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TECHNIQUES

Transesophageal Echocardiography

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ABSTRACT

Despite the progress made in the field of ultrasound, the echocardiographic examination is still of a relatively poor quality in a number of patients. This is basically due to obstacles from the thorax and the lung which very often impede the ultrasound beam transmission. Many of these technical limitations can now be overcome with the advent of transesophageal approach. Transesophageal echocardiography (TEE) is particularly useful when the transthoracic study is not diagnostic, when there is clinico-echocardiographic discordance, in patients with suspected endocarditis and valve dysfunction, in patients with prosthetic valves, particularly mitral valve prosthesis, in patients presenting with systemic thromboemboli, in patients with disease of the aorta, in patients with mitral regurgitation needing to define the cause particularly when surgery is contemplated, and during cardiac or non-cardiac surgery. In this brief overview the clinical applications of TEE are discussed.

KEY WORDS: *cardiac ultrasound, echocardiography, transesophageal echocardiography*

INTRODUCTION

Without non-invasive techniques, many of the developments in cardiology of the last few years would not have been possible. The world of cardiac imaging has in fact been on the receiving end of many technological innovations, which have considerably increased its potential. Exploring the heart by means of ultrasound has particularly played a major role in helping to increase our pathophysiologic knowledge. In just over two decades, we have gone from the simple single-beam echocardiography (M-mode), which enabled temporal evaluation of the various intracardiac structures, to two-dimensional echocardiographic-colour Doppler exploration, enabling the simultaneous exploration of the cardiac structures and blood flow velocities.

Despite the progress made in the field of ultrasound, the echocardiographic examination is still of a relatively poor quality in a number of patients. This is basically due to limiting factors such as the fact that the ultrasonic beam has to cross lung tissue, bone and muscle, which very often impede their optimal transmission. Another limiting factor is that often the cardiac structure interested in may be situated far away from the transducer and consequently difficult to explore. However, many of the technical limitations affecting negatively the quality of an echocardiographic examination can now be overcome thanks to the advent of transesophageal approach.[1,2] Indeed, the possibility of introducing miniature and high frequency transducers into the thorax via the esophagus, bypasses the lungs and all other interfering tissues between transducer and the heart with a dramatic improvement of the image quality.

ABBREVIATIONS
TEE = transesophageal echocardiography

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TRANSESOPHAGEAL ECHOCARDIOGRAPHY

The technique description and image orientation have previously been described.[1,2] The execution of the transesophageal examination does not require any particular skills; the procedure and the precautions are the same as those required for a normal gastroscopic examination. The transducer is inserted into the esophagus following the techniques and maneuvers commonly used when carrying out a gastroscopy. Once this has been done, the various echocardiographic planes need to be found by making the gastroscope move in three different ways: 1) downward, 2) angling the distal part and 3) rotating.

CLINICAL APPLICATIONS

Transesophageal echocardiography (TEE)[3-25] is particularly useful when:

1) The transthoracic study is not diagnostic
2) There is clinico-echocardiographic discordance
3) In patients with suspected endocarditis and valve dysfunction[10]
4) In patients with prosthetic valves, particularly in the mitral position[11,23]
5) In patients presenting with unexplained embolic phenomena particularly when they are young (<50 years old), but also in the elderly[16,18,25]
6) To describe disease of the aorta[6,21,25]
7) To describe the mechanisms of mitral regurgitation, particularly when surgery is contemplated
8) During cardiac or non-cardiac surgery[12,15]

PROSTHETIC VALVES

The excellent resolution of the two-dimensional echocardiographic images and the high quality of the Doppler signal (pulsed and colour) means that during the transesophageal examination valvular and paravalvular leaks can be depicted in virtually all patients.[11,23] The problem is to differentiate the "normal" from the pathological leak and this does require a fair amount of expertise from the operator. In a study performed in our institution concerning consecutive patients with prosthetic mitral valves we found that 91% of the referred patients had a leak 48% mild, which was considered as normal, and in 35% of the patients it was considered to represent moderate to severe paravalvular regurgitation. This difficulty in visualizing a transprosthetic or paraprosthetic mitral leak from the transthoracic approach is because the synthetic material of the valvular prosthesis impedes atrial exploration. This obstacle is easily bypassed with the transesophageal approach, which enables the accurate exploration of the prosthesis via the left atrium.

SUSPECTED INFECTIVE ENDOCARDITIS

The direct effects of infective endocarditis and the valve damage can readily be confirmed or denied with transesophageal echocardiography.[10,19] This is certainly true in the presence of prosthetic valve endocarditis where the prosthetic reverberations hide the potential presence of vegetations. The existence of a paravalvular abscess formation can be depicted with the transesophageal approach. We find one of the most common and difficult to answer referral diagnoses from the transthoracic approach is the presence of a paravalvular abscess. Although often and in expert hands the diagnosis can be made from the transthoracic approach when the abscess is visualized, when no abscess is seen its presence can not be excluded. Conversely, from the transesophageal approach, not only can abscesses be quickly visualized, but also their presence can definitely be excluded.

The diagnosis of prosthetic valve endocarditis remains difficult even with TEE. A negative study cannot exclude the diagnosis.

