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Intelligence two years after epilepsy surgery in children ☆

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ABSTRACT

Intelligence before and two years after epilepsy surgery was assessed in 94 children and adolescents and related to preoperative IQ and seizure outcome. The median full-scale IQ was 70 before and two years after surgery. The proportion with a higher or unchanged postoperative IQ was 24 of 49 (49%) of those with an IQ of 70 and more before surgery, nine of 17 (53%) of those with an IQ of 50–69, and ten of 28 (36%) of those with an IQ of less than 50. A significant difference was found between the 47 individuals who became seizure-free and the 47 with persisting seizures, as 60% of the seizure-free children had a higher or unchanged IQ compared with 32% of the 47 who were not seizure-free. The cognitive outcome of children with intellectual disabilities was as good as that of children with average IQ. Thus, they should not be excluded from epilepsy surgery on the basis of low intellectual level.

1. Introduction

Drug-resistant epilepsy may have a severe impact on a child's psychosocial adjustment and behavior, and the long-term effects of seizures may affect children's cognitive development in a negative way [1–4]. Early epilepsy surgery has the potential to reduce or even prevent a cognitive decline [5,6]. Intellectual disabilities are common in children with medically intractable epilepsy [4], and these children have been shown to have a postoperative seizure outcome similar to that of patients with an average intelligence quotient (IQ) [7,8]. As a result, a low IQ should not be a reason for questioning a patient as a possible surgery candidate. Furthermore, a better outcome after surgery can be expected in patients operated on at a younger age and with a shorter duration of epilepsy [9]. Most studies have reported on seizure outcome after specific surgical procedures, such as temporal lobe resection [10,11] or hemispherectomy [12–14]. As clinicians, we meet children with medically intractable epilepsy and intellectual disabilities, but there are relatively few studies describing the cognitive outcome in unselected children with epilepsy severe enough to justify neurosurgery of any type, especially for the subgroup of children with a low IQ [6,9,15]. Such an approach could help in the clinical setting with an unselected group of children with medically intractable epilepsy.

The aim of this study was therefore to to evaluate cognitive functions before and two years after surgery in a consecutive series of pediatric patients. Specific objectives were to relate cognitive effects to seizure outcome and type of surgery and to explore the effect on IQ in children with a low preoperative IQ.

2. Patients and methods

One hundred and ten children and adolescents underwent epilepsy surgery between 1987 and 2006 at Sahlgrenska University Hospital in Gothenburg and had a structured two-year follow-up. Medical data and outcomes have been presented in a recent paper [16]. Ninety-four of them, 48 (51%) females and 46 males, aged eleven months to 18.7 years, had complete pre- and postoperative assessments of intelligence. Nine children, most of them with a severe or profound learning disability, were not formally tested, three children from other Scandinavian countries did not have a neuropsychological follow-up in Gothenburg, one child was lost to follow-up, and two more children were assessed only with the verbal part and one only with the performance part of the Wechsler Intelligence Scale for Children (WISC). These 16 children were not included in this study.

Resections were performed in 83 (88%) of the 94 children and adolescents: in the temporal lobe in 31, in the frontal lobe in 20, in the parietal lobe in seven, in the occipital lobe in three, multilobe resection in 12, and hemispherectomy in ten children. Forty-three of the 83 resections were performed in the right hemisphere and 40 in the left. Eleven children (12%) had nonresective surgery: seven callosotomies, two disconnections of hypothalamic hamartomas, and two multiple subpial transections (MST). The age at operation,

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duration of epilepsy, gender, and type and side of surgery are presented in Table 1.

The individual's level of functioning and mental age rather than the chronological age were taken into consideration when choosing the method for assessing intelligence or developmental level in learning-disabled children. When an age-appropriate test instrument could not be used, a developmental quotient (DQ) or IQ equivalent was calculated (mental age / chronological age × 100). Hereinafter, IQ will consistently be used to represent DQ/IQ. The Swedish versions of the following tests were used: the Griffiths' Developmental Scales, WPPSI-R, WISC or WISC-III, and WAIS-R. The Raven Coloured Progressive Matrices (RCPM), together with the Speedy Performance Test of Intelligence (SPIQ I and II), were used to measure nonverbal and verbal intelligence in four children in the early years of the study period. A full-scale intelligence quotient (IQ) of >69 was considered to be within the normal range, an IQ of 50–69 was regarded as a mild intellectual disability, and an IQ of <50 was regarded as a moderate-to-severe intellectual disability [17].

2.1. Statistical methods

The median, quartiles (Q_1; Q_3), and range were used to describe intelligence quotients. Distributions of individual changes in full-scale IQ, verbal IQ, and performance IQ between pre- and postoperative assessments, respectively, were described using scatterplots. The Wilcoxon–Mann–Whitney test was used to compare the distributions of changes in full-scale IQ, verbal IQ, and performance IQ two years after surgery between the groups of seizure-free and nonseizure-free children. The difference in the proportion of children and adolescents with a higher or unchanged IQ between the seizure-free group and the nonseizure-free group was analyzed with the chi-square test with Yates' correction for continuity. The 95% confidence interval (95% CI) according to Wilson for the difference in proportions between the two groups was also calculated [18]. A p-value of less than 5% after Holm's sequential correction for multiple tests was regarded as significant. Calculations were performed by software provided by Altman [19].

