

Is echocardiography helpful in the pre-anaesthesia assessment ?

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Pre-anaesthetic evaluation is an integral part of the anaesthetic management and the BSAR has extensively described the anaesthetist's role during this preoperative assessment of the patient (1). In France, since the 94/1050 decret of December 5, 1994, it is a medico-legal responsibility for the anaesthetists to examine the patient "several" days before any elective medical procedure necessitating general or loco-regional anaesthesia.

The goal of this "distant" preoperative evaluation is to evaluate the patient's physical status ahead of the surgical procedure while keeping enough time to optimize it if needed or even to reschedule surgery. It also allows for adapting the medical treatment and in some cases it allows the detection of unsuspected pathologies that could interfere with the perioperative evolution. Organisation of such preoperative assessment clinics varies among the hospitals (2).

During this personal interview, besides obtaining information about medical and surgical history, a careful physical examination should be performed and focused on cardiovascular and respiratory evaluation. Cardiac auscultation is a necessary part of it and allows detecting valvular heart disease (VHD) before surgery in an ever aging surgical population (3).

AUSCULTATION AND CARDIAC MURMURS

In a cohort of 2522 consecutive Dutch patients presenting for preoperative evaluation, VAN KLEI estimated the prevalence of a heart murmur detected by auscultation by the anaesthetist as of 4.2% (4). Age and physical general impression were independently associated with detecting a murmur. In 79% of the patients with a detected murmur an echocardiographic diagnosis was obtained and disclosed aortic valve abnormalities in 39%, mitral valve regurgitation in 24% and other valvular diseases in 7%. Thirty percent of the patients with heart murmur and an available echo did not have any valvular abnormalities and in patients younger than 40 years, murmurs never reflected valvular heart disease.

In another study, the diagnostic accuracy of the cardiac examination made by cardiologists was compared with echocardiography in 100 consecutive patients with an unsuspected systolic murmur (5). Transthoracic echocardiography (TTE) was normal in 21% of the patients, confirming a functional murmur that had been correctly diagnosed by auscultation (diagnostic accuracy 83%). The most frequent organic pathologies were aortic stenosis in 29%, mitral regurgitation in 30%, left or right intraventricular pressure gradient in 11%, mitral valve prolapse in 11% and associated aortic regurgitation in 28%. Combined lesions were present in 35% of the patient with organic valve disease and their detection was more difficult without echocardiography. Patients with functional murmur were much younger than patients with organic heart disease (33 vs 65 years). These benign murmurs are typically midsystolic with their maximal intensity at the base and a crescendo-decrescendo pattern. They result from the acceleration of blood flow through a structurally normal valve and do not require further evaluation.

It is therefore important to define the nature of the murmur. Pathologic murmurs requiring echocardiographic assessment include all diastolic murmurs, systolic murmurs > grade 3 and continuous murmurs.

The ACC/AHA guidelines have defined a strategy for evaluating heart murmurs (6), establishing the role of echocardiography as to : define the primary lesion in terms of cause and severity, define haemodynamics, define coexisting abnormalities, detect secondary lesions, evaluate cardiac chamber size and function, establish a reference point for future comparisons, and re-evaluate the patient after an intervention.

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HYPERTROPHIC CARDIOMYOPATHY

Hypertrophic cardiomyopathy (HCM) can be misdiagnosed as it can present features characteristic of a benign murmur : a non-irradiating, grade 2, crescendo-decrescendo murmur audible on the left sternal border. Angelotti describes one case in whom preoperative TTE was not performed due to the benign nature of the murmur and HCM diagnosed intraoperatively by transoesophageal echocardiography (TOE) used for haemodynamic monitoring (7). In Attenhoffer Jost's study, a left ventricular pressure gradient was present in 9% of the patients with a systolic murmur. Two of those had HCM (5). Increased intensity of the murmur after Valsalva manoeuvre suggests an HCM and imposes to ask for a preoperative echo, especially in young patients because an early onset seems to be associated with the more severe forms of the disease.

VALVULAR HEART DISEASES

Valvular heart disease represents an important public health problem and determines operative risk. Prevalence of VHD increases with age going from 0.7% in the 18-44 year-old age group to 13.3% in the 75 years and older group (8).

AORTIC STENOSIS

A higher than grade 3 systolic murmur heard in the aortic area, irradiating to the right carotid artery and associated with a decreased intensity of the second heart sound evokes aortic stenosis (AS). It is the most common VHD in the elderly and needs to be identified and quantified prior to elective noncardiac surgery as it increases the risks proportionally to the severity of the stenosis (9-11).

Moreover, 44% of patients aged over 75 years and suffering from severe AS have at least one associated non-cardiac comorbidity : chronic obstructive pulmonary disease is the most frequent and affects up to 15% of these patients, while coronary artery disease is present in up to 50% of patients with AS (12). Interestingly, recent findings show that AS shares common risk factors and histological lesions with atherosclerosis.

