Results of surgical treatment of neurocysticercosis in 69 cases

Benedicto Oscar Colli, M.D., Ph.D., Nelson Martelli, M.D., Ph.D., João Alberto Assirati, Jr., M.D., Hélio Rubens Machado, M.D., Ph.D., and Sylvio de Vergueiro Forjaz, M.D., Ph.D.

Division of Neurosurgery, Department of Surgery, Orthopedics and Traumatology, Hospital das Clínicas, University of São Paulo Medical School, Ribeirão Preto, São Paulo, Brazil

The clinical course of 69 patients with neurocysticercosis who underwent surgery to control increased intracranial pressure (ICP) or cyst removal is analyzed. Increased ICP was caused by hydrocephalus in 63 patients, by cerebral edema in four, and by giant cysts in two. Skull x-ray films showed calcifications in 14% and signs of elevated ICP in 46%. Examination of cerebrospinal fluid (CSF) revealed pleocytosis with eosinophils in 52% of cases and a positive complement fixation test for cysticercosis in 66%. Ventriculography allowed localization of the CSF obstruction and ventricular cysts, and generally differentiated between an obstruction due to cysts and an inflammatory process. Computerized tomography showed cysts in the cerebral parenchyma and ventricular dilatation. Ventricular cysts were best seen when intraventricular metrizamide was used. Intracranial shunting and posterior fossa exploration were less effective in the treatment of hydrocephalus than was ventriculooatrial (VA) or ventriculoperitoneal (VP) shunting, although VA or VP shunting was associated with a high percentage of complications. Quality of survival was good in 87% of the cases in the first 3 postoperative months and in 93% of patients who survived 2 years after surgery. Forty-seven patients (68%) were readmitted one or more times for CSF shunt revision; 14 of them for shunt infection (meningitis). The authors conclude that placement of CSF shunts is indicated in the treatment of hydrocephalus, and cyst removal is indicated only when the cyst exhibits tumor-like behavior. Surgical exploration is also indicated when the diagnosis is uncertain.

Key Words • cysticercosis • hydrocephalus • intracranial pressure • surgical treatment

Neurocysticercosis is the most frequently encountered parasitic infestation of the central nervous system. In 1962, Canelas6 reported that it was found in underdeveloped countries, predominantly in Latin America, Africa, Asia, and some countries of eastern Europe; recently, due to population migration, it has become widespread throughout the world.2,6,12,16,19,21,22,26-28

Taenia solium is a tapeworm that normally parasi-
tizes the human bowel. Its proglottids are eliminated with stool and break open, liberating a great number of eggs containing embryos or oncospheres. The shells of tapeworm eggs normally ingested by pigs are dissolved when in contact with gastric juice, releasing an embryot that crosses the intestinal mucosa and reaches the nerveous system, eyes, muscles, and subcutaneous tissue via the blood and lymphatic circulation. The larvae of Taenia (Cysticercus cellulosae) develop in these tissues. Man contracts cysticercosis when he is infested by these larvae, acquired by heteroinfestation (ingestion of food, generally vegetables, contaminated with stools containing eggs of the Taenia), by external self-infestation (self-ingestion of stool), or by internal self-infestation (reverse peristalsis of proglottids from the bowel to the stomach). Heteroinfestation is the most important epidemiological method of acquisition of these larvae.

Neurocysticercosis is a serious problem because of its high rates of mortality and morbidity, especially when accompanied by increased intracranial pressure (ICP). In our hospital, neurocysticercosis was observed in 2.7% of neurological admissions and in 35.8% of cases with increased ICP alone or in combination with other clinical signs.28 Among the surgical procedures...
selected for treatment of neurocysticercosis, mainly for
care for elevated ICP, were exploration of the pos-
terior fossa, supratentorial decompressive craniecto-
my or craniotomies for cyst removal, intracranial
shunting, and ventriculoatrial (VA) or ventriculoperi-
toneal (VP) shunting. The results of these treatments
have varied. In this study, we have analyzed the diag-
nostic problems and clinical course of a group of 69
patients with neurocysticercosis admitted for surgical
treatment to the neurosurgical division of our institu-
tion over a period of $16\frac{2}{3}$ years.

