Case Report

Tricuspid valve Swan-Ganz catheter entrapment before cardiac surgery

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Summary

A Swan-Ganz catheter during cardiac surgery offers peri-operative haemodynamic monitoring, although insertion of these catheters is not without risk. We report a case of Swan-Ganz catheter entrapment within the tricuspid valve during elective off-pump coronary artery bypass surgery. The diagnosis was made immediately by transoesophageal echocardiography, thus preventing forced withdrawal of the catheter. Intra-operatively, the echocardiographically detected findings of complex entrapment was confirmed. The Swan-Ganz catheter was tightly wrapped around the subvalvular apparatus, requiring on-pump open surgical removal. This case illustrates the anatomical complexity of such a catheter entrapment around the tricuspid valve apparatus and the importance of rapid echocardiographic diagnosis to prevent iatrogenic damage.

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Introduction

A Swan-Ganz catheter allows continuous monitoring of cardiac output, along with pulmonary artery pressure, oxygen delivery and consumption. Such measurements can be helpful for diagnostic and therapeutic decisions in complex patients. As well as specific surgical techniques such as enucleation of the heart during off-pump coronary artery bypass graft surgery. A Swan-Ganz catheter is inserted percutaneously in the internal jugular vein or subclavian vein and then, after passing through the right atrium and the tricuspid valve, is advanced into the pulmonary artery under continuous pressure monitoring. A rare and serious complication of this procedure is entrapment of the Swan-Ganz catheter in the tricuspid valve or in its subvalvular apparatus. We present a case which illustrates the underlying anatomical complexity of this complication and the importance of its rapid detection in order to avoid secondary damage to the tricuspid valve.

Report

A 56-year-old man with symptomatic severe triple vessel coronary artery disease was admitted for an elective off-pump coronary artery bypass grafting. Pre-operative transthoracic echocardiography showed normal biventricular function and no valvular disease or dysfunction.

Standard monitoring was applied before induction of general anaesthesia with midazolam, propofol and sufentanil. Neuromuscular blockade was achieved with cisatracurium, following which a tracheal tube was inserted. Invasive arterial blood pressure monitoring was then established by arterial cannulation (Seldicath® 3 Fr 8 cm, Prodimed, Le Plessis Bouchard, France) of the left femoral artery. A triple lumen central venous catheter (Arrow®, Arrow International, Reading, Pennsylvania, USA) and

an 8.5 Fr 10 cm introducer sheath (Arrow®, Arrow International, Reading, Pennsylvania, USA) were then inserted in the right internal jugular vein under ultrasound guidance. Using continuous pressure waveform analysis, a Swan-Ganz catheter (Swan-Ganz CCOmbo V® 8F, Edwards Lifesciences, Irvine, California, USA) was inserted through the introducer sheath and advanced into the right ventricle. However, further advancement into the pulmonary artery was unsuccessful despite repeated attempts with the Swan-Ganz catheter withdrawn into the superior vena cava before each new attempt. Only right ventricular pressure could be measured. After the third attempt, the anaesthetist noticed a new resistance upon trying to withdraw the catheter. Pressure curve analysis indicated that the Swan-Ganz catheter was blocked and thus further manipulation was avoided to prevent possible damage to cardiac or extra-cardiac structures.

A transoesophageal echocardiography probe was inserted and a complete examination of the cardiac structures was undertaken. The mid-oesophageal four-chamber view and the right ventricular inflow-outflow view showed a mobile hyperechoic mass in the tricuspid valve plane and a new significant valve insufficiency. A more detailed view of the right heart cavities, the tricuspid valve and its subvalvular apparatus in the transgastric right ventricular inflow view showed that the Swan-Ganz catheter entered the right atrium via the superior vena cava, crossed the tricuspid valve and looped around several chordae. The resulting tricuspid valve insufficiency was judged to be moderate upon subjective assessment of the regurgitating jet using colour flow Doppler and the absence of systolic inversion in the hepatic venous flow pattern (Fig. 1A). There was no echocardiographic evidence of a tricuspid valve leaflet defect or chordal rupture, however, a leaflet perforation could not be excluded.

The surgical strategy was changed to on-pump cardiac surgery to provide direct access to the tricuspid valve. After full heparinisation with 300 IU.kg⁻¹ of unfractionated heparin, the aorta and both caval veins were selectively cannulated and cardiopulmonary bypass was started. After aortic cross-clamping and cardioplegic cardiac arrest, the right atrium was opened, allowing the tricuspid valve and the subvalvular apparatus to be inspected. The Swan-Ganz catheter was tightly wrapped around the chordae of the valve creating a tension on the subvalvular apparatus that was responsible for the new tricuspid valve regurgitation (Fig. 1B). Even through this direct open surgical approach the Swan-Ganz catheter could not be untangled. Instead the catheter had to be cut into several pieces before it could be successfully removed. Following meticulous inspection of the tricuspid valve to exclude any damage, the right atriotomy was closed and the planned coronary artery bypass grafting procedure was undertaken successfully.

Transoesophageal echocardiography performed after weaning the patient from cardiopulmonary bypass showed no residual tricuspid regurgitation and normal leaflet motion. The patient was informed of the intra-operative events and subsequent change in surgical plan. His postoperative hospital stay was uneventful and he was discharged home after 10 days.

