Surgical procedures for posterior fossa tumors in children: does craniotomy lead to fewer complications than craniectomy?

KANNA K. GNANALINGHAM, PH.D., JESUS LAFUENTE, F.R.C.S., DOMINIC THOMPSON, F.R.C.S.(SN), WILLIAM HARKNESS, F.R.C.S., AND RICHARD HAYWARD, F.R.C.S.

Department of Neurosurgery, Great Ormond Street Hospital for Sick Children, London, United Kingdom

Object. Traditionally, access to the posterior fossa involved a suboccipital craniectomy. More recently, posterior fossa craniotomies have been described, although the long-term benefits of this procedure are not clear. The authors compared the postoperative complications of craniectomies and craniotomies in children with posterior fossa tumors.

Methods. From a total of 110 children undergoing surgery for posterior fossa tumors, 56 underwent craniectomy and 54 had a craniotomy. The mean duration of the hospital stay was longer in the craniectomy group (17.5 compared with 14 days). At operation, similar numbers of patients in both groups had total macroscopic clearance of the tumor, complete dural closure, and duraplasty.

Postoperatively, more patients in the craniectomy group were noted to have cerebrospinal fluid (CSF) leakage (27 compared with 4%; p < 0.01) and pseudomeningoceles (23 compared with 9%; p < 0.05). There was no significant difference between the two groups in the numbers of patients with CSF infections, wound infections, or hydrocephalus requiring permanent CSF drainage. Patients with CSF leaks had a longer duration of hospital stay (20.7 compared with 14.9 days; p < 0.01), and were more likely to have CSF infections (35 compared with 12%; p < 0.01) and wound infections (24 compared with 1%; p < 0.01) than patients without CSF leaks. Postoperatively, wound exploration and reclosures for CSF leakage were more likely in the craniectomy group (11 compared with 0%; p < 0.01). Multivariate analysis revealed that the only predictor of CSF leakage postoperatively was the type of surgery (that is, craniotomy compared with craniectomy; odds ratio 10.8; p = 0.03).

Conclusions. Craniectomy was associated with postoperative CSF leaks, pseudomeningoceles, increased wound reclosures, and thus prolonged hospital stays. In turn, CSF leakage was associated with infections of the CSF and wound. The authors propose mechanisms that may explain why CSF leakage is less likely if the bone flap is replaced.

KEY WORDS • posterior fossa • craniotomy • craniectomy • complication • children

Tumors arising in the posterior fossa are the most common neoplasm to affect the central nervous system in children. Traditionally, access to the posterior fossa involved permanent removal of bone. Although suboccipital craniectomy provides good access to lesions in this area, postoperatively there is a theoretical risk that this area of the brain may be relatively unprotected. Moreover, the loss of anatomical planes may make reoperation more hazardous.

Several authors have described craniotomies in which handheld and high-speed drills are used to gain access to lesions in the midline and cerebellopontine angle. At the end of the operation, the bone flap is replaced and held together with heavy sutures, wires, or titanium plates and screws. The long-term benefits of this procedure in comparison with traditional craniectomies are unknown. To address this issue, we compared the postoperative complications of craniectomies and craniotomies in children with posterior fossa tumors.

Clinical Material and Methods

Between 1985 and 1999, 331 patients underwent surgery for tumors of the posterior fossa by one of three surgeons (R.H., W.H., and D.T.). From this group, 155 patients were selected at random from the neurooncology database at the Great Ormond Street Children’s Hospital in London. Of these, 45 patients were excluded, largely because they had undergone part of their surgical treatment at another institution, and therefore case notes and operative details were inadequate. The remaining 110 patients were selected for the study. Hospital case notes and pre- and postoperative imaging (computerized tomography and MR imaging) were reviewed retrospectively. All children included in the study were given dexamethasone (up to 0.5 mg/kg/day in divided doses) after their diagnosis and underwent resection on the next operating list, usually within 5 days of admission. Postoperatively, patients were rapidly weaned off dexamethasone.
TABLE 1
Demographic details in 110 children with posterior fossa tumors

