REVIEW ARTICLE

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The use of echocardiography as a routine perioperative monitoring standard: The perspective of a cardiothoracic anesthesiologist

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INTRODUCTION

In the era of medicine that has been very advanced as it is today, we as anesthesiologists are required to be able to provide anesthetic services that are comfortable but still safe. Throughout the world, there are more than 300 million major surgery each year, and major cardiovascular adverse events are a significant cause of perioperative morbidity and mortality.[1] This certainly relates to the nature of anesthetic agents that are mostly cardiovascular-depressant. Anesthetic agents such as propofol, ketamine, opioids, inhalation anesthetic agents, and many others, can directly affect the cardiovascular system.[2]

While the major cardiac event occurred during perioperative events is also quite high. Especially for the patients in the perioperative period who will undergo non-cardiac surgery. This frequently reduces the alertness of an anesthesiologist, especially when performing perioperative monitoring. A study from Smilowitz *et al.*,[1] showed that out of 10,581,621 patients admitted to hospital for major non-cardiac surgery plans, 317,479 (3%) patients had experienced major cardiac events. Which can be illustrated that major cardiac events occur in 1 in 33 patients treated for major non-cardiac surgery. Echocardiography is a safe, relatively inexpensive and well-tolerated action for patients.[3]

Regular use of echocardiography in the perioperative period can certainly help to predict and even reduce major events in adverse cardiac events. It is good to be used as a guide for making decisions in carrying out actions, as well as for monitoring the patient's condition regularly during the perioperative period. The use of echocardiography so far has been used for both diagnosis and management in the field of cardiology and is used by another specialist as well, although anesthesiologists do not use it in the perioperative period as a routine manner. Meanwhile, the role of an anesthesiologist as a perioperative doctor has become something that other specialties have begun to rely on.[4]

HISTORY

The initial concept of echocardiography was first introduced by Lazzaro Spallanzani (1729-1799), he showed that echoes from the inaudible sound that allows a bat to navigate its flying directions. Which is where the discovery continued to be developed until later in 1880 by the Curies brothers succeeded in creating an ultrasonic wave through the discovery of piezoelectricity. In 1912, Lewis Richardson proposed a theory that echo-ranging techniques could be used to detect various underwater objects which later developed into what was known as the SONAR (Sound Navigation and Ranging) system by Langevin in 1915.[5]

The technology continued to develop during the world war until then a technology called RADAR (Radio Detection and Ranging) was created. Andre Denier began the use of ultrasound in the medical world in 1946, which revealed the theory of using ultrasound to provide an overview of internal organs in the human body. Until then in 1951, Inge Edler and Hellmurth Hertz began a new era of non-invasive diagnostic techniques by starting to introduce M-mode echocardiography. Which then began the development of these technologies became increasingly complete and sophisticated such as Doppler, 2-dimensional, contrast and transesophageal echocardiography.[5]

Over the past decade, ultrasonic devices have been produced by various manufacturers for a variety of clinical uses. The use and clinical application of ultrasound include also been used in various medical situations, both elective and emergency setting. And the use of ultrasound has proven to be able to provide a fast, less invasive, and good accuracy assessment especially for heart function problems.[4]

ECHOCARDIOGRAPHY IN ANESTHESIA

Echocardiography is generally used more often by a cardiologist and is frequently used mainly in long-term medical management. Therefore, the use of echocardiography is synonymous with a heart specialist, and not an anesthesiologist. Increased awareness of the benefits of anesthesiologists and intensivists has led to wider use of echocardiography in the area of care for anesthesia care. This allows an anesthesiologist to make a time-critical decision by performing bedside echocardiography in an urgent situation. The use of echocardiography by anesthesiologists in the perioperative period provides a

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more promising alternative. Many cardiac pathologies can be found by echocardiography, which leads to deeper examination or optimization of patients around the surgery period. Echocardiography can also be used to get rid of significant pathological problems, avoid unnecessary various examinations, delay actions for optimization, invasive monitoring, and postoperative intensive care.[6,7]

TRANSTHORACIC VS. TRANSOESOPHAGEAL ECHOCARDIOGRAPHY

The use of both transthoracic and transoesophageal echocardiography has been widely used in the era of modern medicine as a supporting tool to improve clinical assessment routinely in patients undergoing cardiac surgery. Each technique certainly has advantages and effects of diagnosis and management of therapy and even the outcome of the patient's condition. The widespread use of both transthoracic and transoesophageal echocardiography by anesthesiologists and intensivists has also greatly increased.[8] Regardless of technological advancements and the availability of ultrasound, it is undeniable that both transthoracic and transoesophageal echocardiography have been carried out extensively by the treating physician, and are part of a routine assessment, and not just limited to being used by expert doctors to narrow the diagnosis.

Transthoracic Echocardiography (TTE) has been known for its lower sensitivity for detection of vegetation compared to transesophageal echocardiography (TEE). However, TTE has been used routinely in many cases of endocarditis. The American Heart Association (AHA) recommends TEE as an initial test to exclude endocarditis in high-risk individuals, especially in patients where TTE is difficult to do.[9]

A study from Biswas *et al.*[9] shows the limitations of TTE in detecting visible endocarditis from vegetation valvular, flow abnormalities of valvular, and also ring abscess. With a sensitivity of 29%, TTE is no longer at the top of the choice for the initial evaluation of infective endocarditis. And likewise, TTE has a lower sensitivity than TEE in detecting vegetation in the mitral valve (11%) and tricuspid (16.7%). Apart from that from a financial point of view, the use of TEE from the start can cut significant expenses. As for the study of Lyons *et al.*[10] also showed that TEE remained more sensitive than TTE for detecting endocarditis features especially in cases of prosthetic infections and pacemaker infections.

