

Clinical guidelines reduce unnecessary preoperative echocardiograph in elderly hip fracture patients

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Abstract

Background The American College of Cardiology (ACC) and the American Heart Association (AHA) have set up guidelines for preoperative usage of transthoracic echocardiograph (TTE) in case of non-cardiac surgery. Unnecessary TTE would increase hospital cost and delay surgery. Therefore, we aimed to analyze whether the TTE before hip fracture surgery was in accordance with guidelines and what the effects were on outcome.

Methods 281 elderly patients who had surgery for an isolated hip fracture were involved. The preoperative TTE test and adherence to the guideline were analyzed. TTE reports were reviewed for the presence of major cardiac abnormality with potentiality to change perioperative management, including left ventricular systolic or diastolic dysfunction, pericardial effusion, moderate or severe valvular disease, and pulmonary hypertension. Primary outcome was time to surgery (TTS), length of hospital stay (LLS), postoperative complications. Secondary outcome was sensitivity and specificity of accordance with the guideline for identifying which patients would have TTE that demonstrated major cardiac abnormality.

Results Of the 281 patients included, 174 patients (61.9%) received the TTE, whereas 107 patients did not. Only 71 of the 174 patients (40.8%) with TTE met the guidelines. Among the 202 patients who did not meet the guidelines (103 with TTE and 99 without TTE), those who received a preoperative TTE had a longer TTS (4.24 vs. 2.10 days, $P = 0.000$) and LOS (10.44 vs. 7.72 days, $P=0.000$). There were no differences in postoperative complication, the sensitivity and specificity of guidelines as the screening tool to identify patients with major cardiac abnormality was 86.7% and 68.7%.

Conclusion Preoperative TTE is frequently overused out of guidelines and lead to unnecessary surgery delay while not reducing the rate of postoperative complications. Stricter adherence to guidelines should be recommended, as it would help decrease unnecessary test.

Background

Hip fracture is the major reason of hospital admission in elderly patients. With a constantly increasing incidence, it is estimated to reach 6.3 million worldwide by the year 2050[1]. Elderly patients with hip fracture commonly presented with multiple comorbidities associated with high morbidity and mortality rates[2, 3]. Cardiovascular complications were the principal causes of death after hip fracture[4, 5]. On the one hand, early surgical intervention is commonly recommended for hip fracture patients as the surgery delay is associated with increased complications and mortality[6, 7]. On the other hand, early surgery is often delayed due to preoperative cardiac risk assessment and stratification. This may involve the preoperative transthoracic echocardiography (TTE) as it is often time consuming. Therefore, extended preoperative TTE should be restricted if it is unlikely to identify the major cardiac abnormality or change perioperative patient management. In 2014, the American College of Cardiology (ACC) Foundation and the American Heart Association (AHA) developed guidelines to determine which patients require preoperative TTE in non-cardiac surgery[8]. The guidelines aimed to identify patients who were most

likely to demonstrate major cardiac abnormality on TTE and consequently reduce unnecessary test. Despite the existence of guidelines, the gap between guideline and clinical practice often exists[9]. In addition, the appropriateness of this guidelines in the management of elderly patients with hip fractures was not established. Therefore, we aimed to identify how often preoperative transthoracic echocardiograph (TTE) is made in accordance with the guidelines and the influence caused by the unnecessary TTE. In addition, to assess whether the guidelines decrease TTE without missing the important cardiac disease.

Patients And Methods

Study population

After institutional review board approval, we retrospectively reviewed the electronic medical records of surgically treated hip fractures (femoral neck, intertrochanteric, sub-trochanteric) in elderly patients from January 1, 2015 to January 1, 2018. Exclusion criteria including (1) multiple fractures besides hip fracture, (2) pathological hip fracture or patients with malignant disease, (3) periprosthetic fracture, (4) surgery delay not related to echocardiography test (e.g. anticoagulant withdrawal, unavailable operation room).

The parameters extracted from medical records included age, sex, fracture type, surgery type, American Society of Anesthesiologists (ASA) class, anesthesiology type, preoperative comorbidities, postoperative complications, TTE reports, date and time of admission, date of echocardiography, surgery and discharged.

Whether adhere to guideline or not

For each patient included, charts were reviewed whether it was recommended to undergo TTE or not according to ACC/AHA guidelines. The indications for undergoing TTE included (1) dyspnea of unknown origin, (2) worsening of known signs or symptoms of heart failure, (3) known history of valvular dysfunction or heart failure without TTE in the last year or worsened symptoms, and (4) suspicion of moderate or greater valvular stenosis or regurgitation.[8] If the patient met one or more of the indications above, it was determined that the patient should undergo TTE. As a result, the patients were divided into 4 groups, including patients met the ACC/AHA guideline and underwent TTE; patients did not meet the guideline but undergo TTE; patients met the guideline but did not undergo TTE; patients did not meet the guideline or undergo TTE.

