Echocardiography or auscultation?

How to evaluate systolic murmurs

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ABSTRACT

OBJECTIVE To compare cardiac physical examination with echocardiography for evaluating systolic murmurs.

QUALITY OF EVIDENCE Three databases were searched for studies comparing echocardiography and auscultation as to sensitivity and diagnostic accuracy: MEDLINE (Ovid Online), EMBASE, and Current Contents. The quality of reported data is lowered by subjective interpretation of results of both cardiac physical examination and echocardiography, especially Doppler colour flow imaging.

MAIN MESSAGE In adults, functional systolic murmurs can usually be distinguished from organic murmurs. Pathologic murmurs frequently have one or more associated clinical abnormalities. If a clinician determines a murmur is benign, results of echocardiography are very likely to be normal, especially in young and middle-aged adults. According to current guidelines, echocardiography should not be ordered for “innocent” systolic murmurs in patients who are asymptomatic and have otherwise normal findings on examination. If patients with functional systolic murmurs could be identified and not routinely referred for echocardiography, great cost savings could be realized.

CONCLUSION Echocardiography is not required for all patients with systolic murmurs and should not replace cardiac physical examination.

RÉSUMÉ

OBJECTIFComparer l'examen physique et l'échocardiographie comme moyen d'évaluer les souffles systoliques cardiaques.

QUALITÉ DES PREUVES Les études comparant l’échocardiographie et l’auscultation en termes de sensibilité et de précision diagnostique ont été répertoriées dans trois bases de données: MEDLINE (Ovid Online), Embase et Current Contents. Une interprétation subjective des résultats amoindrit la qualité des données rapportées, tant pour l'examen physique que pour l'échocardiographie, et particulièrement dans le cas du Doppler couleur.

PRINCIPAL MESSAGE Il est généralement possible de distinguer un souffle systolique fonctionnel d’un souffle organique chez l’adulte. Les souffles pathologiques s’accompagnent souvent d’une ou de plusieurs anomalies cliniques. Lorsqu’un médecin considère qu’un souffle est bénin, les résultats de l’échocardiographie risquent fort d’être normaux, notamment chez les sujets jeunes et d’âge moyen. Les directives actuelles recommandent de ne pas prescrire d’échocardiographie pour un souffle systolique « bénin » chez un patient asymptomatique dont l’examen clinique est par ailleurs normal. Le fait d'identifier les patients qui ont des souffles systoliques fonctionnels et de ne pas les diriger systématiquement en échocardiographie permettrait une réduction sensible des coûts.

CONCLUSION Il n’est pas nécessaire de prescrire une échocardiographie à tout patient qui présente un souffle systolique, et cet examen ne devrait pas remplacer l’examen physique du cœur.

This article has been peer reviewed.
Cet article a fait l’objet d’une évaluation externe.
Echocardiography or auscultation?

Although auscultation played a large role in cardiac diagnosis, widespread and increasing use of Doppler echocardiography in the past 15 to 20 years has diminished its importance. As a result, there have been parallel decreases in auscultation skills and in confidence in using them. This review will compare cardiac physical examination with echocardiography for evaluating systolic murmurs and show that echocardiography is not required for all patients with systolic murmurs.

One of the most common auscultatory findings is a systolic murmur. It occurs in more than 80% of children and up to 52% of adults. Its prevalence and importance vary widely, depending on the group studied. Benign or “innocent” systolic murmurs are relatively common. Among elderly outpatients, the prevalence of systolic murmurs ranges from 29% to 60%, and results of echocardiography are normal in 44% to 100% of cases. Some of this variability is related to varying definitions of “normal” (eg, considering age-related valve sclerosis as pathologic).

Referrals for echocardiography in the United States’ Medicare population have increased progressively. As echocardiography became widely available and more technologically advanced, great increases in use and cost followed. In the United States, the number of echocardiographic studies performed from 1986 to 1989 increased 143% and accounted for more than $126 million in Medicare expenditures. Trends were similar in Ontario: expenditures for echocardiography increased 53% from 1989 to 1992 and accounted for 36% of all health care expenditures for noninvasive cardiac diagnostic tests. Growing use of this technology is not confined to North America.

When primary care physicians hear systolic murmurs, their diagnostic options include ordering echocardiography for further assessment or doing a comprehensive clinical examination to attempt to differentiate benign (or innocent) systolic murmurs from abnormal ones.

