CASE REPORT

Right heart catheterisation may be cautiously performed through a mechanical valve prosthesis in the tricuspid position

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SUMMARY

Right heart catheterisation (RHC) may be performed through a mechanical valve prosthesis in the tricuspid position using a partially inflated pulmonary artery flotation catheter. Preprocedural preparation should include an ex vivo trial with an identical valve prosthesis and the type of catheter to be used for the procedure. The operator should expect immediate unloading of the right ventricle due to catheter-associated tricuspid regurgitation, but it is possible to estimate pulmonary vascular resistance using the Fick principle. The risk of catheter entrapment or damage to the prosthetic leaflets during the procedure is likely to be low. This risk may be acceptable to the clinician and the patient if pulmonary vascular resistance must be measured in order to determine eligibility for heart transplantation.

BACKGROUND

Conventional wisdom states that right heart catheterisation should not be undertaken in patients with a mechanical valve prosthesis inserted in the tricuspid position due to the risk of catheter entrapment, damage to the prosthetic valve leaflets and valve thrombosis. All patients referred for heart transplantation must undergo right heart catheterisation to measure pulmonary vascular resistance and determine whether heart transplantation may be safely undertaken.¹ The presence of a mechanical valve prosthesis in the tricuspid position may therefore act as a barrier to heart transplant assessment. We describe a case in which right heart catheterisation was successfully performed through a mechanical tricuspid valve prosthesis and outline important considerations during the procedure.

CASE PRESENTATION

A 50-year-old man with hypertrophic cardiomyopathy was referred for heart transplant assessment. He had previously undergone mitral valve replacement with a 33 mm St Jude Master Series mechanical prosthesis and tricuspid valve replacement with a 35 mm St Jude Master Series mechanical prosthesis. There were multiple markers of a poor heart failure prognosis, sufficient to justify listing for heart transplantation. Transthoracic echocardiography showed a mechanical prosthesis in the tricuspid position with no significant regurgitation and no significant pulmonary regurgitation. As such, it was not possible to estimate the pulmonary artery systolic pressure, nor the pulmonary vascular resistance, by non-invasive assessment.

INVESTIGATIONS

We performed an ex vivo trial using a pulmonary artery (PA) flotation catheter and a 35 mm St Jude mechanical prosthesis (figure 1). We determined that if the PA catheter passed through either lateral lumen of the bileaflet mechanical prosthesis, then only one leaflet would be prevented from closing while the catheter was across the prosthesis and the catheter could be withdrawn with minimal risk to the valve leaflets. However, the PA catheter should avoid the central lumen of the mechanical prosthesis because both leaflets would be jammed opened while the catheter is across the prosthesis and catheter entrapment is more likely at the time of withdrawal. Partial inflation of the balloon with 0.75 mL of air meant that the PA catheter tip was too large to pass through the central lumen of the prosthetic valve, but could selectively pass through either lateral lumen of the prosthetic valve.

The procedure was performed without interruption of anticoagulation. A 7 French sheath was placed in the right internal jugular vein under ultrasound guidance. A PA catheter was placed in the right atrium and the balloon was inflated with 0.75 mL of air (figure 2). Under fluoroscopic guidance, the PA catheter was passed through the mechanical tricuspid valve prosthesis and into the right ventricle. The patient developed chest tightness and palpitations almost immediately after the PA catheter had crossed the tricuspid valve. There was frequent ventricular ectopy and his arterial blood pressure fell from 103/69 mm Hg to 82/54 mm Hg.

We quickly measured right heart pressures. The mean PA pressure was 25 mm Hg and the mean pulmonary capillary wedge pressure was 18 mm Hg, giving a transpulmonary pressure gradient of 7 mm Hg. The PA oxygen saturation was measured in order to determine cardiac output by the Fick principle. The Fick estimate of pulmonary vascular resistance was 1.97 Wood units. With the balloon completely deflated, the PA catheter was carefully withdrawn back across the tricuspid valve prosthesis. The total length of time for which the PA catheter was across the mechanical prosthesis was around 2 min. The chest tightness, palpitations and ventricular ectopy settled immediately after catheter withdrawal.

OUTCOME AND FOLLOW-UP

A repeat transthoracic echocardiogram after the procedure showed normal function of the prosthetic tricuspid valve, with no evidence of damage

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Figure 1 Ex vivo demonstration of partially inflated PA flotation catheter selectively passing through the wide lateral lumen, but not the narrow central lumen, of a 35 mm St Jude mechanical prosthesis in the tricuspid position.

to the valve leaflets. Having determined that pulmonary vascular resistance is acceptable, the patient has been enrolled onto the waiting list for heart transplantation.

