Decompressive craniectomy for the treatment of traumatic brain injury: does an age limit exist?

A review

Pasquale De Bonis, M.D., Angelo Pompucci, M.D., Annunziato Mangiola, M.D., Q. Giorgio D’Alessandris, M.D., Luigi Rigante, M.D., and Carmelo Anile, M.D.

Institute of Neurosurgery, Catholic University School of Medicine, Rome, Italy

Object. It is generally believed that the outcome of traumatic brain injury is not improved by decompressive craniectomy in patients older than 30–50 years. A literature search was performed to assess the level of evidence with respect to the effect of age on outcome in these cases.

Methods. References were identified by PubMed searches of journal articles published between 1995 and December 2008. The inclusion criteria were as follows: 1) clinical series including adults; and 2) focus on age as a prognostic factor. Technical notes and laboratory investigations were excluded.

Results. Fourteen English-language articles were finally selected. In 5 of the 14 studies, the authors performed no statistical analysis. In 6 studies they concluded that age was not significantly related to outcome (with 1 of these studies showing a correlation between age and outcome only after 65 years). Three studies showed a correlation between age and outcome.

Conclusions. With respect to age and effectiveness of decompressive craniectomy, there are no robust data to establish any degree of core evidence and the referred age thresholds are arbitrary. (DOI: 10.3171/2009.7.JNS09505)

Key Words • decompressive craniectomy • traumatic brain injury • age • outcome • age limit

Decompressive craniectomy is considered to be a second-tier therapy in the treatment of refractory intracranial hypertension. The efficacy of DC in the treatment of TBI has been demonstrated by several retrospective studies.1,2,3,5–14,16–18 However, the effectiveness of DC in improving outcome following severe head injury is challenged by the paucity of strong scientific evidence.15 Recently, a multicenter prospective randomized study proved that a wide craniectomy, compared with limited craniectomy, significantly improves outcome in severe TBI with refractory intracranial hypertension.3 Two ongoing trials (the European RESCUEicp study [Randomised Evaluation of Surgery with Craniectomy for Uncontrollable Elevation of Intra-Cranial Pressure] and the Australian DECRA [Decompressive Craniectomy] trial) will definitely address this issue.

The overall degree to which different patients may benefit from DC remains controversial. It is generally accepted that patient age is one of the main prognostic factors. The most quoted age limits are 30, 40, and 50 years. In fact, in most published series, patients older than 30, 40, or 50 years were excluded a priori. Nonetheless, the prognostic value of age has been investigated in few studies.

In the present study, we performed a literature search to assess the level of evidence with respect to the effect of age on outcome in patients with TBI who underwent DC.
Decompressive craniectomy and age

Methods

Search Strategy

Articles for this review were identified by PubMed searches of the literature from 1995 through December 2008 using the terms “decompressive craniectomy/craniotomy,” “traumatic brain injury,” “brain injury/head injury/traumatic brain injury/traumatic head injury,” and “age.” Reference lists of articles obtained were also checked. The papers published in English were reviewed.

Selection Criteria

Among 429 articles dealing with decompressive craniectomy, 49 English-language articles were identified after an initial step (see Table 1 for search details). From these 49 articles, 13 were selected for inclusion. The remaining 36 articles were excluded because they did not represent clinical series, did not deal with age as a possible prognostic factor, presented pediatric case series, did not address outcome, or were technical notes or laboratory investigations. Another article was identified through analysis of the reference lists of the selected papers.

Results

A total number of 14 papers were selected: 13 retrospective studies and 1 single-center prospective investigation.

Chibbaro et al. reported on a series of 80 patients (age range 16–61 years). These authors did not compare different groups according to age, but showed that patients with a favorable outcome had a mean age of 29 years and those with an unfavorable outcome had a mean age of 48 years (p < 0.0005).

Howard et al. reported on a series of 40 patients: age did not relate to outcome in this analysis. Patients with good outcome had a mean age of 28.2 ± 16.2 and patients with poor outcome had a mean age of 33.6 ± 17.6 (no statistically significant difference). Overall the decompressive craniectomy patients were a relatively young group of patients (age range not reported).

In a series of 33 patients (age range 13–60 years), Morgalla et al. analyzed outcome separately for the 9 patients who were older than 50 years. Of these 9, the only ones who had a good outcome were the 3 who had delayed raised ICP; those who underwent emergency surgery either died (2 patients) or were described as showing an apallic syndrome (4 patients). These authors concluded that there may be a subset of older patients who may benefit from such a procedure when ICP increases slowly over several days.

Recently, Pompucci et al. reported on a series of 55 patients. Age was not a discriminating factor in patient selection. Logistic regression analysis showed age as an independent predictive factor for outcome (p = 0.005). These authors found that patients older than 65 years (20 cases) had a worse outcome (p = 0.006) while 18 patients who were less than 40 years old and 17 patients 40–65 years old showed no difference in outcome.

Reporting on a series of 117 patients (including 36 patients older than 40 years), Meier et al. stated that a comparison of patient age and postoperative results was not possible because of the small number of patients, although it appeared that patients younger than 40 years had a better prognosis than the older ones. A logistic regression analysis based on their data, however, showed that age (< 40 and ≥ 40 years) was not correlated with outcome.

Aarabi et al. did not include patients older than 50 years in their series of 50 patients. They only compared 17 patients younger than 20 years and 33 patients 20–49 years old and found that age was not significantly associated with death or good outcome.