Major cardiac abnormality

Additional analyses with the subgroup of patients with a preoperative TTE was conducted. The preoperative TTE report was reviewed to identify whether there was major cardiac abnormality with potentiality to change perioperative management. According to previous literature, these conditions included a left ventricular ejection fraction diminished by <25%, systolic pulmonary artery hypertension

>55 mm Hg, “moderate” or “severe” valvular disease and pericardial effusion.[10-12] The TTE was defined to have the potentiality to change management if it had one or more of major cardiac abnormalities listed above.

Statistical analysis

Continuous variables are expressed as mean \pm standard deviation and compared using Student’s *t* test between those who did not meet the guideline but underwent TTE and those who did not meet the guideline or undergo TTE. Categorical variables are expressed as percentages and compared using the Chi-squared test or Fisher exact test as appropriate between 2 groups. The assessment of the ACC/AHA guideline as a screening tool was evaluated by calculating sensitivity and specificity for identifying patients in whom TTE would demonstrate major abnormality that would change management. Data were analyzed using SPSS (version 20.0; SPSS, Chicago, IL, USA). Statistical significance was defined as a value of $p < 0.05$.

Results

In total, 324 elderly patients (≥ 65 -year old) with hip fracture were surgically treated in our hospital during the study period. After reviewing the electronic medical records, 43 patients were excluded (5 with multiple fractures, 6 with pathological fracture, 3 with peri-prosthetic fracture, 16 with unavailable operation rooms or anticoagulant withdrawal, 13 with cancer history), 281 patients met the inclusion and exclusion criteria finally. Of those cases included, 174 patients (61.9%) underwent preoperative TTE, the rest 107 patients did not undergo the TTE. Seventy-one of the 174 patients (40.8%) with preoperative TTE met the ACC/AHA guidelines, whereas 103 patients (59.2%) received unnecessary TTE out of guidelines. Of the 104 patients who did not have TTE, 8 (7.4%) met the ACC/AHA guideline (Figure. 1).

Further analysis of the patients who did not meet the ACC/AHA guidelines was conducted, comparing those who underwent TTE ($n = 103$) and those who did not ($n = 99$). There were no statistically significant differences in age, gender, or fracture or ASA class or anesthesiology type or treatment type. Most participants were female, and the most common fracture type was femoral neck. The majority of patients were treated using hemiarthroplasty (table 1).

As for preexisting medical conditions comparison, patients who underwent TTE had a significantly higher rate of chronic obstructive pulmonary disease (17.5% vs. 6.1%, $P = 0.012$). No significant differences were noted in in history of cardiovascular disease, diabetes or other comorbidities listed in table 1.

Among the 202 patients (103 with TTE and 99 without TTE) who did not meet the guidelines for preoperative TTE, those who received a preoperative TTE had a significantly longer average time to surgery (4.24 vs. 2.10 days, $P = 0.000$) and significantly longer hospital length of stay (10.44 vs. 7.72 days, $P = 0.000$) (table 2). Though there was higher rate of pressure sore in patients with TTE, there was no statistical differences. In addition, there were no significant differences in postoperative cardiac complications or others listed at table 3.

Additional analyses with the subgroup of patients with a preoperative TTE explored how frequently TTE reveals cardiac abnormality with potentiality of changing management and whether application of guidelines to indicate TTE was practicable or not. The rate of adherence to the ACC/AHA guideline was 40.8% (n=71). The most common indications for the TTE performed in adherence to the guidelines were known heart disease and over 1 year since the last TTE (n=37), heart murmur (n=17), known heart disease with worsened symptoms (n=7), and dyspnea of unknown origin (n=10). The rest of TTE was ordered for generic “evaluation of cardiac function” although the patient did not show related cardiac symptoms. After reviewing 174 TTE reports, 30 patients were identified by the TTE as having cardiac abnormality with the potentiality to alter perioperative management, including moderate-severe valvular disease (n=13), pulmonary hypertension (n=7), decline in ejection fraction (n=5), moderate-severe pericardial effusion (n=5). Only 4 patients were identified as having major cardiac abnormality among 103 patients who underwent TTE out of guidelines, whereas 26 patients were identified as having major cardiac abnormality among 71 patients whose TTE was adherent to ACC/AHA guideline. As a result, the guidelines were the accurate screening tool to identify patients with major cardiac abnormality with a calculated sensitivity of 86.7 % and a specificity of 68.7% (Table 4).

