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Intraoperative Transthoracic Echocardiography is a Feasible Technique Used in Morbidly Obese Patients for Non-Invasive Cardiovascular Monitoring

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Abstract

Background and objectives: To evaluate the feasibility of an abbreviated focus-assessed transthoracic echocardiography protocol in morbidly obese patients. The purpose of this study was to evaluate whether good images could be obtained from this particularly difficult group of patients for whom acoustic imaging is often poor. Heart imaging could be helpful for cardiopulmonary screening and real-time monitoring.

Materials and methods: The study included 106 morbidly obese patients, who were undergoing laparoscopic bariatric surgery. The mean patient age was 32 years (range 21- 52), and there were 35 males. The parasternal long and short axes, apical 4 and 5 chambers were evaluated.

Results: In 95% of the patients, at least one view was obtained. In 78% two views were obtained and in 31% of the patients, all views and measurements could be performed.

Discussion: In obese patients, the major advantage of having a non-invasive cardiac monitoring device is the ability to perform anesthesia delivery.

Conclusion: Focused echocardiogaphy examination performed by anesthesiologists in the intraoperative period of morbid obese patients is feasible for almost all patients. Echocardiography offers non-invasiveness and speed for assessing the hemodynamic state and heart function of an obese patient. The image quality of the heart is sufficient to undergo interpretation and, therefore can contribute to intraoperative clinical decision-making

Keywords: Anesthesia; Obese patient; Transthoracic echocardiography

Introduction

Obese patients are always challenging for anesthesiologists [1-3]. The effect of obesity and its associated comorbidities, such as hypertension, diabetes, dyslipidemia and obstructive apnea syndrome, induce a different spectrum of pathologies [4,5]. In particular obesity produces the obesity cardiomyopathy, which alters diastolic and systolic functions. In addition, obesity is associated with 30 % increase in ischemic heart disease and sudden death [6]. Laparoscopic bariatric surgery is considered an effective and economical treatment for promoting and maintaining weight lost, thereby decreasing comorbidities, such as heart disease. The preoperative cardiovascular evaluation of the morbid obese patients is challenging, because these patients have exercise intolerance, and there are weight limitations for imaging tests [7]. Therefore, many obese patients arrive in the operating room with limited cardiovascular evaluations and there are known hemodynamic changes that will occur during general anesthesia [8,9]. Physiologic changes occur also because of the pneumoperitoneum and the patient position [10]. Echocardiography is the only technique that provides dynamic and real-time bedside imaging of the heart [11,12].

Small portable ultrasound machines with transthoracic echocardiographic (TTE) probes are now readily available in the operating room. The use of focused transthoracic echocardiography by anesthesiologists has shown that they are able to obtain rapid diagnostic quality images and good assessments of the ventricular load and valvular function [13,14]. The aim of focused intraoperative TTE is to noninvasively enhance the clinical cardiac assessment and immediately evaluate the hemodynamic condition, which is not easily detectable by traditional intraoperative non-invasive monitors.

The aim of the study was to evaluate and assess the feasibility of intraoperative image quality and limitations in morbidly obese patients during laparoscopic bariatric surgery using a focused TTE protocol performed by anesthesiologists.

We hypothesized that current TTE imaging equipment was adequate for identifying the cardiac chambers, valves, and volume status of these patients despite their obesity.

Materials and Methods

The study was conducted with approval from the Human Ethics Committee of the Hospital (FACh A, 131-009), and written informed consent was obtained from all patients.

Prospectively, patients with body mass index (BMI) over 40 undergoing laparoscopic bariatric surgery, between November 2010 and December 2012 were included in the study.

All of the studies were performed or supervised by an anesthesiologist with extensive TTE experience using the Turbo (Sonosite, Fujifilm, Bothell, WA, USA). A 1.5-3.6 MHz phased array transducer was used.

Echocardiography and measurements were obtained with the patient placed in a supine position, anesthetized and intubated. An electrocardiogram, an automated non-invasive blood pressure monitor and a pulse oximeter were continuously used.

The focused echocardiography protocol was divided following the same order:

Parasternal long axis view

The transducer was placed on the third or fourth intercostal space, adjacent to the left lateral margin of the sternum. Here the left atrial size, left and right ventricular contraction and dimension of the left ventricular outflow tract (LVOT) diameter were measured (Figure 1).

Parasternal short axis view

By rotating the transducer 90° from the parasternal long axis view, the short axis view was displayed to evaluate the left ventricular (LV) contractility (Figure 2).

