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Sudden Death from Left Atrial Pressure Line Wedging into Cardiac Valve Prosthesis: Pathologic Findings and Forensic Significance

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Summary. The case of a sudden death from late valve entrapment of a left atrial pressure monitoring line not removed postoperatively is considered from both biomechanical and pathological points of view because of its forensic significance in terms of malpractice liability.

Key words: Left atrial catheter complications – Cardiac valve malfunction – Sudden death

Zusammenfassung. Eine 37 Jahre alte Frau verstarb plötzlich 3 Jahre nach Implantation einer künstlichen Herzklappe in Mitralposition; todesursächlich ware eine Blockade der Kippscheibe der Björk-Shiley-Klappe durch einen nach der Herzoperation im linken Vorhof belassenen Druckmeß-Katheter. Dargestellt werden die morphologischen Befunde und die Biomechanik der akuten Klappendysfunktion. Unter dem Aspekt der ärztlichen Fahrlässigkeit werden die medizinischen Begründungen für den Verzicht auf eine operative Entfernung des Katheters unter Berücksichtigung der Literatur über seltene ähnliche Fälle diskutiert.

Schlüsselwörter: Plötzlicher Tod, Herzklappenprothese – Herzklappenprothese, Verlegung durch Katheterspitze – Arzthaftung, Herzklappenoperation

Introduction

Surgical placement of a temporary venous catheter for left atrial pressure monitoring is a common procedure to evaluate left ventricular performance

after cardiac surgery, also useful to rapidly infuse locally active cardiac medications [1].

From this point of view it performs better than the less invasive pulmonary wedge-pressure monitoring system (Swan et al. [2]), which does not allow direct infusion of cardioactive drugs, although pressure readings are fairly close to actual left atrial values. Those values correlate to cardiac performance because of the close relation between left atrial and ventricular end-diastolic pressures, provided no valvular gradients are present.

Left ventricular postoperative monitoring is vital since early pump instabilities often occur after cardiopulmonary bypass.

As soon as reliable hemodynamic function is achieved and acute infusion of cardioactive drugs is no more required, the monitoring line is withdrawn by traction on its distal end, carefully watching for its integrity and possible bleeding from the small left atrial opening, which usually subsides with in minutes. In case of hemorrage, surgical revision and hemostasis is indicated.

Case Report

On April 1, 1982, a 37-year-old white woman underwent surgical replacement of her stenosed 4-year Angel-Shiley bioprosthesis with a Bjork-Shiley No. 29 mitral valve.

During surgery, after cardiopulmonary bypass, a Vygon 135-17 venous catheter was routinely inserted into the left atrium: monitoring of left atrial pressure was started and continued in the Intensive Care Unit until day 2 p.o. At that time, since the removal of the venous line proved impossible, a decision was taken to cut the catheter below skin level and leave it in place, assuming that even a minor surgical revision might have been dangerous for the slowly recovering patient.

After leaving the hospital on April 15, all cardiologic check-ups showed her good general conditions under cardioactive and anticoagulant therapy. On March 18, 1985, during a routine check, she suddenly lost consciousness and died almost immediately of an intractable bradyarrhythmia.

At autopsy, upon opening the heart, the prosthetic mitral valve was found closed with jamming of the tilting disk by the compressed and bitten tail of the atrial catheter, which entered the ventricular cavity for 15 mm; along its distal course, a non absorbable suture on the atrial wall prevented its withdrawal.

Discussion

Only one occurrence, by Bechara et al. in 1984 [3], in a small number of reported cases, is similar to the one we are dealing with. Those authors reported a left atrial pressure line interfering with the disk of a Bjork-Shiley mitral valve, causing sudden death of a 14-year-old boy. Difficulties had been encountered in removing the venous line 6 months earlier, but the event was impredictable because of the radiolucency of the catheter, whose complete withdrawal was appearently presumed. The authors observed that interference can only ensue with a mechanical prosthesis (a biologic one would have had cusps), when the decrease of left atrial size allows the catheter's tip to reach the valvular orifice.

They recommend to remove any retained catheter in case of mechanical prostheses; in the absence of such a device, the risk/benefit consideration should be taken of a possible cardiopulmonary bypass against the incidence of other complications.