Recent data however, suggest that perioperative risks could be lower in patients at low risk score of CAD, in patients with good physical status and in patients undergoing low-risk surgical procedures (13, 14). Even neuraxial blockade, classically con-

traindicated, has been successfully administered to patients with severe or symptomatic AS (15, 16).

Even younger patients may be at increased risk for AS : a congenital bicuspid aortic valve is indeed prone to early degeneration and calcification.

Clinical examination has a good sensitivity in detecting moderate or severe AS but can be misleading in patients with AS and low cardiac output or combined cardiac lesions (5). Transthoracic echocardiography will provide data about the severity of AS, along with evaluation of the degree of left ventricular (LV) hypertrophy and LV systolic and diastolic function. It is however important to keep in mind that even in case of severe AS, the transvalvular gradient will be reduced in patients with low cardiac output. Postoperative complications are related to the severity of AS and occur even in patients with moderate AS (10). Therefore, a TTE seems warranted if AS is suspected in an asymptomatic patient undergoing moderate and high risk surgery under general or regional anaesthesia and even more in a symptomatic patient (17).

MITRAL STENOSIS

Characteristic of mitral stenosis (MS) upon auscultation is a mitral valve opening snap followed by a mid-diastolic rumbling murmur best heard at the apex. Such a diastolic murmur mandates an echocardiographic evaluation that will establish the severity of stenosis by measuring the valve area, the mean diastolic pressure gradient and by estimation of the pulmonary artery pressures. Transthoracic echocardiography will also permit evaluation of the atrial and ventricular size and function and a thorough analysis of the valvular and subvalvular apparatus that is often thickened and calcified due to rheumatic heart disease.

The cardiac output is fixed and usually low due to mechanical obstruction to LV inflow. Left atrial pressure increases and extends to pulmonary veins and capillaries leading to pulmonary hypertension initially reversible then fixed. The course of the disease is slowly progressive and patients with mild MS may remain asymptomatic for years. Later on, symptoms develop during exercise and conditions that increase heart rate and precipitate with the occurrence of atrial fibrillation (6).

Preoperative echocardiography is therefore mandatory to assess the mitral valve haemodynamic as anaesthesia can sometimes be very delicate in these patients (14). In some selected cases with suitable mitral valve morphology and no left atrial

thrombi, mitral balloon valvotomy may be considered. Generally, if MS is mild or moderate, noncardiac surgery can be performed under careful peri-anaesthesia care. If MS is severe, consideration should be given to postpone the planned surgery after either balloon valvotomy or mitral surgery (18).

MITRAL REGURGITATION

Isolated mitral regurgitation (MR) can be adequately detected by clinical examination but specificity is low (70%) and even lower (64%) in the presence of other VHD (5). Patients may remain asymptomatic for a long time, even with severe MR, due to a compensatory phase of increase in LV and left atrial size. The loudness of the systolic murmur does not correlate well with the severity of the MR (18, 19). Indeed, when MR becomes severe and mitral annulus dilates due to LV dilation, the loudness of the murmur can decrease, not reflecting anymore the severity of the disease.

Transthoracic echocardiography is therefore necessary, and will easily and accurately determine the mechanism of MR, allow quantification of its severity, assess LV size and function, size of the left atrium and of the right ventricle along with estimation of the pulmonary artery pressures.

Asymptomatic patients who are in sinus rhythm and who have normal LV and left atrial dimensions and normal pulmonary artery pressure may exercise without restriction (6). They should normally withstand noncardiac surgery.

If patient is symptomatic, mitral valve surgery should be considered even if LV function is normal. This can usually be done after the planned noncardiac surgery except in some patients with severe MR and LV enlargement and with severely depressed systolic function.

AORTIC REGURGITATION

Aortic regurgitation (AR) represents a condition of combined volume and pressure overload. In chronic AR, the left ventricle responds with a series of compensatory mechanisms, a phase which may last for decades, allowing the majority of patients to remain asymptomatic. Some patients may even develop asymptomatic LV dysfunction. Thorough questioning is therefore not sufficient; moreover, physical examination alone does not allow establishing the severity of the regurgitation.

Echocardiography is therefore indicated to confirm the diagnosis of AR, to assess its mechanism (aortic valve morphology, aortic root size), to evaluate or quantify its severity, and to assess the LV dimensions and LV systolic function (6). This is even more important in symptomatic patients in whom quantitative evaluation of LV function is indispensable.

Generally, even if TTE discloses a moderate to severe aortic regurgitation preoperatively, it does not justify delaying noncardiac surgery. Use of vasodilating agents under adequate monitoring during anaesthesia will reduce regurgitant volume and increase forward stroke volume. Only in some patients with severe AR and reduced LV function, will aortic valve replacement be considered before the planned noncardiac surgery.

