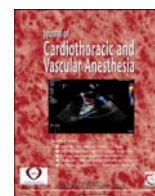




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Original Article

Association of Oral Intake and Transient Mixed Venous Oxygen Desaturation in Patients Undergoing Fast-Track Postoperative Care After Open-Heart Surgery

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Objective: The impact of early resumption of oral intake after cardiac surgery on hemodynamics has not been characterized. The authors examined the effects of early oral intake on the oxygen supply-demand relationship in patients undergoing on-pump cardiac surgery in an early recovery after surgery program.

Design: Prospective data were collected in postcardiac surgical patients in a multidisciplinary intensive care unit (ICU) during an 18-month period.

Setting: Single institution study.

Participants: Forty-three patients who underwent either mitral or aortic valve repair and were successfully liberated from ventilatory support within 10 hours after surgery.

Interventions: Patients were either allowed to resume oral intake on the morning of the first postoperative day or not at the discretion of the surgical team after extubation.

Measurements and Main Results: The oxygen supply-demand relationship was assessed continuously with cardiac index and mixed venous oxygen saturation (SvO₂). Among the subjects, 22 patients were allowed to eat, and transient SvO₂ decrease was noted in 13 patients. All transient SvO₂ decreases occurred in the patients with early oral intake. The hemodynamic status and oxygen supply-demand relationship did not differ between the patients with and without transient SvO₂ decrease. All the subjects were discharged successfully from the ICU on the first postoperative day, and the length of hospital stay was similar irrespective of SvO₂ decrease after early oral intake.

Conclusions: Early oral intake shortly after extubation was associated with transient but significant SvO₂ decrease in patients who underwent fast-track recovery after open-heart surgery. Because this phenomenon did not negatively affect the postoperative outcome, early oral intake may not be harmful.

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Key Words: cardiopulmonary bypass; postoperative care; early recovery protocol; oral intake; mixed venous hemoglobin saturation

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IN THE GENERAL SURGICAL POPULATION, application of early recovery protocol (ERP) is advocated almost universally. Among the several components of ERP, early resumption of oral intake after surgery seems to play an important role in the success of ERP.

In cardiac surgical patients, early recovery or fast-track protocol principally focuses on the timing of liberation of ventilatory support and length of intensive care unit (ICU)

stay.¹⁻⁵ The nutritional aspect of postoperative care typically focuses on parenteral, prepyloric, or postpyloric administration of nutrients to critically ill, ventilated patients.^{6,7} Thus, the effects of nutritional management via oral route in extubated patients have not been examined vigorously.

In the authors' institution, the cardiac surgical team actively applies ERP with early liberation from ventilatory support and provision of oral intake after extubation. The authors incidentally found that several patients experienced a transient and reversible SvO₂ decrease during their ICU stay. Such phenomenon typically occurred after the subjects were allowed to resume nonsolid food at a relatively early phase of the recovery period. Additionally, a transient decrease of SvO₂ has been reported during early mobilization after cardiac surgery.⁸⁻¹¹ Because SvO₂ provides objective assessment of the balance of oxygen supply and demand¹² and decreased SvO₂ is one of the risk factors of poor outcome after aortic valve replacement,¹³ such phenomena may be clinically relevant.

To elucidate the clinical implications of early oral intake on oxygen supply-demand relationship after cardiac surgery, the authors retrospectively analyzed the incidence, time course, risk factors, and impact on outcome of transient and reversible SvO₂ decrease following oral intake in patients undergoing fast-track cardiac surgery.

Methods

The protocol of the original prospective, observational study was approved by the institutional review board (22-61) and registered at Japanese Clinical Trial Registry (UMIN000009685). Patients undergoing first-time, elective cardiac surgery with cardiopulmonary bypass as the first case of the day were screened for possible enrollment in this prospective study. Patients undergoing deep hypothermic cardiac arrest, patients with end-stage renal disease requiring hemodialysis, patients who were intubated and mechanically ventilated already or under mechanical circulatory support were excluded. Written informed consent was obtained at the preoperative clinic.

Standardized anesthetic management was provided to all cardiac patients. After the placement of venous and arterial catheter, general anesthesia was induced with a small dose of fentanyl and propofol and maintained with sevoflurane and propofol, supplemented with rocuronium. A pulmonary artery catheter (744HF75, Edwards Lifesciences, Irvine, CA) was inserted via right internal jugular vein and both continuous cardiac index (CCI) and SvO₂ were monitored continuously (Vigilance, Edwards Lifesciences). Body temperature was maintained around 36°C throughout the surgical procedure, including the period during cardiopulmonary bypass. Typical pump flow during cardiopulmonary bypass was 2.0 L/min/m².

After ICU arrival, continuous SvO₂ and CCI monitoring was resumed, and these data were downloaded to the computer. Only the data with satisfactory signal quality were included in the analysis. During ICU stay, moderate restrictive fluid management with acetate Ringer solution was employed. Typically,

combination of dopamine and nitroglycerin infusion was provided for hemodynamic support. The decision to liberate patients from ventilatory support made was at the discretion of the cardiac surgical team, who were not involved in the original study. However, surgical team members were allowed to access all hemodynamic data, including SvO₂ and CCI. These patients who typically are extubated in the ICU as soon as they regain consciousness achieve hemodynamic stability and successful ventilatory weaning process. The authors arbitrarily defined surgery as fast-track cardiac surgery if the patients were liberated from ventilatory support within 10 hours after ICU arrival, and such patients were enrolled in this analysis. After liberation, patients were kept in a semirecumbent position and allowed to intake small ice cubes. Patients who successfully achieved fast-track surgery were either allowed to orally intake nonsolid, jelly-type food (600 kcal, 200 mL) in the morning (early oral intake group) or were withheld the same oral intake until noon (delayed oral intake group). The decision to allow early oral intake also was made at the discretion of the surgical team.

SvO₂ desaturation was defined arbitrarily as transient and reversible desaturation that lasted more than 20 minutes and maximal desaturation > 10% compared with baseline value. A similar definition was used in the previous study.⁹ The degree and the time course of transient SvO₂ decrease were characterized by the interval between oral intake and the start of transient SvO₂ decrease, duration of desaturation, maximal decrease of SvO₂ from the pre-oral intake level, and area under the curve of SvO₂ decrease.

All data were statistically analyzed with either Prism (version 6, Graphpad Software, La Jolla, CA) or Stata (version 13, StataCorp, College Station, TX). Normality of the distribution was tested with the D'Agostino-Pearson normality test. Data were expressed as either mean ± standard deviation (SD) or median [range], according to the distribution. The differences between the groups were examined with either the unpaired t-test or Mann-Whitney U-test. The risk factors of SvO₂ desaturation were analyzed with multivariate logistic regression. A p value < 0.05 was considered significant.

Results

Details of patient flow are summarized in the CONSORT flow chart (Fig 1). Forty-three patients underwent fast-track recovery. During the 18-month study period, 22 were allowed early oral intake, and the other 21 refrained from early oral intake. Transient SvO₂ desaturation occurred in 13 subjects. All subjects who experienced SvO₂ desaturation were in the early oral intake group, and none in the delayed group experienced SvO₂ decrease (p < 0.001). The comparison of demographic and operative data between the patients with and without transient SvO₂ desaturation irrespective of the timing of oral intake is summarized in Table 1. The typical time course of this phenomenon is presented graphically in Figure 2, and the profiles of SvO₂ desaturation are summarized in Table 2. The multivariate logistic regression revealed that early oral intake is the single risk factor of transient SvO₂ desaturation in patients undergoing fast-track cardiac surgery. To

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