Article

Not peer-reviewed version

Echocardiography Does Not Delay Surgery in Elderly Patient with Hip Fracture: Pulmonary Hypertension and Decreased Left Ventricular Ejection Fraction Are Associated with in Hospital Mortality

Carlo Rostagno *, Alessandro Cartei, Gaia Rubbieri, Alice Ceccofiglio, Giulio Maria Mannarino, Roberto Civinini

Posted Date: 29 April 2026

doi: 10.20944/preprints202604.2079.v1

Keywords: hip fracture; echocardiography; outcome

 doi:10.20944/preprints202604.2079.v1

Article

Echocardiography Does Not Delay Surgery in Elderly Patient with Hip Fracture: Pulmonary Hypertension and Decreased Left Ventricular Ejection Fraction Are Associated with in Hospital Mortality

Carlo Rostagno [1,*], Alessandro Cartei [2], Gaia Rubbieri [2], Alice Ceccofiglio [2], Giulio Maria Mannarino [2] and Roberto Civinini [3]

[1] Dipartimento medicina sperimentale e clinica, Università di Firenze, Florence, Italy
[2] Dipartimento di Geriatria , SOD Geriatria AOU Careggi, Florence, Italy
[3] SOD Ortopedia e traumatologia AOU Careggi, Florence, Italy
* Correspondence: carlo.rostagno@unifi.it; Tel.: (+390557948063)

Abstract

Cardiovascular complications are the main cause of early mortality in elderly patients after hip fracture surgery. Echocardiography, although suggested by guidelines to improve risk stratification, is frequently omitted for the risk to delay surgery. Aim of the study was to evaluate whether preoperative echocardiographic in patients with hip fracture effectively delays surgery and which echocardiographic abnormalities are associated with in-hospital mortality. The study included hip fracture patients aged > 70 years admitted in the period January 1, 2019, to December 31, 2024, to the Hip fracture Unit of a teaching tertiary hospital. Echocardiography was indicated according to clinical criteria (detection of heart murmur, pathological electrocardiographic changes, known heart disease and the presence of ≥ 2 coronary risk factors). In the study entered 2272 patients, 1593 had indication for preoperative echocardiography that was performed in 1502. Mean age was significantly higher in ECHO than in NO-ECHO group (85.4 ± 8 vs. 80.5 ± 11 years, $p < 0.0001$). ECHO group patients had more frequently at least two comorbidities. In-hospital mortality was 7.3% in ECHO patients compared to 2.3% in NO-ECHO patients. At multivariate analysis showed decreased left ventricular ejection fraction and pulmonary hypertension other than age, anemia, reduced functional capacity expressed as lost BADL and cancer were independent predictors of in-hospital mortality. Echocardiography identifies a population at a high risk of in-hospital mortality, three times higher compared to the group of NO ECHO patients. A reduced left ventricular ejection fraction and an increase in pulmonary pressure are independent predictors of in hospital mortality.

Keywords: hip fracture; echocardiography; outcome

1. Introduction

Routine preoperative echocardiography before non-cardiac surgery has not been demonstrated to improve outcomes in large cohort studies [1,2], although specific abnormalities such as degree of mitral regurgitation or aortic stenosis, LVEF and E/e' ratio may be associated with increased mortality in patients undergoing intermediate- or high-risk noncardiac surgery [3]. Cardiovascular complications, mainly heart failure and myocardial infarction/damage, are the leading causes of death and prolonged hospitalization after hip surgery [4]. Risk stratification according to the AHA/ACC or ESC guidelines in patients with known heart disease may be difficult since at least 35% of patients have cognitive impairment and/or moderate/severe functional limitations [5,6]. Symptoms related to heart failure or chronic coronary artery disease may be underestimated. Early surgery, within 24-36 hours from trauma, is associated with a significant improvement in clinical outcomes

 doi:10.20944/preprints202604.2079.v1

[7,8]. According to SIGN guidelines echocardiography is recommended to better stratify surgical risk and define anesthesiologist strategy in suspected aortic stenosis if examination does not delay surgery [9]. Substantial changes in the perioperative management has been reported in not less than 20% of hip fracture patients after echocardiogram. Moderate to severe valvular heart disease (such as aortic stenosis or mitral regurgitation) are not rarely found by chance at hospital admission or have not been reevaluated since a long term [10,11]. Moreover, in patients with known heart failure or unexplained poor functional capacity, the assessment of left ventricular function and filling pressures may guide therapeutic optimization to limit postoperative complications rate. Results of previous investigations about preoperative echocardiography are contrasting. The main concern with preoperative echocardiography in patients with hip fracture is related to unacceptable delay in treatment and related increase in complications and mortality [12–14]. Canty et al. [15] compared high-risk cardiac patients underwent a preoperative transthoracic echocardiography (TTE) toa randomized cohort with similar cardiac risk but not undergoing preoperative TTE. Mortality at both 30 days (4.7% vs. 15.2%, p=0.047) and 12 months postoperatively (17.1% vs. 33.3%, p=0.031) was lower in patients underwent echocardiography. Among 354 patients underwent TTE before hip surgery age, history of CAD, presence of moderate-severe aortic stenosis and LVEF <50% were independent predictors of mortality [16]. Higher average E/e' values, lower left ventricular (LV) ejection fraction, and higher prevalence of significant mitral regurgitation were related to the risk of major cardiovascular events or death in 1453 patients (51% male; age, 67 ± 16) who underwent intermediate- or high-risk major abdominal surgery or orthopedic surgery [3]. A large retrospective study did not show in-hospital mortality differences between echocardiography screened versus no screened in more than 25,000 propensity score matched patients. A greater average time to surgery without significant advantage on in hospital outcome were reported by AbuSharar et al. [17]. The study however, included only 42 patients, 22% of those had ACC/AHA indications for pre-operative echocardiogram. Aim of the present study was to evaluate whether in setting of a multidisciplinary hip fracture management time to surgery was delayed by echocardiography, when needed. Secondary endpoints were the effects of examination on in hospital mortality and length of stay. Finally, we searched for the relation between specific echocardiographic abnormalities and in-hospital mortality.

