

Clinical Paper

Hanging-associated left ventricular systolic dysfunction



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ABSTRACT

Backgrounds: Although hanging injury is infrequent, its clinical course is usually devastating. Hanging patients usually need cardiopulmonary resuscitation (CPR). However, hanging-associated cardiovascular damage has not been fully established. The aim of this study was to evaluate echocardiographic findings in patients with hanging injury.

Methods: We enrolled 25 patients (nine males and 16 females with mean age of 33 ± 15 years) with hanging injury. Echocardiography was performed within 2 weeks after admission. Clinical, demographic, and laboratory data as well as transthoracic echocardiographic findings were analyzed.

Results: Of the 25 patients, eight (two males and six females with mean age of 34 ± 13 years) showed left ventricular systolic dysfunction (LVSD). Mean LV ejection fraction was $34 \pm 16\%$. Global hypokinesia was present in one patient. Apical ballooning with sparing of the basal segment was present in two patients. Basal akinesia and apical hyperkinesia were present in one patient. Four patients showed regional wall motion abnormalities unmatched with coronary territories. The duration of suspension or CPR was not significantly different according to the presence of LVSD.

Conclusion: This study showed the echocardiographic findings in considerable numbers of patients with hanging injury for the first time. Variable patterns of LVSD were present in patients with hanging injury.

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1. Introduction

Hanging is one of the most commonly used methods of suicidal attempts. In many countries, suicide rates are increasing, including South Korea.^{1,2} Among the variable methods of suicidal attempts, incidence of hanging have increased particularly for decades worldwide,^{1,3–6} including pediatrics and young people.⁴ The prognosis of hanging is usually poor, particularly in people with cardiopulmonary arrest (CPA), regardless whether they are adults or pediatrics.^{1,7–11} If patients with CPA survived, survivors usually would suffer severe neurological injury. However, if patients of hanging do not have CPA when they arrive at hospital, the prognosis is favorable. A high proportion of them could survive without neurological deficits.^{7,10–13} Duration of suspension, presence of CPA, initial resuscitation, depth of coma, and presence of respiratory arrest or hypopnea are known prognostic predictors.^{1,7,14,15}

Laboratory data such as lower basal excess in arterial gas analysis were reported as poor prognostic predictors.⁷

In some cases, hanging injuries have adverse effects on cardiac function. There are several case reports and studies about the cardiac impairment in hanging patients.^{16–21} However, no study has assessed the echocardiographic findings or their significance in hanging patients. Therefore, the aim of this study was to evaluate the echocardiographic findings and their significance in patients with hanging injury.

2. Methods

2.1. Study population

All cases of hanging admitted to the Emergency Department of our hospital between May 1997 and May 2014 were retrospectively analyzed. We searched computerized records of the hospital electronic medical record system using ICD-10 code for hanging, strangulation, and suffocation. We manually reviewed all records of these patients. A total of 191 patients' records of hanging injury were identified. Of the 191 patients, 25 who underwent

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echocardiography within 2 weeks after admission to the hospital were enrolled in this study. This study was approved by the Ajou University Hospital Institutional Review Board (approval number: AJIRB-MED-MDB-14-200).

2.2. Data

Clinical, demographic, and laboratory data of these cases were analyzed. We searched clinical information such as presence of cardiovascular risk factors (diabetes, hypertension, dyslipidemia, and smoking), presumptive duration of suspension, presence of CPA, duration of cardiopulmonary resuscitation (CPR) in the cases with CPA, and Glasgow Coma Scale (GCS). The duration of suspension was typically difficult to determine. It was usually estimated from family reports when the patient was last seen. Electrocardiography and laboratory tests including creatine kinase-MB (CK-MB), troponin-I, lactate, and arterial gas analysis (pH, basal excess) were evaluated.

2.3. Echocardiographic findings

We searched echocardiographic findings for all 25 cases. Collected echocardiographic data included left ventricular ejection fraction (LVEF), left ventricular fractional shortening (LVFS), left ventricular end-diastolic dimension (LVEDD), left ventricular end-systolic dimension (LVESD), left ventricular mass index (LVMI), presence of regional wall motion abnormalities (RWMA), and wall motion score index. We defined left ventricular systolic dysfunction (LVSD) by echocardiographic finding when echocardiography showed RWMA such as hypokinesia, akinesia, dyskinesia, or aneurysm in two or more segments of the left ventricle using the 17-segment model.²² The patterns of RWMA were analyzed and interpreted with agreement between two cardiologists who were specialized in echocardiography.