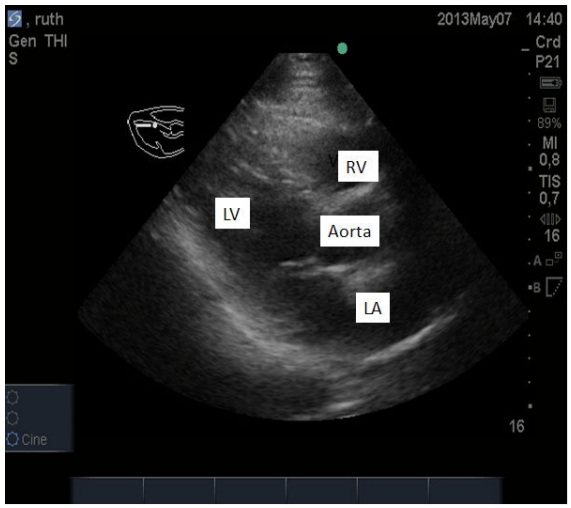

Figure 1: Transthoracic echocardiographyic parasternal long axis view. LV: Left Ventricle; RV: Right Ventricle; LA: Left Atrium

Apical 4-chamber view

The transducer was placed over the apex of the heart, and the ultrasound beam was directed parallel to the long axis. Here, it was important to observe the atrial and ventricular cavities.

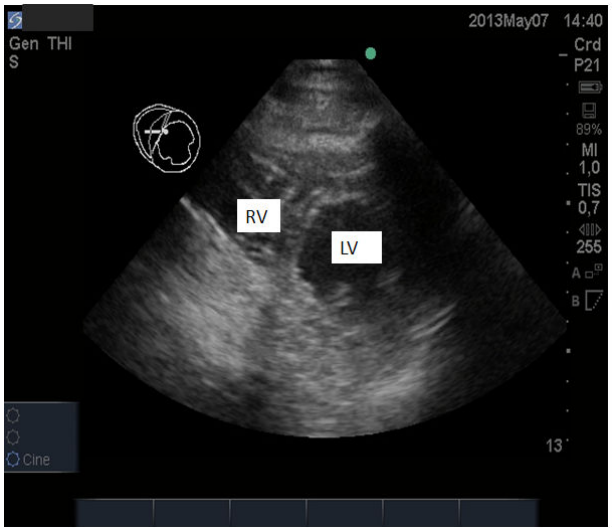

Figure 2: Transthoracic short axis view. LV: Left Ventricle; RV: Right Ventricle.

At the level of the mitral valve, the diastolic function was assessed measuring the LV inflow (Figure 3). Rotating the probe counter clockwise, a 3-chamber view was obtained for measuring the velocity of the outflow tract

Subcostal views were omitted because of the interference with the surgical field.

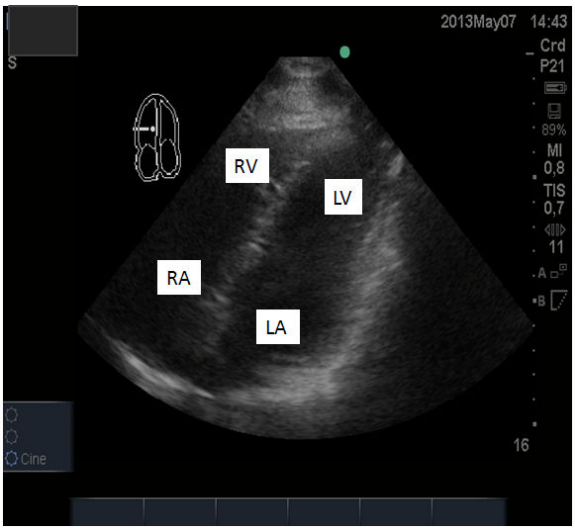

Figure 3: Transthoracic four chamber view. LV: Left Ventricle; RV: Right Ventricle; LA: Left Atrium; RA: Right Atrium

Statistical analysis

Continuous data were expressed as a mean value ± SD or as a percentage. Descriptive data were analyzed using STATA 10.0 (StataCorp LP4905 Lakeway DriveCollege Station, Texas, USA).

Results

Hundred-six obese patients with BMI of 43 ± 12 were included in the study. There were 35 males and 21 females. The average patient age was 32 ± 10 years.

In 95% of patients, it was possible to obtain at least one usable window of the proposed views to assess the heart.