Discussion

Though the ACC/AHA guidelines set up the standard algorithm for preoperative cardiac assessment in non-cardiac surgery, its adherent rate was not known. In this study, we confirmed that preoperative TTE in elderly patients with hip fracture is frequently not according to these guidelines in daily practice. A large number of patients are receiving unnecessary preoperative TTE without detecting the major cardiac abnormality. Although no significant difference in postoperative complications was identified, those patients with preoperative TTE out of guideline had the longer time to surgery and longer total hospital length of stay.

Based on the ACC/AHA guidelines, the patients who require noninvasive cardiac testing are those with active high-risk cardiac conditions. High risk patients might benefit from delaying hip fracture surgery to assess or clear the cardiac comorbidities[8]. However, delaying surgery due to unrecommended TTE could lead to worse outcome[13]. As our results showed, patients who had the TTE out of guidelines had higher prevalence of chronic obstructive pulmonary disease compared with the patients without TTE. However, there was no significant difference in cardiac related factors, including history of cardiovascular disease or ASA class. One possible explanation was that the indications for TTE were unclear and were rarely adherent to guidelines in clinical practice. Thus, a standardized protocol to determine which patients should undergo TTE was extremely valuable in clinical practice.

Unnecessary surgery delay(≥48h) increases the perioperative complications and mortality[14]. Patients without preoperative TTE was closed to this target time; however, those with TTE out of guideline were delayed almost 2 days. Previous studies have also shown a growing concern with surgery delay due to preoperative cardiac test. Luttrell et al. evaluated the impact of preoperative TTE on the elderly hip fractures (131 patients with TTE, 563 patients without TTE). They concluded that the patients with

preoperative TTE had obvious longer waiting time to surgery[15]. Harun et al. reviewed the effect of preoperative non-invasive cardiac test on hip fracture patients and found that further cardiac test led to a significant delay to surgery[16]. Cluett et al. compared the outcomes between the patients with cardiac evaluation besides electrocardiograph (22 patients) and the control group with only electrocardiograph (86 patients), which found the patients with further cardiac test had obvious surgery delay[17].

Therefore, we need to balance the benefits of TTE for preoperative cardiac risk assessment and the morbidity caused by surgery delay. High risk patients may benefit from delaying hip fracture surgery to undergo TTE and optimize the cardiac comorbidities. However, delaying surgery with a preoperative TTE that is not recommended or contributing may lead to worse outcome. Although ACC/AHA guideline had set up the criteria to determine which patients need preoperative TTE in non-cardiac surgery, its accuracy of acting as a screening tool to identify high risk patient with major cardiac abnormality was rarely studied. Our study demonstrated that the sensitivity of ACA/AHA guidelines for identifying patients who may have major cardiac abnormality with the potential to modify anesthesia or medical management was as high as 86.7% and the specificity was 68.7%. Our results supported those of a similar study from Chris et al, they reviewed 100 patients with preoperative TTE and found 66% was in accordance with the guideline. The sensitivity and specificity of guideline for identifying patients who may have cardiac abnormality were 100% and 40%.[18]

These guidelines were also proved to be effective to prevent the overuse of the other cardiac test. Stitgen et al. found that only 29% of geriatric patients with hip fracture who received a cardiology consultation had met the ACC/AHA guidelines and the consultation out of guideline did not change perioperative management but caused prominent surgery delay[19]. Smeets et al. conducted a retrospective study involving 388 patients and found the most frequent reason for incorrect preoperative cardiac screening was overscreening. In addition, the delay to surgery was increased by 9.9 h in the case of overscreening[20]. Recently, Smeets et al. published the prospective study involving 166 hip fracture patients and 87% of patients received preoperative cardiac screening in adherence to guideline, which was associated with a diminished use of preoperative resources[21].

To our best knowledge, there was only one study evaluating the correspondance between guideline and TTE utilization before[18]. However, they divided the patients into 2 groups (with TTE and without TTE) without further subdividing based on whether adhering to guidelines or not. The further subdivision could eliminate other unwanted disturbance, making the result difference more solely caused by TTE out of guideline. In addition, the pericardial effusion was not regarded as the abnormality with potentiality to change management, but it was proved to affect perioperative management in recent study[11]. Our study showed implementation of guidelines could improve the appropriate usage of preoperative TTE test, reduce unnecessary surgery delay. Several limitations should be noticed when interpreting these results. Firstly, surgery delay is multifactorial not solely caused by the TTE test, however we tried to minor the bias by excluding patients with surgery delay due to the unavailability of an operating room, surgeon or anticoagulant withdrawal. Secondary, evaluating whether TTE was adherent to guideline or not was subjective, but we decreased the bias by assessing the cases by two independent observers (X.P.C, Y.C.M)

blinded to the TTE result and discussed with the third observer(Q.T.L) when they have different opinions and drew the conclusion finally. Thirdly, we mainly focused on whether TTE identify major cardiac abnormality which was proved to change management in previous literature, this may overlook the other informations provided on TTE.

