Neurodevelopmental outcomes in children with large temporal arachnoid cysts

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OBJECTIVE Management of children with large temporal arachnoid cysts (TACs) remains controversial, with limited data available on their neurodevelopmental outcome. The aim of this study was to examine neurodevelopmental outcomes in children with large TACs.

METHODS In this medical center–based cohort study, 25 patients (19 males) who were diagnosed in childhood with large TACs (9 patients [36%] with a Galassi type II and 16 patients [64%] with a Galassi type III TAC) were examined. The mean ± SD age at assessment was 11.1 ± 5.6 years (range 2.7–22 years). Twelve patients (48%) had right-sided, 12 (48%) had left-sided, and 1 (4%) had bilateral cysts. Nine patients (36%) underwent surgery for the cyst. The siblings of 21 patients (84%) served as control participants. Neurodevelopmental function was assessed using the Adaptive Behavior Assessment System (ABAS), Vanderbilt Behavioral Rating Scale (VBRS), and Developmental Coordination Disorder Questionnaire (DCDQ), and quality of life was measured using the treatment-oriented screening questionnaire (TOSQ). The results of all instruments except for TOSQ were compared with those of the sibling control participants.

RESULTS The mean ± SD ABAS score of the patients was 93.3 ± 20.09 compared with 98.3 ± 18.04 of the sibling control participants (p = 0.251). Regarding the incidence of poor outcome (ABAS score < 80), there was a trend for more patients with TAC to have poor outcome than the sibling controls (p = 0.058). Patients who underwent surgery scored significantly worse with regard to the VBRS total score compared with those who did not (p = 0.020), but not on ABAS, DCD, or TOSQ. The mean score of the cognitive and psychological items on TOSQ was lower than that for the physical items (p < 0.001).

CONCLUSIONS Children with a large TAC performed similarly to their sibling control participants in neurodevelopmental function. However, a subgroup of those with cysts did have an increased risk for poor outcomes in general function. Neurodevelopmental assessment should be part of the management of all patients with TAC.

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KEY WORDS arachnoid cyst; follow-up; neurodevelopment; quality of life; brain congenital anomalies; hydrocephalus

Intracranial arachnoid cysts are often discovered as incidental findings on imaging performed for the evaluation of head trauma, seizures, and developmental delay. However, arachnoid cysts may produce symptoms due to increasing intracranial pressure.10 The prevalence of arachnoid cysts in children is approximately 2.6% compared with adults, for whom the prevalence ranges from 1.1%34 to 2.3%,26 thereby suggesting the resolution of cysts in certain cases. Most arachnoid cysts arise in the middle fossa, they more commonly occur in male patients, and the majority are located on the left side.15

Arachnoid cysts in the area of the sylvian fissure have been staged by Galassi et al.7 Conservative management is the rule for Galassi type I cysts, but controversy exists regarding the management of patients with Galassi type II and III cysts.31 Uncertainty exists, especially in young-
er children, regarding whether temporal arachnoid cysts (TACs) tend to grow. Al-Holou et al. found that more than 90% of TACs remained stable with no cases of cyst enlargement, new symptoms, or surgery performed in those patients who are 4 years and older.

Cognitive and behavioral deficits associated with TAC have been suggested, but the findings have not been definitive. Head CT performed in 76 children with mental retardation found only 2 children with arachnoid cysts, a prevalence similar to that of the general population. Lang et al. first reported disturbances of higher cognitive processes in a case series of 10 adults with TAC and frontal arachnoid cyst.

Subsequently, multiple studies performed by a Norwegian group found several neuropsychological deficits in adults with TAC that resolved with surgery. In contrast, Rabiei et al. found no association between arachnoid cysts and cognitive impairment. Spansdahl and Solheim found that anxiety scores were 3 times higher than normal in adults with TAC, with no significant differences between operated and nonoperated patients.