2. Materials and Methods

The study is part of a project of Italian Health Ministry and Regione Toscana –RF-2010-2316600- and was approved by Ethical Committee of Regione Toscana. Written informed consent to treatment and collection of clinical data for research purposes was obtained at admission. The study was conducted according to STROBE statements and performed in line with the principles of the Declaration of Helsinki.

The aim of the study was to evaluate the relationship between echocardiographic alterations and intra-hospital mortality in elderly patients hospitalized for hip fragility fracture. As a secondary objective, the difference in outcome between patients who had undergone pre-operative echocardiography and those who were referred for surgery without echocardiographic examination was compared.

2.1. Preoperative Evaluation

In the study were enrolled all patients with hip fracture admitted to a tertiary teaching hospital between January 1, 2019 and December 31, 2024. The patients were followed by a multidisciplinary group for fragility fractures. At admission each patient was carefully evaluated by the Internal Medicine-geriatric specialist (general clinical conditions, presence of comorbidities and ongoing medical treatment). For each patient , demographic data (age and sex), functional capacity prior to trauma (using the Basic Activities of Daily Living Assessment Scale, BADL), and the presence of comorbidities (arterial hypertension, atrial fibrillation, ischemic heart disease, heart failure, COPD, diabetes, both peripheral and cerebral vasculopathy, neoplasms, renal failure, anemia -Hb < 10 g/dl,

 doi:10.20944/preprints202604.2079.v1

osteoporosis and a number of ≥ 2 disease, and cognitive Impairment) were recorded in the database. Echocardiography was performed usually within 24 hours by a single operator with an ESAOTE MY LAB 40 echocardiograph. In the protocol were included patients with newly detected or known systolic murmurs, ECG abnormalities, known heart disease or presence of ≥3 coronary risk factors. Parameters were collected according to criteria of the European Association of Echocardiography (EAE) /American Society of Echocardiography (ASE) {18].

Left ventricular ejection fraction was measured using Simpson rule and patients were stratified into four groups. LVEF < 30% severe impairment of systolic function, LVEF between 30-39% moderate systolic dysfunction, LVEF between 40-55% mild systolic dysfunction, LVEF > 55% normal systolic function.

Systolic pulmonary artery pressure was calculated according to standardized criteria. In relation with measured values patients were stratified in: mild pulmonary hypertension (PAPs 25-29 mmHg), moderate pulmonary hypertension (PAPs 30-40 mmHg), severe pulmonary hypertension (PAPs >40 mmHg). Severity of valve regurgitation (aortic and mitral) was assessed by semiquantitative method and stratified as mild, moderate, and severe. Patients with aortic stenosis were divided into 3 groups according to peak gradient: mild aortic stenosis (gradient between 30 and 49 mmHg), moderate aortic stenosis (gradient between 50 and 70 mmHg) and severe aortic stenosis (gradient > 70 mmHg*).* Right ventricular function evaluated by Tricuspid Annular Plane Systolic Excursion *(TAPSE)* was defined as normal, (TAPSE > 20mm), mild dysfunction (TAPSE between 20 and 15 mm) and severe dysfunction (TAPSE < 15 mm).

2.2. Statistical Analysis

The parameters considered were expressed as mean values and standard deviations. Categorical variables were expressed as distribution frequencies. In the comparison between groups continuous parameters were compared by Student Test for unpaired data while the χ^2 or the Fisher Exact Test were used for categorical variables. The influence of the different parameters on mortality was evaluated by multivariate logistic regression analysis.

3. Results

The study included 2274 patients admitted to a tertiary teaching hospital between January 1, 2019, and December, 31, 2024 with diagnosis of low energy hip fracture. Mean age was 83.8 years. More than seventy percent were females (72.6%) with a female-to-male ratio of 2.65:1. Types of fracture are reported in table. A significant functional impairment, expressed as loss of 2 or more BADL, was found in 28.2%. Twenty-one percent had cognitive impairment. More than half of the patients (62.4%) had at least 2 comorbidities. Time to surgery was less than 48 hours from trauma in 76.5% of patients. Only 24 (about 1%) were treated conservatively. Characteristics of patients are reported in Table 1.

 doi:10.20944/preprints202604.2079.v1

Table 1. Clinical characteristics of enrolled patients.

