Risk Factors for Perioperative Cardiac Complications After Lumbar Fusion Surgery

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Abstract
Cardiac complication is a leading cause of death in the perioperative period after non-cardiac surgery. The present study retrospectively investigated perioperative cardiac complications after spinal fusion surgery in 901 consecutive adult patients who underwent fusion surgery in the lumbar spine from January 2005 to December 2006. Cardiac complications developed in seven patients (0.8%), four males and three females aged 62 to 75 years (mean 66.6 years), in the perioperative period (myocardial infarction in 6 and angina pectoris in 1). Cardiac complications developed after mini-open transforaminal lumbar interbody fusion in four patients and after anterior lumbar interbody fusion in three. No patient had any symptoms related to cardiac disease before surgery. Common features were age over 60 years, a medical history of hypertension and/or diabetes mellitus, and presence of calcified atherosclerosis of the abdominal aorta and/or common iliac arteries. Five patients improved after conservative medical treatment in an intensive care unit. Percutaneous transluminal coronary angioplasty was performed in one patient and coronary artery bypass graft surgery in one. The possibility of perioperative cardiac complications should be considered before lumbar fusion surgery, especially in elderly patients with hypertension and/or diabetes mellitus, and calcified atherosclerosis of the abdominal aorta and/or common iliac arteries.

Key words: spinal fusion, myocardial ischemia, complications

Introduction
Life expectancy in Korea was 62.3 years for men and 70.5 years for women in 1983, but dramatically increased to 73.4 years for men and 80.4 years for women in 2002. Consequently, the number of elderly patients with spinal disease requiring lumbar fusion surgery is also increasing. The general consensus is that elderly patients have a high risk of perioperative complications including cardiac problems after lumbar fusion surgery because of their age and comorbid conditions. Cardiac complications are the leading cause of death in the perioperative period after non-cardiac surgery. Silent myocardial ischemia occurs in 8% of patients with neurogenic claudication, and can possibly develop into overt coronary artery disease or myocardial infarction after spinal surgery. Numerous studies have investigated the surgical outcomes and related complications of lumbar fusion surgery, but no studies have focused on the perioperative cardiac complications after lumbar fusion surgery.

The present study reviewed 901 consecutive adult patients who underwent lumbar fusion surgery for degenerative lumbar spinal disease in a single hospital and analyzed cardiac complications in the perioperative period to elucidate the common features of patients with complications that might help to predict and prevent the incidence of cardiac complications in the perioperative period.

Materials and Methods
Clinical and radiological data of 901 consecutive adult patients aged 22 to 82 years (mean 59.7 years) with male:female ratio of 29.3:70.7 who underwent lumbar fusion surgery in Gimpo Airport Wooridul Spine Hospital from January 2005 to December 2006 were retrospectively reviewed to identify patients who developed cardiac complications in the perioperative period. Preoperative cardiac evaluation included history taking, physical examination, and resting electrocardiography (ECG) in all patients. Fusion surgery was not recommended for patients with overt
coronary artery disease, myocardial infarction, or congestive heart failure. Asymptomatic patients aged 65 years or older, patients with a history of previous heart disease, and patients with abnormal ECG findings suggesting ischemic heart disease (significant Q wave abnormality, ST depression or elevation, and/or T wave inversion) were referred to a cardiologist for conventional echocardiography to evaluate the risk of perioperative cardiac complications. If a patient was identified as having a high risk of perioperative cardiac complications, fusion surgery was delayed and the patient was recommended to undergo further evaluations (i.e., thallium perfusion scintigraphy or coronary angiography) and treatment of the cardiac disease in another general hospital.

Radiography, computed tomography (CT), and magnetic resonance (MR) imaging of the lumbar spine were performed before surgery in all 901 patients. Fusion surgery was single level in 726 patients (80.6%), two level in 140 (15.5%), three level in 25 (2.8%), and four level in 10 (1.1%). Anterior lumbar interbody fusion (ALIF) was performed in 494 patients (54.8%), transforaminal lumbar interbody fusion (TLIF) in 399 (44.3%), posterior lumbar interbody fusion in six (0.7%), and posterolateral fusion in two (0.2%). Posterior instrumentation was installed following fusion surgery in all patients except 10 who underwent stand-alone ALIF.