In the only pediatric study to date that assessed cognitive and neuropsychological function in patients with arachnoid cysts, Park et al. found no significant differences between the study and control groups in terms of verbal, performance, or full-scale IQ. No adverse group differences were found in the arachnoid cyst group regarding executive function, inattention, and impulsivity, but the authors noted that 35.7% of patients were outside of the normal range for inattention and 39.7% of patients were outside of the normal range for impulsivity. Similarly, no significant negative differences were seen for depression or anxiety symptoms. The 20 patients who underwent surgery for arachnoid cyst did not show significant differences in intelligence, memory, or anxiety compared with the rest of the population.

In summary, data regarding neurodevelopmental deficits due to TACs and whether they serve as an indication for surgery remain mixed. Thus, the clinician is limited in making recommendations. The aim of this study was to examine neurodevelopmental outcome in children with Galassi type II or III TAC.

**Methods**

**Participants**

This study included a convenience sample of patients with TAC (age range 2–20 years) who presented during the pediatric period with a Galassi type II or III TAC to the Pediatric Neurology Unit or Pediatric Neurosurgery Department at Dana Children’s Hospital, Tel Aviv Medical Center. The sibling with the closest age to each patient served as the control participant. Patients were included if they completed at least 1 of the study questionnaires. For the purposes of this study, classification was based on size (Galassi type I, II, and III) and not dysmorphology. Therefore, for this study, a patient with cyst size consistent with type II but with a skull protuberance above the cyst area was considered to have a Galassi type II cyst.

**Measures**

The following questionnaires were completed by parents and used as proxies for measuring neurodevelopmental function.

**Adaptive Behavior Assessment System–2nd Edition**

The Adaptive Behavior Assessment System (ABAS)—2nd Edition (Hebrew versions; http://www.psychtech.co.il/New/Products/ABASII) generates a general adaptive composite (GAC) score that summarizes performance across all skill areas, except for work, and a subscore for each of the 3 general areas of adaptive behavior as follows. The conceptual composite score summarizes performance across the communication, functional academics, and self-direction skill areas. The social composite score summarizes performance across the leisure and social skill areas. The practical composite score summarizes performance across community use, home living, health and safety, and self-care skill areas. The mean score is 100 with a 15-point standard deviation. This instrument has been used to assess individuals with intellectual disability, learning difficulties, and attention-deficit/hyperactivity disorder. In this study, we used the parent version.

**Vanderbilt Behavioral Rating Scale**

Vanderbilt Behavioral Rating Scale (VBRS) is a behavioral rating scale based on the Diagnostic and Statistical Manual, Fourth Edition criteria for attention-deficit/hyperactivity disorder, oppositional defiant disorder, and conduct disorder. In addition, VBRS includes screens for mood and anxiety symptoms and a rating of child performance. The parent form has 55 items that comprise 6 subsections: attention (items 1–9), hyperactivity-impulsivity (10–18), oppositional defiant disorder (19–26), conduct disorder (27–40), and anxiety and depression (41–47). Symptoms are rated using a 1–3 scale where a positive response is a score of 2 or 3 (often and very often, respectively) that reflects problematic behavior. Overall function (48–55) is rated using a 1–5 scale where a positive response is a score of 4 or 5 that reflects problems in performance. Subscores are generated for each of the subsections. A total score and mean total score were generated by summing or averaging all of the symptom items (1–47). This instrument was administered using either the Hebrew or Arabic translation, as appropriate.