Total	2274	COMORBIDITIES	
Gender (N°, % female)	1637(71%)	Atrial fibrillation	526 (23.1%)
Age (mean)	83.8±8.7	COPD	208 (9.1%)
TYPE OF FRACTURE		Diabetes	405 (17.8%)
Neck Femur	1106 (48%)	Neoplasms	467 (20.5%)
Pertrochanteric	1033 (46%)	Heart failure	184 (8.1%)
Subtrochanteric	135 (6%)	Dementia	476 (20.9%)
TIPO DI INTERVENTO		CAD	361 (15.9%)
Intramedullary nail	1113 (49%)	Peripheral arteriopathy	545 (23.9%)
Cephalic prosthesis	568 (24%)	Hypertension	1464 (64.3%)
Total prosthesis	338 (15%)	Renal failure –(creat clearance <25 ml/min/1.73m2)	305 (13.4%)
Screws	228 (1146%)	Transfusion	1125 (49.4%)
No surgery	24 (1%)	Anemia	152 (6.7%)
TIME TO SURGERY		Comorbidites ≥ 2	1419 (62.4%)
< 48h	1649 (76.5%)	PRESERVED BADL	
		< 4	575 (28.2%)

According to study protocol 1593 patients had indication to perform preoperative echocardiography. Echocardiography was performed before surgery in 1502 patients. Ninety-one despite clinical indication were not examined, mainly due to organization problems. The other 681 without clinical indications, "NO ECHO" group, underwent only routine ECG without further preoperative cardiological evaluation. 86% of echocardiograms was performed within 24 hours from trauma. In Figure 1 is reported the flow chart of the study.

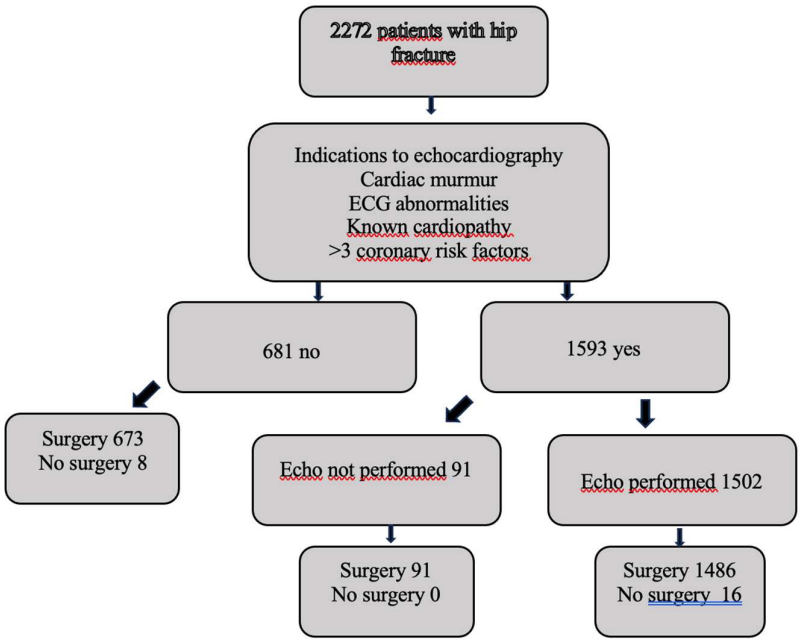

Figure 1. Flow chart of the study.

 doi:10.20944/preprints202604.2079.v1

Mean age was higher in the group with indication to echocardiography (85.4 ± 7.2 years ECHO group vs 80.4 ± 11.2 the NO ECHO group). Both groups had a higher female prevalence (71.3% ECHO and 74.87% NO ECHO respectively) however the proportion was lower in those with indication to echo who did not perform examination. In patients not evaluated with preoperative echocardiogram time to surgery was on average 2.1 ± 2.3 days in comparison with 2.7 ± 4.1 days in those who underwent echocardiogram. Similar time to surgery was found patients with indication to examination in which the exam was not performed.

Detailed data about type of fracture and surgical treatment are reported in Table 2.

Table 2. Clinical characteristics of the three groups.

	No echo = 681	*No echo with indication = 91*	*Echo = 1502*	*p*
M F	170 (25%) 511 (75%)	38 (40%) **53** (60%)	431 (28.7%) 1071 (71.3%)	0.02
Mean age (years)	80.4 ± 11.2	84+ 8	85.4 ± 7.9	<0.0001
Type of fracture Neck Perthrocanteric Subthrocanteric	 360 (52.7%) 291 (43.3%) 30 (4.1%)	 44 44 3	 702(46,8%) 695 (46,4%) 102 (6.8%)	=0.01
TIME TO SURGERY (days)	2.1 ± 2.3	2.9 +3.7	2.7 ± 4.1	<0.001
SURGERY < 48H (%)	80%	75%	74%	<0.0001
PRESERVED BADL < 4	171 (22.8%)	14 (15%)	411 (31.1%)	<0.001
Anemia <10g/dHb	113 (14%)	8 (9%)	31 (4,1%)	ns
Type of surgery No surgery	8 (1%)	0 (0%)	16 (1%)	0.05
Intramedullary nail	320 (46%)	50 (54%)	743 (49%)	
Cephalic prosthesis	132 (19%)	17 (19%)	422 (28%)	
Total prosthesis	130 (19%)	18 (20%)	190 (13%)	
Screws	91 (1549%)	6 (7%)	131 (9%)	

Functional impairment defined as BADL < 4 was found in 22.8% of patients who did not undergo echocardiogram and 31.09% of patients who underwent echocardiography. Two or more comorbidities were found in 72% patients whit indication echocardiography in comparison to 42% in patients who did not. The frequencies of the different comorbidities found in the three groups are shown in the Table 3:

 doi:10.20944/preprints202604.2079.v1

Table 3. Distribution of comorbidities in the three groups.