### Results

Cardiac complications occurred in seven patients (0.8%), four men and three women aged 62 to 75 years (mean 66.6 years), in the perioperative period which were all related to ischemic heart disease: myocardial infarction in six patients and angina pectoris in one (Table 1). All seven patients underwent fusion surgery due to radiculopathy with claudication caused by lumbar spinal stenosis and instability. Mini-open TLIF was performed in four patients and ALIF in three (with additional posterior decompression in two and without posterior decompression in one). Single-level fusion was performed in five patients, and two- and three-level fusion in one patient each. All patients underwent posterior instrumentation following fusion surgery. The operation time was 165 to 375 minutes (mean 247.9 minutes). The blood loss during operation was 300 to 1200 cm³ (mean 632.9 cm³). Two patients received blood transfusion.

All patients showed no symptoms related to cardiac disease before surgery, although one had a previous history of angina pectoris which was proven stable and asymptomatic before surgery. All patients had a medical history of hypertension.

Table 1  Summary of patients with perioperative cardiac complications after lumbar fusion surgery

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Sex</th>
<th>Age (yrs)</th>
<th>Type of surgery</th>
<th>Level</th>
<th>Cardiac complication</th>
<th>Onset day*</th>
<th>Medical disease</th>
<th>ECG</th>
<th>Echo-cardiography</th>
<th>Ca</th>
<th>Smokin-</th>
<th>Serum choles-</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>M</td>
<td>62</td>
<td>ALIF + PD</td>
<td>L4-5, L5-S1</td>
<td>MI</td>
<td>3</td>
<td>HT, DM</td>
<td>WNL</td>
<td>yes</td>
<td></td>
<td>yes</td>
<td>hyper</td>
<td>medical</td>
</tr>
<tr>
<td>2</td>
<td>M</td>
<td>70</td>
<td>mini-open TLIF</td>
<td>L4-5</td>
<td>MI</td>
<td>1</td>
<td>HT, cerebral infarction</td>
<td>WNL</td>
<td>yes</td>
<td></td>
<td>yes</td>
<td>WNL</td>
<td>medical</td>
</tr>
<tr>
<td>3</td>
<td>F</td>
<td>75</td>
<td>mini-open TLIF</td>
<td>L4-5</td>
<td>angina</td>
<td>0</td>
<td>DM, angina</td>
<td>WNL</td>
<td>yes</td>
<td></td>
<td>no</td>
<td>hyper</td>
<td>medical</td>
</tr>
<tr>
<td>4</td>
<td>F</td>
<td>67</td>
<td>ALIF + PD</td>
<td>L2-3, L3-4, L4-5</td>
<td>MI</td>
<td>0</td>
<td>HT</td>
<td>LVH</td>
<td>WNL</td>
<td>yes</td>
<td></td>
<td>no</td>
<td>WNL</td>
</tr>
<tr>
<td>5</td>
<td>M</td>
<td>66</td>
<td>mini-open TLIF</td>
<td>L4-5</td>
<td>MI</td>
<td>1</td>
<td>HT</td>
<td>WNL</td>
<td>yes</td>
<td></td>
<td>no</td>
<td>WNL</td>
<td>PTCA</td>
</tr>
<tr>
<td>6</td>
<td>F</td>
<td>62</td>
<td>ALIF</td>
<td>L5-S1</td>
<td>MI</td>
<td>0</td>
<td>HT</td>
<td>WNL</td>
<td>yes</td>
<td></td>
<td>no</td>
<td>WNL</td>
<td>medical</td>
</tr>
<tr>
<td>7</td>
<td>M</td>
<td>64</td>
<td>mini-open TLIF</td>
<td>L3-4</td>
<td>MI</td>
<td>7</td>
<td>HT, DM</td>
<td>WNL</td>
<td>yes</td>
<td></td>
<td>yes</td>
<td>WNL</td>
<td>CABG</td>
</tr>
</tbody>
</table>

and/or diabetes mellitus. One patient also had a history of chronic smoking. Two patients showed hypercholesterolemia in preoperative laboratory tests. Preoperative ECG findings demonstrated ischemic heart disease in four patients (inferior wall infarction in one, septal infarction in one, suggestive anterolateral ischemia in one, and suggestive anterior ischemia in one), left ventricular hypertrophy in one patient, and no abnormal findings in two patients. Conventional echocardiography showed ejection fraction and wall motion within normal limits in all patients. CT of the lumbar spine demonstrated calcified atherosclerosis of the abdominal aorta and/or common iliac arteries in all patients.

