Risks of In-Hospital Death and Complications After Fusion Surgery in Patients with Atlantoaxial Subluxation: Analysis of 1090 Patients Using the Japanese Diagnosis Procedure Combination Database

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Key words
- Atlantoaxial subluxation
- Complications
- Database
- Rheumatoid arthritis
- Mortality

Abbreviations and Acronyms
AAS: Atlantoaxial subluxation
DPC: Diagnosis Procedure Combination
ICD-10: *International Classification of Diseases*, 10th Revision
RA: Rheumatoid arthritis
SSI: Surgical-site infection
VA: Vertebral artery

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OBJECTIVE: **To examine in-hospital mortality and postoperative major complications in patients undergoing fusion surgery for atlantoaxial subluxation (AAS) and to examine whether the risk of perioperative complications varies between patients with and without rheumatoid arthritis (RA).**

METHODS: **A retrospective analysis of data from the Diagnosis Procedure Combination database, a nationwide administrative impatient database in Japan, identified 1090 patients who underwent spinal fusion surgery for AAS during 2007–2012. Patients' clinical characteristics were extracted, including age, sex, use of homologous blood transfusion, length of stay, and type of hospital. Clinical outcomes included in-hospital death and major complications, including surgical-site infection, sepsis, cardiac events, respiratory disorders, acute renal failure, pulmonary embolism, perioperative stroke, and vertebral injury. Massive blood transfusion was defined as at least 6 units of red blood cells.**

RESULTS: **Four hundred sixty-five patients (42.7%) were classified as the RA group. In-hospital mortality after fusion surgery for AAS was 0.5% (5/1090), and major complications occurred in 5% (55/1090). Multivariate analyses showed that patients with RA were more likely to have major complications after surgery than patients without RA (odds ratio: 1.69; 95% confidence interval: 0.96–2.97; $P = 0.07$), and the rate of massive blood transfusion was significantly greater in patients with RA than in patients without RA (odds ratio: 2.29; 95% confidence interval: 1.12–4.68; $P = 0.02$).**

CONCLUSIONS: **The in-hospital mortality after fusion surgery for AAS was relatively low. However, patients with RA had an increased risk of postoperative complications and massive blood transfusion compared with patients without RA.**

INTRODUCTION

Atlantoaxial subluxation (AAS) is a serious condition characterized by instability at the atlantoaxial junction, which may result in intractable neck pain, progressive myelopathy caused by cord compression, or spinal cord injury (17, 23). AAS is known to be associated with several conditions, including rheumatoid arthritis (RA), os odontoideum, and trauma, and often requires surgical stabilization once patients become symptomatic.

With recent advances in spinal instrumentation surgery, posterior fusion surgery has been performed increasingly in treatment for AAS, reportedly with good clinical outcomes (2, 7, 11, 13, 26). The procedure, however, carries a potential risk of injury to adjacent vessels such as the vertebral artery (VA), which may lead to massive intraoperative hemorrhage and even death (12). In particular, patients with RA are considered to have increased risk of VA injury compared with those without RA (21, 22).

Despite the potentially devastating consequences, the available evidence on the mortality and morbidity of posterior fusion surgery for AAS is mostly limited to single-institution case series. Currently, the literature only contains one meta-analysis examining this issue (10). In that meta-analysis of more than 2000 patients undergoing C1-2 transarticular screw fixation, the authors concluded that the procedure was safe with a 30-day perioperative mortality of 0.8%. The generalizability of their findings, however, was limited critically by the heterogeneity of their study population (samples obtained during a study period of more than 20 years) and the small retrospective nature of the studies included in the meta-analysis.

Using a nationwide inpatient database, we sought in this study to examine the mortality and postoperative major complications in patients undergoing fusion surgery for AAS. We also examined whether the risk of perioperative complications varies between patients with and without RA.

METHODS

Data Source

We used data abstracted from the Japanese Diagnosis Procedure Combination (DPC) database, the details of which were described previously (3-6). To summarize, the database includes administrative claims data and discharge abstract data from hospitals across Japan. All 82 academic hospitals are obliged to participate in the database, but the participation of community hospitals is voluntary. In 2012, approximately 50% of all acute-care inpatients in Japan were included in the DPC database. The database includes the following information: unique identifier of the hospital; type of hospital (academic or nonacademic); patient age and sex; main diagnoses; surgical procedures; comorbidities that were already present at admission and complications that occurred after admission recorded according to *International Classification of Diseases*, 10th Revision (ICD-10) codes; length of stay; and in-hospital death. The advantage of the DPC database is the clear differentiation between comorbidities and complications. The anonymous nature of the data allowed the requirement for informed consent to be waived. Study approval was obtained from the Institutional Review Board of The University of Tokyo.