In 78% of patients it was possible to obtain 2 of the proposed views. Subsequently, in 56% of patients, 3 views were found, and in 31% all proposed views and measurements were found. In only 3 patients (5%) no images could be taken.

The parasternal long axis view with the patient lying supine provided the best cardiac window in most patients, with an 81% success rate.

The presence of pneumoperitoneum did not significantly influence the achievability of a successful examination.

With a 34 % success rate the 5-chamber apical view was the most difficult view to obtain.

Discussion

This study was designed to assess the feasibility of a focused TTE in morbidly obese patients. In this study, we found that the 2D TTE images were useful for obtaining at least one acceptable quality view that could be used to directly assess the hearts of morbidly obese patients. Despite all of the limitations of this study population and the prejudgment that it would not be possible to obtain any views, because of the poor window quality in morbidly obese patients, the success rate was considerable (>one-third), and all cardiac windows were obtained. As illustrated by our patients, the parasternal transducer positions provided the highest yields, despite the supine position of the patient. With this view, substantial information about dimensions and contractility was obtained. According to the literature, this result was positive [15,16].

Previous data in perioperative populations undergoing non-cardiac surgery have supported the concept of a limited TTE and its ability to provide additional information that is not obtainable with standard clinical examination [17,18]. This process can be performed in approximately 10 minutes.

Having TTE monitoring during a laparoscopic bariatric surgery can lead to different scenarios. The heart can be completely normal during the entire procedure. TTE had the effect of reassuring the anesthesiologist, which led to a reduced requirement for further investigation and, reduced invasive monitoring and postoperative level of care. The goal is to avoid the insertion of more invasive monitoring tools, such as an arterial line or a central venous catheter, with the known risks and difficulties associated with both procedures, particularly in obese patients.

Another completely different scenario might occur if a clinically important hemodynamic or valvular abnormality is diagnosed in an obese patient with intraoperative TTE; this images can alert the anesthesiologist to an increased cardiac risk, leading to an increase in the level of intraoperative hemodynamic monitoring and treatment or postoperative care. The unique nature of anesthesia practice with sudden changes in patient physiology in the operating room means that having anesthesiologists with some TTE capability is invaluable.

It must be clearly stated that focused echocardiographic examinations are not a substitute for formal accredited TTE assessments. Instead they are designed for situations where limited examinations formats also assess intraoperative volume status, LV contractility and function and to exclude significant pathology. There have been several models for limited cardiac assessment such as the FATE (focused assessment with transthoracic echocardiography) examination in intensive care [19]. The HEART (hemodynamic echocardiographic assessment in real time) scan [20] is an assessment of ventricular filling, function and pressures: it is repeatable, as required, to allow for dynamic changes (e.g. intraoperatively).

As yet, there are no formal training guidelines for physicians wishing to incorporate TTE into their anesthesia practice. Recent data in the ICU literature suggest that non-cardiologists may acquire basic skills in focused critical care echocardiography with approximately 10 hours of didactic and practical teaching [21]. One of the problems with performing a limited or goal directed TTE is the failure to recognize significant pathology that might be observed during a formal TTE. Focused TTE, however, accurately identifies major cardiac abnormalities compared to non- invasive monitoring. Royse et al. [22] found that a novice operator could reach agreement with an expert operator in as few as 20 studies for basic hemodynamic state measurements and in 40 studies for all of the measurements performed.

This study has several limitations. The correct acquisition, processing and interpretation data require a thorough understanding of the possible pitfalls, along with an understanding of the limitations related to the patients, equipment and examiner. Another major limitation of an abbreviated goal directed TTE protocol is the subjective and qualitative nature of the assessment. With experience and training, however, the ability to extract increasingly large amounts of data has improved. Another important limitation of the study included the observational nature of the design, which was aimed at establishing proof of the concept of focused TTE examination in obese patients, rather than the effect on patient outcomes, which will be the subject of future investigations for our study group.

Conclusion

In conclusion the focused performed echocardiogaphic examination of morbidly obese patients performed by anesthesiologists in the intraoperative period is feasible for nearly all patients. One or more acoustic windows were obtained in 80% of the patients. Echocardiography is non-invasive and can quickly assess the hemodynamic state and function of the hearts of obese patients. The image quality of the heart is sufficient for interpretation and, therefore, can contribute to intraoperative clinical decision-making in morbidly obese patients. Further studies will be needed to study the impact and changes in patient management based on the echo images.

Competing Interests

The authors have reported no external funding or conflicts of interest.

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