Craniectomy Versus Craniotomy in Traumatic Brain Injury: A Propensity-Matched Analysis of Long-Term Functional and Quality of Life Outcomes

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Introduction

Surgery for patients with traumatic brain injury (TBI) remains controversial. Studies suggest that craniectomy (CE) may be superior to craniotomy (CO) by reducing intracranial pressure and limiting post-operative brain swelling. Few studies report comprehensive long-term functional and quality of life outcomes.

Methods

All patients with TBI who underwent CE or CO were extracted from the TBI Model Systems database from 2000-2012. A 1:1 propensity matching with replacement technique was used to match baseline characteristics including age, Glasgow Coma Score, Marshall CT score, TBI sub-type, and intracranial hypertension across groups. The matched sample was analyzed for outcomes during hospitalization, acute rehabilitation, and up to two years follow-up.

Table 1. Baseline admission characteristics for all Propensity Matched TBI patients.

	Craniotomy (n=1470)	Craniectomy (n=1470)	Standardized Mean Difference
Age (IQR)	43 (26,60)	42 (27,56)	6.4
Male	1102 (75%)	1097 (75%)	0.15
AA race	305 (21%)	321 (22%)	2.9
GCS total (IQR)	11 (7,14)	11 (7,14)	3.7
Insurance Type			
None	67 (5%)	70 (5%)	Reference
Private	706 (48%)	707 (48%)	3.0
Medicaid	414 (28%)	414 (28%)	4.7
Medicare	283 (19%)	279 (19%)	2.2
Education level			
≤ High school	878 (60%)	899 (61%)	5.7
College	486 (33%)	462 (31%)	
Graduate	88 (6%)	71 (5%)	
Married	528 (36%)	527 (36%)	0.9
TBI sub-type			
SAH	988 (67%)	957 (65%)	6.8
SDH	1085 (74%)	1057 (72%)	8.0
IVH	407 (28%)	416 (28%)	0.5
ICH	1084 (74%)	1090 (74%)	0.15
Marshall CT score			
I	342 (23%)	385 (26%)	Reference
II	278 (19%)	265 (18%)	4.2
III	244 (16%)	237 (16%)	0.9
IV	606 (41%)	583 (40%)	3.0
Elevated ICP	700 (48%)	647 (44%)	5.6
Penetrating	131 (9%)	128 (9%)	1.9

AA = African American; CT = Computed Tomography; GCS = Glasgow Comas Scale; ICP = Intracranial pressure; IQR = Interquartile range; TBI = Traumatic brain injury; ICH = Intracerebral hemorrhage and/or contusions; IVH = Intraventricular hemorrhage; SDH = Subdural hemorrhage; SAH = Subarachnoid hemorrhage.

Results

We identified 1,470 patients in both CE and CO groups. Baseline characteristics were well-matched between groups (standardized mean difference <10). CE patients demonstrated a longer length of stay (LOS) in the hospital (median days: 22 vs. 18; p<0.0001) and acute rehabilitation (26 vs. 21; p<0.0001). CE patients were more likely to be hospitalized at one-year follow-up (39% vs. 25%; p<0.0001) for reasons other than cranioplasty including seizures (12% vs 8%; p<0.0001), neurologic events (i.e. hydrocephalus) (9% vs. 4%; p<0.0001), and infections (10% vs 6%; p<0.0001). CE patients were significantly more impaired on the Extended Glasgow Outcome Scale, required more supervision, and were less likely to be employed or living at home at one-year post-injury. No difference was observed in Satisfaction with Life Scale (SWL) scores at one-year. Kaplan Meier estimates for mortality at one- and two-year follow-up showed no difference between CE and CO groups (hazard ratio: 0.57; p=0.4).

Conclusions

Patients who underwent CE versus CO after TBI had longer LOS, decreased functional status, and more rehospitalizations. Survival at two years and SWL scores remained similar. CE for TBI is associated with worse functional outcomes.