ENDOCARDITIS PROPHYLAXIS

The presence of a structural heart disease per se does not justify ordering a preoperative TTE to establish the need for infective endocarditis (IE) prophylaxis. Routine prophylactic antibiotherapy is already applied for many types of surgery to reduce the incidence of surgical site infection and is not linked to the presence of an underlying cardiac disease (18, 20, 21). Recent guidelines consider that antibiotic prophylaxis is no longer indicated in patients with valvular heart disease such as mitral or aortic stenosis for prevention of IE (20).

In the adolescent or young adult with native heart valve disease, antibiotic prophylaxis is no longer indicated for prevention of IE. Only in selected circumstances, it is recognized that some clinicians and some patients may still feel more comfortable continuing with prophylaxis for IE provided that the risks associated with the antibiotics are low. This applies especially to patients with bicuspid aortic valve, coarctation of the aorta, severe mitral valve prolapse or HCM but it is anticipated that this attitude will change over time (20). Prophylaxis is still recommended for patients with prosthetic cardiac valves, patients with a history of IE and cardiac transplant recipients who developed VHD.

CORONARY ARTERY DISEASE

The presence and severity of coronary artery disease (CAD) is linked to perioperative and long-term morbidity and mortality. Preoperative identi-

cation of patients at high risk for cardiac events helps reducing their occurrence through therapeutic adjustments, close perioperative management and monitoring. As patients undergoing vascular surgery are known to be at high cardiac risk, some hospitals have developed a consultant-led vascular preoperative assessment clinic in order to improve patient outcome and reduce last-minute cancellations (22).

There is much to say on the topic of preoperative evaluation before noncardiac surgery. Many studies have been recently published on preoperative cardiac assessment (23), risk stratification (24) and the use of perioperative β -blockade (25).

Although the presence of segmental wall motion abnormalities (SWMA) on a resting TTE means that there is an underlying CAD, standard echocardiography has no place in the algorithm for cardiac risk assessment. Halm showed that routine preoperative TTE was not useful in predicting postoperative ischemic events and added no incremental prognostic information to predictive models that contained known clinical risk factors (26). Although low ejection fraction and wall motion score were univariate predictors of congestive heart failure (CHF) and ventricular tachycardia, such an association was no longer significant after multivariate analysis. Ejection fraction was a poor diagnostic test with limited predictive value. In that study, both the anaesthesiologists and surgeons were blind to the echocardiographic findings.

Pharmacological testing like Dobutamine stress echocardiography (DSE), aims to reproduce part of the stress the myocardium will undergo during the surgical procedure and has a good predictive and prognostic value, correlated to the extent of induced ischemia (27-29).

Appropriateness criteria for stress echocardiography have been recently published (30) and incorporate the recent guidelines on perioperative cardiovascular evaluation and care for noncardiac surgery (13). As for any general expert consensus these guidelines should be considered as recommendations and do not preclude the caring physician to exert clinical judgement in determining whether to order a test in an individual patient.

In these algorithms, non-invasive testing as DSE is to be considered after evaluation of clinical predictors and surgical risk of the planned procedure. Appropriate indications of DSE in the preoperative setting are evaluation before intermediate- or high-risk noncardiac surgery (Table 1) in patients with poor exercise tolerance and intermediate clinical risk predictors (ischemic heart disease, compensated or prior heart failure, diabetes, renal insuffi-

ciency). However these new, clinically based guidelines are already challenged (31, 32) while cardiac computed tomography could in a near future, be a modern non-invasive tool for evaluation of cardiac patients before noncardiac surgery (33).

CONGESTIVE HEART FAILURE

CHF can be due to either systolic or diastolic left ventricular dysfunction. The presence of heart failure is without any doubt an important risk factor of perioperative adverse cardiac outcomes (34) maybe even more important than CAD (35).

In a large recent study examining administrative data of 159,327 patients aged 65 and older, Hammill showed that patients with heart failure undergoing common major surgery had a significant higher risk of operative mortality and 30-day hospital readmission than other patients, including patients with CAD (36). Moreover, the presence of combined CAD and heart failure added no further risk of mortality or readmission compared to heart failure alone. In this study, no distinction was made between the systolic or diastolic nature of heart failure nor was the influence of the preoperative therapy evaluated.

The usefulness of preoperative echocardiography in patients suffering from CHD seems intuitively evident but is difficult to prove. Its added value could be in determining the severity of the underlying heart disease in high risk patients (11). The ACC/AHA clinical practice guidelines recommend the use of echocardiography for the management of any patient with suspected CHF (37, 38). Indeed, echocardiography may provide clues to the aetiology of the heart failure, may guide therapy and even assess prognosis. In a population-based study Senni showed that despite its recognized utility in the management of patients with CHF, echocardiography is underused in the community (39). Even more important is the finding that both morbidity and mortality were associated with the lack of information which could have been provided by echocardiography. Use of angiotensin-converting enzyme inhibitors was less and survival was worse in patients who did not undergo echocardiography (39).