Figure 1 (a) Colour-flow Doppler mid-oesophageal inflow-outflow view of the right ventricle shows a new, at least moderate regurgitation of the tricuspid valve. (b) The intra-operative view of the tricuspid valve via the right atriotomy shows entrapment of the Swan-Ganz catheter around the chordae of the anterior (arrow 1) and posterior (arrow 2) tricuspid leaflets. The middle part of the Swan-Ganz catheter (with the thermistor wire – white star) seems to cross the tricuspid valve correctly whereas the distal part (black star) is looping back into the right atrium.

Discussion

The pulmonary artery catheter, also known as an Swan-Ganz catheter, has remained a popular monitoring instrument among cardiac anaesthetists since its introduction in 1970 [1]. Although the use of the Swan-Ganz catheter in cardiac surgery is evaluated differently, in a survey conducted by Judge et al. 68% of cardiac anaesthetists reported using an Swan-Ganz catheter frequently for cardiopulmonary bypass surgery [2]. Interestingly, there was a 45% recorded usage rate for Swan-Ganz catheter monitoring during minimally invasive cardiac surgery and off-pump coronary artery bypass grafting [2, 3]. In contrast, only 3.5% of cardiac anaesthetists did not use an Swan-Ganz catheter at all [2]. The American Guidelines for myocardial revascularisation (ACCF/AHA 2011) specify in this context that *"placement of a pulmonary artery catheter may be reasonable in clinically stable patients undergoing coronary artery bypass grafting after consideration of baseline patient risk, the planned surgical procedure, and the practice setting"* [4]. Furthermore, transoesophageal echocardiography, which in addition to haemodynamic monitoring also allows direct intra-operative assessment of ventricular function, regional wall motion and valve function, is also recommended for cardiac surgery [4]. In the survey conducted by Judge et al., transoesophageal echocardiography, was used alone in 94% of on-pump coronary artery bypass grafting and in 90.6% of all off-pump coronary artery bypass grafting procedures [2]. transoesophageal echocardiography, used a complementary monitoring tool to an Swan-Ganz catheter by 97.9% of survey respondents [2].

Despite the lack of specific recommendations, off-pump coronary artery bypass grafting surgery may still be an optimal indication for dual use of an Swan-Ganz catheter and transoesophageal echocardiography, as haemodynamic monitoring and subsequent patient management by anaesthetists is crucial for the feasibility and success of the operation. particularly during the haemodynamically critical phase of cardiac enucleation [5]. This may be necessary for direct access to the distal right and circumflex coronary arteries including their lateral branches. A Swan-Ganz catheter may provide the only available haemodynamic parameters by measuring pulmonary artery pressure and determining cardiac output. Due to air interference and strong distortion of the cardiac axis, transoesophageal echocardiography, is of very limited, if any use. Finally, as the present case demonstrates, the combination of both techniques allowed detection of a complication which would not have been diagnosed immediately without transoesophageal echocardiography.

Use of an Swan-Ganz catheter is not without risk. A rare, yet possible complication is entrapment in the tricuspid valve chordae during positioning. This was first described in a case report from 1976 [6]. Since then, few other case reports have been published. However, two subsequent case reports describe percutaneous Swan-Ganz catheter removal, in which both chordae and papillary muscle ruptures have been observed [7, 8]. The present case visually depicts the complexity of the Swan-Ganz catheter entrapment. The intra-operative view exemplifies why any attempt to advance or even forcibly withdraw the catheter under these conditions can lead to a further tightening of an existing loop, with the catastrophic consequences mentioned above [6–8].

Surgical Swan-Ganz catheter complications associated with cardiac interventions have also been described. These are mainly accidental catheter entrapments near various suture sites [8]. According to a proposed algorithm by Rupert et al., a serious complication should always be considered as soon as resistance is encountered when pulling the catheter after cardiac surgery [9]. Additionally, position of the Swan-Ganz catheter before sternal closure should also be echocardiographically clarified to detect a complication at an early stage, ideally before sternal closure. If this has not been done, or if Swan-Ganz catheter entrapment occurs in a non-surgical context, then a percutaneous approach for endovascular catheter removal remains an option [7, 10]. In this technique, a guidewire is advanced through femoral venous access into the right atrium, through which various endovascular devices (e.g. a loop or clamp) can be inserted under fluoroscopic guidance [10]. This may help release the Swan-Ganz catheter, but is unlikely to succeed with tight knots. In this case, endovascular cutting with subsequent removal of several small parts will be necessary. As reported above, this can increase the risk of tricuspid valve damage, which may require its subsequent surgical repair or even prosthetic replacement [7, 8].

In conclusion, a Swan-Ganz catheter remains an effective haemodynamic monitoring device and can be used in conjunction with transoesophageal echocardiography, in cardiac surgery. Serious life-threatening complications can result from Swan-Ganz catheter entrapment around the tricuspid valve apparatus. Surgical removal of a trapped catheter can be challenging and highly complex. We recommend other clinicians have a high index of suspicion for Swan-Ganz catheter entrapment in the tricuspid valve apparatus in cases of unsuccessful Swan-Ganz catheter positioning, abnormal pressure measurements and any resistance that occurs when trying to withdraw the catheter.

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