**Developmental Coordination Disorder Questionnaire**

The Developmental Coordination Disorder Questionnaire (DCDQ; Hebrew version) is a parent-completed measure designed to identify subtle motor problems in children that are formally known as developmental coordination disorders. The DCDQ consists of 15 items that include everyday activities (e.g., catching a ball) that children can typically perform. These items are grouped into 3 distinct factors: control during movement, fine motor, and handwriting, and general coordination. The total score ranges from 15 to 75 (a higher score indicates better motor coordination) and suggests the presence, risk, or absence of developmental coordination disorder. The validity
and reliability of the previous Hebrew version of DCDQ were demonstrated for school-aged children in Israel.\textsuperscript{33}

Treatment-Oriented Screening Questionnaire

The presence of physical, cognitive, and/or behavioral deficits and their effects on quality of life (QOL) due to TAC were measured using the treatment-oriented screening questionnaire (TOSQ).\textsuperscript{11} TOSQ measures late effects and identifies specific deficits in survivors of pediatric brain tumors. This questionnaire was designed for patients who are 6–18 years of age. In this study, we used the parent version. Each potential late effect is examined using items that provide an objective assessment of the symptom’s severity and a subjective assessment of the symptom’s influence on the individual’s QOL. The output of TOSQ consists of 12 scores in the areas of endocrinology, neurology, neurosurgery, occupational therapy, ophthalmology, pain therapy, physiotherapy, psychology, sleep therapy, social work, special education, and speech therapy. Most items are scored using a 5-point Likert scale, and each area score is a weighted average of the individual questions in that subsection. Thus, the TOSQ results reflect the patient’s health status in the areas examined, with a higher score suggesting more difficulties.

Procedures

The parents of the children who met the inclusion criteria were provided an explanation of the study. Eighty-nine percent (25 patients) of parents approached agreed to participate. Clinical data were retrieved from the medical records. Cyst location and Galassi type were verified by a senior neurosurgeon (J.R.) based on the most recent findings on MRI for those with no intervention or on the presurgical MRI for those who underwent intervention. We obtained neurodevelopmental information about the patients during the years 2014–2016, using questionnaires as follows: for the identified patient, the parent completed the appropriate ABAS as well as VBRS, DCDQ, and TOSQ. The patient’s sibling who was closest in age served as the sibling control participant and for whom the parents completed the appropriate ABAS, VBRS, and DCDQ assessments.

This study was approved by the medical center’s review board, and fully informed consent was obtained from the parents. The statistical analysis was performed using IBM SPSS Statistics for Windows (version 23.0, IBM Corp.).

Statistical Analysis

Descriptive statistics were used for the categorical variables. Parametric tests were used when at least 30 participants, or at least 15 pairs of participants, completed a certain outcome measure; otherwise, nonparametric tests were conducted.\textsuperscript{23} To determine differences between the patients and sibling controls on ABAS, VBRS, and DCDQ scores, the paired-sample t-test or its nonparametric equivalent, the Wilcoxon signed-rank test, was used for all subsections and percentile rankings where applicable. Pearson’s or Spearman’s correlation coefficients were calculated to determine the differences between these measures in the patients and sibling control participants. To examine the differences between the operated and nonoperated subgroups and for subgroups with different cyst characteristics (right vs left, Galassi type II vs III, frontotemporal vs temporal), the Mann-Whitney U-test or independent samples t-test was performed on the ABAS, VBRS, DCDQ, and TOSQ scores. For dichotomous items, the chi-square test was performed. When statistical power was calculated, this was in accordance with a 2-tailed test.

Results

The study group consisted of 25 patients with Galassi type II or III TAC. See Fig. 1 for representative images of Galassi type II and III cysts in our cohort. We obtained data about the sibling control participants for 21 of these patients. Table 1 presents clinical information for the patients with TAC. Symptom presentation varied, and many patients had multiple symptoms. The majority of the cysts (64%) were Galassi type III. Table 2 provides information for those patients who underwent surgery for the cyst. The indications for surgery and the type of intervention were at the discretion of the surgeon, with more than 1 surgeon managing patients in this cohort.

Demographic information regarding the groups is pre-
sented in Table 3. The age at presentation for all patients with cysts was in the pediatric period, with a majority of patients presenting from the antenatal to preschool period. Male patients predominated in the cohort (76%). The distributions of mean age, sex, and ethnicity did not differ significantly between the patient and sibling control groups. Not all patients completed all questionnaires, thus explaining the different numbers of patients included in the analyses of each of the different instruments (Supplementary Tables 1 and 2).

