Quality of life after hemicraniectomy for traumatic brain injury in adults

A review of the literature

SHABBAR F. DANISH, M.D.,¹ DEAN BARONE, P.A.-C.,¹ BRADLEY C. LEGA, M.D.² AND SHERMAN C. STEIN, M.D.²

¹Division of Neurosurgery, University of Medicine and Dentistry of New Jersey–Robert Wood Johnson Medical School, New Brunswick, New Jersey; and ²Department of Neurosurgery, University of Pennsylvania Health System, Philadelphia, Pennsylvania

Decompressive hemicraniectomy is well accepted for the surgical treatment of intractable intracranial hypertension in cases in which medical management fails. Although it is performed as a life-saving procedure when death is imminent from intracranial hypertension, little is known about the functional outcomes for these patients on long-term follow-up. In this study, the authors performed a systematic review of the literature to examine neurological outcome after hemicraniectomy. A literature search revealed 29 studies that reported outcomes using GOS scores. The GOS scores were transformed to utility values for quality of life using a conversion method based on decision analysis modeling. Based on the literature, 1422 cases were analyzed. The average 6-month-postoperative mortality rate was 28.2%. The mean QOL value among survivors was 0.592, which corresponds roughly to a GOS score of 4. Although more studies are needed for validation of long-term neurological outcome after hemicraniectomy, the assumption that most patients remain in a vegetative state after this intervention is clearly incorrect. (DOI: 10.3171/2009.3.FOCUS945)

KEY WORDS • traumatic brain injury • hemicraniectomy • outcome

Head injury is a major cause of morbidity and mortality worldwide. Trauma itself is the leading cause of death in the first 4 decades of life, with traumatic brain injury being implicated in at least half the cases.¹³ One of the fundamental pathophysiological processes after traumatic brain injury is the development and propagation of an escalating cycle of brain swelling and an increase in ICP. The goals of the clinical management of severe head injury consist of interrupting this cycle by controlling ICP and maintaining cerebral perfusion pressure and cerebral blood flow to avoid brain ischemia. This management strategy has been developed as a result of reported strong correlations between uncontrollable high ICP and high rates of morbidity and mortality. The relationship between high ICP and poor outcome has been demonstrated consistently in both single-center and multicenter studies, and the ability to bring elevated ICP under control has long been considered a requirement for improving outcome of patients with severe head injuries.⁸,¹⁷,²⁰,²³ In an effort to reduce ICP, hemicraniectomy has evolved as a surgical option that has recently seen a “re-birth.” Logically, it seems that opening a tight skull would reduce ICP, improve blood flow, and reduce swelling, leading to reduced morbidity and mortality. This concept has yet to be proved, however, with respect to improvement in clinical outcome.²⁰

Those who are skeptical of the procedure raise several questions. Does the craniectomy quantitatively control raised ICP? Does brain herniating through the defect escalate the problems? What prognostic information can we give the families of those for whom the procedure is being proposed? Do the results justify the treatment? The last question is the focus of this review. Because of the lack of prospective, randomized trials, debate exists over the clinical outcome expected for patients undergoing the procedure. Especially in centers where craniectomy has not gained acceptance, there is a notion that patients whose head injuries are severe enough to mandate hemicraniectomy persist with severe disability or in a vegetative state, rendering the procedure futile and wasteful. Furthermore, because most studies use GOS scores to report outcomes, results from different studies cannot be combined and simply averaged. Finally, we must ask if the growing experience with hemicraniectomy over the years has led to better outcomes.

The present work is a review of the literature with respect to outcomes following hemicraniectomy. By con-
vertic GOS scores to utility values for QOL, we provide an average outcome for patients undergoing hemicraniectomy that is derived from the literature and is statistically sound.

**Methods**

A structured search of the English-language literature was performed to obtain the necessary data. A Medline search of all entries containing the subject heading “cerebrocerebral trauma” along with any combinations of the words “hemicraniectomy,” “decompression” (or “–ive”), or “craniectomy” was examined. The list was supplemented by reviewing the bibliographies of selected papers and using the “Related Articles” feature of PubMed. We decided to limit the analysis to series of at least 5 surgically treated cases, published between 1997 and December 2008 and containing GOS scores obtained at least 6 months after initial treatment. Series restricted to children (< 20 years old) were not included; when identified separately, pediatric cases were removed from series containing both adults and children.

We converted GOS scores to measures of utility or QOL using the formula published by Aoki et al. We found 29 articles reporting 1422 cases involving adult patients in whom decompressions were performed. The mean years of patient accrual were between 1987 and 2005. Total numbers in each GOS category are shown in Table 1. Among survivors, the median GOS score was 4. For the pooled data, the average 6-month postoperative mortality rate was 28.2% (range 23.5–33%), and the mean QOL value among survivors was 0.592 (range 0.526–0.658). This QOL value is quite close to that reported for a GOS score of moderate disability. The main outcomes are illustrated in Fig. 1. Overall, the pooled mean utility of decompressive craniectomy was 0.426 (95% CI 0.362–0.490). This outcome value is the mean of values for surviving patients and those who died. Favorable outcomes (GOS scores of 4 or 5) were achieved by 63.3% of survivors (95% CI 59.9–66.7%). For the entire series, including nonsurvivors, 46% of outcomes were favorable (95% CI 34.5–57.5%).

