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Impact of echocardiography on one-month and one-year mortality of intertrochanteric fracture patients

Mahmut Kalem [a, *], Hakan Kocaoğlu [a], Ercan Şahin [b], Merve H. Kocaoğlu [c], Kerem Başarır [a], Hakan Kınık [a]

[a] Ankara University Faculty of Medicine, Department of Orthopedics and Traumatology, Ankara, Turkey
[b] Bulent Ecevit University Faculty of Medicine, Department of Orthopedics and Traumatology, Zonguldak, Turkey
[c] Ankara University Faculty of Medicine, Department of Anesthesiology and Reanimation, Ankara, Turkey

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ABSTRACT

Objective: The aim of this study was to analyze the effects of preoperative echocardiography on patient survival, timing of surgery in length of hospital stay in patients who will undergo hip nailing for an intertrochanteric fracture.
Methods: The clinical records of the patients who were admitted to a tertiary university hospital with an intertrochanteric femur fracture were retrospectively analyzed. The age, gender, American Society of Anesthesiologists (ASA) score, days to surgery, total hospital stay, cardiac drug prescription/modification, cardiac intervention and presence of an echocardiography assessment including detailed findings were reviewed. Mortality data were accessed from the national civil registration system.
Results: 181 (110 women and 71 men; mean age 81 (44–98)) cases were studied whom 65 underwent pre-operative echocardiography. Time to surgery and total hospital stay was 2 days longer at transthoracic echocardiography (TTE) group ($p < 0.001$). At one month control group survival rate was 93.1% on contrary it was 75.4% at TTE group. One-year survival rates were 77.3% and 55.1% respectively. Likewise mean expected survival time was 21.6 ± 1.03 months for control group and 15.12 ± 1.64 months for TTE group ($p < 0.001$). Only increased left ventricular end diastolic diameter (LVEDD) was showed to be associated with increasing one-year mortality with a hazard ratio of 10.78 (2.572–45.19) at multivariate model.
Conclusion: Cardiac findings and requisite for preoperative TTE and increased LVEDD is a strong predictor for mortality. TTE significantly lengthens the time to surgery. Also LVEDD measurement can be easily performed in the bedside which we believe would save time and reduce mortality.
Level of evidence: Level III Diagnostic study.

Introduction

At the beginning of millennium 1.6 million patients worldwide had hip fracture in a year and data show incidence is expected to increase.[1] Hip fracture is a significant burden for health care and economics.[2] And it is associated with a one-year mortality rate ranging from 14% to 36%.[3] Many comorbidities that patients with hip fracture have may increase the risk of mortality.[4] Heart disease is common in this elderly population and remains the most frequent cause of postoperative mortality.[5]

Cardiac conditions associated with the highest rates of mortality in non-cardiac surgery include aortic stenosis, cardiac failure and pulmonary hypertension, all of which are reliably evaluated by echocardiography.[3,6,7] On contrary preoperative echocardiography can lengthen the time to surgery, where delay to the time of surgery is considered as another major risk factor for the mortality of hip fracture patient.[3,4,8,9] Although hip fracture is not considered an

* Corresponding author. Ankara University Faculty of Medicine, Department of Orthopedics and Traumatology, Ibn-i Sina Hospital Department of Orthopedics and Traumatology, Altindag, Ankara, Turkey. Fax: +90 3123112522.
E-mail address: drkalem@hotmail.com (M. Kalem).
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orthopedic emergency many authors and guidelines assert the importance early surgery.[9–12]

In spite many known risk factors, the mortality rates for people with trochanteric fracture has not been reduced. Since neither the impact of echocardiographic findings leading to death nor the effect of preoperative delay caused by echocardiography assessment has been fully investigated, we decided to explore these factors that might be adjusted in order to improve outcome.

The aim of this study was to analyze whether if it is worthy to perform a preoperative echocardiography and whether a specific TTE finding was related to the survival of intertrochanteric fracture surgery with closed intramedullary nail fixation the at the one and twelve month mortality. Secondarily we want to determine whether preoperative echocardiographic assessment in intertrochanteric fracture patients had an impact on the timing of surgery, the length of the hospital stay and medical and cardiac optimization.

Patients and method

This is a retrospective study approved by the Local Medical Human Research Ethics Committee (23 May 2016, 10-432-16) Between 1 January 2013 and 31 December 2014, all patients who were admitted to a tertiary university hospital and sustained an intertrochanteric fracture of femur were included. Any patient was excluded if the surgery was not for isolated intertrochanteric femur fracture or any surgical technique other than closed proximal femoral nail fixation was used. Also cases were excluded if the patient had terminal cancer (e.g. metastatic fracture) at the time of operation.