Patient Selection and Data

We included all patients aged 20 years or older who underwent spinal fusion surgery for AAS (ICD-10: S131) between 1 July 2007, and 31 March 2012. Patients younger than 20 years of age were excluded from the analysis in this study to focus on the adult population. Patients requiring emergency admission were excluded from the study. Because of the limited availability of DPC data before 2011, the study involved patient data extracted for a total of 39 months as follows: 1 July to 31 December 2007–2010; 1 January to 31 December 2011; and 1 January to 31 March 2012.

We assessed the patients' clinical characteristics, including age, sex, use of homologous blood transfusion, length of stay, and type of hospital. The patients were divided into 2 groups according to the pathological difference of AAS as follows: RA group (ICD-10: M53, M58, M59, M60, M64, M68, M69) and non-RA group.

Outcomes

The outcomes used in this study were in-hospital death and major complications, including surgical-site infection (SSI) (ICD-10: T814), sepsis (A41), cardiac events including acute coronary events (I21) and heart failure (I50), respiratory disorders (J18, J95, J96), acute renal failure (N17), pulmonary embolism (I26), perioperative stroke (I60–I63), and vertebral injury (S15.1).

We also examined the total amount of blood transfusion during hospitalization. We defined massive blood transfusion as at least 6 units of red blood cells, based on previous reports (15, 20, 25).

Statistical Analysis

Continuous variables were compared by analysis of variance or the Kruskal–Wallis test, and proportions were compared using the χ^2 test. Multivariate logistic regression analyses were performed to determine factors associated with the occurrence of major complications and massive blood transfusion. The threshold for significance was a value of $P < 0.05$. All statistical analyses were performed using SPSS ver. 22.0 (SPSS Inc., Armonk, New York, USA).

RESULTS

A total of 167,230 patients who underwent spinal surgery were identified from the DPC database. Among them, 1090 patients (0.7%) underwent spinal fusion surgery for AAS (379 men and 711 women). The mean age (± standard deviation) was 64.5 (± 11.6) years. Of these, 465 patients (42.7%) were classified as the RA group. The proportion of females was greater, and the length of stay was longer in the RA group than in the non-RA group (Table 1).

Table 2 summarizes the adverse events after surgery. In-hospital death occurred in 5 patients (0.5%). Of these, 4 patients were in the RA group and 1 was in the non-RA group. Table 3 shows the characteristics of the fatal cases.

Regarding major postoperative complications, 55 patients (5.0%) had at least 1 major complication. The most common major complication was SSI (2.8%), followed by cardiac events (0.9%) and respiratory complications (0.8%). VA injury was not documented in the present series.

Blood transfusion was performed for 132 patients (12%). Patients with RA were more likely to receive blood transfusion than those without RA (14.9 vs. 9.8%, $P = 0.01$). Thirty-three patients (3.0%) received massive blood transfusion (19 in the RA group vs. 14 in the non-RA group, $P = 0.06$). Of the patients who received a massive blood transfusion, 1 patient died during hospitalization.

Table 4 shows the results of the multivariate logistic regression analyses for major complications and massive blood transfusion. Patients with RA were more likely to have major complications after surgery than patients without RA (odds ratio: 1.69; 95% confidence interval: 0.96–2.97; $P = 0.07$). Patients with RA also were more likely to receive massive blood transfusion than patients without RA (odds ratio: 2.29; 95% confidence interval: 1.12–4.68; $P = 0.02$).

DISCUSSION

This study had 3 main findings. First, our analysis of nationwide data showed that

Table 1. Characteristics of the Patients in the RA and Non-RA Groups

	Overall (n = 1090)	RA (n = 465)	Non-RA (n = 625)	*P* Value
Age, years; mean (SD)	64.5 (11.6)	65.2 (9.2)	63.9 (13.1)	0.73
Sex, n (%)				<0.001
Male	379 (34.8)	101 (21.7)	278 (44.5)	
Female	711 (65.2)	364 (78.3)	347 (55.5)	
Academic hospitals, n (%)	567 (52.0)	244 (52.5)	323 (51.7)	0.81
Length of stay, days; median (IQR)	29 (21–44)	31 (21–48)	26 (20–40)	0.002

P values are for comparisons between the RA group and the non-RA group.
IQR, interquartile range; RA, rheumatoid arthritis; SD, standard deviation.

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