Adaptive Behavioral Assessment System

Table 4 presents the overall GAC score and subscores of the ABAS questionnaire for the cyst group and the sibling control group. Figure 2 presents the actual GAC scores. Questionnaires were obtained from 20 complete pairs, and 3 additional patients with cysts but without a sibling control participant completed ABAS. The patient and sibling control groups had a 5-point difference in the GAC score that favored the sibling control participants. However, this difference did not reach statistical significance. Effect sizes were weak, thereby indicating that the group means did not substantially differ regardless of the small sample size. Patients with cysts and their sibling control participants were significantly similar with respect to the overall ABAS scores (GAC) and all 3 major subscores. When the analyses were performed in a dichotomous manner—by comparing poor outcome (defined as an ABAS GAC score less than 80) to good outcome—there was a trend for more patients with cysts to have a poor outcome than the sibling control participants (7 of

### TABLE 1. Clinical characteristics of 25 patients with a TAC

<table>
<thead>
<tr>
<th>Clinical Parameter</th>
<th>No. of Patients (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reason for presentation</td>
<td></td>
</tr>
<tr>
<td>Antenatal ultrasonography</td>
<td>3 (12)</td>
</tr>
<tr>
<td>Increasing head circumference</td>
<td>7 (28)</td>
</tr>
<tr>
<td>Headache</td>
<td>5 (20)</td>
</tr>
<tr>
<td>Seizure &amp; learning difficulties</td>
<td>4 (16)</td>
</tr>
<tr>
<td>Incidental finding on imaging</td>
<td>3 (12)</td>
</tr>
<tr>
<td>Visual complaints</td>
<td>2 (8)</td>
</tr>
<tr>
<td>Tourette syndrome</td>
<td>1 (4)</td>
</tr>
<tr>
<td>Surgery</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>9 (36)</td>
</tr>
<tr>
<td>No</td>
<td>16 (64)</td>
</tr>
<tr>
<td>Galassi cyst type</td>
<td></td>
</tr>
<tr>
<td>II</td>
<td>9 (36)</td>
</tr>
<tr>
<td>III</td>
<td>16 (64)</td>
</tr>
<tr>
<td>Side</td>
<td></td>
</tr>
<tr>
<td>Lt</td>
<td>12 (48)</td>
</tr>
<tr>
<td>Rt</td>
<td>12 (48)</td>
</tr>
<tr>
<td>Bilateral</td>
<td>1 (4)</td>
</tr>
<tr>
<td>Lobe</td>
<td></td>
</tr>
<tr>
<td>Frontotemporal</td>
<td>15 (60)</td>
</tr>
<tr>
<td>Temporal</td>
<td>10 (40)</td>
</tr>
</tbody>
</table>