Clinical Material and Methods

This retrospective analysis reviews the cases of 69
patients with neurocysticercosis who underwent cere-
brospinal fluid (CSF) shunting or cyst removal to con-
trol elevated ICP between January, 1968, and June,
1984. Twenty-three of these patients who were treated
with VA or VP shunting were included in a previous
study.8

In addition to the clinical and epidemiological find-
ings, diagnosis of neurocysticercosis was made by posi-
tive complement fixation testing of the CSF in 44
patients, from analysis of cellular and biochemical
changes in the CSF plus neuroradiological findings in
eight, from surgical plus neuroradiological findings in
seven, from neuroradiological findings in six, and at
autopsy in four. Neuroradiological examination in-
cluded skull x-ray films, carotid angiography, pneu-
moencephalography, central pneumoencephalography,
ventriculography with positive water-soluble contrast
material, and computerized tomography (CT) of the
skull.

Surgical results were judged according to ICP find-
ings as “improved” when there was complete remission
of the signs of elevated ICP, “unchanged” when signs
of intracranial hypertension persisted despite surgery,
and “worsened” when the surgical procedure or its
complications resulted in the patient's death. Some
patients who were considered improved needed one or
more readmissions for shunt revision, and others were
left with sequelae of increased ICP, generally a visual
deficit.

Quality of survival was considered “good” when pa-
tients could return to work, “moderate” when patients
could care for themselves without help, and “poor”
when patients were in a vegetative state. Operative
mortality (death due to surgery or its complications)
was considered as “early” if it occurred during the first
30 postoperative days, and “late” if it occurred after the
30th postoperative day.

Summary of Cases

Clinical Features and Examinations

The patients' age at initial presentation ranged from
5 to 61 years (84.1% were aged between 10 and 50 years
and 42.8% between 20 and 40 years). The duration of
symptoms at admission varied from 1 day to 33 years
(60.9% of patients had symptoms for less than 1 year,
43.5% for less than 6 months, and 20.3% for less than
1 month). The most marked signs and symptoms
observed at admission are listed in Table 1. Increased
ICP was due to hydrocephalus in 63 cases (91.3%), to
an intracranial inflammatory process causing cerebral
edema (pseudotumoral type) in four (5.8%), and to
giant cysts representing a space-occupying mass in two
(2.9%).

The CSF was analyzed in all but one patient, and
several samples were obtained from each patient at
different periods of their illness. The following results
suggested or confirmed the diagnosis of neurocysticer-
cosis: increased opening pressure in 45.2% of cases,
increased cell count in 69.1%, increased eosinophil
count in 52.9%, increased protein level in 44.8%, de-
creased glucose concentration in 27.7%, decreased chlo-
ride content in 3.3%, and a positive complement fixa-
tion test for cysticercosis in 65.7%.

Skull x-ray films were obtained in 63 patients and
showed calcifications that suggested cysticerci in nine
(14.3%) and signs of elevated ICP in 29 (46%). Sellar
erosion was observed in 21 patients (33.3%), suture
widening in six (9.5%), and increased convolutional
markings in three (4.8%). Carotid angiography was
performed in 53 patients and showed hydrocephalus in
48 (90.6%) and expansive processes in two (3.8%);
normal angiograms were obtained in three cases (5.7%).
Ventriculography was carried out in 62 patients (pneu-
moencephalography in four, pneumoventriculography
in 30, and positive contrast ventriculography in 28).
Results of these examinations are summarized in Table
2. Computerized tomography scans of the skull were
Surgical treatment of neurocysticercosis

TABLE 2
Ventriculographic findings in 62 patients

<table>
<thead>
<tr>
<th>Type of Examination</th>
<th>No. of Cases</th>
<th>Normal Studies</th>
<th>Nonobstructive Hydrocephalus</th>
<th>Obstructive Hydrocephalus</th>
<th>Other Cysts</th>
<th>Ventricular Irregularities</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>4th Ventricle</td>
<td>Aqueduct</td>
<td>Lateral Ventricle</td>
<td>3rd Ventricle</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Inflammation</td>
<td>Cysts</td>
<td></td>
<td>Irregularities</td>
</tr>
<tr>
<td>pneumoencephalography</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>central pneumoventriculography</td>
<td>30</td>
<td>1</td>
<td>14</td>
<td>9</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>ventriculography with positive contrast medium</td>
<td>28</td>
<td>0</td>
<td>3</td>
<td>9</td>
<td>12</td>
<td>4</td>
</tr>
<tr>
<td>total cases</td>
<td>62</td>
<td>3</td>
<td>19</td>
<td>18</td>
<td>10</td>
<td>1</td>
</tr>
</tbody>
</table>