Two independent anesthetists who were solely work with orthopedics department more than 10 years routinely evaluated all patients at the time of admission. Patients suspected of having cardiac disease, or worsening of known cardiac disease was first consulted to cardiology department and transthoracic echocardiography (TTE) was carried out by a single independent echocardiography technician since TTE is a user dependent procedure. All patients received combine spinal-epidural block with close hemodynamic monitoring. A single trauma surgeon treated the patients with proximal femoral intramedullary nail.

Medical data regarding age, gender, ASA score, days to surgery, total hospital stay, cardiac drug prescription/modification, cardiac intervention and presence of an echocardiography assessment upon a cardiac diagnosis were gathered retrospectively from hospital database at November 2016. A detailed data was sorted from echocardiography reports including findings such as left ventricular hypertrophy, left ventricular excursion, fractional shortening, valvular heart disease (stenosis, regurgitation or insufficiency), cardiac ejection fraction and pulmonary artery pressure (Table 1). One month and twelve month mortality data were accessed from the national civil registration system.

Those patients who underwent pre-operative echocardiography were clustered as TTE group, and those who did not to form the control group. Also subgroups for having specific TTE findings were formed to determine the specific impact on mortality. The primary outcome measure was mortality at first month and twelve months after surgery. Secondary outcome measures included the number of days before surgery and total days spent in hospital and the effect of echocardiography on medical or invasive cardiac treatment. Cox proportional hazards model (including univariate predictors of mortality with two-tailed p values below 0.10), Kaplan–Meier, Chi-square and Mann–Whitney-*U* tests were used as appropriate. Data were analyzed using SPSS for Windows 15 (SPSS Inc, Chicago, IL, USA). Statistical significance was defined as a value of $p < 0.05$.

Table 1
Table showing the detailed data sorted from echocardiography reports (TTE: transthoracic echocardiography).

Detailed TTE Findings	Normal Findings
Left ventricular hypertrophy	Posterior wall/septal thickness <1.1 cm
Left ventricular end diastolic diameter	<5.5 cm
Fractional shortening (%)	>30%
Left atrial dilatation	>4.0 cm
Right atrial dilatation	>4.5 cm
Right ventricular dilatation	>8.0 cm (base-to-apex-length)
Left ventricular wall motion	No hypokinetic area
Ejection fraction (%)	>55%
Aort diameter	<3.5 cm
Aortic valve stenosis	No gradient at valve
Mitral valve stenosis	No gradient at valve
Tricuspid valve stenosis	No gradient at valve
Pulmonary valve stenosis	No gradient at valve
Pulmonary arterial blood pressure	<25 mmHg
Mitral valve insufficiency	No regurgitation
Aortic valve insufficiency	No regurgitation
Tricuspid valve insufficiency	No regurgitation
Pulmonary valve insufficiency	No regurgitation

Results

In the 24-month study period (from January 2013 to December 2014), 203 consecutive intertrochanteric fracture patients were admitted to the hospital. Data were collected on 181 cases; two cases were international patients with no mortality records on national registry, fourteen patients had other surgeries for concomitant injury and six patients had terminal stage cancer. Of those 181 cases sixty-five patients underwent pre-operative echocardiography; whereas one hundred sixteen patients did not received TTE. For further investigation detailed findings at TTE were recorded as mentioned earlier at methods.

Median age of patients was 81 (44–98) where in control group 81 (44–94) and in TTE group 83 (48–98). There were 110 women (64 in control and 46 in TTE) and 71 (52 in control and 19 in TTE) men. ASA of the patients were distributed as ASA I 46.6%, ASA II 48.3% and ASA III %5.2 at control group. On the contrary %23.1 was ASA I, % 61.5 was ASA II and %15.4 was ASA III at TTE group. Contritely age, gender distribution and ASA distribution was statistically different between groups (Table 2).

Five patients out of 65 at TTE group underwent cardiac interventions (4 pacemaker implantation and 1 angiography) preoperatively, while two out of 116 patients had a pacemaker implanted. However this is not statistically significant ($p = 0.096$; >0.005).

16 patients at control group needed a medical optimization preoperatively where 22 medication optimizations were made at TTE group. This ratio is significantly higher at TTE group ($p = 0.001$).

Table 2
Table showing age, gender and ASA distributions between the groups (TTE: transthoracic echocardiography, ASA: American Society of Anesthesiologists score).