### TABLE 2. Clinical characteristics of the patients who had surgery for TAC

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Surgical Indication</th>
<th>Age at Op (yrs)*</th>
<th>Galassi Type</th>
<th>Age at Study (yrs)</th>
<th>Procedure</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Vomiting &amp; papilledema</td>
<td>2006 (3)</td>
<td>II</td>
<td>12</td>
<td>Yes</td>
<td>CPS</td>
</tr>
<tr>
<td>2</td>
<td>Headaches &amp; hemiparesis</td>
<td>2007 (3)</td>
<td>II</td>
<td>10</td>
<td>Yes</td>
<td>CPS</td>
</tr>
<tr>
<td>3</td>
<td>Macrocephaly</td>
<td>2009 (0.7)</td>
<td>II</td>
<td>6</td>
<td>No</td>
<td>CPS</td>
</tr>
<tr>
<td>4</td>
<td>Cyst growth (asymptomatic)</td>
<td>2009 (0.2)</td>
<td>II</td>
<td>11</td>
<td>No</td>
<td>CPS</td>
</tr>
<tr>
<td>5</td>
<td>Cyst growth (symptomatic)</td>
<td>2009 (0.9)</td>
<td>II</td>
<td>6</td>
<td>No</td>
<td>CPS</td>
</tr>
<tr>
<td>6</td>
<td>Macrocephaly</td>
<td>2010 (3)</td>
<td>II</td>
<td>11</td>
<td>Yes</td>
<td>CPS</td>
</tr>
<tr>
<td>7</td>
<td>Rage attacks</td>
<td>2010 (3)</td>
<td>II</td>
<td>15</td>
<td>Yes</td>
<td>EVD</td>
</tr>
<tr>
<td>8</td>
<td>Headaches</td>
<td>2012 (3)</td>
<td>II</td>
<td>15</td>
<td>Yes</td>
<td>EVD</td>
</tr>
</tbody>
</table>

CPS = cystoperitoneal shunt; EVD = external ventricular drain. *For patients who were younger than 1 year, the age in months is noted in parentheses. †Fenestration failed with symptomatic subgaleal and subdural collection.
20 vs 2 of 20; \( p = 0.058 \)). We were not able to identify any characteristic on ABAS that identified this subgroup of patients with poor outcome.

Comparison of the overall score (GAC) and the 3 subscores revealed no significant differences between operated versus nonoperated patients, Galassi type II versus type III cysts, right- versus left-sided cysts, or frontotemporal versus temporal involvement.

**Vanderbilt Behavior Rating Scale**

Table 5 presents the mean VBRS scores of the patient and sibling control groups. Fourteen complete pairs were obtained, and an additional 3 patients with cysts but without a sibling control participant completed the instrument. Despite the limited power of the small sample, the weak effect sizes of these comparisons suggest that a larger sample size with similar mean values would not have reached statistical significance either.

We found that those patients who underwent surgery had significantly higher mean values on the anxiety and depression subsection (i.e., worse function) than those patients who did not undergo surgery (\( p < 0.027 \)). No significant differences were noted on VBRS between patients with Galassi type II versus type III cysts, right- versus left-sided cysts, or frontotemporal versus temporal involvement.

**Developmental Coordination Disorder Questionnaire**

Table 6 includes the mean scores and the 3 subscores of the DCDQ for patients with cysts and the sibling control participants. Thirteen complete pairs were obtained, and an additional 3 patients with a cyst but without a sibling control participant completed the instrument. No significant differences were found between the patients and their siblings on the DCDQ subscores or total score. As with previous measures, the effect sizes were weak, thereby indicating a low magnitude of difference between the scores of the patients with cysts and the sibling control participants.

No significant differences were found between the operated versus nonoperated subgroups or the left- versus right-sided cyst subgroups. The sample size was insufficient to assess differences in the subgroups of patients with Galassi type II versus type III cysts or frontotemporal versus frontotemporal cysts.

**Treatment-Oriented Screening Questionnaire**

The mean total group scores on TOSQ for those patients with TAC who underwent surgery (90.75 ± 18.53) versus nonoperated patients (91.25 ± 24.86) were not statistically different. The mean group scores for the individual items did not differ between these groups either.

We performed a more detailed examination of the items on TOSQ by looking at the mean scores of each of the individual items and then grouping them into physical or cognitive and psychological items (Fig. 3). The mean score of the cognitive and psychological items (1.86) was significantly more negatively affected than the mean score of the physical items (1.13) (Wilcoxon Z-score = -4.29, \( p < 0.001 \)). In contrast, there were no differences in the individual items between the operated versus nonoperated subgroups, nor were there any differences between right- versus left-sided cysts, Galassi type II versus type III cysts, or temporal versus frontotemporal cysts.

