Clinical Neurology and Neurosurgery 136 (2015) 33–40

Contents lists available at ScienceDirect

Clinical Neurology and Neurosurgery

journal homepage: www.elsevier.com/locate/clineuro

Review

Early cranioplasty vs. late cranioplasty for the treatment of cranial defect: A systematic review

Hao Xu*, Chaoshi Niu, Xianming Fu, Wanhai Ding, Shiying Ling, Xiaofeng Jiang, Ying Ji

Department of Neurosurgery, Anhui Provincial Hospital Affiliated to Anhui Medical University, Hefei, Anhui 230001, PR China

ARTICLE INFO

Article history:
Received 25 October 2014
Received in revised form 18 May 2015
Accepted 25 May 2015
Available online 29 May 2015

Keywords:
Cranioplasty
Decompressive craniotomy
Meta-analysis
Systematic review

ABSTRACT

Background: Cranioplasty is considered as a routine procedure in everyday neurosurgical practice for the patient with cranial defect, however, there is no established consensus on optimal surgical timing.
Objective: To compare the effect of early cranioplasty (1–3 months after DC) and late cranioplasty (3–6 months after DC) on the complications and recovery of neurological function in the management of patients who received decompressive craniotomy.
Methods: In this paper, the authors report a systematic review and meta-analysis of operative time, complications and neurological function outcomes on different timing of cranioplasty. Randomized or non-randomized controlled trials of early cranioplasty and late cranioplasty surgery were considered for inclusion.
Results: Nine published reports of eligible studies involving 1209 participants meet the inclusion criteria. Compared with late cranioplasty, early cranioplasty had no significant difference in overall complications [RR = 1.14, 95%CI (0.83, 1.55), $p > 0.05$], infection rates [RR = 0.87, 95%CI (0.47, 1.61), $p > 0.05$], intracranial hematoma [RR = 1.09, 95%CI (0.53, 2.25), $p > 0.05$]; subdural fluid collection [RR = 0.47, 95%CI (0.15, 1.41), $p > 0.05$]. However, early CP significantly reduced the duration of cranioplasty [mean difference = −13.46, 95%CI (−21.26, 5.67), $p < 0.05$]. The postoperative hydrocephalus rates were significant higher in the early cranioplasty group [RR = 2.67, 95%CI (1.24, 5.73), $p < 0.05$].
Conclusion: Early CP can only reduce the duration of operation, but cannot reduce the complications of patients and even increase the risk of hydrocephalus. More evidence from advanced multi-center studies is needed to provide illumination for the timing selection of CP surgery.

Contents

* Corresponding author. Tel.: +86 551 62284067; fax: +86 551 62284067.
E-mail address: tony_xuhao@163.com (H. Xu).

http://dx.doi.org/10.1016/j.clineuro.2015.05.031
0303-8467/

1. Introduction

Decompressive craniotomy (DC) – a surgical procedure that involves the removal of part of the skull to accommodate brain swelling – has been used for many years in the management of patients with brain edema and/or intracranial hypertension due to subarachnoid hemorrhage, traumatic brain injury, cerebral infarction, intracerebral hemorrhage (ICH), and other causes [1,11,18,20]. Since more patients survive because of the DC surgery, the number of subsequent cranioplasty (CP) procedures is increasing.

CP is considered as a routine procedure in everyday neurosurgical practice which can facilitate neurological recovery and improve cerebral blood flow (CBF), cerebrospinal fluid (CSF) hydrodynamics after decompressive craniotomy [20,21]. Nonetheless, CP is noticed with a relatively high complication rates [13,21,37]. According to Schuss [32], the infection rate is 16.4%. Chang [8] and Gooch [14] have also reported the rate as 16% and 14.7% respectively.

