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Original Research Article

Assessment of functional recovery after cranioplasty

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ABSTRACT

Background: Cranioplasty is done after decompressive craniectomy surgeries either for cosmetic reasons or to afford protection against the development of the syndrome of the trephined which is deterioration after cranial decompression procedures. The aim of the study was to study functional recovery after cranioplasty based on improvement of Barthel activities of daily living (ADL) score.
Methods: This was a prospective study done over 6 months period, December 2020 to May 2021. The functional recovery following cranioplasty was assessed based on improvement in Barthel ADL score. Pre-operative and post-operative Barthel ADL score after 3 months after cranioplasty of patients are found out. The change in Barthel score is analyzed and significance found out using paired t test.
Results: In this study, 62 patients were included. 42 patients had improvement of ADL score. 14 patients had no change and 6 patients had worsening of score. After cranioplasty, ADL score has improved and it was statistically significant ($p<0.001$). Also, patients with low level of dependency (level 1, 2 and 3) have decreased in number and patients with higher levels of dependency (level 4 and 5) have increased in number after the surgery, suggesting that there is shift of patients from lower level of dependency to higher levels.
Conclusions: Cranioplasty seems to offer patients clear benefits in terms of neurological improvement in many cognitive domains as well as in quality of life. Hence, cranioplasty advocated for functional/neurological recovery rather than cosmetic reasons.

Keywords: Decompressive craniectomy, Syndrome of the trephined, Cranioplasty, Barthel ADL score

INTRODUCTION

Decompressive craniectomy is the standard surgical treatment for malignant cerebral edema and brain herniation resulting from cerebral infarction, intracranial hemorrhage and severe traumatic brain injury.[1] After decompressive craniectomy, cranioplasty is also generally performed either for cosmetic reasons or to afford protection against the development of the syndrome of the trephined. Syndrome of the trephined- neurological deterioration following the decompressive procedure.[3] Cranioplasty is the treatment for this syndrome of trephined. A neuropsychological assessment is an important measure of outcome and much more representative of the prognosis of neurosurgical patients than other outcome scales.[2] In the present study, neurological recovery after cranioplasty is studied by analysing the improvement/deterioration in the Barthel ADL (activities of daily living) score.[4,9]

The objective of this study was to assess the neurological recovery after cranioplasty, by means of functional improvement in activities of daily living.

METHODS

This prospective study was conducted in the department of neurosurgery, Government Medical College, Kottayam. Study period was 6 months, December 2020 to May 2021.

Convenient sampling was done for collecting samples. After selecting the patients according to inclusion and exclusion criteria, well informed consent was taken. A detailed proforma was used to collect the required data of the patient. The functional recovery was assessed based on the improvement in the activities of daily living. The Barthel activities of daily living (Barthel ADL) score was used to assess the patients. Pre-operative and post-operative Barthel ADL score after 3 months after cranioplasty of patients were found out. The change in Barthel score was analyzed and significance found out using paired t test. The patients are categorised pre-operatively and post-operatively to various levels of dependency and change in level of dependency after surgery was studied.

Inclusion criteria

All patients who were done with cranioplasty in department of neurosurgery, Government Medical college, Kottayam were included.

Exclusion criteria

Patients who were having- (a) in whom grafts removed after cranioplasty due to infections/decreased GCS score; (b) patients who expired post-operative; (c) patients suffering from a rapidly evolving cerebral pathology (e.g. tumor); and (d) patients transferred to other hospitals before cranioplasty or whose follow-up cannot be assured were excluded.

Table 1: Levels of dependency.

Values	Levels of dependency
80-100	Patient should be able to live independently
60-79	Minimally dependent
40-59	Partially dependent
20-39	Very dependent
<20	Totally dependent

THE BARTHEL INDEX

Patient Name: _____
Rater Name: _____
Date: _____

Activity	Score
FEEDING 0 = unable 5 = needs help cutting, spreading butter, etc., or requires modified diet 10 = independent	_____
BATHING 0 = dependent 5 = independent (or in shower)	_____
GROOMING 0 = needs to help with personal care 5 = independent face/hair/teeth/shaving (implements provided)	_____
DRESSING 0 = dependent 5 = needs help but can do about half unaided 10 = independent (including buttons, zips, laces, etc.)	_____
BOWELS 0 = incontinent (or needs to be given enemas) 5 = occasional accident 10 = continent	_____
BLADDER 0 = incontinent, or catheterized and unable to manage alone 5 = occasional accident 10 = continent	_____
TOILET USE 0 = dependent 5 = needs some help, but can do something alone 10 = independent (on and off, dressing, wiping)	_____
TRANSFERS (BED TO CHAIR AND BACK) 0 = unable, no sitting balance 5 = major help (one or two people, physical), can sit 10 = minor help (verbal or physical) 15 = independent	_____
MOBILITY (ON LEVEL SURFACES) 0 = immobile or < 50 yards 5 = wheelchair independent, including corners, > 50 yards 10 = walks with help of one person (verbal or physical) > 50 yards 15 = independent (but may use any aid; for example, stick) > 50 yards	_____
STAIRS 0 = unable 5 = needs help (verbal, physical, carrying aid) 10 = independent	_____
TOTAL (0–100):	_____

Provided by the Internet Stroke Center — www.strokecenter.org

Figure 1: The barthel index.

