Outcome and Surgical Management for Geriatric Traumatic Brain Injury: Analysis of 888 Cases Registered in the Japan Neurotrauma Data Bank

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Key words
- Elderly
- Surgical management
- Traumatic brain injury

Abbreviations and Acronyms
AEDH: Acute epidural hematoma
ASDH: Acute subdural hematoma
CI: Confidence interval
GCS: Glasgow coma scale
GOS: Glasgow outcome scale
ICH: Intracerebral hematoma
ICP: Intracranial pressure
JNTDB: Japan Neurotrauma Data Bank
OR: Odds ratio
TBI: Traumatic brain injury

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Citation: World Neurosurg. (2014) 82, 6:1300-1306.
http://dx.doi.org/10.1016/j.wneu.2014.08.014

*Journal homepage: **www.WORLDNEUROSURGERY.org***

*Available online: **www.sciencedirect.com***

OBJECTIVE: **As the aged population is rapidly growing globally, geriatric traumatic brain injury (TBI) becomes an increasing problem. There are higher mortality and poorer functional outcome in the geriatric TBI population (≥65 years) compared with younger groups despite neurosurgical interventions. Therefore, current treatment priorities and cost-effectiveness should be critically examined. We evaluated the benefit of surgical management in the elderly (≥65 years) after TBI.**

METHODS: **A total of 3194 patients with confirmed TBI were enrolled from 1998 to 2011, in the Japan Neurotrauma Data Bank. Retrospective analysis was conducted from the Japan Neurotrauma Data Bank on 888 (28%) patients (≥65 years) who did and did not undergo surgery. In particular, the effect of low Glasgow coma scale (GCS) (3–5) was compared with outcome with and without surgery.**

RESULTS: **Of all the patients 65 years of age and over, 478 (54%) were given surgical management (craniectomy, craniotomy, or burr-hole evacuation). This group of patients had significantly more favorable outcome at 6 months (18% vs. 7%) and less mortality (62% vs. 81%). However, within this surgical group, patients with initial GCS scores of 3–5 had significantly more unfavorable outcome (96% vs. 79%) and more mortality (87% vs. 57%) compared with those with GCS scores of 6–15.**

CONCLUSIONS: **We confirmed that age is a major determinant of outcome after TBI. In addition, we found that neurosurgical management is associated with the improvement of the prognosis and a decrease in the rate of mortality in geriatric TBI. However, surgical management was not shown to be an effective treatment in elderly patients with GCS scores of 3–5.**

INTRODUCTION

The aged population is rapidly growing in the United States and globally. Japan is one of the fastest aging societies, in which people more than 65 years of age comprise 24% of the overall population and they are expected to increase to 30% in 2025 (2).

Recently, the growth of the aged population has become an increasing problem for those who manage traumatic brain injury (TBI). In general, age is closely associated with increased poor outcome and mortality after TBI (3, 5, 21, 37, 42). In fact, according to several studies on TBI, age could be the most significant factor in the prediction of outcome (18, 19, 23, 26, 28, 31, 41, 44, 45). Hukkelhoven et al. (18) previously examined four prospective TBI series, covering 5600 patients and found that mortality and unfavorable outcome in patients older than 55 years of age were proportionally worse with increased age compared with those younger than 35 years of age. In addition, the association between age and poor outcome was previously assessed by odds ratio (OR) and was shown to be increased by 40%–50% per 10 years of age. Outcomes and poor prognostic factors in geriatric TBI are shown in Table 1. Thus, the influence of increasing numbers of elderly persons with TBI may place severe demands on health care resources, especially in developed countries (25). The current belief regarding the aged population and craniotomy is that these procedures may do more harm than good and are possibly used less on patients in coma, who are more than 65 years old, because of this perception of poor prognosis in geriatric TBI (5, 21). However, solid evidence to show that craniotomy will negatively affect outcome in geriatric TBI patients is lacking, given that at present there are no prospective randomized studies, or definitive treatment guidelines, specifically for this age group. In addition, hospitalization of the geriatric TBI population may be associated with other medical complications, which would in turn negatively affect the patient's outcome (16). Therefore, the role of current neurosurgical treatments should be critically examined in this elderly group.