COMORBIDITY	NO ECHO n 681	NO ECHO with indications n 91	ECHO n 1502	P
ATRIAL FIBRILLATION	0	57 (62%)	469 (31%)	<0.0001
COPD	25 (4%)	11 (12%)	167 (11%)	<0.0001
DIABETES	99 (14%)	17 (18%)	299 (20%)	ns
CANCER	113 (16%)	27 (29%)	327 (21%)	ns
HEART FAILURE	0	27 (29%)	169 (11%)	<0.0001
DEMENTIA	141 (20%)	21(23%)	320 (21%)	ns
CORONARY DISEASE	0	28 (30%)	337 (22%)	<0.0001
PERIPHERAL ARTERY DIS.	103 (15%)	30 (33%)	412 (27%)	<0.0001
HYPERTENSION	358 (52%)	59 (64%)	1045 (69%)	<0.0001
≥ 2 COMORBITIES	263 (38%)	70 (73%)	1088 (72%)	<0.0001
RENAL FAILURE	43 (6%)	13 (15%)	263 (17%)	0.002
TRANSFUSION	284(41%)	42 (44%)	811 (53%)	<0.0001

In the echocardiographic group, left ventricular dysfunction was appreciable in 24.6%, while severely depressed ventricular function in 19 patients. Moderate-severe aortic stenosis and mitral regurgitation were found respectively in 7 and 23%. Moderate-to-severe pulmonary hypertension was observed in 40.6%, while only 18 patients showed a depressed RV function (TAPSE < 15). Twenty five percent had abnormalities of diastolic pattern. Echocardiogram led to a modification of the anesthetic strategy (general vs. spinal anesthesia) in 13% of patients and in 20% to the need of ICU stay in the 24 hours after surgery. Aortic stenosis accounted for 70% of cases, a marked reduction in left ventricular function in 27% to and finally severe mitral valve disease in the remaining 3%.

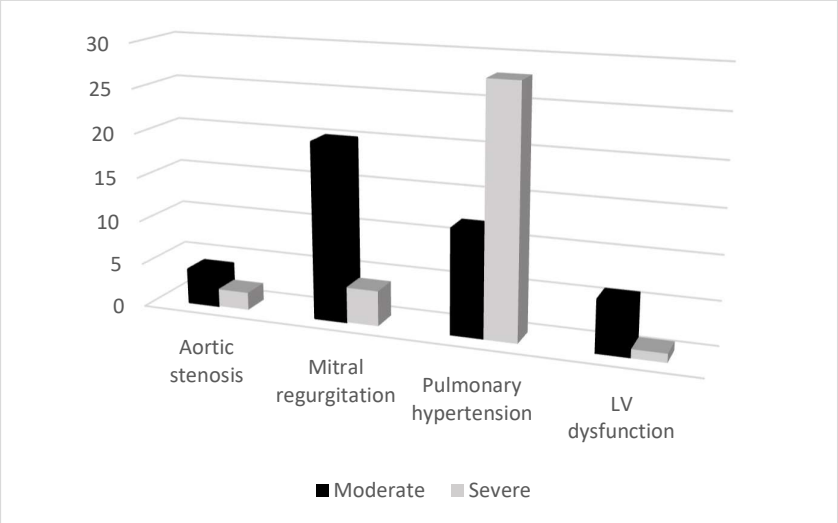

Figure 2. Frequency distribution of moderate-severe echocardiographic abnormalities.

 doi:10.20944/preprints202604.2079.v1

In hospital mortality was 2% in patients who did not undergo echo, 7.3% in patients who underwent echo and finally 10% in patients with indication to echo in whom examination was not performed. In each group patients discharged alive were younger and more frequently female. Time to surgery was longer in patients died in hospital as well they had a lover functional capacity (Table 4). Anemia and cognitive impairment were the only factors associated with mortality in patients who did not undergo echocardiographic examination (Table 5). In patients underwent echocardiographic examination anemia, atrial fibrillation, heart failure, COPD, cognitive impairment, >2 comorbidities and finally renal failure were significantly more frequent in patients died in hospital in comparison to discharged alive

Table 4. Comparison of clinical characteristics between patients discharged alive or died in hospital in the three groups (§ p=0.004, *0.0001, ° p=0.005 (difference in the same group).

	NO ECHO (681)		NO ECHO with indications (91)		ECHO (1502)		
	Discharged alive (666-98%)	Died (15-2%)	Discharged alive (82-90%)	Died (9-10%)	Discharged Alive (1392-92.7%)	Died (110-7.3%)	P <0.0001
Female Male	500 (75%) 166 (25%)	9(60%) 6 (40%)	50 (60%) 32(40%)	5 (58%) 4 (42%)	1006 (72%) 386 (28%)	65 (59,1%) 45(40,9%)§	<0.0001
Mean age	79.8±11,4	86.1±6.8,1°	81.3±7.5	87.2±7*	85.4±7,9	88.9±6,4*	0.005
Time to surgery (gg)	2.1±2.3	.3.1±6.8	2.5±2.0	9.3±13	2.6±4.1	4.0±10,§	<0.001
SURGERY < 24 h (%)	80%	61%*	64%	4.4%	74%	52%*	<0.0001
PRESERVED BADL <4	94 (13%)	9 (60%)*	21 (25%)	5 (55%)	517 (37%)	51 (58%)*	<0.0001

In Tables 5 and 6 are reported the different comorbidities rate in patients of non-echo group and respectively of patients with indication underwent or not echocardiography.