Ninety-two percent of parents reported that their child with a TAC had excellent to good health status, 88% reported that their child was very satisfied or satisfied with their QOL, and 96% reported that their child’s QOL was

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**TABLE 3. Demographic characteristics of the patients with cysts and sibling control participants**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Total Participants</th>
<th>Patients w/ Cyst</th>
<th>Sibling Controls</th>
<th>( p ) Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of participants</td>
<td>46</td>
<td>25</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>Age at assessment, mean (SD) in yrs</td>
<td>11.0 (5.7)</td>
<td>12.7 (4.9)</td>
<td>NS</td>
<td></td>
</tr>
<tr>
<td>Sex, n (%)</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>34 (73.9)</td>
<td>19 (55.9)</td>
<td>15 (44.1)</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>12 (26.1)</td>
<td>6 (50.0)</td>
<td>6 (50.0)</td>
<td></td>
</tr>
<tr>
<td>Ethnicity, n (%)</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td></td>
</tr>
<tr>
<td>Jewish</td>
<td>37 (80.4)</td>
<td>19 (51.4)</td>
<td>18 (48.6)</td>
<td></td>
</tr>
<tr>
<td>Arabic</td>
<td>7 (15.2)</td>
<td>4 (57.1)</td>
<td>3 (42.9)</td>
<td></td>
</tr>
<tr>
<td>Russian</td>
<td>2 (4.3)</td>
<td>2 (100)</td>
<td>0 (0)</td>
<td></td>
</tr>
</tbody>
</table>

NS = not significant.

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**TABLE 4. ABAS scores of the patient and sibling control groups (\( n = 20 \) pairs)**

<table>
<thead>
<tr>
<th>Score</th>
<th>Patients*</th>
<th>Controls*</th>
<th>( p ) Value†</th>
<th>Statistical Power (%)‡</th>
<th>Effect Size§</th>
<th>Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>GAC</td>
<td>93.3 (20.1)</td>
<td>98.3 (18.0)</td>
<td>0.251</td>
<td>13.2</td>
<td>0.18 (weak)</td>
<td>0.598</td>
</tr>
<tr>
<td>Conceptual</td>
<td>96.3 (17.7)</td>
<td>99.0 (17.9)</td>
<td>0.643</td>
<td>7.7</td>
<td>0.07 (weak)</td>
<td>0.496</td>
</tr>
<tr>
<td>Social</td>
<td>93.2 (18.5)</td>
<td>100.4 (21.4)</td>
<td>0.210</td>
<td>20.7</td>
<td>0.20 (weak)</td>
<td>0.476</td>
</tr>
<tr>
<td>Practical</td>
<td>91.9 (20.6)</td>
<td>95.0 (18.4)</td>
<td>0.492</td>
<td>7.9</td>
<td>0.11 (weak)</td>
<td>0.505</td>
</tr>
</tbody>
</table>

* Values are shown as the mean (SD) score.
† Determined using the Wilcoxon signed-rank test.
‡ Calculated using the 2-tailed test.
§ Calculated by dividing the Wilcoxon Z-score by the square root of the number of participants.
excellent to good. Based on the parent reports, 8% of the cohort had a confirmed learning disability, 28% had a suspected learning disability, and 64% had no learning disability.

**Discussion**

This is the first study to focus on neurodevelopmental outcomes in patients with pediatric Galassi type II and III TACs. We found no significant group differences between children with a large TAC and their sibling control participants, though further analysis found a trend that suggested that a minority of such children have abnormal neurodevelopment as manifested by abnormal adaptive function. In contrast, most patients with a large TAC had function