Table 1. Outcomes and Poor Prognostic Factors in Geriatric Patients with Traumatic Brain Injury

Authors/Year	Age (years)	Number of Patients	Unfavorable Outcome	Mortality	Poor Prognostic Factors
Cagetti et al., 1992 (5)	80–100	28	NR	89%	Low GCS
Hukkelhoven et al., 2003 (18)	≥ 65	101	85% at 6 months	72%	Increased age
Jamjoom et al., 1992 (19)	≥ 65	66	70%	61%	Increased age, low GCS, pupillary dilatation
Kotwica and Jakubowski, 1992 (21)	≥ 70	136	70%	52%	Increased age, intracranial mass lesion, GCS < 9
Mosenthal et al., 2002 (26)	≥ 65	153	43% at discharge	30%	Increased age, low GCS
Nakamura et al., 2006 (29)	≥ 50	535	80% at discharge	61%	Increased age, motor vehicle accidents, falls, jumps
Pennings et al., 1993 (31)	≥ 60	42	NR	79%	Increased age
Ross et al., 1992 (35)	Elderly	195	NR	75%	ICP ≥ 20 mmHg
Susman et al., 2002 (42)	≥ 65	3244	54% (dependent living)	24%	Increased age
Tokutomi et al., 2008 (44)	≥ 70	189	90% at 6 months	69%	Increased age, early hypoixa, low GCS, associated systemic injury, intracranial mass lesion, systemic complication
Vollmer et al., 1991 (45)	≥ 56	71	92% at 6 months	80%	Increased age
Present study	≥ 65	888	87% at 6 months	70%	Increased age, low GCS

NR, not recorded; ICP, intracranial pressure; GCS, Glasgow coma scale.

In the present study, we used the Japan Neurotrauma Data Bank (JNTDB) to evaluate the benefit of surgical management for patients more than 65 years old after TBI.

METHODS

Patient Population and Data Collection

The JNTDB is a national registry designed to collect and report data on patients with TBI. It was established as a part of the Japan Society of Neurotraumatology in 1998. A total of 3194 patients were enrolled from 1998 to 2011 in the JNTDB except for the years 2002, 2003, 2007, and 2008. Data were not collected for these 4 years because this period was spent conducting data analysis; giving 9 years of data available for analysis. We compared outcome in 1563 patients less than 65 years of age with the elderly patients 65 years of age and older. Of these, we selected 1123 patients 65 years of age or older and we excluded 235 patients (20.9%) who were lost to follow-up assessment at 6 months after head injury. A retrospective analysis was thus conducted on 888 elderly patients to compare the factors affecting outcome between patients who did and did not undergo surgical treatments, defined as decompressive craniectomy, craniotomy, or burr-hole evacuation. We included burr-holes, because we found a number of patients with acute TBI, who underwent delayed burr-holes in the subacute period. Patients who underwent only a burr-hole for intracranial pressure monitoring without further neurosurgical intervention were excluded from the surgical group. From 1998 to 2001, data were collected at 10 emergency medical centers; from 2004 to 2006, 9 centers were added and data were collected at 19 emergency medical centers; from 2009 to 2011, 2 centers were added totaling 21 emergency medical centers where data were collected. Neurosurgical services are available in each of these institutions and neurosurgeons supervised diagnosis, treatment, and management of these TBIs.

Early hypotension was defined as systolic blood pressure less than 90 mmHg on admission. Early hypoxia was defined as arterial oxygen tension less than 60 mmHg on admission. Outcome and mortality were assessed at 6 months after injury. All patients were assessed by the 5-point Glasgow outcome scale (GOS) and were categorized as having unfavorable (GOS score, 1–3) or favorable (GOS score, 4 or 5).

To evaluate the effect of surgical management in different types of head injury, patients were categorized into three groups: acute subdural hematoma (ASDH), acute epidural hematoma (AEDH), and brain contusion and/or intracerebral hematoma (brain contusion/ICH). These were then compared with outcome with and without surgery. Patients who suffered from multiple head injuries were excluded in this analysis. Specifically, we tested the relationship between surgical management for patients with low Glasgow coma scale (GCS 3–5) on admission and outcome with moderate and high GCS (GCS 6–15).

Statistical Analysis

Differences between the 2 study groups were assessed by a χ^2 test for categorical variables and a *t*-test was used for comparison of mean age, with a level of significance set at $P < 0.05$. Logistic regression analysis was used to identify independent predictors of unfavorable outcome