RESULTS

We have followed up 63 patients who were done cranioplasty. 1 patient had wound infection of graft and hence excluded from study. 62 patients were included in study. 42 patients had improvement of ADL score. 14 patients had no change in ADL score. 6 patients had worsening of ADL score. After cranioplasty, ADL score has improved and it is statistically significant (p<0.001).

From the above table, we can see that patients with low level of dependency (level 1, 2 and 3) have decreased in number and patients with higher levels of dependency (level 4 and 5) have increased in number after the surgery, suggesting that there is shift of patients from lower level of dependency to higher levels.

In the level of dependency, 18 patients have improvement, 39 patients are same status, 6 patients have worsened. Out of these 4 patients improved from their total dependent level to independent.

Table 2: Mean and standard deviation of ADL value of patients pre and post operatively (n=62).

	Mean±SD
Pre-operative ADL	70.97±35.562
Post-operative ADL	85.81±24.863

Table 3: Association between mean pre and post-operative ADL scores.

Association between	Difference of mean	Standard Deviation	P value
Pre-op and post-op ADL	-14.839	26.534	<0.001

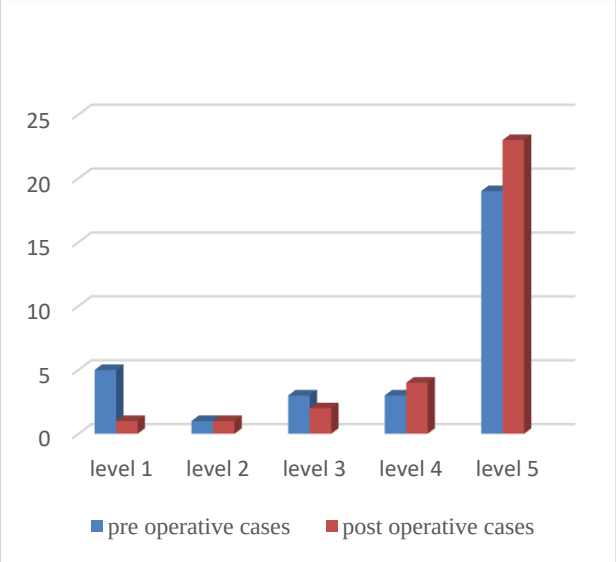

Figure 2: Number of pre-operative and post-operative patients in various levels of dependency.

DISCUSSION

In this study, post operatively ADL score has improved and it is statistically significant (p<0.001). Also, patients with low level of dependency (level 1, 2 and 3) have decreased in number and patients with higher levels of dependency (level 4 and 5) have increased in number after the surgery, suggesting that there is shift of patients from lower level of dependency to higher levels. This study provides clear evidence of the possibility of functional recovery after an adequate cranioplasty.

After decompressive surgery, atmospheric pressure is transmitted to the cranial cavity, causing inward rotation of the scalp at the cranial defect.[5] This pressure acting on the cerebral cortex may cause neurological deficits. Maekawa et al using ^{133}Xe CT scanning, reported that cranioplasty after decompressive craniectomy might increase cerebral blood flow (CBF) not only in the symptomatic hemisphere, but also in the other hemisphere. Although transcranial Doppler does not directly measure CBF, it does measure blood flow velocity in the basal intracranial arteries, through a different window.[6] Our results confirmed previous reports that cranioplasty significantly improved neuropsychological status, with regard to memory function, processing speed and inhibitory control, language function and visual-constructive ability.

We found that the ADL which are functional scores of daily activities, improved significantly.

Cranioplasty improved CBF velocities in all major intracranial arteries, not only on the side of the lesion adjacent to the cranioplasty, but also in distant regions, such as the contralateral hemisphere.[7] Thus, the neurological improvement after cranioplasty may be due to the increase in cerebral blood flow velocities in all vessels, on both the lesional and the non-lesional side, resulting from elimination of the effects of atmospheric pressure on the brain.[8] The repair of cranial defects seems to offer patients clear benefits in terms of neurological improvement in many cognitive domains as well as in quality of life.[10-12]

Limitations

Some post-operative patients were likely to improve not only due to cranioplasty, but also due to neuroplasticity after the initial trauma/surgery during the period of observation.

CONCLUSION

In busy centres, neurosurgeons are least concerned about doing cranioplasty after the initial life-saving decompressive surgeries and consider this surgery as a cosmetic surgery only. But it seems to offer patients clear benefits in terms of neurological improvement in many cognitive domains as well as in quality of life as it is clear

from our study. Hence, cranioplasty advocated for functional/neurological recovery rather than cosmetic reasons.

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