**TABLE 5. VBRS scores of the patient and sibling control groups (n = 14 pairs)**

<table>
<thead>
<tr>
<th>VBRS Score (questions)/Area Examined</th>
<th>Patient*</th>
<th>Control*</th>
<th>$p$ Value†</th>
<th>Statistical Power (%)‡</th>
<th>Effect Size§</th>
<th>No. of Patients w/ Scores Reaching Clinical Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of questions w/ score 2 or 3 (Q1–9)/attention</td>
<td>1.6 (2.7)</td>
<td>1.5 (2.0)</td>
<td>0.906</td>
<td>5.1</td>
<td>0.02</td>
<td>3 Patients w/ Cysts</td>
</tr>
<tr>
<td>No. of questions w/ score 2 or 3 (Q10–18)/hyperactivity &amp; impulsivity</td>
<td>0.8 (1.2)</td>
<td>2.4 (3.1)</td>
<td>0.106</td>
<td>43.7</td>
<td>0.31</td>
<td>0 Siblings</td>
</tr>
<tr>
<td>No. of questions w/ score 2 or 3 (Q1–18)</td>
<td>2.5 (3.3)</td>
<td>3.9 (5.0)</td>
<td>0.329</td>
<td>14.1</td>
<td>0.18</td>
<td>0 Patients w/ Cysts</td>
</tr>
<tr>
<td>No. of questions w/ score 2 or 3 (Q19–26)/oppositional defiant disorder</td>
<td>1.4 (2.1)</td>
<td>2.0 (3.2)</td>
<td>0.858</td>
<td>9.0</td>
<td>0.03</td>
<td>2 Patients w/ Cysts</td>
</tr>
<tr>
<td>No. of questions w/ score 2 or 3 (Q27–40)/conduct disorder</td>
<td>0.2 (0.8)</td>
<td>0.3 (0.8)</td>
<td>0.655</td>
<td>6.3</td>
<td>0.08</td>
<td>1 Patients w/ Cysts</td>
</tr>
<tr>
<td>No. of questions w/ score 2 or 3 (Q41–47)/anxiety &amp; depression</td>
<td>0.3 (0.7)</td>
<td>0.3 (1.1)</td>
<td>0.785</td>
<td>0</td>
<td>0.05</td>
<td>1 Patients w/ Cysts</td>
</tr>
<tr>
<td>No. of questions w/ score 4 or 5 (Q48–55)/overall function</td>
<td>1.1 (2.2)</td>
<td>0.6 (1.4)</td>
<td>0.180</td>
<td>11.1</td>
<td>0.25</td>
<td>3 Patients w/ Cysts</td>
</tr>
<tr>
<td>No. of questions w/ score 2 or 3 (Q1–47)</td>
<td>0.5 (0.4)</td>
<td>0.6 (0.6)</td>
<td>0.753</td>
<td>0.06</td>
<td></td>
<td>3 Patients w/ Cysts</td>
</tr>
<tr>
<td>Total score (actual sum of scores) (Q1–47)</td>
<td>21.6 (17.1)</td>
<td>26.6 (24.0)</td>
<td>0.701</td>
<td>0.07</td>
<td></td>
<td>3 Patients w/ Cysts</td>
</tr>
</tbody>
</table>

* Values are shown as the mean (SD).
† Determined using the Wilcoxon signed-rank test.
‡ Calculated using the 2-tailed test.
§ Calculated by dividing the Wilcoxon Z-score by the square root of the number of participants.
that was normal or above normal. More focused measures of behavior and motor coordination did not reveal any group differences.

We also found that more than 95% of our cohort with cysts reported QOL to be good or better with no difference between those who did and did not undergo surgery for the cyst. Thus, we can state that having a large TAC does not preclude satisfactory QOL. Because we did not have presurgical QOL data on those who underwent surgery, we are unable to make a statement regarding the value of surgery on later QOL outcome. Interestingly, the cognitive and psychological items on TOSQ were noted to be significantly more negatively affected than the physical items.

Temporal cyst location and its possible effect on the areas involved in cognitive function may explain this finding. Our findings further buttress the position that a large TAC can be managed conservatively, notwithstanding indications that suggest otherwise, such as increased intracranial pressure. We suggest that our data support using baseline and ongoing neurodevelopmental assessments as a standard part of the ongoing care of children with a large TAC because a demonstration of normal function would support a conservative approach.