Cardiac complications developed immediately (within 24 hours) after surgery in five patients. Myocardial infarction occurred 3 and 7 days after surgery in one patient each. Five of the seven patients presented with typical clinical symptoms of myocardial infarction or angina, such as intractable chest pain, dyspnea, diaphoresis, and/or palpitations. However, one patient who underwent ALIF with posterior decompression presented with upper abdominal pain 3 days after surgery. Because the patient had undergone ALIF, surgical complication related to ALIF was first suspected, but myocardial infarction was eventually identified. One patient who underwent mini-open TLIF presented with sudden dyspnea, cyanosis, and diaphoresis 7 days after surgery. Pulmonary embolism was first suspected instead of ischemic heart disease, but myocardial infarction was eventually identified. All patients were transferred to another general hospital and underwent conservative medical treatment in the intensive care unit. Five patients were successfully treated and recovered. Two patients required further interventions because of persistent symptoms despite conservative treatment: percutaneous transluminal coronary angioplasty in one and coronary artery bypass graft surgery in the other. There was no mortality among the patients with cardiac complications.

Case Illustration

Case 7: A 64-year-old male had undergone posterolateral fusion at the L4–5 levels in another hospital 2 years previously. However, his symptoms recurred and he suffered from neurogenic claudication and bilateral buttock pain for 10 months. Neurological examination found bilateral big toe dorsiflexion weakness (power grade III/IV) and decreased ankle jerk. He had a medical history of hypertension and diabetes mellitus. He had a history of chronic smoking. He did not have any symptoms related to ischemic heart disease. Laboratory tests showed no abnormalities. ECG revealed anterolateral ischemia. Conventional echocardiography demonstrated normal wall motion and ejection fraction. Radiography revealed the previous posterolateral fusion at the L4–5 levels. CT and MR imaging showed adjacent segment disease, severe stenosis with disc herniation at the L3–4 space (Fig. 1A). CT also revealed calcified atherosclerosis of the abdominal aorta and common iliac arteries (Fig. 1B, C).

He underwent mini-open TLIF at the L3–4 levels (Fig. 1D). Operating time was 240 minutes and in-
traoperative blood loss was 350 cm³. After surgery, his clinical symptoms improved. Seven days after surgery, the patient complained of severe dyspnea, but did not complain of chest pain. Pulse oximetry showed decreased O₂ saturation below 70% despite application of O₂. He was transferred to another general hospital under the suspicion of pulmonary embolism, but the final diagnosis was acute myocardial infarction. His cardiac symptoms did not improve with conservative medical treatment in the intensive care unit. Coronary angiography demonstrated occlusion of the coronary arteries so he underwent coronary artery bypass surgery.

Discussion

Perioperative cardiac complications are rare after lumbar fusion surgery but may result in significant morbidity and even mortality. Only two previous studies specifically focused on the perioperative complications of lumbar fusion surgery in elderly patients.³,⁴) Myocardial infarction developed in three of 98 elderly patients (3%) who underwent arthrodesis,³) whereas only one of 166 elderly patients (0.6%) showed myocardial infarction after arthrodesis.⁴) In the current study, the overall cardiac complication rate was 0.8%. All patients with perioperative cardiac complications were aged over 60 years, and all cardiac complications were related to ischemic heart disease.

Silent myocardial ischemia is a manifestation of coronary artery disease which is associated with episodes of myocardial ischemia that are not accompanied by chest pain or angina equivalent.⁶) The incidence of silent myocardial ischemia is estimated at 0.5% to 15%.¹⁰,¹²,¹⁴,¹⁸,¹⁹,²⁶) Patients with silent myocardial ischemia have three- to five-fold higher risk of symptomatic coronary artery disease and cardiac death compared with nonsymptomatic control subjects.¹⁵,¹⁹,³¹) Silent myocardial ischemia can be identified by 24-hour continuous ambulatory ECG monitoring, thallium perfusion scintigraphy, and dobutamine echocardiography.¹⁰,¹³,¹⁹,²²,²⁷) Elderly patients requiring lumbar fusion surgery usually have neurogenic claudication caused by spinal stenosis and thus cannot walk the long distances required to stress the cardiovascular system. Therefore, the possibility of concurrent asymptomatic or silent cardiac disease is considered high in these patients.¹⁰) A chemical cardiac stress test, dobutamine echocardiography, in patients suffering from neurogenic claudication found that 8% had induced cardiac wall abnormalities indicating myocardial ischemia.¹⁰)