But in perioperative settings, TTE and TEE are the most commonly used the modalities of cardiac imaging. So that the differences, benefits, and similarities of each TEE and TTE can be complementary for echocardiography perioperative. The view of TTE can provide an excellent knowledge base to provide a comparison of the views of TEE. TTE and TEE complement each other in their ability to give the specific structures better images. TTE gives better resolution of the anterior structure, such as the right ventricle, outlet of the right ventricular, pulmonary valve, and anterior pericard. The apical TTE view gives better imaging of the pericard and apex of the left ventricular. Meanwhile, TEE will provide better imaging of the posterior structure, such as the mitral valve, left atrium, septum interatrial and appendage of the left atrial.[11]

The flexible TEE probe is used by inserting it along the esophagus to image the heart and large blood vessels. And for its proximity to the heart, the penetration of TEE requires less depth and needs higher frequency transducer (5-7 MHz) that allows superior spatial imaging from the posterior of the cardiac structure in comparison with TTE. Especially during heart surgery, TEE remains the preferred modality for intraoperative cardiovascular assessment.[12,13]

With the lower frequency of ultrasound (3-5 MHz), TTE allows greater depth penetration, but at the expense of spatial resolution. TTE transducers are placed directly on the patient's chest in 4 windows: parasternal, apical, subcostal, and suprasternal. Unlike TEE, TTE describes the anatomical structure anterior to posterior. Space quantification is easier to do by TTE, where the distance between the probes makes it possible to provide a complete picture of the ventricular and atrial boundaries. TTE can be quickly performed, noninvasive, and provides accurate hemodynamic assessment during cardiovascular emergencies such as cardiac tamponade and circulatory shock. TTE generally can provide more reliable hemodynamic data because it provides flexibility in the position of the transducer. However, TTE may be limited by factors such as the position of the patient that must be in the supine position, the inability to access the chest without contaminating the surgical field, and the condition of the mediastinal tube is attached. Surgical pads, mediastinal air, and tubes can inhibit ultrasonographic transmission so that will reduce the quality of TTE imaging.[11]

PREOPERATIVE MONITORING

The use of echocardiography can be started during the preoperative period. The preoperative evaluation that has been routinely carried out such as collecting disease history, physical examination, checking vital signs in various non-invasive ways is indeed very important to do. But often all of these data is not enough to be able to provide a true picture of

hemodynamic status, as well as to be able to look for a variety of hidden diseases in healthy patients or high-risk patients, as well as in critically ill patients. So that routine use of echocardiography in the preoperative period will be a very useful addition.[14]

In preoperative evaluation, echocardiography can help determine the condition of undifferentiated murmurs, shortness of breath in patients with a history of previous heart problems, severity of heart valve disease in patients who have not been able to excavate their previous history (such as in patients with mental disorders or patients with low education levels), or critically ill patients who cannot speak because of being intubated or seriously ill, in which patients will be planned for immediate surgery. So the role of the use of echocardiography here can also be used as a function for monitoring or screening cardiorespiratory function, diagnostics and even for therapeutic interventions in the perioperative period.[4]

INTRA-OPERATIVE MONITORING

In the operating room, an anesthesiologist frequently must act as another specialist. This is because when in an operating room an anesthesiologist often has to deal with a variety of comorbid conditions in patients who often appear during surgery. From a serial case study showed that patients with aorta stenosis (AS) can undergo non-cardiac surgery with a major complication rate of less than 10%, as a result of knowing the existence of US conditions from the start and monitoring of the US during surgical durante, which causes various medical interventions (such as giving vasoactive agents, adjusting surgical techniques can be given earlier and more precisely.[1]

Routine echocardiographic examinations on non-cardiac surgery can be an ideal examination, where a frequent collection of patient history and conventional monitoring often cannot provide a good picture of the disease underlying the patient's condition, especially in patients who appear stable. Conventional management of patients in unstable hemodynamic conditions with the administration of fluids and vasopressors will work in most cases. However, in a hemodynamic situation that is unresponsive and unstable, the use of echocardiography can provide information needed to consider a rational approach to definitive clinical care. So this might be the new gold standard for hemodynamic monitoring especially in anesthesia service standards.[4]

POST-OPERATIF MONITORING

Hemodynamic monitoring with echocardiography especially for hypotensive events in the postoperative period will able to identify the cause of hypotension. The cause of hypotension after surgery is often caused by secondary vasodilation due to anesthesia or other drugs, or intraoperative hypovolemia. Echocardiography will help to distinguish the causes so they will make a better diagnosis and management quickly right after surgery in the post-anesthesia care unit.[4]

CONCLUSION

The use of echocardiography allows an anesthesiologist to be able to see the condition and performance of the heart directly and manifestly that occurs under the skin. And now ultrasonographic devices are increasingly sophisticated with smaller and more portable sizes making it possible to carry out echocardiography examinations immediately, anytime and anywhere, especially during perioperative periods. Of course, this will make it possible for an anesthesiologist to get the latest diagnostic information from patients during the perioperative period so that it can lead to better and safer anesthesia and perioperative management for patients.

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