TABLE 3
Evolution of increased ICP signs after cerebrospinal fluid shunting*

<table>
<thead>
<tr>
<th>Type of Shunting &amp; ICP Status</th>
<th>Months Postoperative</th>
<th>Years Postoperative</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0-3 &gt; 3-6 &gt; 6-9 &gt; 9-12 &gt; 12-15 &gt; 15-18 &gt; 18-21 &gt; 21-24 &gt; 2-3 &gt; 3-4 &gt; 4-5 &gt; 5-6 &gt; 6-7 &gt; 7-8 &gt; 8-9 &gt; 9-10 &gt; 10</td>
<td></td>
</tr>
<tr>
<td>VA or VP shunting</td>
<td></td>
<td></td>
</tr>
<tr>
<td>improved</td>
<td>50</td>
<td>46</td>
</tr>
<tr>
<td>worsened</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>follow-up ended</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>hypothalamic catheter ventriculostomy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>improved</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>unchanged</td>
<td>9</td>
<td>0</td>
</tr>
<tr>
<td>worsened</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>follow-up ended</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

* ICP = intracranial pressure; VA = ventriculoatrial; VP = ventriculoperitoneal.

obtained in 31 patients. In three of these cases, it was performed after intraventricular injection of metrizamide. Examinations were normal in two cases. Hydrocephalus and ventricular cysts were observed in nine (29%) cases each, parenchymal calcifications in 11 cases (35.5%), low-density areas in 15 cases (48.4%; seven of these with ring-like enhancement of contrast material), and giant cysts, amorphic masses with contrast enhancement, and diffuse cerebral edema in one case each.

Surgical Treatment and Results

The 69 patients were submitted to a total of 98 surgical procedures, including 56 VA or VP shunting operations, 19 posterior fossa explorations, 14 hypothalamic catheter ventriculostomies,11 three Torkildsen ventriculostomies, four supratentorial decompressive craniectomies, and two supratentorial craniotomies for giant cyst removal. The VA and VP shunting procedures involved the use of the following shunts: Hakim in 18, Holter in 17, Pudenz in 17, Ames in three, and Macchi in one. The clinical course of patients treated with CSF shunting is presented in Table 3.

Posterior fossa exploration with or without cyst removal was performed after shunting procedures in 12 patients, before shunting procedures in three, after implantation of a reservoir (similar to the Ommaya variety) in three, and as the only procedure in one patient. Five of six patients who had not previously had shunt placement required posterior fossa shunting. The three patients with a Torkildsen ventriculostomy had early shunt obstruction and were then submitted to a VA or VP shunt placement.

Supratentorial decompressive craniectomies were effective in the control of elevated ICP due to cerebral edema in 75% of the cases. One of the two patients who underwent supratentorial craniotomy for giant cyst removal had a good result; the other needed a shunting procedure for associated hydrocephalus. Two patients in whom a reservoir was implanted have shown improvement of their signs of increased ICP. One of these underwent posterior fossa exploration for removal of a free cyst in the fourth ventricle. The other patient stayed well, without ICP signs, for 5 years.

The quality of survival in this series of patients is summarized in Table 4. Eight of 19 patients submitted to a posterior fossa exploration showed transient or permanent neurological deterioration; they all presented either inflammatory obstruction of the fourth ventricle or fourth ventricle cysts associated with in-

J. Neurosurg. / Volume 65 / September, 1986 311
TABLE 4
Quality of survival of all patients

<table>
<thead>
<tr>
<th>Quality of Survival*</th>
<th>Months Postoperatively</th>
<th>Years Postoperatively</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0-3 3-6 6-9 9-12 12-15 15-18 18-21 21-24</td>
<td></td>
</tr>
<tr>
<td>good</td>
<td></td>
<td></td>
</tr>
<tr>
<td>no. of cases</td>
<td>59 55 48 47 45 44 42</td>
<td>39 32 25 23 18 15 11 10 7</td>
</tr>
<tr>
<td>follow-up ended</td>
<td>0 2 2 1 1 0 0 2</td>
<td>1 6 5 2 5 2 4 1 3</td>
</tr>
<tr>
<td>died</td>
<td>0 0 1 0 0 0 1 0</td>
<td>2 1 0 0 1 0 0 0 0</td>
</tr>
<tr>
<td>moderate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>no. of cases</td>
<td>2 1 0 0 0 0 0 0</td>
<td>0 0 2 0 0 0 0 0 0</td>
</tr>
<tr>
<td>follow-up ended</td>
<td>0 0 1 0 0 0 0 0</td>
<td>0 0 0 0 0 0 0 0 0</td>
</tr>
<tr>
<td>died</td>
<td>0 0 3 0 1 0 0 0</td>
<td>0 0 0 0 0 0 0 0 0</td>
</tr>
<tr>
<td>poor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>no. of cases</td>
<td>1 0 0 0 0 0 0 0</td>
<td>0 0 0 0 0 0 0 0 0</td>
</tr>
<tr>
<td>follow-up ended</td>
<td>0 0 0 0 0 0 0 0</td>
<td>0 0 0 0 0 0 0 0 0</td>
</tr>
<tr>
<td>died</td>
<td>7 1 0 0 0 0 0 0</td>
<td>0 0 0 0 0 0 0 0 0</td>
</tr>
</tbody>
</table>