<table>
<thead>
<tr>
<th>Demographic Data</th>
<th>No. of Patients (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>no. of patients</td>
<td>W/ Craniotomy: 54 (49) W/ Craniectomy: 56 (51)</td>
</tr>
<tr>
<td>age (yrs)</td>
<td>mean ± SEM 5.56 ± 0.5 range 0.3–15</td>
</tr>
<tr>
<td></td>
<td>5.96 ± 0.5 range 0.2–14</td>
</tr>
<tr>
<td>sex (M/F ratio)</td>
<td>1:5:1 1:8:1</td>
</tr>
<tr>
<td>days in hospital</td>
<td>mean ± SEM 14 ± 1 range 7–45</td>
</tr>
<tr>
<td></td>
<td>17.5 ± 1.3† range 5–42</td>
</tr>
<tr>
<td>tumor type</td>
<td>astrocytoma 28 (52) 24 (43)</td>
</tr>
<tr>
<td></td>
<td>medulloblastoma 12 (22) 20 (36)</td>
</tr>
<tr>
<td></td>
<td>ependymoma 9 (17) 7 (13)</td>
</tr>
<tr>
<td></td>
<td>other 5 (9) 5 (9)</td>
</tr>
<tr>
<td>site of tumor</td>
<td>midline 42 (78) 42 (75)</td>
</tr>
<tr>
<td></td>
<td>rt side 7 (13) 8 (14)</td>
</tr>
<tr>
<td></td>
<td>lt side 5 (9) 6 (11)</td>
</tr>
</tbody>
</table>

† p < 0.01, unpaired Student t-test.

TABLE 2
Intraoperative details in children with posterior fossa tumors

<table>
<thead>
<tr>
<th>Intraop Data</th>
<th>No. of Patients (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>additional cervical laminaectomy</td>
<td>W/ Craniotomy: 2 (4) W/ Craniectomy: 2 (4)</td>
</tr>
<tr>
<td>extent of resection (macroscopic clearance)</td>
<td>W/ Craniotomy: 42 (78) W/ Craniectomy: 64 (64)</td>
</tr>
<tr>
<td>dural closure (complete)</td>
<td>47 (87) 51 (91)</td>
</tr>
<tr>
<td>duraplasty materials</td>
<td>7 (13) 6 (11)</td>
</tr>
<tr>
<td>cervical fascia</td>
<td>1 3</td>
</tr>
<tr>
<td>pericranium</td>
<td>2 1</td>
</tr>
<tr>
<td>dural substitute</td>
<td>4 1</td>
</tr>
<tr>
<td>bovine pericardium</td>
<td>0 1</td>
</tr>
<tr>
<td>wound drains</td>
<td>0 (0) 0 (0)</td>
</tr>
</tbody>
</table>

From a total of 110 patients, 56 underwent craniectomy and 54 had a craniotomy. The majority of procedures were performed with the patient in the sitting position (108 procedures, 98%) and the remainder with the patient in the prone position. There was no difference in the mean age and male/female ratio between the two groups (Table 1). Required), and hydrocephalus requiring treatment were also recorded. The treatment given for each of these complications, including aspiration of the pseudomeningocele, reclosure of the wound (after induction of general anesthesia), LP, EVD, VP shunt placement, and third ventriculostomy were noted. At our institution, routine CSF diversion (that is, EVD, VP shunts, or third ventriculostomies), either before or during surgery, is not performed. These procedures are reserved for children who experience symptomatic hydrocephalus that has not been controlled by steroid medications.4,5,17

Statistical Analysis

Univariate statistical analysis was conducted using the chi-square test (with the Yates correction) for categorical variables (for example, patient sex, CSF leakage, and so on) and the unpaired Student t-test for normal variables (for example, patient age and duration of hospital stay).

For multivariate analysis, a logistic regression model was used to ascertain the confounding effects of preoperative factors (patient age, sex, date of surgery, operating surgeon, pre- and intraoperative CSF drainage) and intraoperative factors (type of operation—craniectomy compared with craniotomy, additional cervical laminaectomy, extent of tumor resection, completeness of dural repair, duraplasty, and site and type of tumor) on complications, including CSF leakage, CSF infection, wound infection, and the appearance of pseudomeningocele. In this model the surgical complication of interest was the dependent variable, and the other confounding factors were entered as covariates in a forward stepwise manner.

Two-tailed tests were used because both the magnitude and direction of change could not be predicted. The null hypothesis was rejected at a significance level of less than 0.05. All tests were performed using a commercially available statistical package (SPSS, Chicago, IL).