Conclusion

A majority of preoperative TTE were out of guideline and did not appear to identify cardiac abnormality or meaningfully influence management, while caused surgery delay and longer hospital stays. Our data suggested that implementation of the ACC/AHA guidelines in perioperative management could reduce unnecessary TTE without sacrificing the patient safety.

Abbreviations

TTE, transthoracic echocardiograph; ACC, American College of Cardiology Foundation; AHA, American Heart Association; TLS, time to surgery; LLS, length of hospital stay; ASA, American Society of Anesthesiologists

Declarations

Acknowledgements

Not applicable

Authors' contributions

.P.C, Y.C.M and Q.J.Z designed the study and modified and approved the final version of the manuscript. X.P.C wrote the first draft of the manuscript. Y.C.M, Z.T.D and Q.T.L collected the data. Q.T.L, Y.C.M and J.X.L analyzed and interpreted the data. Q.J.Z revised the manuscript.

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Ethics approval and consent to participate

The review board of the Guangdong Provincial People's Hospital approved the whole research plan.

Consent for publication

All authors reviewed the final version of the manuscript and approved it for submission.

Availability of data and materials

The data and materials are available from the medical records department of Guangdong Provincial People's Hospital

Competing interests

The authors declare that they have no competing interests.

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Tables

Table 1. Patient characteristics of 202 patients who did not meet ACC/AHA guidelines

Characteristics	With TTE (n=103)	Without TTE (n=99)	P value
Age (years)	81.07±6.08	79.51±8.61	0.140
Gender, n (%)			0.081
Female	80 (77.7)	66 (66.7)	
Male	23 (22.3)	33 (33.3)	
Fracture type, n (%)			0.597
Femoral neck	57 (55.3)	57 (57.6)	
Intertrochanteric	44 (42.7)	42 (42.4)	
Subtrochanteric	2 (1.9)	0 (1.1)	
Treatment type, n (%)			0.457
Hemiarthroplasty	41 (39.8)	33(33.3)	
Total hip arthroplasty	18 (17.5)	21(21.2)	
Proximal femoral nail anti-rotation	44 (42.7)	43(43.5)	
Cannulated screw fixation	0 (0)	2(2)	
ASA class, n(%)			0.848
ASA I	23(22.3)	24(24.2)	
ASA II	48(46.6)	41(41.5)	
ASA III	28(27.2)	31(31.3)	
ASA IV	4(3.9)	3(3)	
Anesthesiology type, n (%)			0.994
General anesthesia	27(26.2)	26(26.3)	
Regional anesthesia	76(73.8)	73(73.7)	
Preexisting medical history			
Cardiovascular disease	73(70.9)	59(59.6)	0.092
COPD	18(17.5)	6(6.1)	0.012
Cerebrovascular disease	20(19.4)	15(15.2)	0.423
Diabetes	22(21.4)	18(18.2)	0.571
Previous fragility fracture	15(14.6)	7(7.1)	0.087

Kidney function impairment	6(5.8)	6(6.0)	0.640
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Abbreviations: TTE, transthoracic echocardiography; ASA, American Society of Anesthesiologists; COPD, Chronic obstructive pulmonary disease

Table 2. Treatment timing for 202 patients who did not meet guidelines

Treatment time	Non-TTE n=99	TTE n=103	P value
Length of hospital stay, days	7.72±3.24	10.44±4.56	0.000
Time to surgery, days	2.10±2.13	4.24±2.11	0.000
Time from surgery to discharge, days	5.68±2.60	6.19±3.66	0.256

Abbreviations: TTE, transthoracic echocardiography.