Table 5. Distribution of comorbidities in patients discharged alive and died in hospital in non-echo group.

Comorbidity	**Discharged alive (666)**	**Died (15)**	**p**
Anemia	100 (15%)	9 (41%)	<0.0001
COPD	24 (4%)	3 (12%)	ns
Diabetes	105 (17%)	3 (12%)	ns
Cancer	139 (20%)	7 (29%)	ns
Dementia	137 (20%)	11 (45%)	0.002
Peripheral vascular dis	141 (21%)	7 (29%)	ns
Hypertension	353 (53%)	13 (54%)	ns
Comorbidities ≥ 2	256 (38%)	14 (58%)	ns
Renal failure	39 (6%)	3 (12%)	ns
Transfusion	277 (41%)	12(50%)	ns

 doi:10.20944/preprints202604.2079.v1

Table 6. Distribution of comorbidities in patients discharged alive and died in hospital in patients with indication to echocardiography who performed or not examination. # p=0.001, *p=0.02, ° p=0.001 (difference in the same group).

Comorbidity	ECHO (1502)		No ECHO with indication (91)		p
	Discharged alive n 1392	**Died n 110**	**Discharged alive n 82**	**Died n 9**	
Atrial fibrillation	423 (30%)	46 (42%)*	55 (60%)	2 (22%)*	0.0001
Anemia	86 (6%)	24 (21%)°	4 (5%)	5 (55%)#	0.0001
COPD	146 (10%)	21 (19%)*	7 (9%)	2 (22%)	0.02
Diabetes	279 (20%)	20 (18%)	15 (18%)	1 (11%)	ns
Cancer	292 (21%)	35 (32%)*	21 (25%)	3 (33%)	0.04
Heart failure	147 (10%)	22 (20%)#	14 (17%)	7 (77%)#	0.0001
Dementia	286 (20%)	34 (30%)*	13 (16%)	4 (44%)*	0.02
Coronary artery disease	305 (22%)	32 (29%)	22 (26%)	3 (33%)	ns
Peripheral vascular dis	375 (7%)	37 (33%)*	18 (21%)	6(66%)#	0.002
Hypertension	977 (70%)	68 (62%)*	53 (64%)	6 (66%)	0.02
Comorbidities ≥ 2	992 (71%)	96 (87%)°	63 (76%)	7 (77%)	0.004
Renal failure	225 (16%)	38 (34%)°	10 (12%)	3 (33%)	0.0001
Transfusion	757 (54%)	54 (49%)	37 (45%)	5 (55%)	ns

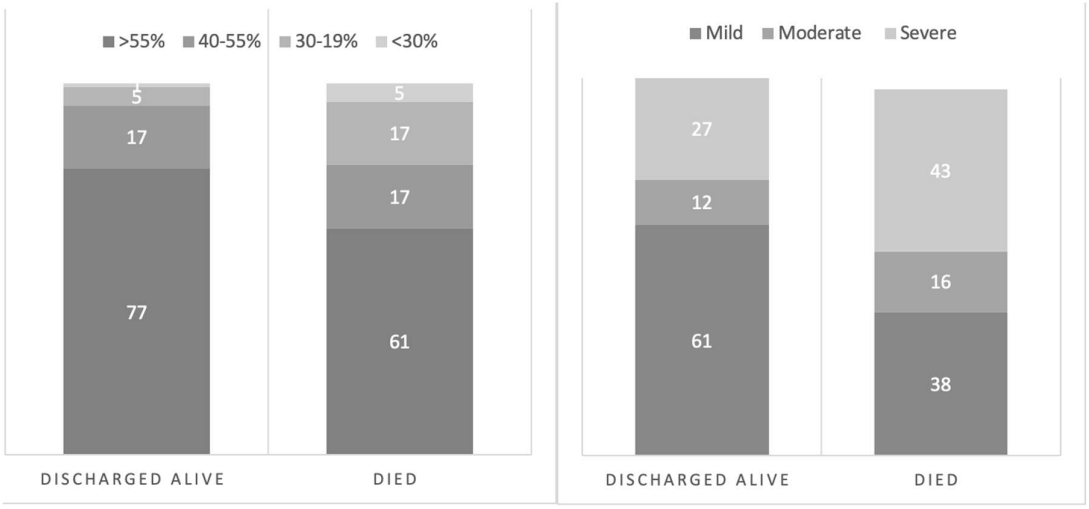

Figure 3. Distribution of LVEF and pulmonary artery pressure in patients discharged alive and died in hospital.