Our finding of a pediatric subgroup with affected neurodevelopment stands in contrast to both the unequivocal negative effects on neurodevelopment reported in patients

<table>
<thead>
<tr>
<th>Score</th>
<th>Patient*</th>
<th>Control*</th>
<th>p Value†</th>
<th>Statistical Power (%)‡</th>
<th>Effect Size§</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total DCDQ</td>
<td>62.5 (12.1)</td>
<td>62.1 (12.9)</td>
<td>0.969</td>
<td>5.1</td>
<td>0.01</td>
</tr>
<tr>
<td>Control during movement</td>
<td>25.6 (5.4)</td>
<td>25.6 (5.6)</td>
<td>0.844</td>
<td>0</td>
<td>0.05</td>
</tr>
<tr>
<td>Fine motor &amp; handwriting</td>
<td>17.0 (3.2)</td>
<td>16.4 (4.1)</td>
<td>0.766</td>
<td>7.2</td>
<td>0.08</td>
</tr>
<tr>
<td>General coordination</td>
<td>19.6 (4.8)</td>
<td>19.8 (4.6)</td>
<td>0.843</td>
<td>5.1</td>
<td>0.05</td>
</tr>
</tbody>
</table>

* Values are shown as the mean (SD).
† Determined using the Wilcoxon signed-rank test.
‡ Calculated using the 2-tailed test.
§ Calculated by dividing the Wilcoxon Z-score by the square root of the number of participants.

FIG. 3. QOL subscores of the patients with TAC. The mean score of the cognitive and psychological items (mean 1.86) was significantly more negatively affected than the score of the physical items (mean 1.13) (Wilcoxon Z-score = -4.29, p < 0.001). Error bars represent the standard deviation for each item. Conc = concentration; paresthes = paresthesia.
with arachnoid cysts by numerous studies performed by a Norwegian group, and the report by Rabiei et al., which found no correlation between negative cognitive effects and arachnoid cysts. Both groups differed from our study in that they examined adult cohorts with various types and grades of arachnoid cysts.

In contrast, and of greater relevance, our findings are generally consistent with the only other pediatric study of neuropsychological function in children with arachnoid cysts in the literature, which found no significantly adverse neuropsychological effects in children with cysts versus controls. However, that study differed from ours in both population and design. The study had a similarly sized but more varied group, with only 54% of the cohort having Galassi type II or III TACs. The study also used a combination of direct measures and questionnaires with clinical nonsibling control participants versus our study, which used more robust sibling control participants.

Finally, in contrast to the study that examined QOL in adults with arachnoid cysts, our findings are more optimistic, with 96% of our patients reporting good or better QOL. Again, the differences between these 2 studies, including patient age and TAC size, limit a more complete comparison.

A notable minority of our cohort functioned above average on ABAS, a measure of adaptive function, despite including patient age and TAC size, limit a more complete comparison.

Conclusion

We have shown that children with large TACs perform similarly to sibling control participants, although a subgroup with low ABAS scores had an increased risk of poor outcomes in general function. These findings support the use of neurodevelopmental assessment as an integral part of the management for all patients with TAC. Future prospective studies of this condition are warranted.

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Disclosures
The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

Author Contributions
Conception and design: Schertz, Constantini, Fattal-Valevski. Acquisition of data: Schertz, Constantini, Esbel, Roth. Analysis and interpretation of data: all authors. Drafting the article: Schertz. Critically revising the article: all authors. Reviewed submitted version of manuscript: all authors. Approved the final version of the manuscript on behalf of all authors: Schertz. Statistical analysis: Schertz, Esbel, Sela, Fattal-Valevski. Administrative/technical/material support: Schertz, Constantini, Esbel, Fattal-Valevski. Study supervision: Schertz, Constantini, Fattal-Valevski.

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Online-Only Content
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