3. Ethics

According to the Swedish National Board of Health and Welfare, clinicians are obliged to secure the quality of care by performing and reporting the results of clinical studies in everyday practice. Approval from an internal review board is not required for this type of research. All participants or caregivers gave their informed consent to participate in this follow-up. Participants and all data have been handled according to the Helsinki Convention.

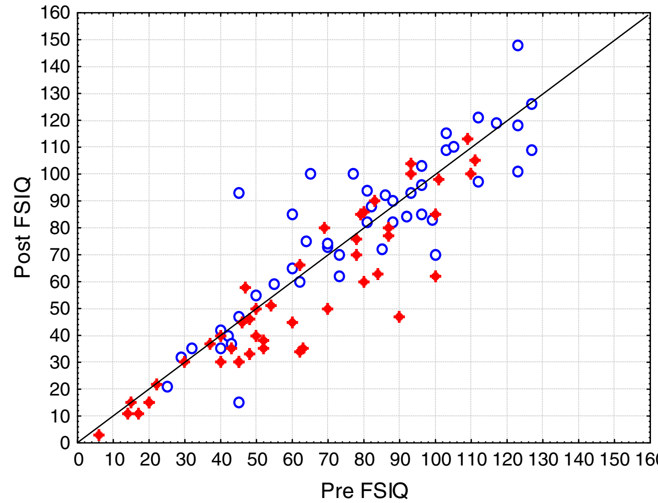

Fig. 1. The pre- versus postoperative full-scale IQ (FSIQ) in 47 seizure-free (circles) and 47 nonseizure-free (crosses) children and adolescents. The median (and quartile) change in FSIQ for the seizure-free group was 2 (−6, 6), whereas it was −5 (−15, 0) for the nonseizure-free group.

4. Results

The distributions of individual changes in full-scale IQ, verbal IQ, and performance IQ are shown in Figs. 1–3. Higher or unchanged full-scale IQ and verbal IQ scores two years after surgery were recorded in 43 (46%) of the 94 children, while 51 (54%) had a higher or unchanged performance IQ (see Figs. 1–3 and Table 2). The median full-scale IQ in the 94 children and adolescents was 70 both before surgery and at the two-year follow-up but with slightly different distributions (Q_1 45; Q_3 93, range: 6–127 and Q_1 38; Q_3 93, range: 3–148, respectively, see Fig. 1). The median levels of the verbal IQ were 74 (Q_1 47; Q_3 99, range: 6–128) before surgery and 70 (Q_1 42; Q_3 95, range: 3–146) at follow-up (see Fig. 2). The median performance IQ was 70 (Q_1 45; Q_3 90, range: 6–126) with the same median of 70 at the two-year follow-up (Q_1 35; Q_3 93, range: 3–143) (see Fig. 3). For comparative reasons, the mean (SD) values for FSIQ, VIQ, and PIQ before surgery were 70 (29.87), 72 (31.38), and 68 (29.66), and the mean (SD) values two years after surgery were 67 (32.17), 68 (32.79), and 67 (32.61).

Table 1
Number, side of operation, gender, age at operation, and duration of epilepsy for the 94 children and adolescents related to the type of operation.

Type of operation	Number	Gender	Age at operation	Duration of epilepsy
	Total n (right:left hemisphere)	n female:male	Md (range, years:months)	Md (range, years:months)
Resections				
Temporal lobe	31 (16:15)	20:11	11:0 (3:8 to 18:7)	6:0 (0:2 to 16:5)
Frontal lobe	20 (8:12)	13:7	11:5 (3:10 to 16:1)	6:3 (1 to 14:11)
Parietal lobe	7 (4:3)	6:1	10:8 (9:6 to 18:4)	5:7 (2:7 to 10:5)
Occipital lobe	3 (2:1)	1:2	13:5 (12:10 to 16:7)	9:1 (0:4 to 13)
Multilobe	12 (8:4)	3:9	9:2 (2:9 to 17:6)	4:11 (2:2 to 10:10)
Hemispherectomy	10 (5:5)	1:9	5:5 (0:11 to 18:4)	5:0 (0:6 to 13)
Total	83 (43:40)	44:39	10:8 (0:11 to 18:7)	5:6 (0:2 to 16:5)
Nonresective surgery				
Callosotomy	7	2:5	9:10 (4:6 to 13:7)	5:6 (3 to 8:6)
Disconnection of hamartoma	2	0:2	11:9 (8:2 to 15:9)	12:0 (8:2 to 15:9)
Multiple subpial transection	2 (0:2)	2:0	15:6 (15:5 to 15:8)	11:10 (11:3 to 12:5)
Total	11 (0:2)	4:7	11:11 (4:6 to 15:9)	8 (3 to 15:9)
Total	94 (43:42; 9)	48:46	10:8 (0:11 to 18:7)	5:9 (0:2 to 16:5)