Results

Two of the surgeons performed posterior fossa craniectomies as well as craniotomies, whereas the third surgeon performed craniotomies only. Posterior fossa craniectomies were accomplished by placing three or four burr holes with the aid of a craniotome equipped with protective guard and by removing the rest of the bone with rongeurs.3 In our unit, craniotomies have been used since 1987. Craniotomies were performed as described previously, by using a high-speed drill equipped with a foot plate (Midas Rex, Inc., Fort Worth, TX).4,10,14 In brief, two burr holes were placed laterally just inferior to the transverse sinus on each side. After stripping the dura mater with dissectors, the bone flap was created by making horizontal cuts to the midline and downward cuts to the foramen magnum. At the end of the operation, the occipital bone flap was replaced and secured with absorbable sutures (O-polydioxane, PDS, or vicryl) passed through twist-drill holes made in the bone. For all craniotomies and craniectomies, the dura mater, cervical muscle, and cervical fascia were closed in layers by using absorbable sutures. Closure of the skin layer was routinely applied to the wound postoperatively.

Postoperative complications, including wound infections, CSF leaks, CSF infection, the development of clinically apparent pseudomeningocele (and any treatment required), and hydrocephalus requiring treatment were also recorded. The treatment given for each of these complications, including aspiration of the pseudomeningocele, reclosure of the wound (after induction of general anesthesia), LP, EVD, VP shunt placement, and third ventriculostomy were noted. At our institution, routine CSF diversion (that is, EVD, VP shunts, or third ventriculostomies), either before or during surgery, is not performed. These procedures are reserved for children who experience symptomatic hydrocephalus that has not been controlled by steroid medications.4,5,17

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Two-tailed tests were used because both the magnitude and direction of change could not be predicted. The null hypothesis was rejected at a significance level of less than 0.05. All tests were performed using a commercially available statistical package (SPSS, Chicago, IL).

Results

From a total of 110 patients, 56 underwent craniectomy and 54 had a craniotomy. The majority of procedures were performed with the patient in the sitting position (108 procedures, 98%) and the remainder with the patient in the prone position. There was no difference in the mean age and male/female ratio between the two groups (Table 1).
The mean duration of hospital stay was longer in the craniectomy group (by 25%; \( p < 0.01 \), unpaired Student t-test). The majority of tumors were in the midline, and, based on pathological findings, astrocytomas, medulloblastomas, and ependymomas accounted for 91% of tumors. The other tumor types consisted of germ cell tumors (three); pineoblastoma and cerebellar hemangioblastoma (two each); and acoustic neuromas, pineal astrocytomas, and meningioma (one each). There was no difference between the two groups in the site or pathological type of the posterior fossa lesions (Table 1).

**Intraoperative Details**

There was no difference between the groups in the number of patients who underwent an additional cervical laminectomy of C-1 to gain access to the posterior fossa tumor, total macroscopic resection of tumor (as judged by the surgeon and based on immediate postoperative MR images), and completeness of the dural closure (Table 2). Duraplasty was performed in similar numbers of patients in both groups, and both synthetic and biological grafts were used. Wound drains were not used in any of the patients. There were no significant perioperative complications, including death, in either group.

**Postoperative Complications**

Postoperatively, more patients in the craniectomy group were noted to have CSF leakage (27 compared with 4%; \( p < 0.01 \), chi-square test) and pseudomeningoceles (23 compared with 9%; \( p < 0.05 \), Table 3). There were no significant differences between the two groups in the numbers of patients noted to have CSF infections, wound infections, or postoperative hydrocephalus who required clinical treatment.

Two of the surgeons performed both craniotomies (54 operations) and craniectomies (22 procedures), and the rate of postoperative CSF leakage and pseudomeningoceles following these procedures is shown in Fig. 1. As stated before, patients who underwent craniectomy were more likely to have CSF leaks (18 compared with 4%; \( p < 0.05 \), chi-square test), but not pseudomeningoceles (14 compared with 9%, \( p = 0.57 \)).

The characteristics of the 17 patients with and the 93 without postoperative CSF leaks from the occipital wound are shown in Table 4. Patients with CSF leaks had a longer duration of hospital stay (by 39%; \( p < 0.01 \), unpaired Student t-test), and were more likely to have CSF infections (35 compared with 12%) and wound infections (24 compared with 1%), than patients without CSF leaks (\( p < 0.01 \), chi-square test). There was no association between CSF leakage and completeness of dural closure, use of duraplasty, development of pseudomeningocele, or the need for permanent CSF drainage (that is, VP shunts or third ventriculostomy).