Many neurosurgeons questioned the traditional delayed timing of cranioplasty (3–6 months after DC) and tried to explore the advantages of cranial repair at an early stage (1–3 months after DC) in terms of complications and neurological function outcomes. However, the results remain controversial [5,9,12,19,39]. In this paper, we report a comprehensive systematic review and meta-analysis to evaluate the clinical advantages of early CP compared with late CP for the patients with large cranial defects after decompressive craniectomy.

2. Methodology

2.1. Search criteria

All full text randomized and non-randomized controlled trials, comparing the clinical outcomes of early CP (1–3 months after DC) and late CP (3–6 months after DC) for the patients with large cranial defects after decompressive craniectomy in published studies were included. Case reports of less than ten subjects, comments, letters, editorials, protocols, guidelines, animal studies and cadaver articles were excluded. The Medline, Embase, Cochrane library, Ovid, and CBM databases were searched for English-language articles published from May 1994 to May 2014. Unpublished studies were excluded. Databases were searched using the keywords and MeSH terms: terms “cranioplasty”, “cranial defect”, “calvarial defect”, “skull defect”, “bone flap replacement”, “skull repair”, “cranial replacement”, “randomized controlled trials”, “random” and “control and trials”. Titles, abstracts, and subject headings were searched. The reference lists of all included articles and review papers were scrutinized for additional publications.

2.2. Search selection

Search result titles were initially screened to exclude articles that had no relation to the interventions or outcomes of interest. Abstracts of articles of potential interest were then reviewed in detail by two reviewers. To be included, articles had to analyze one or more variables described in the pertinent clinical questions, specifically, early (1–3 months after DC) vs. late surgery (3–6 months after DC). The outcome of interest was overall complications, infection, hydrocephalus, intracranial hematoma, subdural fluid collection such that a rate could be calculated. The full text of potential articles were ordered and evaluated against the eligibility criteria. Discrepancy was resolved through discussion.

2.3. Data extraction

The information from the studies was entered onto a standard data collection sheet by RT and checked independently. All data was tabulated onto a predefined spreadsheet. All articles were anonymised for author name, institution, journal title and year of publication to blind reviewers during data extraction, appraisal and analysis.

2.4. Outcome measures

The outcome measure was time of CP, overall complications, infection rate, hydrocephalus, intracranial hemorrhage, subdural fluid collection.

2.5. Analysis

Meta-analysis was carried out using REVMAN software (version 5.0 for Windows. Copenhagen: The Nordic Cochrane Centre, The Cochrane Collaboration, 2008). Quality assessment of the included studies was done independently by two reviewers. Differences of opinion were resolved by discussion. The mean difference of operation durations was assessed comparing early CP and late CP groups. The appropriateness and relative risk were evaluated of the complication rates. Statistical heterogeneity was measured using c^2 and I^2 statistics. Besides, we used a random-effects meta-analysis to pool results of the primary studies for judging appropriateness. Meta-analysis was carried out using REVMAN software (version 5.0.24 RevMan, Cochrane Collaboration, Oxford, England)).

3. Results

3.1. Search strategy

We found 253 potentially eligible articles of which 9 studies [5,6,8,9,27,28,32,34,41] were included. 244 non-pertinent titles or abstracts were excluded (Fig. 1). 1209 patients were included, 543 of which received early CP and the other 666 adopted late CP. The follow-up periods were more than 3 months. The main reasons of large cranial defects after decompressive craniectomy include brain injury, cerebral infarction, subarachnoid hemorrhage and ICH (Table 1). Archavlis [4] grouped research date into three groups: <7 weeks, 7–12 weeks, and >13 weeks. Because both the first two groups are under 3 months, we combined the first two groups into one group to compare with the other group.

3.2. Outcome measure

3.2.1. Mean operative time

Four studies [9,27,28,32] recorded the mean operative time (minutes). A meta-analysis showed significant difference between the early CP group and late CP group of mean operative time in favor of early CP group [mean difference = −13.46, 95%CI (−21.26, 5.67), $p < 0.05$] (Fig. 2).