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Effectiveness of surgical rib fixation on prolonged mechanical ventilation in patients with traumatic rib fractures: A propensity score–matched analysis

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ABSTRACT

Purpose: We investigated whether surgical rib fixation improved outcomes in patients with traumatic rib fractures.
Materials and Methods: This was a retrospective study using a Japanese administrative claim and discharge database. We included patients with traumatic rib fractures admitted to hospitals where surgical rib fixation was available from July 1 2010, to March 31, 2013. We detected patients who underwent surgical rib fixation within 10 days of hospital admission (surgical group) and those who did not (control group). The main outcome was prolonged mechanical ventilation, defined as that performed for 5 or more days, or death within 28 days. One-to-four propensity score matching was performed between the 2 groups with adjustment for possible confounders.
Results: Among 4577 eligible patients, 90 (2.0%) underwent the surgical rib fixation. After the matching, we obtained 84 and 336 patients in the surgical and control groups, respectively. Logistic regression analyses showed that the surgical group was significantly less likely to receive prolonged mechanical ventilation or die within 28 days than the control group (22.6% vs 33.3%; odds ratio, 0.59; 95% confidence interval, 0.36-0.96; $P = .034$).
Conclusions: Surgical rib fixation within 10 days of hospital admission may improve outcomes in patients with traumatic rib fractures.

1. Introduction

Most rib fractures are treated nonoperatively. In fact, a study using the National Trauma Data Bank showed that only 0.7% of patients with flail chest, which is one of the most severe conditions in multiple rib fractures, received surgical fixation for rib fractures [1]. However, patients who received conservative treatments for rib fractures often had long-lasting disability [2]. Thus, the current nonoperative treatments for rib fractures are not necessarily ideal for the patients.

Several previous studies have shown the benefits of surgical rib fixation, including 3 randomized controlled trials [3–5]. Nevertheless, these studies involved small sample sizes. Consequently, operative management is not recognized as a standard treatment option, even for flail chest. A previous study in the United States involving trauma, orthopedic, and thoracic surgeons reported that only 26% had performed or assisted on surgical fixation for rib fractures [6]. Because of the potential benefits for patients with rib fractures, the effects of surgical rib fixation on outcomes need to be further evaluated.

We investigated the effects of surgical fixation for rib fractures on patient outcomes in a real-world clinical setting, using a national administrative claims and discharge database in Japan.

2. Materials and methods

2.1. Study design and setting

The present study was a retrospective cohort study. We used a Japanese national administrative claims and discharge abstract database called the Diagnosis Procedure Combination (DPC) database [7,8]. This database collects data for all inpatients discharged from participating hospitals. In 2013, approximately 1000 hospitals including 82 university hospitals participated in the database system.

The DPC database contains the following information for individual patients: age; sex; diagnoses including primary diagnoses, complications during hospitalization, and preexisting comorbidities; medical and surgical procedures performed; drugs used; and discharge status. Diagnoses are recorded by both *International Classification of Diseases,*

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10th Revision (*ICD-10*) codes and text data written in Japanese. Procedures and drugs are recorded with the dates of use.

The present study was approved by the institutional review boards and ethics committee of The University of Tokyo. Informed consent was waived because of the anonymous nature of the data.

2.2. Patient selection

Among all the inpatients recorded in the DPC database, we included those who satisfying all of the following criteria: admission to hospitals with injuries including rib fractures (S223, S224, or S225) from July 1, 2010 to March 31, 2013, and admission to hospitals where surgical fixation for rib fractures was performed for at least 1 patient during the study period. We divided the patients into a surgical group and a control group. The surgical group contained patients who received surgical rib fixation within 10 days of hospital admission, whereas the control group contained those who did not. Patients who died within 10 days of hospital admission were excluded. Patients younger than 20 years were also excluded.

2.3. Variables

Patients were subdivided into 3 age groups: <59, 60-74, and ≥75 years. To adjust for injury severity, we used the following items: Japan Coma Scale (JCS) score on admission; procedures performed on admission including mechanical ventilation, chest drainage, catecholamine use, and transfusion; and interventions for associated injuries performed during hospitalization. The JCS is a scale for measuring impaired consciousness [9,10]. For the JCS, a score of 0 indicates alertness, single-digit scores of 1 to 3 indicate drowsiness, double-digit scores of 10 to 30 indicate somnolence, and triple-digit scores of 100 to 300 indicate coma. The interventions for associated injuries were as follows: craniotomy, spinal fusion, thoracotomy, laparotomy, pelvic internal fixation, open reduction and internal fixation (ORIF) for limb fractures, and transarterial embolization. We also identified whether hospitals were tertiary trauma centers or not.