*Quality of survival was considered good if the patient could return to work, moderate if self-care was possible, and poor if the patient was in a vegetative state.

flammary process of the posterior fossa. Five of these patients died from surgical complications.

Forty (71.4%) of the 56 patients undergoing VA or VP shunting procedures and six patients having other operations required readmission one or more times. Readmission occurred in the first postoperative year in 53.6% of cases and in the first and second postoperative years in 62.7%. Neurological causes of readmission were meningitis in 25 patients (cysticercotic in 20 and bacterial in 11), CSF fistula in four, seizures in three, and other causes in 10. Causes of readmission other than neurological were: malfunctioning shunts in 53, infections other than meningitis in four, diagnostic procedures in six, and other causes in seven. The total period of hospitalization for each patient ranged from 8 to 300 days (median 61 days). The daily cost of hospitalization for each patient was approximately $30 and the average total cost for each patient was about $1800.

Forty-six (82.1%) of the 56 VA or VP shunt procedures, nine (64.3%) of the 14 hypothalamic catheter ventriculostomy procedures, and all three Torkildsen ventriculostomy procedures involved reoperation one or more times (88 operations performed on 47 patients). Sixty-seven (76.1%) of the 88 reoperations were carried out in the first postoperative year and 77 (87.5%) in the first and second postoperative years. Reoperations on patients with VA or VP shunts were due to shunt malfunction in 51 (68%) of 75 operations: ventricular catheter occlusion in 24 cases, distal catheter occlusion in nine, CSF fistula in eight, shunt replacement in five, nonobstructive malfunction in three, catheter rupture in one, and catheter erosion in one. Other causes of reoperation in patients with VA or VP shunts were meningitis in 13 and other infections in 11. All patients with a hypothalamic catheter ventriculostomy or Torkildsen ventriculostomy had their intracranial shunt changed to a VA or VP system.

Twenty-three (33.3%) of the 69 patients suffered one or more episodes of postoperative bacterial infection. Of these, 14 (60.9%) had meningitis and nine (39.1%) had other infections (pulmonary, urinary, septic, and abdominal wall infections). Among the 56 VA or VP shunts placed, 21 (37.5%) were infected; of these, 14 (66.7%) were associated with one or more episodes of meningitis. The most frequently identified microorganisms in patients with meningitis were *Staphylococcus aureus* or *S. epidermidis* in eight (57.1%), *Escherichia coli* in two, *Proteus mirabilis* in two, and *Pseudomonas aeruginosa*, *Enterobacter aerogenes*, *Klebsiella pneumoniae*, *Citrobacter freundii*, and *Aerobacter aerogenes* in one each.

The early, late, and total operative mortality rates were, respectively, 1.8%, 19.6%, and 30.4% in patients with VA or VP shunt placement, and 5.3%, 21.1%, and 26.5% in patients undergoing posterior fossa exploration. The late operative mortality rate was 25% for patients submitted to supratentorial decompressive craniectomy. There were no operative deaths among patients with hypothalamic or Torkildsen ventriculostomies or supratentorial craniotomies.

**Discussion**

The group of patients analyzed in this study was selected from among patients with neurocysticercosis to include only those with surgical treatment for control of increased ICP; thus, ICP signs predominated, although other signs of encephalic impairment were also present (Table 1). Symptoms of elevated ICP were due to hydrocephalus in the majority of cases, differing from other series8,26 which have reported a more equal distribution among hydrocephalus, tumor, and pseudotumor findings as causes of intracranial hypertension in patients with neurocysticercosis.