**Treatments Given**

The different treatments required for postoperative complications in these patients are summarized in Table 5. It shows that similar numbers of patients in the two groups

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### Table 3

<table>
<thead>
<tr>
<th>Complication</th>
<th>No. of Patients (%)</th>
<th>Craniotomy</th>
<th>Craniectomy</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSF leak</td>
<td>2 (4) 15 (27)*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>pseudomeningocele</td>
<td>5 (9) 13 (23)†</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CSF infection</td>
<td>6 (11) 11 (20)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>wound infection</td>
<td>1 (2) 4 (7)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>postop hydrocephalus needing treatment</td>
<td>8 (15) 13 (23)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* \( p < 0.01 \), chi-square test.
† \( p < 0.05 \).

### Table 4

<table>
<thead>
<tr>
<th>Factor</th>
<th>No. of Patients (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Factor</td>
<td>W/O CSF Leak</td>
</tr>
<tr>
<td>no. of patients</td>
<td>93 (85) 17 (16)</td>
</tr>
<tr>
<td>days in hospital (mean ± SEM)</td>
<td>14.9 ± 0.9 20.7 ± 2.4*</td>
</tr>
<tr>
<td>pre- &amp; intraop CSF drainage</td>
<td>18 (19) 2 (12)</td>
</tr>
<tr>
<td>dural closure (complete)</td>
<td>83 (89) 15 (88)</td>
</tr>
<tr>
<td>duraplasty (present)</td>
<td>11 (12) 2 (12)</td>
</tr>
<tr>
<td>CSF infection</td>
<td>11 (12) 6 (35)*</td>
</tr>
<tr>
<td>wound infection</td>
<td>1 (1) 4 (24)*</td>
</tr>
<tr>
<td>pseudomeningocele</td>
<td>13 (14) 5 (29)</td>
</tr>
<tr>
<td>permanent CSF drainage†</td>
<td>21 (23) 3 (18)</td>
</tr>
</tbody>
</table>

* \( p < 0.01 \), unpaired Student t-test or chi-square test.
† All VP shunts and third ventriculostomies.
operative CSF infection or wound infection (p
were not significant predictors for the development of post-
type of tumor) had a significant influence on CSF leakage
additional cervical laminectomy, extent of tumor resection,
ratio 10.8, 95% confidence interval 1.3–90.6, p = 0.03).

dictor of CSF leakage postoperatively was the type of oper-

mies) either peri- or postoperatively (p = 0.41, chi-square
test).

required prolonged application of pressure bandages to the
occipital wound, aspiration of pseudomeningoceles, inser-
tion of lumbar drain, and LP. Wound reclosure for CSF
leakage and/or wound infection was necessary in six pa-
tients in the craniectomy group, but none in the craniotomy
group required reclosure (p < 0.01, chi-square test).

Preoperatively and intraoperatively, 10 patients in each
group required CSF drainage in the form of EVD or VP
shunting, or third ventriculostomy (Table 5). In these pa-
tients, excision of the tumor was performed less than 4 days
after CSF drainage. Postoperatively, eight patients in the
craniotomy group and 14 in the craniectomy group required
CSF drainage. Four patients in the craniotomy group and 10
in the craniectomy group needed VP shunts postoperative-
ly (p = 0.1, chi-square test). These shunts were inserted over
a mean of 36.2 ± 12 days after surgery (range 2–210
days; < 30 days in 11 patients). Overall, 14 patients in the
craniection group and 10 in the craniectomy group needed
permanent CSF drainage (VP shunts or third ventriculostomies)
either peri- or postoperatively (p = 0.41, chi-square test).

Logistic Regression Analysis

Logistic regression analysis revealed that the only pre-
dictor of CSF leakage postoperatively was the type of opera-
tion (that is, craniotomy compared with craniectomy; odds
ratio 10.8, 95% confidence interval 1.3–90.6, p = 0.03).
None of the other factors (patient age, sex, date of surgery,
operating surgeon, pre- and intraoperative CSF drainage,
additional cervical laminectomy, extent of tumor resection,
completeness of dural repair, use of duraplasty, and site and
type of tumor) had a significant influence on CSF leakage
(p > 0.1). Logistic regression also showed that these factors
were not significant predictors for the development of post-
operative CSF infection or wound infection (p > 0.1).

Discussion

Traditional access to the posterior fossa has involved a

craniection. Although this gives an excellent exposure, it
leaves this area of the cerebellum and dura covered by only
muscle and scalp. Craniotomy for posterior fossa lesions
is a more recent development. Yasargil and Fox described
a technique for creating a bone flap in the posterior fossa by
using three burr holes and a Gigli saw; the bone flap could
then be replaced at the end of the procedure. With improved
technology, others have described midline and lateral pos-
terior fossa craniotomies in which high-speed drill instru-
mentation is used. Our technique is similar to that

described previously, and we used absorbable sutures to
secure the bone flap. The benefits of craniotomies over
the traditional craniectomies are less clear. We compared
the postoperative complications of both surgical approach-
es in children with posterior fossa tumors.