Table 3. Comparison of postoperative complications for patients who did not meet the guideline

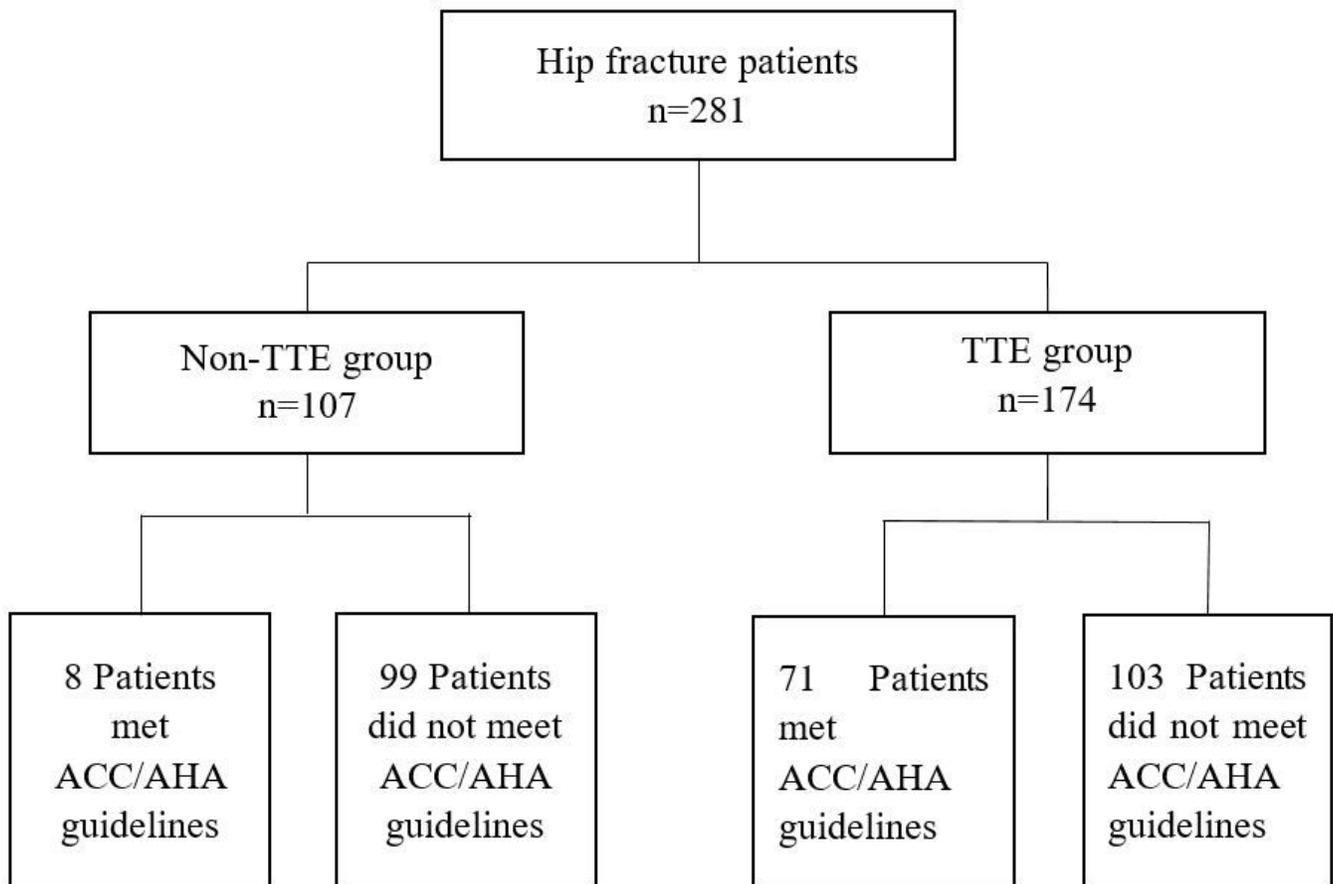
Postoperative complications	Non-TTE (%) n=99	TTE (%) n=103	P Value
New onset malignant arrhythmia	3(3.0)	8(7.8)	0.138
Acute myocardial infarction	2(2.0)	3(2.9)	1.000
Heart failure	3(3.0)	5(4.9)	0.721
Pneumonia	3(3.0)	6(5.8)	0.499
Acute kidney failure	0(0)	1(0.9)	1.000
Cerebrovascular accident	3(3.0)	5(4.9)	0.721
Surgical site infection	2(2.0)	5(4.9)	0.474
Pressure sores	2(2.0)	7(6.8)	0.100
Delirium	8(8.1)	10(9.7)	0.685
Intensive care unit stay	2(2.0)	0(0)	0.239

Abbreviations: TTE, transthoracic echocardiography.

Table 4. Result about whether the TTE met the guidelines and the TTE results reviewing

TTE results reviewing		
	With major abnormality	Without major abnormality
Guideline criteria		
Adhere to guideline	26	45
Out of guideline	4	99

Figures



TTE, transthoracic echocardiography; ACC/AHA, American College of Cardiology/American Heart Association

Figure 1

Preoperative TTE and ACC/AHA guidelines status for 281 hip fracture patients.