Regard echocardiographic parameters moderate and severely depressed left ventricular function was found in 5.5% and 1.0% of patients discharged alive in comparison to 17.3% and respectively 4.5% of patients died in hospital (p<0.0001) (Figure 1). Moderate-to-severe mitral regurgitation was found in 22.8% of patients discharged alive and in 31.8% of patients went to death (p=0.0014). Thirty-nine percent of patients discharged alive had moderate to severe pulmonary hypertension in comparison to 59.1% of patients who died. (p=0.0018) We did not find any statistically

 doi:10.20944/preprints202604.2079.v1

significant difference in rate of aortic stenosis and regurgitation, diastolic abnormalities and finally TAPSE between patients discharged alive and patients died in hospital. At multivariate analysis age, time to surgery, anemia at admission, and cancer were independently related to in-hospital mortality while preserved functional capacity expressed as maintained BADL was related with survival. Among echocardiographic parameters an increased in-hospital mortality was associated with reduced EF (OR 1.45 – 95% CI 1.06- 1.93 p=0.02) and increased pulmonary pressure (OR 1.22 – 95% CI 1.02- 1.47, p=0.03) (table

	Odds Ratio	95% CI	P
Age	1.07	(1.031 to 1.11)	0.0005
Time to surgery	1.03	(1.01 to 1.07)	0.0423
BADL >4	0.85	(0.74 to 0.98)	0.0286
Anemia<10 g/dl Hb	3.41	(1.82 to 6.37)	0.0001
Cancer	1.95	(1.18 to 3.21)	0.0084
Left Ventricular ejection fraction	**1.45**	**(1.07 to 1.99)**	**0.0189**
Pulmonary hypertension	**1.22**	**(1.02 to 1.47)**	**0.0257**

4. Discussion

AHA/ACC guidelines for cardiac evaluation in patients who need non-cardiac surgery suggest assessment of left ventricular function (class I, N-RB) in patients with new dyspnea, physical examination findings of HF, or suspected new/worsening ventricular dysfunction, as well in patients with aortic stenosis to help guide perioperative management [6]. Otherwise, ESC guidelines recommend echocardiography with in patients with poor functional capacity and/or high NT-pro-BNP/ BNP or if murmurs are detected before high-risk (class I B) and in patients with suspected new CVD or unexplained signs or symptoms before high-risk NCs (class IIa,B) [5]. Patients with fragility hip fracture represent a major challenge in preoperative evaluation since significant cardiopathy may be masked by poor functional capacity related to age and frailty as well to cognitive impairment therefore they may benefit most from preoperative echocardiography. Results of previous investigations about preoperative echocardiography in patients with hip fracture are contrasting. Since both survival and functional results are related to time to surgery, within 24-48 hours from trauma, the main concern with preoperative echocardiography is related to unacceptable delay in treatment waiting examination and related increase in complications and mortality [12–14]. Canty et al. [15] compared patients at increased cardiac risk underwent preoperative transthoracic echocardiography (TTE) to a randomized cohort with similar cardiac risk but not undergoing preoperative TTE. In the TTE group mortality was lower at both 30 days and 12 months postoperatively ((4.7% vs. 15.2%, p=0.047 and respectively 17.1% vs. 33.3%, p=0.031). In the study by Chen et al. [19] mortality rate was 2.8% while postoperative cardiac complications were 7.6%. History of coronary artery disease (CAD) and presence of aortic stenosis were independent predictors of postoperative cardiac complications. Age history of CAD, aortic stenosis and LVEF <50% were independent predictors of mortality. A retrospective study included 1453 (51% male; age, 67 ± 16) underwent TTE before intermediate- or high-risk major abdominal surgery or orthopedic surgery [20]. The primary endpoints were major adverse events (MAEs), i.e., all-cause mortality and major adverse cardiovascular-cerebral events (MACCEs) at a follow-up of 56 days. Mortality was 2.4% and MACCEs rate 1.2%. Higher average E/e' values, lower Left ventricular (LV) ejection fraction, and higher prevalence of significant mitral regurgitation (MR) other than moderate-advanced chronic kidney disease (CKD) were associated with MAEs. A recent case control matched 113 hip fracture

 doi:10.20944/preprints202604.2079.v1

patients who did or did not undergo preoperative TTE [**21].** Indication for TEE was adequate in 71%. TTE group had longer time to surgery and LOS of average 20 hours and respectively 2 days in comparison to non-TTE group ($p < 0.0001$). There was higher 90-day mortality for the TTE group (odds ratio 4.4, 95% confidence interval 1.3-14.7, $p < 0.03$) but no difference at 2-years. In a large retrospective study form Japan 34,679 (52.1%) of 66,620 hip fracture patients underwent preoperative echocardiography screening [16]. Propensity score matching created a matched cohort of 25,205 pairs of patients. There were no in-hospital mortality differences between the 2 groups (screened versus no screened: 417[1.65%] vs 439 [1.74%]). Preoperative echocardiography was not associated with reduced postoperative complications and intensive care unit admissions. In our study echocardiography was performed according to protocol in patients with newly detected or known systolic murmurs, ECG abnormalities, known heart disease or presence of ≥3 coronary risk factors. Ninety-four % of those with clinical indications underwent examination. We did not find difference in time to surgery between patients underwent or not to echocardiography, since our organization allowed to perform bed-side examination at time of the admission in multidisciplinary ward. In more than 20% of those underwent echocardiography perioperative strategy was changed according to ultrasonographic findings: in 13% anesthesiologic strategy was modified from spinal to general anesthesia, in the remnants post-operative ICU was required. TTE had a higher mortality, as expected since inclusion criteria identified a higher-risk surgical group. Mortality in patients with indication but who do not undergo echocardiography had 10% mortality in comparison to 7.3% of those underwent examination. The small number of patients in the group who did not made echo and the absence of randomization do not allow to draw conclusions. At multivariate analysis in-hospital mortality was associated with reduced EF (OR 1.45 – 95% CI 1.06- 1.93 p=0.02) and increased pulmonary pressure (OR 1.22 – 95% CI 1.02- 1.47, p=0.03). Other factors related to mortality were age, time to surgery, anemia at admission, functional impairment, and cancer. Careful preoperative treatment with the aim to decrease congestion may improve outcome in these patients.

