Elevated Hemoglobin Concentration Affects Acute Severe Head Trauma After Recovery from Surgery of Neurologic Function in the Tibetan Plateau

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BACKGROUND: **Long-lived inhabitants of the plateau region have a higher hemoglobin concentration, which is the leading cause of damage in various organs, especially the nervous system. The aim of this study was to investigate the effect of hemoglobin concentration on mortality and neural functions after decompressive craniectomy in patients with hypoxia.**

METHODS: **Patients with acute severe head trauma were classified into an elevated hemoglobin concentration group (EHb) and a moderate hemoglobin concentration group (MHb). The survival rate was evaluated by comparing the Glasgow Coma Score on days 1, 3, 7, and 15 after surgery (Kaplan-Meier survival curve). The Glasgow Outcome Scale classification method was used to evaluate recovery of neural function.**

RESULTS: **The Glasgow Coma Score scores on days 3, 7, and 15 were lower in the EHb group compared with the MHb group ($P < 0.05$). Mortality was significantly higher in the EHb group compared with the MHb group ($P < 0.05$). After 6 months, the Glasgow Outcome Scale of the MHb group was significantly higher than that of the EHb group ($P < 0.05$).**

CONCLUSIONS: **Elevated hemoglobin concentration has a serious impact on neurologic recovery and mortality, as seen in patients with acute severe head trauma after decompressive craniectomy.**

INTRODUCTION

Tibet is located on a plateau at an average height of 4500 m above sea level. The O_2 level is 62% at this height. Ambient P_{O_2} (partial pressure of oxygen) and arterial P_{O_2} are about 97 and 56 mm Hg, respectively. More than 3 million people in this region have red blood cell hyperplasia as a result of lack of oxygen, which leads to increases in blood viscosity, dizziness, headache, and shortness of breath.

Long-time inhabitants of this area have high hemoglobin levels, which are required to increase the transport of oxygen but which can damage several organs of the body, specifically the nervous system.[1-5] Acute severe head trauma with brain edema is a common disease in this hypoxic environment. Decompressive craniectomy (surgical removal of a part of the skull to reduce intracranial pressure) is the only effective treatment for acute severe head trauma. The recovery of neural functions after acute severe head trauma takes longer because of the hypoxic environment.[6,7] The purpose of this study was to investigate the effect of hemoglobin concentration on mortality and morbidity after decompressive craniectomy in patients with hypoxia.

METHODS

Group by Hemoglobin Concentration: Preoperative Examination

Several studies have shown that at altitudes of 1100, 2800, 3600, and 4000 m, hemoglobin levels are 13.53 ± 8.76 g/dL, 15.57 ± 0.64 g/dL, 17.71 ± 0.80 g/dL, and 18.03 ± 0.78 g/dL, respectively. At an altitude of more than 4000 m, brain oxygen pressure decreases drastically, leading to cranial nerve injury.[8] Hemoglobin concentrations 30 minutes before surgery were checked and the groups were divided into an elevated hemoglobin concentration (EHb) group, with hemoglobin concentration greater than 18 g/dL, and a moderate hemoglobin concentration (MHb) group, with hemoglobin concentration less than 18 g/dL. The preoperative Glasgow Coma Scale (GCS) score and head computed tomography were used to define the severity of acute severe traumatic brain injury.

Patient Population

This work was carried out in accordance with the Declaration of Helsinki. A total of 237 patients with acute severe head trauma

Key words
- Acute severe head trauma
- Elevated hemoglobin concentration group
- Hemoglobin concentration
- Moderate hemoglobin concentration group

Abbreviations and Acronyms
EHb: Elevated hemoglobin concentration group
GCS: Glasgow Coma Scale
GOS: Glasgow Outcome Scale
MHb: Moderate hemoglobin concentration group
SD: Standard deviation

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(determined by computed tomography scans and GCS score) were enrolled in this study from January 2001 to January 2012. A total of 89 patients (54 men and 35 women, age ranging from 16 to 75 years) underwent surgery (Figure 1). The patient characteristics for each group (EHb and MHb) after admission are listed in Table 1.

Clinical Management and Surgical Treatment

Those patients who had hernia formation were given mannitol immediately. After the preoperative examination, decompressive craniectomy was performed in all patients.

