).
[**] $p < 0.01$.

Gender and age at seizure onset are uniformly spread among both groups. TR was offered to patients who were significantly younger. The SR group consisted of 81% right handers as opposed to 91% in the TR group. The diagnosed pathology was evenly spread among the two groups. It mainly showed exclusively mesiotemporal sclerosis (MTS) of 72% in SR and 61% in TR group, which is not significantly different.

2.1. Surgical procedure

All 100 subjects underwent a partial resection of the dominant anterior temporal lobe, including the amygdalo-hippocampal complex. Resections were performed with intraoperative electrocorticography. The decision on which type of surgery should be offered was made in the epilepsy working group and was based on information presented mainly by EEG (Leijten, Alpherts, Van Huffelen, Vermeulen, & Van Rijen, 2005). SR normally was offered in cases without neocortical involvement. If neocortical involvement was suspected, a TR was offered if the patient could sustain the procedure. The mapping procedure was applied in 40 subjects. Electrical stimulation was produced by a Grass model S-88. Hand-held bipolar electrodes were used, spaced 7 mm apart which delivered 40 Hz 0.3 ms monophasic square pulses at 4–12 mA. The neuropsychological test consisted of a computerized set of 260 black and white drawings (Alpherts, Aldenkamp, & Van Veelen, 1997; Snodgrass & Vanderwart, 1980). The advantage of using this set is that the pictures have been standardized on four variables of central relevance to cognitive processing: name agreement, image agreement, familiarity and visual complexity. Besides these parameters, the naming time of each picture is assessed (Snodgrass & Yuditsky, 1996). Critical areas were those areas which successively yielded hesitations or near-errors and were tested at least three times. The procedure is similar to the procedure described by Ojemann (1987). Change of medication was not considered until two years after the operation.