SHORT REPORT

Comparison of transthoracic echocardiography with harmonic imaging with transoesophageal echocardiography for the diagnosis of patent foramen ovale

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The optimal diagnostic method for patent foramen ovale is currently unclear. This study compared bubble contrast second harmonic transthoracic (TTE) and transoesophageal echocardiography (TOE) on 87 consecutive patients referred for TOE for all indications. A right left shunt was diagnosed in 34 cases (39%), with TTE positive in 26 cases (sensitivity 76.5%), TOE positive in 27 cases (sensitivity 79.4%). Pitfalls of TTE included quality of echo and left sided valve lesions, and for TOE the ability to perform an adequate Valsalva manoeuvre. In conclusion, both tests have similar sensitivity and should be viewed as complementary modalities.

The diagnosis of patent foramen ovale (PFO) is becoming increasingly important with the recognition of its association with cryptogenic stroke,¹ migraine,² potential for paradoxical embolisation, and the availability of options for device closure of PFOs. The optimal method for detecting PFOs, however, remains controversial with authors holding strong but diametrically opposite views on the superiority of bubble contrast transthoracic (TTE)³ and transoesophageal echocardiography (TOE).⁴ Transmitral Doppler has also been suggested to be superior to 2-D TTE for the detection of bubbles crossing into the left heart.⁵ Previous comparisons of TTE and TOE have historically shown TOE to be superior,⁶ although more recent trials have shown similar outcomes for TOE and TTE, with neither method able to correctly identify all patients, and a larger study showing a small superiority for TTE.^{7,8} Possible pitfalls for the two methods may include image quality for TTE, which has improved substantially with modern machines offering second harmonic imaging, and the inability to perform an adequate Valsalva manoeuvre to induce right-left shunting during TOE. We have performed a comparison of the two diagnostic methods with particular reference to these potential pitfalls.

METHODS

Consecutive patients referred for TOE for all indications underwent initial imaging by TTE for the detection of a PFO using a Hewlett Packard Sonos 5500 with second harmonic imaging. Imaging was performed in the apical four chamber view, with injection of 10 ml of agitated saline (9 ml saline, 0.5 ml blood, 0.5 ml air repeatedly agitated through a three way tap), which achieved opacification of the right heart in all cases. The first injection was performed at rest, with three subsequent injections performed with Valsalva, coughing, and hepatic manual compression, all of which are commonly used in clinical practice to increase right atrial pressure. The presence of a PFO was determined by the presence of bubbles in the left heart within five cardiac cycles and was classified as small (0–10 bubbles), moderate (10–50), or large (>50).

The occurrence of bubbles after five cardiac cycles was classified as attributable to an intrapulmonary shunt. TOE was then performed under local anaesthesia and sedation with midazolam, and the procedure repeated as for TTE with the interatrial septum imaged in the 110–130° plane. Image quality and quality of the dynamic manoeuvres was graded as good, fair, or poor. TTE and TOE was performed by independent, blinded operators.

RESULTS

The study population comprised 87 patients, 39 (45%) male, mean age 55 years (range 22–80). The indication for TOE was to detect a shunt or a cryptogenic stroke in 22 cases (25%). The mean dose of midazolam used was 3.5 mg.

A right-left shunt was diagnosed in 34 cases (39%), with most of these being attributable to a PFO, although two cases had a true atrial septal defect. No cases of intrapulmonary shunting were detected. Neither TTE nor TOE detected all right-left shunts. TTE was positive in 26 cases, with a sensitivity of 76.5%. TOE was positive in 27 cases, with a sensitivity of 79.4%. Of the eight cases missed by TTE, one had a poor echo window and three had moderate or severe mitral regurgitation, with no complicating factors in the remaining four. Of the seven cases missed by TOE, five had poor or fair quality dynamic manoeuvres. TOE also diagnosed 4 of 87 (4.6%) interatrial septums as being aneurysmal.

The size of the shunt was classified by TTE as small in 36%, moderate in 36%, and large in 28%. Shunt size by TOE was classified as small in 47%, moderate in 35%, and large in 18%. For TTE, most positive cases were diagnosed either at rest or with the Valsalva manoeuvre, with cough producing a shunt in 58% of positive cases and manual hepatic pressure only 8%. For TOE, 67% of positive cases were diagnosed either with bubble contrast at rest or on colour flow Doppler. The Valsalva manoeuvre produced a shunt in 24% of positive cases, cough in 59%, and manual hepatic pressure only 6%.

DISCUSSION

In this consecutive series, an atrial shunt was detected in 39% of cases, which is substantially higher than the incidence of PFO in the general population of 27.3%. This is probably because of the high proportion (25%) in our series in whom the requirement for TOE was suspicion of a shunt or cryptogenic stroke. Neither TTE nor TOE was able to detect all of these cases, and had similar sensitivity of 77%–79%. These findings are similar to those of Clarke *et al.*,⁷ although in another modern series the sensitivity of TTE with second harmonics was over 90%.⁸

The main pitfalls of TTE in this series were image quality and left sided valve lesions (in this case MR) probably

Abbreviations: TTE, transthoracic echocardiography; TOE, transoesophageal echocardiography; PFO, patent foramen ovale

Learning points

- Patent foramen ovale can be diagnosed by bubble contrast TTE and TOE on modern echo machines with a sensitivity of about 80%.
- Pitfalls of TTE include quality of the echo window and the presence of left sided valve lesions.
- Pitfalls of TOE predominantly relate to the ability to perform a dynamic manoeuvre to raise right atrial pressure.
- For TTE Valsalva manoeuvre is the optimal dynamic manoeuvre, while for TOE cough but not manual hepatic pressure is an acceptable alternative.

because of the increase in left atrial pressure caused by MR making it more difficult to produce a right-left shunt after a Valsalva. However, in 50% of the TTE false negative cases, no obvious cause for the diagnostic inaccuracy was apparent. In contrast, the main pitfall of TOE seems to be the ability to perform a dynamic manoeuvre to increase right atrial pressure while under sedation. In this situation, a cough seems to be more useful than the Valsalva manoeuvre, possibly as it is easier for the patient to perform, while manual hepatic pressure produces a positive result in few cases. It has been also suggested that bed tilting might be an alternative dynamic manoeuvre to raise right atrial pressure, with the potential advantages of not requiring patient cooperation and of being more standardised.⁹

In summary, for the diagnosis of PFO neither bubble contrast TTE with second harmonic imaging nor TOE was more than 80% sensitive, and the two tests should be seen as complementary rather than conflicting modalities. TTE is best performed with a Valsalva manoeuvre, but a cough may be a preferable manoeuvre to increase right atrial pressure for a

sedated patient undergoing TOE. Manual hepatic pressure is not an alternative to either of these and should be avoided.

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