Quality of evidence

Three databases were searched for studies comparing echocardiography with physical examination in terms of sensitivity and diagnostic accuracy: MEDLINE (Ovid Online) from 1980 to the present, and EMBASE and Current Contents from 1998 to the present. Only English articles were retrieved. MeSH terms used for MEDLINE included “echocardiography” (expanded to retrieve all varieties of echocardiography, including Doppler and transesophageal), “physical examination,” “heart auscultation,” and “heart sounds,” including “heart murmurs.” The search included sensitivity and specificity data along with diagnostic errors, clinical competence, and cost-benefit analyses.

The quality of reported data is limited by the subjective nature of the results of both cardiac physical examination and echocardiography, especially Doppler colour flow imaging. Most studies are retrospective and observational cohort studies with relatively small numbers. Also, most studies compare cardiac physical examination performed by cardiologists or cardiac fellows with echocardiography; few studies compare physical examination performed by family physicians with echocardiography. A weakness of echocardiography data, in terms of the comparison, is their qualitative, subjective nature and the fact that physicians could misinterpret the physiologic degrees of valve regurgitation as “pathologic” in otherwise healthy people.

Evidence favouring echocardiography

Even under ideal conditions, cardiac physical examination does not identify pathologic conditions accurately or correctly judge the severity of cardiac lesions. Information obtained from auscultation is subjective, depends on the examiner’s expertise, and does not result in a permanent objective recording.

It is not readily duplicated by other examiners. Its precision for examining systolic murmurs is only fair ($ statistic 0.03) in a clinical setting. Improper interpretation of auscultatory information does not necessarily arise from the inexperience or ineptitude of examiners. Even experienced clinicians disagree about heart sounds and murmurs. Certain auditory limitations (eg, insensitivity to low-frequency sounds, masking of low-intensity sounds by adjacent loud sounds) contribute to the inaccuracy.

In a structured search strategy, relevant studies analyzing systolic murmurs showed that cardiologists and senior cardiac fellows were efficient at identifying abnormal and normal murmurs, but noncardiologist examiners were not. There were very few data on the latter group.

Because cardiac physical examination is relatively crude compared with newer noninvasive diagnostic techniques and not always reliable, American Heart Association and American College of Cardiology (AHA/ACC) current guidelines

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recommend echocardiography for patients with or without symptoms “if clinical features indicate at least a moderate probability that a murmur reflects structural heart disease.” Determining that level of probability remains a challenge. These guidelines were generated by a committee who assessed the sensitivity, specificity, and diagnostic accuracy of more than 3000 studies (1990 to 1995) graded by consensus and classified according to the weight of evidence.7

The gradual degradation of auscultation skills is becoming increasingly apparent in training programs, despite efforts to preserve them by using simulation technology in medical education.8,9 A study of 314 senior internal medicine and family practice residents in several US training programs showed that only 20% of abnormal heart sounds were correctly identified from auscultatory tapes.10 Residents who received formal auscultatory training had greater confidence in their skills, but no greater accuracy.

A comparison of auscultation skills in US, Canadian, and British internal medicine trainees showed that performance was slightly better in Canada than in the United States, but was poor in all three countries.11 For practising US physicians, economic forces (ie, declining reimbursement for services) have constrained the time necessary to perform adequate physical examinations, prompting busy clinicians to truncate cardiac examinations, which leads to even further erosion of clinical skills.

Determining the cost-effectiveness of routine echocardiography for patients with systolic murmurs must include the implications of missed diagnoses when relying on physical examination alone and changes in management that result from the echocardiographic information obtained. This approach is especially important in hospitals (eg, intensive care units),3 where echocardiography could significantly reduce the rate of missed cardiac diagnoses, compared with physical examination, and significantly expedite therapy, which in turn could limit other testing and shorten hospital stays. Finally, today’s clinicians might be uncomfortable with even a modicum of diagnostic uncertainty, knowing that a safe, painless, noninvasive diagnostic test (ie, echocardiography) is readily available.

Evidence favouring comprehensive clinical cardiac assessment
Attenhofer Jost et al12 studied 100 consecutive adults (mean age, 58 years) with systolic murmurs of unknown cause. The examining cardiologists (who were blinded to history and electrocardiographic [ECG] and chest radiograph results) were asked to determine whether murmurs were functional or organic and significant or insignificant. Echocardiography was used as the reference standard. Approximately 20% of patients had functional murmurs. The sensitivity of physical examination for detecting significant heart disease was 79%. Significant heart disease was missed in only two patients (2%), both of whom had aortic stenosis. Minor, insignificant lesions that were missed by physical examination were noted more frequently. The authors concluded that, in adults, functional murmurs can usually be distinguished from organic murmurs. Whether inclusion of history and ECG and chest radiography results would have altered the outcome of clinical assessment and the results of this study is unknown.