THE FUTURE ? HANDHELD ECHO ?

Because the traditional physical examination by anaesthetists and even board-certified cardiolo-

Table 1

Cardiac risk * stratification for non-cardiac surgery

<i>High risk surgery</i>	<i>Intermediate risk surgery</i>	<i>Low risk surgery</i>
Reported cardiac risk often more than 5%	Reported cardiac risk generally 1% to 5%	Reported cardiac risk generally less than 1%
– Aortic and other major vascular surgery – Peripheral vascular surgery	– intraperitoneal surgery – intrathoracic surgery – carotid endarterectomy – head and neck surgery – orthopedic surgery – prostate surgery	– endoscopic procedures – superficial procedures – cataract surgery – breast surgery – ambulatory surgery

* combined incidence of cardiac death and nonfatal myocardial infarction. From FLEISHER L. A., *et al.* (13).

gists is somehow inaccurate, it could perhaps be ideally complemented by the use of hand-carried cardiac ultrasounds (HCU) (40). These devices are more and more miniaturized (41) and despite some technical limitations, their real-time cardiovascular imaging capabilities could assist physicians in the initial cardiovascular assessment of the patient. Such devices have proved to have a good diagnostic accuracy in the identification of global LV systolic dysfunction, LV hypertrophy and pericardial effusion and even the presence of aortic abdominal aneurysm in hypertensive elderly patients. They are less precise in assessing SWMA, right ventricular dysfunction and valvular lesions. The level of expertise of the HCU user is of major importance and poses the problems of training in performance and interpretation once such a sophisticated technique becomes widely available. When performed by physicians with expertise in TTE, at the time and as a complement of the physical examination, point-of-care echocardiography could have a promising future in shortening the time to diagnosis and even in reducing the cost of the medical diagnosis. Should its role be considered as a screening instrument, similarly to the stethoscope and hence, should patients with abnormal findings still be referred for further complete echocardiographic evaluation (42) or will HCU obviate the need for a standard TTE, the debate is still open (43).

ECONOMICS

TTE is an easily performed non-invasive diagnostic test that provides accurate information about valve anatomy, systolic and diastolic function and haemodynamic status of the patient.

Being a diagnostic test, the impact of its use on outcome is harder to assess than that of a therapeutic

agent : TTE rarely has a direct impact on patient survival (44).

However, the result of the preoperative echo could by itself influence perioperative management, leading to changes in medical therapy (b-blocking drugs or statins), to more aggressive treatment (like percutaneous coronary interventions) or to the delay or even cancellation of the planned noncardiac surgery. In a small retrospective study, O'Neill showed that targeted preoperative echocardiography using international guidelines led to a significant change in management of 4.3% of patients scheduled for moderate to high risk vascular surgery (45). But changing a diagnosis or a treatment does not always imply an economical benefit and may even result in the incurrence of new, unnecessary costs.

In Belgium, a TTE is reimbursed 65.76 € in 2008 (N104) and one patient is only entitled one echo per year in the same echo lab. Echocardiographic re-evaluation of a patient is permitted during the same year in some evolutive cardiac pathologies. A "repetition code" is used to identify such cases.

For a surgical patient, a second echo may be reimbursed the same year as a preoperative examination before cardiovascular surgery or before non-cardiac surgery at moderate or high risk if he suffers from :

- documented, asymptomatic, moderate aortic or mitral valve disease
- suspected or documented CAD
- documented cardiomyopathy or CHD
- complex congenital heart disease partially or non corrected

No specific reimbursement code exists for DSE reimbursement. Such a test is therefore retributed via a mix of echocardiography, electro-

cardiography and pharmacological testing codes. (Dr. A. Pasquet, personal communication).

CONCLUSION

Why should a skilled anaesthetist ask for a preoperative echocardiography? For patient reassurance? Or for its own? To confirm existing data? To find a new suspected or unexpected diagnosis? To evaluate the progression of a known cardiac condition?

One should ask oneself "will echocardiography and the treatment based on its findings really alter patient's outcome?" (44). Routine preoperative TTE is neither helpful nor economical (18). The anaesthetist's general physical impression of the patient's health status followed by a careful auscultation is still a valuable and cost-effective diagnostic tool (4, 46).

Asking for a transthoracic echo should be determined according to the history, the physical examination, cardiac auscultation and to the age of the patient. Before the age of 40, the probability of detecting a severe VHD is low except in presence of signs evoking possible HCM.

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