What is known about preoperative echocardiography in patients who need hip fracture surgery is the result of observational studies with different protocols and inclusion criteria and do not give definitive indication. An ongoing multicenter trial started in 2025 will enroll 2000 adults with hip fractures [22]. Participants will be randomized before surgery to either receive focused cardiac ultrasound as part of their preoperative assessment or to routine care without FCU. Aim of the study is to determine whether preoperative focused ultrasound examinations of hip fracture patients reduce serious postoperative complications, improves the quality of recovery, improves life quality, and is cost-effective.

5. Conclusions

Results from our study confirm that in a large volume well organized multidisciplinary hip fracture unit the execution of echocardiography does not affect time to surgery. Moreover, we demonstrated that impaired left ventricular ejection fraction and pulmonary hypertension are associated with an increased mortality. At present several evidence exist that echocardiographic findings have direct implications for perioperative management and risk stratification. Further investigations are needed to evaluate whether these changes may affect clinical outcome. Moreover, the ongoing randomized study had to establish the usefulness of focused echocardiography to improve clinical outcomes.

 doi:10.20944/preprints202604.2079.v1

Author Contributions: "Conceptualization, C.R..; methodology, C.R.; formal analysis, C.R., A.C.; investigation, G.R., A.Ce., G.M..; data curation, C.R..; writing—original draft preparation, C.R., R.C.; writing—review and editing, C.R, A.C..; supervision, C.R. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: The study is part of a project of Italian Health Ministry and Regione Toscana (RF-2010-2316600) and was approved by Ethical Committee of Regione Toscana (protocol code 13556_oss, date of approval 11 September 2018). The study was conducted according to STROBE statements and performed in line with the principles of the Declaration of Helsinki.

Informed Consent Statement: Written informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The original contributions presented in this study are included in the article. Further inquiries can be directed to the corresponding author(s).

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Smilowitz NR, Berger JS. Perioperative Cardiovascular Risk Assessment and Management for Noncardiac Surgery: A Review. JAMA. 2020 Jul 21;324(3):279-290. doi: 10.1001/jama.2020.7840.
2. Wijeysundera DN, Beattie WS, Karkouti K, Neuman MD, Austin PC, Laupacis A. Association of echocardiography before major elective non-cardiac surgery with postoperative survival and length of hospital stay: population based cohort study. BMJ. 2011 Jun 30;342:d3695. doi: 10.1136/bmj.d3695.
3. Chang HY, Chang WT, Liu YW. Application of transthoracic echocardiography in patients receiving intermediate- or high-risk noncardiac surgery. PLoS One. 2019 Apr 25;14(4):e0215854. doi: 10.1371/journal.pone.0215854. PMID: 31022210;
4. Chao TC, Lee HP, Wu JC, Hsu CJ. Analysis of Cardiac Events and the Subsequent Impact for Geriatric Patients Undergoing Hip Fracture Surgeries. J Clin Med. 2023 Aug 14;12(16):5276. doi: 10.3390/jcm12165276.
5. Halvorsen S, Mehilli J, Cassese S, Hall TS, Abdelhamid M, Barbato E, et al. 2022 ESC Guidelines on cardiovascular assessment and management of patients undergoing non-cardiac surgery. Eur Heart J. 2022;14:3826– 3924. doi: 10.1093/eurheartj/ehac270.
6. Thompson A, Fleischmann KE, Smilowitz NR, de Las Fuentes L, Mukherjee D, Aggarwal NR, Ahmad FS, Allen RB, Altin SE, Auerbach A, Berger JS, Chow B, Dakik HA, Eisenstein EL, Gerhard-Herman M, Ghadimi K, Kachulis B, Leclerc J, Lee CS, Macaulay TE, Mates G, Merli GJ, Parwani P, Poole JE, Rich MW, Ruetzler K, Stain SC, Sweitzer B, Talbot AW, Vallabhajosyula S, Whittle J, Williams KA Sr; Peer Review Committee Members. 2024 AHA/ACC/ACS/ASNC/HRS/SCA/SCCT/SCMR/SVM Guideline for Perioperative Cardiovascular Management for Noncardiac Surgery: A Report of the American College of Cardiology/American Heart Association Joint Committee on Clinical Practice Guidelines. Circulation. 2024 Nov 5;150(19):e351-e442. doi: 10.1161/CIR.0000000000001285. Epub 2024 Sep 24.
7. Scottish Intercollegiate Guidelines Network Management of hipfracture in older people. National Clinical Guideline111. 2009. http://www.sign.ac.uk/pdf/ sign111.pdf
8. Pincus D, Ravi B, Wasserstein D, Huang A, Paterson JM, Nathens AB, Kreder HJ, Jenkinson RJ, Wodchis WP. Association Between Wait Time and 30-Day Mortality in Adults Undergoing Hip Fracture Surgery. JAMA. 2017 Nov 28;318(20):1994-2003. doi: 10.1001/jama.2017.17606.
9. Mazarello Paes V, Ting A, Paes MVI, Masters J, Graham SM, Costa ML; HIPCARE Investigators*. What is the association between time to surgery and patient outcome after hip fracture? : a systematic review. Bone Joint J. 2026 Jan 1;108-B(1):30-38. doi: 10.1302/0301-620X.108B1.BJJ-2025-0035.R1.
10. Hawley S, Javad MK, Prieto-Alhambra D, Lippet J , Sheard S, Arden NK, Cooper C, Judge A . The Refresch study group , Clinical effectiveness of orhtogeriatric and fracture liason service models of care for hip fracture patients : population-based longitudinal study . Age an Ageing 2016:45:236-2