Although it is usual to define the cysticercosis as affecting the fourth ventricle, posterior fossa, or basal cisterns, this terminology is of interest only from the neuroradiological and surgical points of view.
Surgical treatment of neurocysticercosis

FIG. 1. Dimer-X ventriculograms showing hydrocephalus. **Left**: Hydrocephalus due to inflammatory obstruction of the fourth ventricle. The contrast medium delineates a cul de sac (arrows). **Right**: Hydrocephalus due to obstruction of the fourth ventricle by a Cysticercus. The contrast medium reveals a rounded regular mass (arrows).

In 1940, Lange described neurocysticercosis in patients with CSF analysis showing eosinophils and positive complement fixation tests. Without surgical exploration, certain diagnosis of this disease during life may only be achieved from the antigen-antibody reactions in the CSF. There are great differences in CSF findings among series reported in the literature, mainly because the CSF changes were not always correlated with the clinical phases of the illness. The CSF findings vary according to different stages of the disease.

In 1940, Lange described neurocysticercosis in patients with CSF analysis showing eosinophils and positive complement fixation tests. Without surgical exploration, certain diagnosis of this disease during life may only be achieved from the antigen-antibody reactions in the CSF. There are great differences in CSF findings among series reported in the literature, mainly because the CSF changes were not always correlated with the clinical phases of the illness. The CSF findings vary according to different stages of the disease.

Skull x-ray films showed calcifications that suggest cysticerci in 3.6% to 25.3% of patients with neurocysticercosis. Our data agree with those in the literature, except that signs of increased ICP were more frequent because of the selective nature of the series. The main ventriculographic features that suggest the diagnosis of neurocysticercosis were discussed in a previous study. These include inflammatory obstruction when the contrast material outlines a cul de sac (Fig. 1 left), and cyst obstruction when the contrast material outlines a regular, movable, and rounded mass that, in cases of complete obstruction of the aqueduct or fourth ventricle, is similar to an inverted cup (Fig. 1 right). Associated with these two types were regular rounded masses, movable or not, in other ventricles, and irregularities of the ventricular walls, signifying sequelae of inflammatory processes or degenerated cysts attached to the wall. Positive ventriculography with water-soluble contrast medium was more effective in showing intraventricular cysts than were the examinations performed with air.

The main features seen on CT scans of the skull in patients with neurocysticercosis have been described by several authors. These include edema in the cerebral parenchyma, rounded low-density areas (variable in size) with or without a ring of contrast enhancement (Fig. 2 left), amorphous masses in the parenchyma and cisterns demonstrated by contrast material, parenchymal calcifications of various aspects (single or multiple) without a preferred localization (Fig. 2 right), and dilation of the ventricles indicating the site of obstruction. Occasionally, cysts with ring-like contrast enhancement were seen in the ventricles. We found CT scans more effective than skull x-ray films in showing intracranial calcifications, in agreement with other authors. Together, CT and ventriculography allow complete evaluation of patients with hydrocephalus due to neurocysticercosis, and CT after administra-
tion of water-soluble contrast medium into the ventricles permits full assessment of the cerebral parenchyma and the localization of ventricular cysts.\(^9,16,20\)

Posterior fossa exploration generally allowed temporary relief of increased ICP due to transient restoration of the CSF circulation, because the majority of the cases analyzed showed inflammatory obstruction of the fourth ventricle or obstruction by cysts associated with inflammatory processes. The relief of elevated ICP was permanent in one patient who had a single unattached cyst in the fourth ventricle, a finding seen by other authors in 0.7% to 25% of their cases.\(^3,18,24,27\) Only transient relief of increased ICP signs was observed when intracranial shunts (hypothalamic and Torkildsen ventriculostomies) were utilized.

Transient or permanent neurologic deterioration was seen in patients with neurocysticercosis after posterior fossa exploration and was related to the presence of an inflammatory process in the posterior fossa, with or without associated ventricular cysts.\(^3,18,23,24,29\) This worsening occurred in 42.1% of our cases, and we believe that the most important causal factors were: the opening of the inferior part of the cerebellar vermis for exploration of an obstructed fourth ventricle or aqueduct; the distortion of normal anatomical structures due to an inflammatory process; and the increase in the inflammatory process at the site of surgery due to rupture of cysts or surgical handling.