Roldan et al13 compared auscultation with transesophageal echocardiography in 143 asymptomatic outpatients and healthy volunteers (mean age, 38 years). Prevalence of functional murmurs was 31%. Functional murmurs were correlated with low sound intensity (predominantly grade 1) and early systolic timing. Pathologic murmurs frequently had one or more associated clinical abnormalities. Of the 10 subjects with abnormal valves who had apparently normal results on clinical examination, only two (20%) had more than mild regurgitation identified by echocardiography. The valve abnormalities in eight others (80%) were of no clinical significance. Other studies4 have also shown that when clinicians determine murmurs to be benign, echocardiographic results are normal in the vast majority of instances, especially in young and middle-aged adults.1,4,14

In a retrospective review of 169 general medicine patients with systolic murmurs who were examined by noncardiologists, age, male sex, and murmur intensity of grade 3 or more were predictors (with use of a logistic regression model) of positive echocardiography results.15 In that study, if women ≤35 years with murmurs grade 2 or lower had not been referred for echocardiography, 47% of the studies could have been avoided without loss of sensitivity. The prediction model used was developed from the data but was not tested prospectively. Further studies assessing the reliability of clinical examinations, especially in primary care settings, are warranted.

Clinical evaluation of systolic murmurs includes more than just auscultation.1,11 Comprehensive clinical assessment includes clinical history to determine whether patients have symptoms. Symptomatic patients generally require additional testing; asymptomatic patients might not. The nonauscultatory
components of clinical assessment are well known (Table 1\textsuperscript{16}). So-called, dynamic auscultation, an attempt to alter loading conditions (eg, Valsalva maneuver) can be easily performed in the office or at bedside.\textsuperscript{1} Finally, as part of overall comprehensive clinical assessment, results of ECG and chest radiography should be considered. Abnormalities on ECG (eg, left ventricular hypertrophy) or chest radiography (eg, cardiomegaly) generally prompt further assessment. The advantage of integrating physical examination, ECG, and chest radiography as a diagnostic strategy has been demonstrated in patients with dyspnea.\textsuperscript{17} The incremental diagnostic usefulness of incorporating chest radiography and ECG in asymptomatic children with systolic murmurs has been questioned in some studies\textsuperscript{18} but shown to be useful in others.\textsuperscript{19}

Functional murmurs in adults have been related to aortic flow or, less commonly, pulmonary flow;

Table 1. Evaluation of systolic murmurs using comprehensive cardiac assessment\textsuperscript{16}

<table>
<thead>
<tr>
<th>History (asymptomatic vs symptomatic)</th>
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<tbody>
<tr>
<td>Auscultation</td>
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<tr>
<td>Nonauscultatory components</td>
</tr>
<tr>
<td>• Blood pressure, pulse, respiration</td>
</tr>
<tr>
<td>• Carotid pulse, jugular veins</td>
</tr>
<tr>
<td>• Precordial palpation</td>
</tr>
<tr>
<td>• Heart sounds\textsuperscript{1}</td>
</tr>
<tr>
<td>• Abdominal examination (eg, ascites)</td>
</tr>
<tr>
<td>• Extremities (edema)</td>
</tr>
<tr>
<td>Dynamic auscultation (bedside maneuvers)</td>
</tr>
<tr>
<td>Electrocardiography or chest radiography</td>
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</tbody>
</table>

\textsuperscript{1}Including pulse pressure.
\textsuperscript{1}Including clicks, ejection sounds, and splitting of \(S_2\), \(S_3\), and \(S_4\).