EMBOLIC PHENOMENA

Detection of intracardiac masses has always been the most fascinating application of any imaging technique. The detection of intracardiac masses following systemic embolization has further been increased by transesophageal echocardiography.[5,8,16,18,22,24,25] We have learned using the transesophageal approach that intra-atrial thrombotic formations are more common than one would believe. Two are the reasons for this: 1) the very accurate identification and localization of even very small thrombi and 2) the possibility of exploring the left atrial appendage where thrombi are often hidden.

Another reason for systemic embolization is the possibility of *paradoxical embolization* from the right atrium through a patent foramen ovale. Although it is extremely difficult to catch the embolus across the atrial septum, transesophageal echocardiography allows a panoramic exploration of the atrial septum itself so that possible interruption of septal continuity can be seen (atrial septal defects, aneurysm). Even when the atrial septum appears to be uninterrupted, a peripheral injection of normal saline into a vein during a Valsalva maneuver will clearly show the presence of a right-to-left shunt when it exists (patent foramen ovale), with a much higher sensitivity and specificity when compared with the transthoracic approach.

DISEASES OF THE AORTA

Perhaps one of the greatest usefulness of transesophageal echocardiography is its ability to confirm or exclude a suspected diagnosis of *aortic dissection* or intramural hematoma.[6,21,25] The extraordinary quality of the images, together with the speed at which they can be obtained even at the patient's bedside, make this method ideal. Using TEE one can accurately study not only aneurysms and dissections of the ascending aorta but

also of the descending thoracic aorta which, as we know, are difficult to explore from the surface. Recent studies on the role of TEE in the diagnosis of aortic dissection have clearly demonstrated that the diagnostic reliability of this approach is clearly better than that of other cardiac imaging techniques. Furthermore, two-dimensional echocardiography with color flow mapping enables us to identify the site of communication between true and false lumens. The sensitivity and specificity of echocardiography (combined with the transesophageal approach) is 99% and 98% respectively, with a positive and negative predictive accuracy of 98% and 99%. Both computed tomography and aortography have much lower sensitivities. Especially in emergency cases, TEE can provide all the information required for cardiac surgery to be performed without delay and thus reduce mortality in those high-risk patients. Lastly, the patients can be easily followed-up with the transesophageal technique so that the progress of the aneurysm or the post-operative results can readily be assessed.

CONGENITAL HEART DISEASE

Transesophageal echocardiography is a superb technique for assessing simple and complex congenital heart disease.[3,4,17] With its ability to visualize the most posterior cardiac structures, the pulmonary veins and the atrial septum can readily be assessed. Particularly now that many of the previously operated young children with congenital heart disease are surviving and reach adulthood, optimal transthoracic echocardiographic imaging may be very difficult and the need for better imaging is growing. Atrial septal defects can be diagnosed or excluded with sensitivities reaching 100% and percutaneous closure with use of devices can be guided by TEE.[17] Even patent foramen ovale can be diagnosed with greater accuracy using the transesophageal approach and contrast (saline) injection into a peripheral vein.

Assessing complex congenital heart disease such as the long-term results from patients with transposition of the great arteries, the transesophageal approach offers a new echocardiographic window. Among several complications of the Mustard repair for example are systemic and pulmonary venous baffle obstruction. Whereas transthoracic two-dimensional echocardiography is very useful in children, in young adults imaging of the posterior cardiac structures cannot be optimally performed. In contrast with the transesophageal approach all these posteriorly positioned venous channels can be clearly visualized. The addition of color flow interrogation of these channels is very helpful in assessing turbulent flow patterns.

ISCHEMIC HEART DISEASE

Transesophageal echocardiography is of great help also in assessing patients with ischemic heart disease.[7,13] The excellent image resolution allows morphological studies of the left ventricle of a quality, which could never have been obtained with the traditional transthoracic techniques. It has also been used with some success for the visualization of the initial tract of the main coronary arteries.

The combination of coronary artery disease and mitral regurgitation is common and when significant, the risk of death is greater. With the development of more sophisticated mitral valve repair procedures, transesophageal echocardiography has become essential for the detailed description of the precise mechanisms of mitral regurgitation and to assess its suitability for repair.

INTRA-OPERATIVE TEE

The increasing popularity of valve repair over replacement, has led to the explosive application of TEE worldwide both, during non-cardiac surgery as well as during cardiac surgery. [12,15]

Noncardiac surgery

This is essentially limited to the monitoring of the left ventricular function in high-risk patients.

Cardiac surgery

This is particularly useful during mitral valve surgery, particularly during repair procedures. It provides the surgeon with a detailed description of the mechanisms of mitral regurgitation prior to initiating the cardiopulmonary bypass. It provides the surgeon with valuable information influencing the approach to valve repair.

Intraoperative TEE can also be used to assess left ventricular filling and ejection to guide pharmacologic and fluid volume infusions as the patient is being weaned from bypass. In this process, TEE can help detect intraoperative myocardial ischemia by demonstrating new wall motion abnormalities. Importantly, in patients who cannot be weaned from cardiopulmonary bypass, TEE can help determine whether this is due to right or left ventricular dysfunction, valvular dysfunction, or intravascular volume depletion.

CONCLUSION

Transesophageal echocardiography is now a well established and invaluable diagnostic tool, which has its major clinical applications where the more conventional transthoracic echocardiography has its limitations. This technique can now be considered the most clinically useful cardiac imaging method for it is the only one which can supply exceptionally clear images of both the moving cardiac structures and the endocavitary blood flow. It should be used however in combination with transthoracic echocardiography by experienced and accredited echocardiographers as it complements the transthoracic approach, not replacing it.

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