	Control Group	TTE Group	Total	p value
n	116	65	181	n/a
Age (median)	81 (44–94)	83 (48–98)	81 (44–98)	0.012
Gender				0.039
Male	52	19	71	
Female	64	46	110	
ASA Score				0.002
ASA I	54 (46.6%)	15 (23.1%)	69 (38%)	
ASA II	56 (48.3%)	40 (61.5%)	96 (53%)	
ASA III	6 (5.2%)	10 (15.4%)	16 (8%)	
ASA IV/V	0	0	0	

Median time to surgery was one day (0–7 days) at control group and median total day of hospital stay was 5 (1–30). Patients at TTE group were operated at a median of 3 days (0–8 days) and discharged at a median of 7 days (2–77). Both times were significantly longer at TTE group ($p < 0.001$).

There is distinct difference between the survival rates of groups calculated with Mantel–Cox method. At one month postoperatively at control group survival rate was 93.1% on contrary it was 75.4% at TTE group (log rank $p < 0.001$) Also one-year survival rates were 77.3% and 55.1% respectively (log rank $p < 0{,}001$) Also a mean time to death was calculated using Kaplan–Meier survival projections for those subjects who survived at the end of the study.[13] The mean expected survival time was 21.6 ± 1.03 months for control group and 15.12 ± 1.64 months for TTE group ($p < 0.001$).

When the data of the Cox regression analysis is reviewed increasing ASA and prerequisite for TTE showed an association with post-operative one-year mortality. Having an ASA 2 score increases the hazard of mortality by 2.3 times while an ASA 3 score raises the risk by 3.9 times and a prerequisite for TTE doubles the risk of mortality at 12 month (Table 3). However only undergoing a preoperative TTE were associated with increasing 30-day mortality with a hazard ratio of 3.783 (1.618–8.843 $p = 0.002$). Increasing preoperative and total length of stay or any medical optimization was not associated with an increase in 30-day and one-year mortality rates in the regression analysis.

When individual TTE findings' impact on 30-day mortality were investigated no factor was found significant at univariate analysis.

On contrary left ventricular dilatation (increased left ventricular end diastolic diameter, LVEDD) and tricuspid valve insufficiency and high pulmonary arterial pressure tended to be significant in non-survivors than in survivors at one-year follow-up for mortality, thus they are included for hazard ratio analysis. Only increased LVEDD was showed to be associated with increasing one-year mortality with a hazard ratio of 10.78 (95% CI: 2.572–45.19 $p = 0.001$) at multivariate analysis model.

Discussion

The present study showed that requirement for a preoperative echocardiography at closed intramedullary nailing of intertrochanteric fracture almost had a four-fold higher risk of mortality at one-month and two-fold twelve month postoperatively. In further detail the increased mortality is associated with having higher ASA score for the overall patient population and increased left ventricular end diastolic diameter (LVEDD) for the TTE group.

The relation between the mortality and echocardiography originates from the fact that preoperative prerequisite for such kind of examination is a sign of cardiac disease. And it should be noted that echocardiography is not a direct risk factor for mortality however our study suggests it can be deduced as a strong predictor. Some studies in orthopedic literature imply similar results with a perceived need for echocardiography are generally higher risk for morbidity and mortality.[14,15] In a small cohort of trochanteric fracture patients, the group that received a preoperative TTE had almost 7-fold mortality rate at 6 months follow-up.[15] Another paper focused on geriatric population deduced preoperative cardiac screening is frequently unnecessary after hip fracture, and increases the delay to surgery. Delay of >48 h was associated with more cardiovascular complications and mortality postoperatively.[16] Unlike our purely trochanteric fracture cohort these papers investigate both intracapsular and extracapsular fractures of proximal femur, which may alter results since two groups of patients have distinct demographic profiles and treatment consists very different surgeries.

On contrary some papers report no difference or reduced mortality rates with focused TTE and dedicated workflow programs.[17,18] Many established clinical guidelines suggest early surgery for hip fractures.[10,19] These guidelines boosted physicians to develop dedicated fast track programs around the world. These focused programs primarily accelerate preoperative workup for cardiac evaluation and better established post-hospital management of cardiac disease.[18] Improved results illustrate without an recognized and dedicated workflow any extra preoperative workup is useless and delays the time for surgery.[20]

The question as to whether or not preoperative TTE is useful depends on information obtained that can influence perioperative management and improve prognosis.[21,22] In our cohort TTE caused a statistically significant alteration at medical treatment for cardiac optimization. On the contrary, there was no modification for patients at both groups who felt to require preoperative cardiac intervention as part of anesthetic optimization. Though some kind of preoperative optimization was intended early and late mortality for the TTE group did not change for good also. This outcome can be associated with the fact that TTE group had also worse ASA scores. Having poor ASA scores, more co-morbidities and cardiac disease may cumulate risks that surpass physiological limits of these elder patients and any optimization at medical treatment remained insufficient.