There did not appear to be any trend toward improvement of surgical outcomes between 1987 and 2005. Meta-regression showed that there were no significant trends over time with respect to either mortality or QOL among survivors (p = 0.429 and 0.891, respectively). This is also evident in Fig. 1, in which case series are presented from the above-described group of articles, in order of publication date.

**Discussion**

We reviewed more than 1400 reported cases of decompressive craniectomy performed in adults for the treatment of severe traumatic brain injury and uncontrollable intracranial hypertension. The pooled mean 6-month-postoperative mortality rate for the series was approximately 28%, and the pooled mean QOL value among the survivors was almost 60% of the value of a normal state of health. This score is very close to the QOL associated with moderate disability score (GOS score of 4). Favorable outcomes (GOS scores of 4 or 5) were reported for 46% of the series when all patients were considered, and 63% of survivors. Our data also indicate that neither mortality rate nor QOL have improved since the late 1980s, when the procedure regained popularity and saw renewed application to the treatment of ICP.

The findings from this study challenge the occasional charge that hemicraniectomy shifts the outcome from death to a persistent vegetative state and severe disability. Recent outcome studies of protocols including decompressive craniectomy have also not supported this concept. The mean QOL value of survivors after hemicraniectomy when all series were combined in our study places the average survivor in the moderate disability category. Based on our findings, it is reasonable to counsel families that many patients undergoing hemicraniectomy for uncontrollable ICP will be able to function independently.

**Table 1: Total number of patients in each GOS category 6 months postoperatively**

<table>
<thead>
<tr>
<th>GOS Score</th>
<th>No. of Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>383</td>
</tr>
<tr>
<td>4</td>
<td>283</td>
</tr>
<tr>
<td>3</td>
<td>232</td>
</tr>
<tr>
<td>2</td>
<td>110</td>
</tr>
<tr>
<td>1</td>
<td>414</td>
</tr>
</tbody>
</table>

**Results**

Our Medline search yielded 269 English-language articles dealing either with hemicraniectomy or bifrontal decompressive craniectomy for severe traumatic brain injury. Of these, the majority of reports dealt with laboratory research, aspects of the surgery rather than general results. Other publications were reviews, editorials, or duplicated previous reports.

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**Discussion**

We reviewed more than 1400 reported cases of decompressive craniectomy performed in adults for the treatment of severe traumatic brain injury and uncontrollable intracranial hypertension. The pooled mean 6-month-postoperative mortality rate for the series was approximately 28%, and the pooled mean QOL value among the survivors was almost 60% of the value of a normal state of health. This score is very close to the QOL associated with moderate disability score (GOS score of 4). Favorable outcomes (GOS scores of 4 or 5) were reported for 46% of the series when all patients were considered, and 63% of survivors. Our data also indicate that neither mortality rate nor QOL have improved since the late 1980s, when the procedure regained popularity and saw renewed application to the treatment of ICP.

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There are a number of limitations in our study. The populations from which our data are drawn are heterogeneous in terms of patient characteristics, indications for surgery, and decompression techniques used. This heterogeneity limits the precision of our estimates. We cannot adjust for a number of clinical factors known to be associated with outcome, such as age, time of surgery, admission GCS score, preoperative pupillary examination, and other features. We chose QOL as an outcome measure over GOS scores because of its almost universal use in quantitative studies of medical outcomes and because of its conformance to mathematical calculations, such as determining mean values and confidence intervals. The GOS is an interval scale of neurological function; calculating mean GOS scores and other mathematical manipulations are meaningless. Converting a score to a parametric value of QOL has, at most, limited validity but at least allows valid mathematical and statistical calculations. Some might also question the conversion process used by Aoki and associates, in which preferences were those of health care professionals rather than the community. In addition the complication profile queried by Aoki et al. was drawn from aneurysm surgery rather than from hemicraniectomy. Some of the many complications of hemicraniectomy are transient and not reflected in the GOS scores at 6 months.

Nevertheless, the data may prove useful in providing prognostic guidance when counseling family members about a decompression procedure. We cannot conclude that decompressive craniectomy is superior to medical
care alone, because we did not compare outcomes. In addition, a recent Cochrane Review suggested that evidence is lacking. Any definitive conclusions about treatment comparisons must await the completion of the ongoing DECRAN and Rescue ICP trials. In the interim, the findings from this study should lend confidence to practitioners who use the procedure in the treatment of intractable ICP.

Conclusions

Decompressive hemicraniectomy is a well-known surgical option for uncontrollable intracranial hypertension. Although it lacks evidence from randomized trials, pooled outcomes from the current literature show that patients who undergo hemicraniectomy for severe traumatic brain injury can achieve a reasonably good QOL. In the future, the results of ongoing randomized trials should reveal the patient population in which this intervention can make the largest impact.

Disclaimer

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

References

Quality of life after hemispherectomy for TBI


Address correspondence to: Shabbar F. Danish, M.D., Division of Neurosurgery, UMDNJ–Robert Wood Johnson Medical School, 125 Paterson Street, CAB 2100, New Brunswick, New Jersey 08901. email: danishsh@umdnj.edu.