 doi:10.20944/preprints202604.2079.v1

11. Morris AH, Zuckerman JD. National consensus conference on improving the continuum of care for patients with hip fracture. J Bone Joint Surg Am 2002;84-A:670–674
12. Alibhai M, Sharma A, Alibhai MK, Fawdington RA, Moreau AP. Does pre-operative echocardiography delay hip fracture surgery Indian J Anaesth. 2013 Jul;57(4):408-10.
13. Loxdale SJ, Sneyd JR, Donovan A, Werrett G, Viira DJ. The role of routine pre-operative bedside echocardiography in detecting aortic stenosis in patients with a hip fracture. Anaesthesia. 2012;67:51-54. doi: 10.1111/j.1365-2044.2011.06942.9
14. Moran CG, Wenn RT, Sikand M, Taylor AM. Early mortality after hip fracture: is delay before surgery important? J Bone Joint Surg Am 2005 Mar;87(3):483e9
15. Canty DJ, Royse CF, Kilpatrick D, Bowman L, Royse AG. The impact of focused transthoracic echocardiography in the pre-operativeclinic. Anaesthesia. 2012;67(6):618-25. doi: 10.1111/j.1365-2044.2012.07074.
16. Yonekura H, Ide K, Onishi Y, Nahara I, Takeda C, Kawakami K. Preoperative Echocardiography for Patients With Hip Fractures Undergoing Surgery: A Retrospective Cohort Study Using a Nationwide Database. Anesth Analg. 2019 Feb;128(2):213-220. doi: 10.1213/ANE.0000000000003888.
17. AbuSharar SP, Bess L, Hennrikus E. Pre-operative echocardiograms in acute fragility hip fractures: How effective are the guidelines? Medicine (Baltimore). 2021 Mar 26;100(12):e25151. doi: 10.1097/MD.0000000000025151.
18. Douglas PS, Khandheria B, Stainback RF, et al. ACCF/ASE/ACEP/ASNC/SCAI/SCCT/SCMR 2007 appropriateness criteria for transthoracic and transesophageal echocardiography: a report of the American College of Cardiology Foundation Quality Strategic Directions Committee Appropriateness Criteria Working Group, American Society of Echocardiography, American College of Emergency Physicians, American Society of Nuclear Cardiology, Society for Cardiovascular Angiography and Interventions, Society of Cardiovascular Computed Tomography, and the Society for Cardiovascular Magnetic Resonance. Endorsed by the American College of Chest Physicians and the Society of Critical Care Medicine. J Am Soc Echocardiogr 2007;20:787–805Chen X, Ma Y, Deng Z, Li Q, Liao J, Zheng Q. Prediction of Early Postoperative Major Cardiac Events and In-Hospital Mortality in Elderly Hip Fracture Patients: The Role of Different Types of Preoperative Cardiac Abnormalities on Echocardiography Report. Clin Interv Aging. 2020 May 27;15:755-762. doi: 10.2147/CIA.S250620
19. Chang HY, Chang WT, Liu YW. Application of transthoracic echocardiography in patients receiving intermediate- or high-risk noncardiac surgery. PLoS One. 2019 Apr 25;14(4):e0215854. doi: 10.1371/journal.pone.0215854.
20. Lu LY, Rowe K, Johnson M, Desai V, Varady NH, Lange JK, Chen AF. How do preoperative echocardiograms in geriatric hip fracture patients affect care? A matched cohort study. Arch Orthop Trauma Surg. 2025 Jun 14;145(1):344. doi: 10.1007/s00402-025-05914-9.
21. Cid-Serra X, Royse A, Bowyer A, Canty D, Sessler D, Clarke-Errey S, Denault A, LoGiudice D, Ludbrook G, Lin DY, Yang Y, Haji K, Zucherrelli L, Palmer AJ, Piper B, Lwin TN, Dieleman S, Eccleston D, Chuan A, Cooper R, Henderson G, Royse C. Preoperative focused echocardiography on patients with fractured neck of femur. ECHONOF-III trial: study protocol for a multicenter randomized controlled trial. Trials. 2025 Sep 1;26(1):333. doi: 10.1186/s13063-025-09060-w.