Postoperative Complications: CSF Leak and Association
With Craniectomy

The main findings in this study were that craniectomy
was associated with an increased incidence of postoperative
CSF leak, pseudomeningocele, wound reclosures, and thus
prolonged hospital stays. In turn, CSF leakage was associ-
ated with CSF and wound infections and increased hospi-
tal stay.

The retrospective nature of this study meant that a num-
ber of potential confounding factors needed to be consid-
ered when comparing CSF leakage and other postoperative
complications between patient groups undergoing cranioto-
my or craniectomy. The two groups were well matched for
age, sex of the patient, pre- and intraoperative CSF drain-
age, additional cervical laminectomy, site and nature of the
lesion, extent of resection of the tumor, degree of dural
closure, and the use of duraplasty. A further confounding
factor could have been the fact that three surgeons were in-
volved. Of these, two used both surgical procedures, where-
as the third performed craniectomies exclusively. All three
surgeons, however, used a similar method in closure of
dura, muscle, and scalp. Additionally, in a separate anal-
ysis of the postoperative complications in patients of the
two surgeons who performed both surgical procedures, we
confirmed the association between craniotomies and CSF
leakage. Furthermore, the patients included in this study
underwent surgery between 1985 and 1999, a 15-year peri-
od during which the surgical method, neuroanesthesia, and
nursing care are likely to have evolved, and this may be re-
lected in the postoperative morbidity rate. To evaluate the
influence of these confounding factors on postoperative
complications, a logistic regression model was used. Nev-

ertheless, on multivariate analysis the only significant pre-
dictive factor for CSF leakage was still the type of surgery
(that is, craniotomy compared with craniectomy).

To our knowledge there has been only one other study of
the complications related to both kinds of surgery in the
posterior fossa in children. In this retrospective study of 13
children undergoing craniectomy for posterior fossa tu-
mors, it was reported that three experienced CSF leakage
and eight had pseudomeningoceles. Another 13 children
underwent posterior fossa craniotomy, and CSF leakage
was noted in one and pseudomeningocele in three patients.
Surgical intervention, including wound reclosure (two pa-
tients), and repeated LPs and shunt insertion (one patient
each) was required in the craniectomy group only. Thus, the
Posterior fossa craniotomy compared with craniectomy

findings in this small study are consistent with our observations that craniotomy increases the risk of CSF leakage, pseudomeningocele, and the need for wound reclosure. In adult patients undergoing resection of acoustic neuromas via the retrosigmoidal approach, there have been a number of investigations into the effect of covering the bone defect on postoperative headaches.\textsuperscript{7,15,19} In these studies, however, other postoperative complications (including CSF leakage) were not reported or the number of patients involved was too small (< 60), to make meaningful comparisons in this respect.

Possible Mechanisms for Increased CSF Leak With Craniectomy

The mechanism or mechanisms underlying the association between craniectomy and CSF leakage, and, conversely, the reduced risk of this complication with craniotomy, are not clear. Replacing the occipital bone flap may provide an extra anatomical layer that has to be breached before CSF can leak from the wound. Nonetheless, although the bone flap provides a rigid cover, it is by no means a water-tight barrier. In creating the bone flap, a number of burr holes are made at first, and a thin margin of bone is always drilled off around the periphery; CSF can readily leak through these spaces.\textsuperscript{8,10,12}

An alternative explanation may lie in the fact that the bone flap provides a rigid support over the dural closure (Fig. 2). In the postoperative phase, the dura may periodically bulge outward because of CSF buildup or raised pressure within the posterior fossa, for example, when the patient coughs or strains. In patients who have undergone a craniectomy, when the dura bulges out during these episodes, dural sutures may tear out. Consequently, small defects in the dural closure may enlarge and CSF is more likely to leak out and collect in the muscular and subcutaneous planes, leading to pseudomeningoceles and CSF leakage from the wound (Fig. 2A). By contrast, in patients who receive a craniotomy the bulging dura is likely to be pressed against the bone flap. This extra support may prevent dural sutures from tearing out, and thus CSF leakage may be minimized (Fig. 2B).

