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Original Contributions

EARLY NEUROSURGICAL PROCEDURES ENHANCE SURVIVAL IN BLUNT HEAD INJURY: PROPENSITY SCORE ANALYSIS

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□ **Abstract—Background: Studies of trauma systems have identified traumatic brain injury as a frequent cause of death or disability. Due to the heterogeneity of patient presentations, practice variations, and potential for secondary brain injury, the importance of early neurosurgical procedures upon survival remains controversial. Traditional observational outcome studies have been biased because injury severity and clinical prognosis are associated with use of such interventions. Objective: We used propensity analysis to investigate the clinical efficacy of early neurosurgical procedures in patients with traumatic brain injury. Methods: We analyzed a retrospectively identified cohort of 518 consecutive patients (ages 18–65 years) with blunt, traumatic brain injury (head Abbreviated Injury Scale score of ≥ 3) presenting to the emergency department of a Level-1 trauma center. The propensity for a neurosurgical procedure (i.e., craniotomy or ventriculostomy) in the first 24 h was determined (based upon demographic, clinical presentation, head computed tomography scan findings, intracranial pressure monitor use, and injury severity). Multivariate logistic regression models for survival were developed using both the propensity for a neurosurgical procedure and actual performance of the procedure. Results: The odds of in-hospital death were substantially less in those patients who received an early neurosurgical procedure (odds ratio [OR] 0.15; 95% confidence interval [CI] 0.05–0.41). The mortality benefit of early neurosurgical intervention persisted after exclusion of patients who died within the first 24 h (OR 0.13; 95% CI 0.04–0.48). Conclusions: Analysis of observational data after adjustment using the propensity score for a neurosurgical procedure in the first 24 h supports the association of early neurosurgical intervention and patient survival in the setting of significant blunt, traumatic brain injury. Transfer of at-risk head-injured patients to facilities with high-level neurosurgical capabilities seems warranted.**

□ **Keywords—trauma outcomes; blunt head injury; intracranial pressure monitor; craniotomy; trauma center; propensity score; injury survival**

INTRODUCTION

Studies of trauma systems have identified traumatic brain injury as a frequent cause of death or disability (1,2). Survival of the brain-injured trauma patient has been shown

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to increase with trauma system development and timely transfer to a Level-1 trauma center (1,3). Although evidence-based guidelines have been developed for the management of severely brain injured adults and children, the guidelines are largely based upon the ability to improve physiological variables such as intracranial pressure (ICP) or cerebral perfusion pressure (CPP), and upon the known prognostic value of these measures (4–7).

Given the presence of widely recognized practice guidelines, albeit variably applied, it is virtually impossible to perform a definitive randomized, controlled trial of early (i.e., within 24 h of presentation) craniotomy or ventriculostomy for the purpose of evacuating hemorrhage, draining cerebral spinal fluid, and aggressively controlling ICP and maintaining CPP. Indeed, some controversy exists regarding the role that early craniotomy plays. Although neurosurgeons universally support evacuation of large mass lesions to prevent local tissue damage, brain herniation, and secondary infarct (as a result of herniation), the role of decompression craniotomy for medically refractory raised ICP is controversial.

Hence, due to the heterogeneity of patient presentations, practice variations, and potential for secondary brain injury, the importance of early neurosurgical procedures to control ICP and maintain CPP in relation to survival or neurological function remains controversial. Traditional observational outcome studies have been biased, as patients with the most severe injuries are most likely to receive such interventions, yet due to their increased injury severity, they also are expected to have the worst clinical outcomes. Further, an important subset of patients presenting in a moribund state may not warrant such interventions due to their dismal prognosis.

We therefore sought to evaluate the role of early neurosurgical interventions (i.e., craniotomy or ventriculostomy within 24 h of presentation) in determining outcomes in patients with significant blunt traumatic brain injury. We used propensity scores to account for the non-random selection of patients having early neurosurgical interventions at one Level-1 trauma center. We postulated that early neurosurgical intervention is associated with greater survival in patients with clinically significant blunt trauma brain injury.

MATERIALS AND METHODS

Study Design and Setting

We collected data on a retrospectively identified cohort of patients with clinically significant blunt, traumatic brain injury presenting to the emergency department (ED) of a Level-1 trauma center from January 1, 1999, through August 31, 2003. Trained medical record abstractors collected data using a structured data collection instrument. The Institutional Review Board of Oregon Health and Sciences University approved this observational study and waived the requirement of informed consent.

Patients

Consecutive trauma patients aged 18–65 years, transported directly from the scene of injury, evaluated in the ED of a Level-1 trauma center, and retrospectively identified as having a clinically significant brain injury (i.e., head Abbreviated Injury Scale [AIS] ≥ 3) were included in the analysis. The head AIS for a given injury ranges from 1 (minor) to 6 (non-survivable). A score of ≥ 3 represents a serious injury, for example, significant brain contusion, laceration, or hematoma; unconsciousness up to 1 h with focal neurological deficit; or unconsciousness for a more extended period (8).

Children (< 18 years of age) and adults > 65 years of age were excluded, as the project was initiated to collect information on traumatic brain injury patients, including functional outcome, in a working-age population. Due to the difficulty in collecting transfer patient data from the initial hospital evaluation and due to the potential for spectrum bias in such patients, persons initially evaluated at an outside hospital and transferred to this ED were excluded. Patients with penetrating brain injury and those who died within 90 min of ED arrival also were excluded. In addition, a portion of the study population was used in an earlier article describing a decision rule to identify patients requiring high-intensity therapeutic interventions (i.e., patients with high resource needs) at the Level-1 trauma center (9).

Outcome and Intervention Measures

We used survival to discharge as the main outcome variable. A secondary analysis was performed using each patient's expressive functional status at discharge. The expressive functional status was selected because other injuries could affect locomotion and ability to self-feed at the time of hospital discharge. A patient discharged from the hospital as dead or in a "fully dependent" status (i.e., someone unable to express basic needs and wants consistently, even with augmentative communication device or system, despite prompting) was considered as dead or severely disabled at discharge.

The intervention of interest was a composite neurosurgical procedural intervention (i.e., craniotomy or ventriculostomy) within the first 24 h after arrival at the Level-1 trauma center. Because more than one of these procedures often was performed in the same patient and indications