In the current study, fusion surgery was not performed in patients with overt coronary artery disease, myocardial infarction, or congestive heart failure. All patients with perioperative cardiac complications were asymptomatic before surgery and thus considered to have silent myocardial ischemia. Therefore, it is very important that the presence of silent myocardial ischemia should be identified before fusion surgery to prevent perioperative cardiac complications. Several studies have investigated the risk factors for silent myocardial ischemia. Old age, male, abdominal obesity, and reduced high-density lipoprotein levels are all well-established risk factors for overt coronary artery disease, and are also suggested as risk factors for exercise-induced silent myocardial ischemia.¹⁰) A history of previous heart disease and/or smoking is a risk factor for silent myocardial ischemia in patients undergoing elective spinal surgery for symptomatic spinal stenosis.¹⁰) However, such risk factors for silent myocardial ischemia cannot indicate the real risk for the conversion of silent myocardial ischemia to overt coronary artery disease or myocardial infarction after lumbar fusion surgery. Therefore, the present study identified the common features of patients with cardiac complications in the perioperative period as age over 60 years, medical history of hypertension and/or diabetes mellitus, and presence of calcified atherosclerosis of the abdominal aorta and/or common iliac arteries. In contrast, history of heart disease, smoking, or hypercholesterolemia, which are risk factors associated with coronary artery disease, were not common features of the patients with cardiac complications.

Atherosclerosis of the large and medium conduit vessels occurs via a relatively standard process that includes amorphous calcification of a lipid core, which progresses to endochondral bone formation similar to that found in skeletal bone.⁷) Calcified atherosclerosis of the abdominal aorta and/or common iliac arteries can be easily detected by conventional lumbar CT as in our patients. Atherosclerosis is a systemic inflammatory process with a predilection for certain anatomic locations,¹¹,²⁰,²⁴) so patients with calcified atherosclerosis in the abdominal aorta and/or common iliac arteries are quite likely to have calcified atherosclerosis in other vascular beds including the coronary arteries.¹¹) Metabolic syndrome, which includes both hypertension and hyperglycemia, is highly associated with calcified atherosclerotic plaque in the abdominal aorta and coronary arteries of white and African-American people.⁹) The current study indicates that thallium perfusion scintigraphy and/or dobutamine echocardiography should be performed to exclude silent myocardial ischemia caused by concomitant atherosclerosis of
coronary artery in elderly patients over 60 years with hypertension and/or diabetes mellitus and calcified atherosclerosis of the abdominal aorta and/or common iliac arteries who are scheduled for elective lumbar fusion surgery for degenerative lumbar disease to reduce the risk of perioperative cardiac complications and mortality.

The current study found no correlation between cardiac complications and factors related to surgery, such as type of fusion surgery (i.e., anterior or posterior), operating time, and blood loss. One interesting point was the incidence of cardiac complications after mini-open TLIF. Compared with conventional posterior decompression and fusion surgery, mini-open lumbar fusion via the paramedian route significantly reduces muscle injury and systemic inflammatory reactions during the acute postoperative period. Therefore, mini-open lumbar fusion has become important in preventing medical morbidity after spinal surgery. However, four patients with cardiac complications (3 myocardial infarctions and 1 angina pectoris) had undergone mini-open TLIF, which demonstrates that mini-open or so-called minimally invasive fusion surgeries are no exceptions to the incidence of perioperative cardiac complications.

Myocardial infarction may develop without chest pain, especially in postoperative patients, the elderly, and patients with hypertension or diabetes mellitus, and may manifest as isolated dyspnea, exacerbation of heart failure, or acute confusion, etc. In the current study, two patients with myocardial infarction showed atypical symptoms, upper abdominal pain and dyspnea, which may result in delayed diagnosis and treatment.

The limitation of the current study is that it only describes the common features of the patients with cardiac complications in the perioperative period. Any meaningful statistical analyses of risk factors is limited by the small number of patients with complications. Therefore, a multicenter, prospective study would be able to elucidate risk factors with statistical significance.

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Commentary

Degenerative lumbar spine disease becomes more common with advancing age. With subsequent increases in life expectancy, more patients are presenting for surgical management of symptomatic lumbar spine disease at advanced ages, increasing the risks of medical complications of lumbar spine surgery. Dr. Lee and colleagues have performed a retrospective analysis of 901 consecutive adult patients undergoing lumbar fusion over a one-year period to determine the incidence of perioperative cardiac complications and clinical features that might predict which patients are at higher risk.

Not unexpectedly, the authors found that age over 60 years, a medical history of hypertension and/or diabetes mellitus, and the presence of calcified atherosclerosis of the abdominal aorta and/or iliac arteries placed patients at higher risk of having perioperative cardiac complications. Only seven of the 901 patients experienced a cardiac complication in the perioperative period, including six mild cardiac infarctions and one case of angina pectoris. Most of the cardiac complications developed immediately (within 24 hours) after surgery. None of the patients with cardiac complications experienced mortality.

The low incidence of cardiac complications in this patient population (0.8%) is a tribute to the careful patient selection provided by the authors and the preoperative workup of patients at risk for cardiac disease.

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