Table 2. Propensity Matched TBI Outcome Scales

	Craniotomy (n=1470)	Craniectomy (n=1470)	P value
LOS Hospital	18 (10,26)	22 (15,33)	<0.0001*
LOS Rehab	21 (13,32)	26 (16,44)	<0.0001*
Rehab Discharge to Home	1172 (80%)	1061 (72%)	<0.0001*
Employment			
1 year	385 (26%)	324 (22%)	0.007*
2 years	351 (24%)	302 (21%)	0.3
Rehospitalization			
1 year	371 (25%)	569 (39%)	<0.0001*
2 years	511 (35%)	700 (48%)	<0.0001*
Rehospitalization Diagnosis**			
Seizures	115 (8%)	183 (12%)	<0.0001*
Neurological disorder	61 (4%)	138 (9%)	<0.0001*
Psychiatric	44 (3%)	54 (4%)	0.3
Infectious	90 (6%)	150 (10%)	<0.0001*
Orthopedic	114 (8%)	166 (11%)	0.001*
General Health	113 (8%)	163 (11%)	0.001*
Other	114 (8%)	117 (8%)	0.8
Mortality			
30 days	1 (0.1%)	0	-
6 months	23 (2%)	36 (2%)	0.09
1 year	57 (4%)	56 (4%)	0.9
2 years	96 (7%)	99 (7%)	0.8

IQR = Interquartile range; TBI = Traumatic brain injury; LOS = Length of stay; Rehab = Acute Rehabilitation
*Statistically Significant
**One year follow-up

Table 3. Propensity Matched TBI Outcome Scales

	Craniotomy (n=1470)	Craniectomy (n=1470)	P value
FIM total			
Rehab admission	47 (27,66)	38 (21,60)	<0.0001*
Rehab Discharge	92 (76,105)	86 (69,201)	<0.0001*
1 year	122 (113,126)	119 (106,125)	<0.0001*
2 years	123 (125,126)	122 (110,126)	0.0002*
FIM motor			
Rehab admission	32 (17,47)	25 (14,41)	<0.0001*
Rehab Discharge	67 (55,79)	63 (50,77)	<0.0001*
1 year	90 (84,91)	89 (78,91)	<0.0001*
2 years	91 (85,91)	90 (81,91)	0.0004*
FIM Cognitive			
Rehab admission	14 (8,20)	11 (6,18)	<0.0001*
Rehab Discharge	24 (19,28)	22 (16,27)	<0.0001*
1 year	33 (29,35)	32 (27,35)	<0.0001*
2 years	33 (30,35)	33 (28,35)	0.0009*
Disability Rating Scale			
Rehab admission	12 (8,17)	14 (10,18)	<0.0001*
Rehab Discharge	6 (5,8)	6 (5,9)	<0.0001*
1 year	3 (1,6)	3 (1,7)	0.006*
2 years	2 (0,5)	3 (1,7)	0.05
GOSE≤4			
1 year	624 (42%)	727 (50%)	0.0001*
2 years	558 (38%)	657 (45%)	0.0002*
Full Time Supervision			
1 year	260 (18%)	363 (25%)	<0.0001*
2 years	247 (17%)	293 (20%)	0.03*
Satisfaction with Life Scale			
1 year	29 (20,77)	31 (19,77)	0.5
2 years	29 (19,77)	32 (20,77)	0.7

IQR = Interquartile range; TBI = Traumatic brain injury; FIM = Functional Independence Measure; GOSE = Extended Glasgow Outcome Score; Rehab = Acute Rehabilitation
*Statistically Significant

Learning Objectives

By the conclusion of this session, participants should be able to:
1) Describe the importance of long term functional and quality of life outcomes for patients with TBI after craniectomy versus craniotomy.
2) Discuss, in small groups, how these differences in outcomes influence surgical decision-making and prognostication.
3) Identify an effective surgical treatment for patients with traumatic brain injury that accounts for functional and quality of life outcomes.
How will your research improve patient care?
This research demonstrates differences in long-term functional and quality of life outcomes for patients with TBI after craniectomy versus craniotomy. The findings in this study will better inform surgical decision-making and prognostication for TBI patients.

References

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