2.4. Statistical analysis

Two subgroups (patients without LVSD as the “none-LVSD” group, and patients with LVSD as the “LVSD” group) of enrolled patients were compared to each other. Continuous variables and ordinal variables were presented as means $\pm$ SD. Continuous variables were compared using *t* test (normal distribution) or Mann–Whitney rank sum test (skewed distribution). Categorical measures were compared with Fisher’s exact test. Statistical analysis was performed with Statview version 18.0 software. A two-tailed *p* value of less than 0.05 was considered as statistically significant.

3. Results

3.1. Baseline characteristics

Of the 25 patients, eight had LV systolic dysfunction (Table 1). The mean age of the 25 patients was 33 ± 15 years. The mean age of the non-LVSD group and the LVSD group was 33 ± 16 and 34 ± 13 years, respectively. Nine (36%) of the 25 patients were males, including seven of 17 (41%) in the none-LVSD group and two of eight (25%) in the LVSD group. Between the two groups, there was no significant difference ($p > 0.05$) in duration of suspension, presence of CPA, duration of CPR, GCS, in-hospital mortality, CK-MB, troponin-I, or lactate, except in pH (6.89 ± 0.33 in the none-LVSD group vs. 7.29 ± 0.22 in the LVSD group, $p < 0.05$). All four patients without CPA survived (Fig. 1). Of 21 patients who had CPA, only four (19%) survived. Survived patients after resuscitation had neurological sequelae to some extent. Initial electrocardiogram showed sinus rhythm in all patients. Four patients in the none-LVSD group and

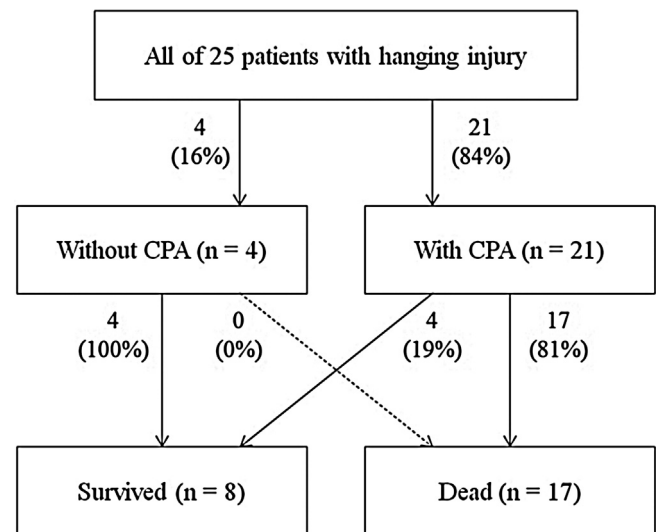


Fig. 1. In-hospital mortality of patients with hanging injury.

one patient in the LVSD group showed T wave change. QT prolongation was revealed in three patients in the none-LVSD group (QTc: 521, 544 and 636 ms) and two patients in the LVSD group (QTc: 485 and 510 ms). One patient in the none-LVSD group had QRS widening with QRS duration of 124 ms. LVEF was lower ($p < 0.05$) in the LVSD group ($34 \pm 16\%$) than that in the none-LVSD group ($65 \pm 8\%$). LVESD and wall motion score index were higher ($p < 0.05$) in the LVSD group compared to those in the non-LVSD group.

3.2. Patients with LV systolic dysfunction

Eight patients had LV systolic dysfunction, including two males and six females (Table 2). Of the eight LVSD patients, five had CPA, of which one survived. Of the three patients who had no CPA, all survived. LVSD included global hypokinesia ($n = 1$), apical ballooning like Takotsubo cardiomyopathy ($n = 2$), basal akinesia ($n = 1$), and non-specific RWMA unmatched with coronary territories ($n = 4$) (Fig. 2).

Follow-up echocardiography was performed in three patients. In one patient (female, 13 year-old), echocardiography revealed global hypokinesia with LVEF of 30%. After 2 weeks, echocardiography was performed again. It revealed completely restored LV function with LVEF of 76%. In another patient (female, 33 year-old), echocardiography revealed akinesia of the mid and apical segments of LV but not the basal segments. Her LVEF was 15% which was compatible with apical ballooning. Echocardiography performed 4 days later showed no significant change compared to previous one. In another patient (female, 26 year-old), echocardiography revealed apical ballooning pattern of LV systolic dysfunction with 12% of LVEF. Echocardiography performed 9 days later showed fully recovered LV function with 71% of LVEF.

4. Discussion

The cause of death in suicidal hangings usually includes various mechanisms.²³ The relative contribution of each theory (airways occlusion and asphyxia, occlusion of the neck vessels with interruption of cerebral blood flow, and cardiac inhibition by vagal stimulation) to the mechanism of death in hanging has not been fully determined.^{23,24} However, all these mechanisms may be associated with cardiac impairment in hanging injury.^{16,24–27}

Stress-induced cardiomyopathy involving transient LV systolic dysfunction in the absence of obstructive coronary artery

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