When intraventricular hemorrhage occured, cerebrospinal fluid drainage was applied to decrease the incidence of hydrocephalus.

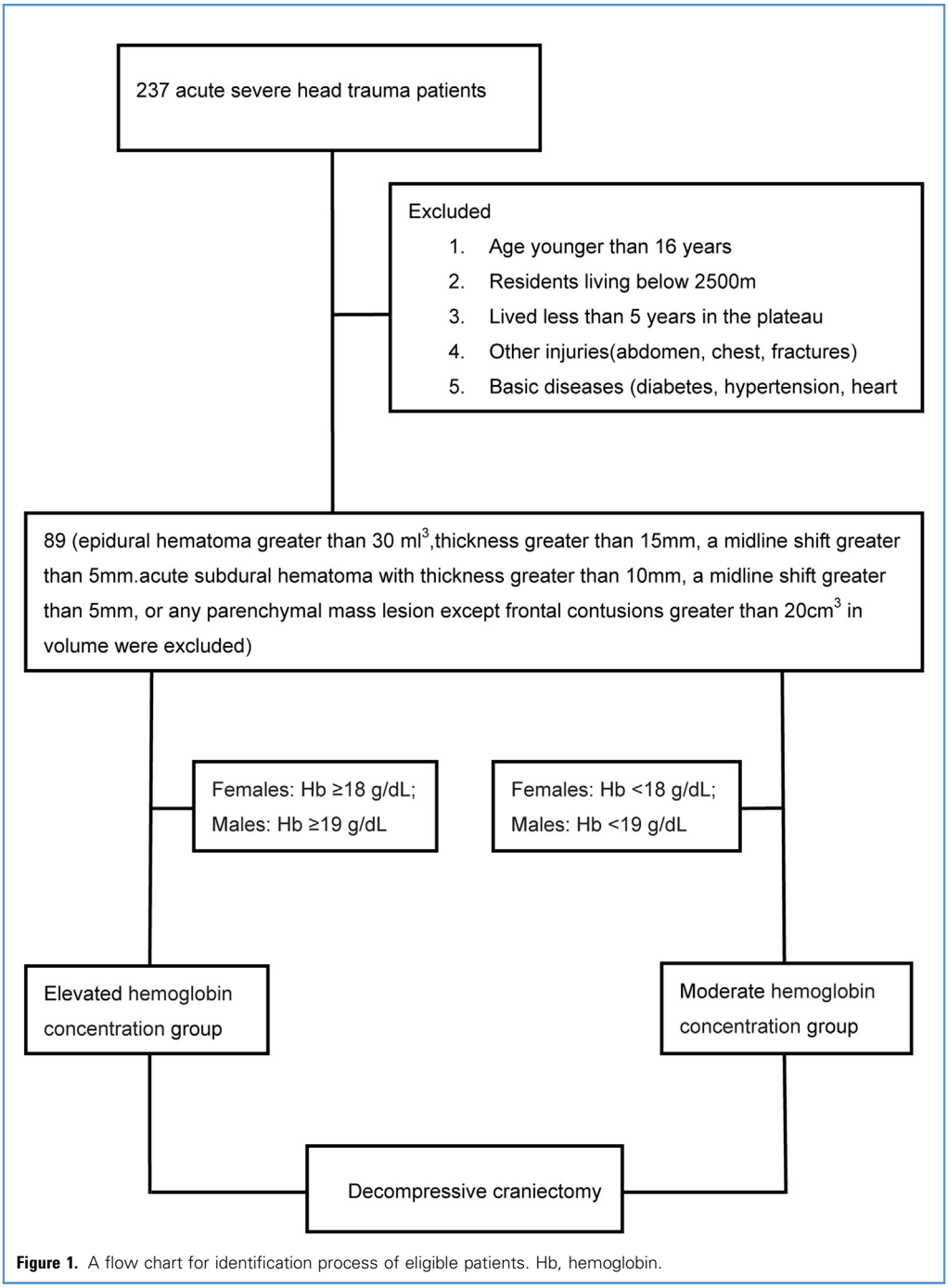

Figure 1. A flow chart for identification process of eligible patients. Hb, hemoglobin.