DISCUSSION

We have shown that right heart catheterisation with a PA flotation catheter may be performed through a mechanical tricuspid valve prosthesis when it is essential to obtain information about pulmonary vascular resistance. Prior to the procedure, it was instructive to conduct an ex vivo trial with the specific size/type of mechanical valve prosthesis and the PA flotation catheter that will be used during the procedure. This will allow the operator to appreciate the potential for catheter entrapment and determine how much air should be placed into the PA flotation catheter in order to prevent passage through the central lumen of the prosthesis.

The operator should expect immediate catheter-induced tricuspid regurgitation during the procedure. This phenomenon will unload the right ventricle. Forward flow into the pulmonary artery, transpulmonary blood flow and left atrial filling will decrease. Pulmonary artery pressure and pulmonary capillary wedge pressure are likely to fall resulting in an underestimation of the transpulmonary pressure gradient, compared with the normal physiological situation. However, pulmonary vascular

resistance should not be affected because this measurement is independent of small changes in cardiac output.² We elected to estimate cardiac output by the Fick principle, rather than by thermodilution, because of the unreliability of the thermodilution technique in the presence of significant tricuspid regurgitation induced by the catheter.³ In addition, we wished to minimise time with the catheter across the prosthesis because of patient discomfort, frequent ventricular ectopy and hypotension. However, one has to allow sufficient time for the PA oxygen saturation to settle following the change in haemodynamics associated with catheter-associated tricuspid regurgitation, in order to ensure accurate Fick estimation of cardiac output.

There have been several reported cases of right heart catheterisation in patients with a mechanical tricuspid valve prosthesis. In the first case series, right heart catheterisation was performed through a ball-cage mechanical tricuspid prosthesis without complications.⁴ Ball-cage prostheses are likely to be less susceptible to catheter-induced complications due to absence of a hinge and leaflets. In the second reported case, the operator avoided the mechanical tricuspid prosthesis by performing direct puncture of the right ventricle from the chest wall.⁵ This approach allows right heart catheterisation in the absence of catheter-induced tricuspid regurgitation, but we felt that the risk of tamponade at the time of sheath removal was unacceptably high in an anticoagulated patient. In the third reported case, a bileaflet mechanical tricuspid prosthesis was crossed with a guide wire, followed by a deflated PA catheter.⁶ We modified this technique because the guide wire could become entrapped in the hinge mechanism of the mechanical leaflets and potentially guide the PA catheter through the central lumen of the mechanical prosthesis where it would interfere with both leaflets.

Our favourable experience with this single case does not indicate that the procedure is risk free. It is uncertain whether right

Figure 2 Fluoroscopy of partially inflated PA flotation catheter positioned in the right atrium prior to passage through a 35 mm St Jude mechanical prosthesis in the tricuspid position.

Learning points

- ▶ Right heart catheterisation may be performed through a mechanical tricuspid valve prosthesis using a pulmonary artery flotation catheter.
- ▶ The operator should expect instantaneous catheter-induced tricuspid regurgitation, but it remains possible to estimate pulmonary vascular resistance by the Fick technique.
- ▶ The risks of right heart catheterisation through a mechanical tricuspid valve prosthesis are impossible to quantify, but the procedure may be justified if required to determine eligibility for heart transplantation.

heart catheterisation can be safely performed with other types of mechanical prosthesis and whether it would be less well tolerated in patients with significant pulmonary hypertension. Clinicians who wish to attempt this procedure should consider the limitations of right heart catheterisation in the presence of catheter-induced tricuspid regurgitation, be aware of potential complications of the procedure and have surgical support available in the event of a serious mechanical problem.

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REFERENCES

- 1 Costanzo MR, Augustine S, Bourge R, *et al*. Selection and treatment of candidates for heart transplantation. A statement for health professionals from the Committee on Heart Failure and Cardiac Transplantation of the Council on Clinical Cardiology, American Heart Association. *Circulation* 1995;92:3593–612.
- 2 Callan P, Clark AL. Right heart catheterisation: indications and interpretation. *Heart* 2016;102:147–57.
- 3 Heerdt PM, Pond CG, Blessios GA, *et al*. Inaccuracy of cardiac output by thermodilution during acute tricuspid regurgitation. *Annals Thorac Surg* 1992;53:706–8.
- 4 Bristow JD, Kloster FE, Herr R, *et al*. Cardiac catheterization studies after combined tricuspid, mitral, and aortic valve replacement. *Circulation* 1966;34:437–47.
- 5 Gibson MA, Carell ES. Direct right ventricular puncture for hemodynamic evaluation of a mechanical tricuspid valve prosthesis: a new indication for an old procedure. *Cathet Cardiovasc Diagn* 1997;42:278–82.
- 6 Lairez O, Delmas C, Boudou N, *et al*. Should right heart catheterization be realized in patients with a mechanical tricuspid valve? *Intervent Cardiol* 2013;5:275–7.

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