In 2005, Ucar et al. reported on a series of 100 patients. These authors used logistic regression analysis and compared the mean age of patients with good outcomes (26.5 ± 11.1 years) and mean age of patients with bad outcomes (30.7 ± 13.1; p = 0.046).

Albanese et al. observed that “DC is a salvage procedure that should be considered in case of medical treatment failure, especially in young patients,” yet they also stated that given the small number of patients in their cohort (40 cases), analysis of the effect of age was difficult.

A statistically significant difference in outcome (p = 0.046) was found between older and younger patients in a study by Münch et al. These authors reported on a series of 49 patients and compared 29 patients younger than 50 years and 15 patients 50 years old or older (data were not available for 5 patients from the initial cohort).

According to indication guidelines of Guerra et al., DC should be performed only in patients under 50 years of age. In a prospective study, which included 57 patients, the authors only had performed DC in 2 patients older than 50 years and 5 patients 40–49 years of age. Accordingly, a statistical comparison among age-based groups was impossible due to the small number of patients in these groups. In fact, the authors stated that “logistic regression analysis did not indicate age as a predictive factor to outcome.”

Kunze et al. reported that young patients respond better to DC than older patients. They found that 80% of

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<th>Search No.</th>
<th>Description</th>
<th>Results (no. of articles)</th>
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<tbody>
<tr>
<td>1</td>
<td>matching the terms “decompressive craniotomy” OR “decompressive craniectomy”</td>
<td>429</td>
</tr>
<tr>
<td>2</td>
<td>matching the terms “brain injury” OR “head injury” OR “traumatic brain injury” OR “traumatic head injury”</td>
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<tr>
<td>3</td>
<td>matching #1 AND #2</td>
<td>203</td>
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<tr>
<td>4</td>
<td>matching #3 AND “age”</td>
<td>53</td>
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<tr>
<td>5</td>
<td>#4 w/ limit: English language</td>
<td>49</td>
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* All searches for this study were performed on January 10, 2009; the publication date limits were set to January 1995–December 2008.
patients under 30 years of age had a GOS score of 4 or 5, while 80% of the older patients had a GOS score of 1 or 2. This study included 28 patients 8–44 years of age, and no statistical analysis was performed by the authors.

Another German group analyzed outcome in 62 cases involving patients treated by DC (age range 4–74 years). These authors did not compare age groups by means of statistical analysis, but found that in the group of patients 30 years of age or younger there were 7 with good outcome (GOS score range 4–5) and 17 with unfavorable outcome (GOS score range 1–3), and in the group of patients older than 50 years there were 3 with good outcomes and 17 with bad outcomes. In the group of patients 31–50 years of age, 8 had a good outcome and 10 had a bad outcome.

Polin et al. compared 18 patients younger than 17 years old and 17 patients 17 years of age or older with 2 control populations. Pediatric patients had a higher percentage of favorable outcomes than adults (44 vs 29%, respectively); however, the authors did not compare these data using statistical analysis. Moreover, they found all 35 patients showed a statistical advantage over the control group.

A Chinese group studied 108 patients who underwent decompressive craniectomy after a closed head injury. Their study was mainly focused on surgical complications secondary to DC. In this cohort, there were 50 patients 41–60 years of age and 14 patients older than 60 years. Although the authors did not compare patient outcomes according to age, they found that the mean age of patients with a GOS score of 1 was 46.8, the mean age of patients with GOS scores of 2 or 3 was 43.1, and the mean age of patients with GOS scores of 4 or 5 was 43.7. That difference was not significant.

Discussion

There was great heterogeneity with respect to patient inclusion criteria and data presentation in the series reviewed in this study. All authors describe DC as one of the second-tier therapies for treating intractable ICP (after maximal medical therapy). The definition of intractable ICP after which authors perform DC varies widely among series. For some authors the threshold was 20 mm Hg, for other authors 25 mm Hg, or even 40 mm Hg. This element could affect outcome (as demonstrated by Clifton et al., who showed a significant relationship between an ICP > 25 mm Hg and a poor outcome in patients suffering from severe brain injury), making reliable comparison of results of different series—as in meta-analysis—impossible.

Other elements contributing to methodological heterogeneity include: arbitrary age limit within the inclusion criteria, lack of stratification within the age groups, lack of outcome end points, and small sample size. Even if data from these studies (including a total number of 854 patients) are not comparable because of the heterogeneity of populations and data presentation, it is quite evident that great controversy exists with respect to the effect of age on the efficacy of DC. In fact, in 5 studies no statistical analysis was performed; in 6 studies the authors concluded that age was not significantly related to outcome (with one of these studies showing a correlation between age and outcome only in patients older than 65 years); and 3 articles showed a correlation between age and outcome.

Conclusions

Our thorough analysis of published papers shows that, with respect to patient age and DC effectiveness, there are no robust data to establish any degree of core evidence and that the referred age thresholds are arbitrary. In most published series, patients older than 30–50 years were excluded a priori. In most of the studies that included older patients, the authors did not perform appropriate statistical analyses to assess differences in the outcome between age groups, or found no correlation between age and outcome. Based upon these considerations, we believe that proper randomized controlled trials using age stratification (and including patients older than 30–50 years) are warranted to establish age as a limiting factor for the effectiveness of DC, as well as to define an age threshold if present.

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