

Clinical Study

Echocardiographic predictor of acute heart failure after spine surgery: a novel tissue Doppler index associated with a potentially fatal complication of the operation

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Abstract

BACKGROUND CONTEXT: Acute heart failure (HF) is a potentially fatal complication after spine surgery.

PURPOSE: We sought to identify clinical and echocardiographic predictors of postoperative HF in spine surgery patients.

STUDY DESIGN: Retrospective observational study.

PATIENT SAMPLE: A total of 305 patients (128 men; age, 65±9 years) who underwent spine surgery were consecutively enrolled. A transthoracic echocardiography was performed to all patients before the index operation. Patients with a history of HF or with left ventricular (LV) systolic dysfunction (LV ejection fraction <50%) were excluded.

OUTCOME MEASURES: Heart failure was defined according to the Framingham criteria. The presence of postoperative dyspneic symptom and the sign of bilateral ankle edema were recorded by the physicians. Chest X-ray was mandatory for all patients and interpreted by the two physicians, including at least one radiologist.

METHODS: Clinical, operative, and echocardiographic parameters were compared between patients with and without acute HF during the postoperative period (duration, 11±9 days). This study was supported by Boryung Pharmaceutical Company (Seoul, Republic of Korea; 13,440 USD).

RESULTS: Postoperative HF occurred in 31 patients (10%). Compared with those without postoperative HF, these patients were older (73±7 vs. 64±9 years), had longer anesthesia time (7.4±4.2 vs. 3.6±2.1 hours), and were treated with a greater volume of fluid replacement during the operation (3.8±0.7 vs. 1.3±0.1 L) ($p<.05$ for all). On echocardiographic evaluation, the ratio of early diastolic mitral inflow velocity to early diastolic mitral annular velocity (E/E') was higher (11 vs. 8) and left atrial volume index was larger (20±6 vs. 17±6 mL/m²) in patients with HF than in the control group ($p<.05$ for all), whereas the differences in LV ejection fraction and LV size were not significant. In multivariate analysis, E/E' (odds ratio, 1.399; 95% confidence interval, 1.169–1.674; $p<.0001$), age, and quantity of replaced volume during surgery were independent predictors of postoperative HF.

FDA device/drug status: Not applicable.

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CONCLUSIONS: Acute HF after spine surgery was rather common even in previously healthy patients. E/E' reflecting LV filling pressure predicted postoperative HF in patients who underwent spine surgery. © 2014 Elsevier Inc. All rights reserved.

Keywords: Spine surgery; Prognosis; Congestive heart failure; Echocardiography; Diastolic function

Background

Recently, the number of spine surgeries has dramatically increased [1]. However, postoperative medical complications occur frequently, despite extensive preoperative screening of patients who are at high risk [2]. In addition, because of the rising age of both the general population and spine surgery candidates [2], surgeons are highly interested in postoperative outcomes. Among the various postoperative medical complications, acute heart failure (HF) is strongly associated with poor prognosis, including mortality [3]. The prevalence of HF is rapidly increasing in our aging society [4,5]. Acute HF is also a relatively common complication after spine surgery; the rate has been reported to be 1% to 25% [6–8]. Previous research has sought to identify indicators of postoperative prognosis related to HF after spine surgery. Several clinical characteristics such as age, sex, and obesity have been suggested as risk factors [2]. However, the preoperative risk factors for HF need to be reevaluated because our knowledge of HF has recently broadened.

Echocardiographic techniques and knowledge have advanced substantially in the last 2 decades, and echocardiography is currently regarded as a mainstay among noninvasive diagnostic tools to assess cardiac anatomy and function [9,10]. In particular, Doppler mitral inflow velocity–derived variables represent the cornerstone of diastolic function evaluation and Doppler tissue imaging (DTI), which is less affected by cardiac loading conditions and is reproducible as well, has also been used as a helpful complementary method [9,11]. Echocardiography can serve as an effective imaging modality for preoperative risk evaluation of the cardiovascular system. However, the value of echocardiographic predictors of HF after spine surgery, which presents a modest risk of cardiovascular complication, remains to be determined. In this study, we sought to identify an echocardiographic predictor, along with other clinical risk factors, of postoperative HF in spine surgery patients at a large-volume center mainly dedicated to spine surgery.

Methods

Study sample

A total of 305 patients (128 men; age, 65 ± 9 years) who underwent spine surgery between July and September 2012 were consecutively enrolled. Patients with a history of heart disease such as HF, left ventricular (LV) systolic dysfunction (LV ejection fraction [EF] $<50\%$ on echocardiography), documented coronary artery disease, more than mild valvular heart disease, cardiomyopathy, pericardial

disease, or congenital heart disease were excluded. All patients were in normal sinus rhythm on 12-lead electrocardiogram before the index surgery. Patients with a medical history of chronic obstructive pulmonary disease or chronic kidney disease (estimated glomerular filtration rate <60 mL/min/1.73 m²) were also excluded. The study protocol was approved by the Institutional Review Board of Wooridul Spine Hospital, Seoul, Korea, and complied with the Declaration of Helsinki.

Echocardiography

Preoperative transthoracic echocardiographic evaluation of all patients was performed using commercially available equipment (Vivid 9, GE Vingmed Ultrasound, Horten, Norway; or Siemens ACUSON Sequoia C512, Siemens Medical Systems, Forchheim, Germany). Standard M-mode, two-dimensional, and color Doppler imaging were performed in parasternal and apical views. End diastole was determined as the frame with the largest LV cavity area right before the onset of the QRS-complex, and end systole was the frame with the smallest cavity area. Left ventricular end-diastolic dimension, LV end-systolic dimension, and LV EF were calculated from two-dimensional recordings using the modified Quinones method, as described previously [12]. Left atrium (LA) volume was assessed by the modified biplane area-length method and was indexed to body surface area (LAVI) [13]. Early and late diastolic mitral inflow velocities (E and A, respectively) were measured using the pulsed wave Doppler method, by placing the sample volume at the level of the mitral valve leaflet tips. The DTI-derived early and late diastolic mitral annular velocities (E' and A', respectively) and peak systolic mitral annular velocity (S') were measured from the septal corner of the mitral annulus in apical 4-chamber view. We calculated E/E', which represents LV filling pressure. Two experienced echocardiographer-cardiologists who were unaware of subjects' clinical data analyzed the echocardiographic data and reached consensus.

Definition of postoperative HF

Heart failure is a clinical syndrome resulting from cardiac structural and/or functional abnormality [14,15]. Diagnosis of HF was made by experienced cardiologists in patients who developed cardinal symptoms (dyspnea and fatigue) and/or signs (rale on chest auscultation and edema) of HF. We defined postoperative HF according to the Framingham criteria: at least two major criteria or one major criterion in conjunction with two minor criteria during the acute postoperative period. Major criteria included

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