The outcomes of interest were prolonged mechanical ventilation for 5 or more days or death within 28 days, tracheotomy or death within 28 days, 28-day mortality, and length of hospital stay. The definition of prolonged mechanical ventilation was derived from the finding that the median duration of mechanical ventilation was 5 days among patients with rib fractures who required mechanical ventilation in this study.

2.4. Statistical analysis

We performed a 1:4 propensity score matching between the surgical group and the control group. This matching was performed to enhance the baseline comparability between the 2 groups. A logistic regression model was used to estimate a propensity score for the receipt of surgical fixation for rib fractures for each patient. The following factors were included in the model: patient age and sex; procedures performed on admission including mechanical ventilation, chest drainage, transfusion, and the use of catecholamines; the JCS scores on admission; the presence of flail chest; associated injuries requiring surgical or radiologic interventions; and hospital type. The *c* statistic was calculated to evaluate the goodness of fit for the model. Each patient in the control group was matched with a patient in the surgical group with the closest estimated propensity on the logit scale within a specified range (≤0.20 of the pooled SD of estimated logits) [11]. In both the total population and the matched population, categorical data were compared between the surgical group and the control group using the χ^2 test or Fisher exact test as appropriate, whereas continuous data were compared using the Mann-Whitney *U* test. In addition, we performed logistic regression analyses of surgical rib fixation for the 2 outcomes of prolonged mechanical ventilation or death within 28 days, and tracheotomy or death within 28 days. The logistic regression analyses were fitted with generalized estimating equations that accounted for the pairwise nature of the surgical patients and the controls. Because severe head and torso injuries are strong predictors of outcome in patients, we performed a

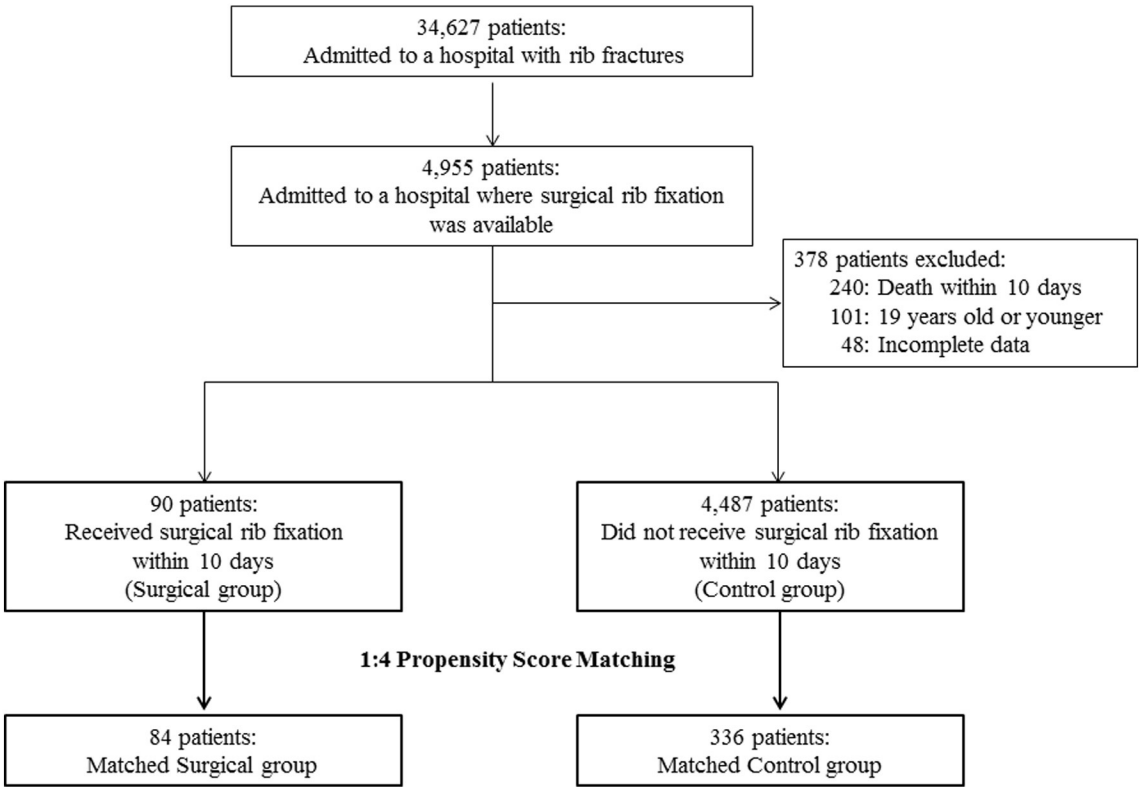

Fig. 1. Selection process of the surgical and control groups.