Our results showed preoperative TTE caused two days delay to surgery and increased length of hospital stay consecutively. Delaying surgery for an intertrochanteric fracture may increase the incidence of the complications caused by immobilization like pressure sores, thromboembolic complications, urinary infection and pneumonia. This may even be reflected in an increase in mortality.[9] Late surgery will also prolong the pain and discomfort involved with the injury, increase the length of hospital stay and may possibly reduce the chance of a successful rehabilitation.[11] However cardiac work up cannot purely blamed for delaying surgery. Delay is multifactorial and system related factors such as unavailability of surgery at weekends or other comorbidities need to be optimized can also interrupt surgery. A policy of prioritizing hip fracture patients for surgery should be pursued by concerning physicians.[16]

In our study we found a patient group with increased left ventricular end diastolic diameter (LVEDD) had an increased risk of mortality at on year follow-up (OR: 10.78 with 95% CI: 2.572–45.19) This patients had normal ejection fraction and increased LVEDD without apparent valve stenosis or deficiency, which also are hypertensive. Increased LVEDD has been correlated with dilated, ischemic or hypertensive cardiomyopathy, ventricular septal defect and mitral/aortic regurgitation. Dilated left ventricular mass with a thinner myocardial wall predisposes heart to diastolic and systolic dysfunction, diminished coronary artery circulation and ventricular dysrhythmias.[23]

Many studies reveal transition from concentric left ventricular hypertrophy with normal ejection fraction (EF) to heart failure can be seen in the follow-up and this transition is closely related with myocardial infarction through the period.[24] Another recent data from Framingham Hearth Study showed that increased LVEDD with

Table 3
Predictors of death among intertrochanteric fracture surgery patients during the first 12 months after surgery; identified univariate predictors of mortality with two-tailed p values below 0.10 were entered into a multivariate Cox proportional hazards model (TTE: transthoracic echocardiography, ASA: American Society of Anesthesiologists score).

Predictor	HR	95%CI	p value
TTE	1.959	1.149–3.340	0.014
ASA 2	2.330	1.194–4.546	0.013
ASA 3	3.909	1.641–9.315	0.002

normal EF (as seen in our patient group) are at higher risk for future cardiac events: heart failure with reduced EF, malign dysrhythmias, stroke, myocardial infarction.[25] Thus, a normal EF with normal valvular structures does not rule out any future cardiac risks. Through our findings, when evaluating the preoperative echocardiography there was only the increased LVEDD significantly indicated the increased risk for one-year mortality.

The major limitation of this study is its retrospective nature. Making a deduction for mortality of patients with a retrospective cohort may have some complications. Primarily patients' deaths may not have been fully attributable to cardiac pathology. Other chronic diseases like Alzheimer's disease or diabetes can also increase the rate of mortality after trochanteric fracture.[26,27] Similar outcome can also be predicted by the fact that patients warranting a TTE had worse ASA scores also need more alteration at their medical treatments. Another limitation is having two statistically different groups by means of age, sex and ASA score. On contrary studying only trochanteric femur fracture patients who treated by the same anesthesia team and a single surgeon with closed intramedullary nailing is a clear advantage. In ideal conditions demographic and medical conditions should be randomized for a comparison. However fully randomizing patients into groups by means of cardiac disease is almost impossible for this setting.

Conclusion

Preoperative TTE is a strong predictor for one-month and one-year mortality for trochanteric fracture patients who treated with closed reduction and intramedullary nailing. Although preoperative optimization is essential it should be noted that having a TTE significantly lengthens the time to surgery and does not improve the survival of patients even tough cardiac medical alterations were made. Thus TTE should be individually titrated for each patient according to the perioperative risk. Although anesthesiologists mostly underscore the EF, aortic stenosis and wall motion abnormalities preoperatively, our results show LVEDD is also a significant mortality indicator. LVEDD measurement can be easily performed from parasternal long-axis view in the bedside or in the operation theater setting by a trained anesthesiologist. We believe this would save time and reduce mortality.

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