Furthermore, the deep muscles in the suboccipital region of the neck have extensive attachments to the occipital bone (semispinalis capitis, rectus capitis posterior major/minor, and superior oblique muscles).\textsuperscript{11} With both surgical approaches to the posterior fossa, this muscular attachment is usually stripped off at the periosteal level. Consequently, on closure of the neck wound there is likely to be a dead space deep in the muscular layer, into which CSF may collect. This may act as an impetus for CSF leakage and pseudomeningocele formation in patients undergoing craniectomy. Replacing the bone flap may help to eliminate this potential space by encouraging early reattachment of the muscles to the occipital bone flap.

Other Postoperative Complications

In performing craniotomies we used high-speed drills equipped with a foot plate. Intraoperative trauma to venous sinuses and underlying brain tissue is a rare but recognized hazard with the use of high-speed drills in this region.\textsuperscript{19} Nonetheless, trauma to venous sinuses was not seen in any of the patients in this study. It was our impression that once

![Diagram](image-url)

**Fig. 2.** Schematic drawing showing a possible mechanism to explain CSF leakage. A: In patients who undergo a craniectomy, the dura mater may periodically bulge outward because of raised pressure within the posterior fossa, which occurs when the patient coughs or strains. When the dura bulges out during these episodes, dural sutures may tear out. Small defects in the dural closure may then enlarge and CSF leakage is more likely. B: In patients who undergo a craniotomy the bulging dura is likely to be pressed against the bone flap. This extra support may prevent dural sutures from tearing out, and thus CSF leakage may be minimized.

the lateral burr holes were made, good separation of dura mater from the occipital bone is the key to avoiding this complication.\textsuperscript{12} Moreover, the relatively small midline keel of the occipital bone in children helps to avoid dural tears when approaching the midline with the craniotome.\textsuperscript{10} Conversely, in adult patients the larger midline keel of the occipital bone and the greater adherence of dura to overlying occipital bone may increase the risk of dural tears when performing a craniotomy.

Traditional teaching asserts that suboccipital craniotomies allow for increased space within the posterior fossa and that this may compensate for cerebellar swelling postoperatively. Conversely, with craniotomies, replacing the bone flap might be expected to lead to decompensation as a result of cerebellar swelling and brain stem compression. This was not our experience, however, and postoperatively we did not need to remove the bone flap for raised pressure in any patient. We believe that the perioperative administration of steroid drugs, bulk tumor removal, and adequate drainage of CSF intraoperatively may compensate for any cerebellar swelling postoperatively.\textsuperscript{2,17}

For craniotomies, the bone flaps created are stripped of periosteum and muscle attachments. Replacing such “free bone flaps” that are devoid of vascular supply may theoretically increase the risk of deep-seated infections. Nonetheless, there was no difference in the superficial wound infection rate between the craniectomy and craniotomy groups, and no patient in the craniotomy group developed osteomyelitis of the bone flap, which is extremely rare.\textsuperscript{3,5,12,20} Indeed, for supratentorial craniotomies there is no difference in the rate of infection between free and osteoplastic bone flaps.\textsuperscript{14}

Furthermore, craniotomies may have additional advantages in the long term. In our study, four patients (three from the craniectomy and one from the craniotomy group) underwent surgery for recurrent tumor some time later. If re-
operation is required, replacement of the bone flap makes reopening much easier, because the risk of incising the dura during dissection of the muscle layer is virtually eliminated. Additionally, in adult patients undergoing removal of acoustic neuroma via the retrosigmoidal approach, it has been reported that the severity of postoperative headache could be reduced by the placement of bone or similar material (that is, cranioplasty) to fill the bone defect.\textsuperscript{7,15,19} Although the exact mechanism of this effect is unknown, it is thought to be related to scar tissue between the dura mater, leading to traction on the dura during neck movement.\textsuperscript{7,15} Interposition of a rigid barrier between the dura and muscle will counter this effect and thus reduce postoperative headaches.

In adult patients, the replacement of the occipital bone flap or performance of a cranioplasty improves the long-term cosmetic appearance of the surgical defect.\textsuperscript{7} This finding may also apply to the pediatric population, although in young children the gradual reossification of the postcraniectomy site makes cosmetic considerations less important.\textsuperscript{13}

Conclusions

It is evident from this study that in children with posterior fossa tumors, craniectomy increases the risk of postoperative CSF leakage, pseudomeningocele formation, wound reclosures, and thus prolonged hospital stays. We recommend posterior fossa craniotomy instead, and with the currently available high-speed drill instrumentation, this procedure is relatively easy to learn and perform.

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References


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