We have routinely used implantation of a reservoir as a preliminary measure in performing ventriculographic examination and puncture to relieve increased ICP in patients with hydrocephalus due to neurocysticercosis. In two of these patients there was permanent relief of the ICP elevation after reservoir implantation. It was believed that the reservoir had acted as an intracranial shunt or caused displacement of a movable cyst that partially obstructed the fourth ventricle; this was supported by ventriculographic examination and has been mentioned by other authors.\(^2,21,27\)

Ventriculoatrial and VP shunting are considered the most effective procedures for treatment of hydrocephalus due to neurocysticercosis, with relief in 50% to 95% of cases.\(^1,8,12,15,19,21,29\) Of the patients submitted to these procedures in our series, 85.5% enjoyed relief of increased ICP signs and 87% had a good outcome in the first 3 postoperative months; of the patients followed for more than 2 years, 92.9% remained without evidence of intracranial hypertension, and 93% had a good outcome, although most patients needed one or more shunt revisions. These data agree with the findings of others regarding patients followed for more than 1 year. The differences between series relative to relief of elevated ICP are probably due to different postoperative follow-up periods in a disease that characteristically evolves with recurrent episodes.

An important point to be considered is the long hospitalization required by these patients.\(^19\) In our series, 67% needed one or more readmissions due to shunt complications and other problems, and the me-

dian period of hospitalization was 61 days, resulting in high hospital costs. Shunt revision was necessary in 25% of the patients reported by McCormick, \textit{et al.},\(^21\) and in 68.1% of ours. Considering only those patients with VA or VP shunting, this number increased to 82.1% and the most frequent cause of revision was shunt obstruction. Bacterial infections were found in 25% of these cases, and 92.9% of them needed shunt removal for treatment because the responsible microorganisms from the hospital environment were resistant to the majority of antibiotics. The predominant cause of death in patients with neurocysticercosis treated with VA or VP shunting was bacterial infection.\(^1\)

There is a wide variation in the reported mortality rates of patients with neurocysticercosis treated by posterior fossa exploration (from 0% to 66%\(^2-4,17-19,26-28\)) and of those submitted to VA or VP shunting (from 0% to 25%\(^8,12,17\)). The variation of results in patients with posterior fossa exploration may be explained by the different number of patients with loose cysts in the fourth ventricle and of patients with an associated inflammatory process. In our most recent cases, however, the inflammatory process due to cyst rupture or surgical handling could be controlled with steroids. We believe that the different mortality rates in patients with VA or VP shunting are due to the fact that some authors consider the late mortality rate and others do not; it is more difficult to attribute death to a surgical procedure after a long time has elapsed.

The displacement of cysts\(^2,21,27\) carries a high risk because it can cause death due to acute elevation of ICP from obstruction of the CSF circulation. It was considered by Apuzzo, \textit{et al.},\(^2\) as a factor that should be evaluated in choosing the surgical procedure for these patients. Although we have observed this type of displacement and agree that it may represent a risk, we have seen it in untreated patients but not in patients submitted to CSF shunting.

Conclusions

Based on the results of this series, surgical treatment for patients with neurocysticercosis may be summarized as follows:

1. Patients with hydrocephalus due to inflammatory obstructions or cysts or a combination of these may be initially treated with VA or VP shunting. If, after resolution of the hydrocephalus, the symptoms from tumor-like behavior of a ventricular cyst persist, it may be treated as in Item 2.

2. Patients with parenchymatous, ventricular, or cisternal cysts who have symptoms due to local mass effect should be treated with cyst removal by direct approach.

3. Patients with increased ICP caused by an inflammatory process with diffuse cerebral edema who do not respond to treatment may be helped by decompressive craniectomies to relieve the hypertension.

4. In cases in which diagnostic procedures are not sufficient to allow differentiation between neurocysti-
Surgical treatment of neurocysticercosis

cercosis and a neoplasm, surgical exploration is indicated.
Analyzing this series concerning quality of survival, frequency of readmission, and postoperative complications, we believe that patients who survive more than 2 years have a good chance for useful life. The explanation for this may be the fact that, in the first 2 years, the patient has a number of episodes of recurrence of the illness due to cyst death. The cysts originate from one infestation, die at different times, and cause the occurrence of shunt complications from an active inflammatory process.
Considering the economic effects of high hospital costs, the patient's inactivity and illness in a productive period of life, the social cost of this illness is unsupportable in our country, justifying all efforts for eradication of this disease.

References

Manuscript received October 3, 1985. Accepted in final form March 4, 1986. This paper was presented at the International Congress of Neurological Surgery, Toronto, Ontario, Canada, July 7–13, 1985.

Address reprint requests to: Benedicto Oscar Colli, M.D., Ph.D., Departamento de Cirurgia, Ortopedia e Traumatologia, Hospital das Clínicas da Faculdade de Medicina de Ribeirão Preto, “Campus” Universitário, Monte Alegre, 14.100, Ribeirão Preto, São Paulo, Brasil.