Table 2. Characteristics of benign (functional) systolic murmurs\textsuperscript{13}

<table>
<thead>
<tr>
<th>Grade 1-2</th>
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<tr>
<td>Early systolic</td>
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<tr>
<td>No associated diastolic murmur</td>
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<tr>
<td>No associated cardiac abnormalities (normal jugular venous pressure, carotid arteries, results of palpation; no gallop sounds, clicks, or ejection sounds; normal (S_2) splitting)</td>
</tr>
<tr>
<td>No cardiac symptoms</td>
</tr>
<tr>
<td>Normal electrocardiography and chest radiography</td>
</tr>
<tr>
<td>Carotid arteries, carotid pulse volume, and contour as assessed by palpation; jugular venous pressure and contour (inspection); palpation, precordial palpation</td>
</tr>
</tbody>
</table>

increased intraventricular systolic velocities; venous hum; and other vibratory phenomena. Clinical characteristics of functional or benign systolic murmurs are outlined in Table 2\textsuperscript{22}. After comprehensive clinical assessment, patients deemed to have functional systolic murmurs do not need to be referred for echocardiography.

In the guidelines for management of patients with valvular heart disease, an AHA/ACC task force\textsuperscript{20} recommended that:

2-D echocardiography and color flow Doppler imaging are not necessary for all patients with cardiac murmurs and usually add little but expense in the evaluation of asymptomatic patients with short, grade 1-2 systolic murmurs and otherwise normal physical findings.

Also in the guidelines for appropriate use of echocardiography, a class 3 indication (ie, echocardiography should not be ordered) includes “innocent” murmurs in asymptomatic patients who have otherwise normal examinations. If an examiner was "uncertain,” this was considered a class 2A indication (weight of evidence or opinion in favour of usefulness or efficacy) for ordering the test. A problem with this latter provision is the increasing trend to diagnostic "uncertainty” as clinical skills weaken.

Caution advised
Despite the advantages of echocardiography, primary care physicians should be aware of its limitations. Depending on the patient population studied and the experience of the echocardiography laboratory, 5% to 10% of studies remain inadequate for interpretation. The technique is operator-dependent, in terms of both data acquisition and interpretation. Results might be hard to reproduce. Criteria for age-related valve changes are not standard, and grading of severity of valve regurgitation by colour flow imaging remains qualitative, subjective, and unreliable. (Quantitative echocardiographic techniques are being introduced but have not yet become standardized, except in tertiary care centres or research laboratories.) Finally, the incidence of diagnostic error is high in echocardiography performed on children in community-based adult echocardiography laboratories.\textsuperscript{21}

Glimpse into the future
With requisite background training in echocardiography, cardiologists using miniature, point-of-care ultrasound devices can improve diagnostic accuracy.\textsuperscript{22} Ultrasound-assisted physical examination by primary
care physicians is also being evaluated. Small, portable, hand-held cardiac ultrasound devices are undergoing clinical testing, ostensibly as an extension of physical examination, but they could become the stethoscope of the future. If they do, ultrasound techniques will need to be taught in medical school. Initial experience with, and reaction to, echocardiography as a teaching tool for medical students has been positive.

**Conclusion**

Time constraints on busy clinicians and the lure of noninvasive technology have contributed to the erosion of clinical skills and the declining importance of clinical cardiac examination. For systolic murmurs, careful clinical assessment can reduce costs by reducing unnecessary testing. If patients with functional systolic murmurs can be identified and not routinely referred for echocardiography, substantial cost savings can be realized. Cardiac examination should remain the first-line diagnostic tool of every clinician; echocardiography should not replace it. Echocardiography should be considered, however, when examiners are uncertain about results of clinical examination or if they suspect a significant cardiac abnormality.

The future will decide whether the binaural stethoscope becomes a museum relic like its predecessor, the monaural stethoscope of more than a century ago, or remains a valid, useful clinical diagnostic tool.

**Competing interests**

None declared

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**References**


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**Editor’s key points**

- Despite a decrease in auscultation skills that parallels an increased reliance on echocardiography to assess heart murmurs, functional murmurs can usually be distinguished from pathologic murmurs by clinical examination.
- Functional murmurs are usually early in the systole and low in intensity (grade 1).
- If a murmur is judged functional in young or middle-aged adults with no other symptoms or signs, echocardiography is unnecessary.

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**Points de repère du rédacteur**

- Malgré le fait que les médecins soient de moins en moins habiles à l’auscultation alors qu’ils se fient davantage à l’électrocardiographie pour évaluer les souffles cardiaques, il est néanmoins possible de distinguer les souffles fonctionnels des souffles pathologiques à l’examen physique.
- Les souffles fonctionnels s’entendent généralement tôt dans la systole et leur intensité est faible (grade 1).
- Quand un souffle est jugé fonctionnel chez un sujet jeune ou d’âge moyen sans autres signes ou symptômes, l’électrocardiographie n’est pas nécessaire.