Some of these have been pointed out by Rejes et al. in 1973 [4]: they report of a Serratia marcescens bacteremia from a left atrial line after mitral valve replacement. After having diagnosed a valvular endocarditis, evidence was found at surgery that a catheter's fragment was the source of the bacteremia: the authors suggest to check for such fragments, before deciding valve replacement and alert that tying too strictly a purse around a catheter might cause difficulties at removal. Robles de Medina et al. reported in 1977 [5] on drawing, in an asymptomatic patient, of a similar fragment of catheter, by a modified ureteral stone catcher.

In those cases the catheter was rather ignored than abandoned; about this occurrence, Win et al. [6] suggested in 1980 to document with echocardiography any left atrial remnant; in their experience, surgical retrieval of a left atrial line, sutured at the pericardium, had been mandatory.

Behl and Brown in 1983 [7] recommend sharp tractions over distal ends of catheters rather than steady slow pullings that may dangerously stretch their viscous elastic bodies.

In 1984, the same authors [8] supported the use a mediastinoscope to recover a retained catheter to prevent recurrent bacteremia, thrombus formation, or disk prostheses immobilization.

Since the mechanism of the prosthesis is critical in case of wedging of a venous catheter, its description is useful for a better understanding of the accident.

The prosthetic mitral valve is a mechanic device, studied by Viking O. Bjork and manufactured by Shiley Inc., Irvine, Ca., USA, with a tilting vitreous-carbon disk (Pyrolite-Carbomedics Inc.), held in a metallic ring-like structure (Stellite-Cabot Co.), which is sutured to the fibrous remnants of the explanted natural valve thorough a ring of syntetic fabric (Teflon-DuPont). This valve has been extensively implanted [9] since January 19, 1969, when it was first used in cardiac surgery [10].

The disk pivotes, according to atrioventricular differential pressure, along a chord so that the valvular orifice has a major and a minor opening. Both the angle, between 0 and 60–70 deg, and the opening direction are crucial to unobstructed flow.

Since its clinical appearing, the Bjork prosthesis received some mechanical updatings: from a Delrin disk and 50 deg opening, to the vitreous carbon disk (1971) and 60 deg opening, originally with a conic and after 1975 with a spheric profile. Models after 1976 have radio-opaque concave-convex disks and still open up to 60 deg. A disk opening of 70 deg was obtained in a small series in 1980, with an unfortunate outcome due to fatigue breaks in the metallic structure. Ultimate in hemodynamic performance is the 1982 "monostrut" model with a more mobile disk, opening up to 70 deg, and a satellite structure carved into final form by molecular erosion systems.

The tolerance [11] between valvular orifice and tilting disk is of paramount importance: its value (0.0635 mm) accounts for efficent flushing of the pros-

thesis to prevent blood clotting, for silencing the operation and for reducing hemolysis, and was indicated by Browdie et al. [12] in 1978 as critical to the possibility of wedging a vascular catheter. The authors excluded, at least experimentally, chances of blocking the disk in Bjork-Shiley valves, but admitted it for the Lillehey-Kaster models.

This was, of course, not true in our present case, but the very first notes in literature about jamming of a Bjork-Shiley prosthesys did not appear until 1983 [3]. This fact is particularly meaningful from a forensic point of view, since at surgery (1982) this complication was not to be expected, but at the time of death (1985), it should already have come to the operators' attention.

The peculiarity of the case rises some unusual considerations. First of all, the literature before 1982 warned of too tight a suture of the catheter that might prevent its withdrawal: in our case, the proximate cause of the failure at removal was entirely the suture made of non reabsorbable material. Surgical sutures can be reabsorbable and non reabsorbable according to the components that, if reabsorbable, lisate in approximately 10 or 20 days [13]. Had the left atrial catheter been fixed with a reabsorbable suture, it could have been successfully retrieved after a short time, less than the time needed for atrial volume reduction and for the catheter tip to reach the valve. A second point is the inserting procedure of the atrial catheter: if the venous line is established before left atriotomy, it is easy to check for its intra-atrial length: in the present case, according to witnesses, it was positioned after closing the atrium, at the end of cardiopulmonary bypass: without length markings on it (and the catheter did not have any), it is actually difficult to assess its intracardiac portion.

Another point of forensic interest is the problem of liability of the surgeons, because of the difficulty of attributing individual or staff malpractice liability.

Setting a left atrial pressure line is considered to be routine procedure that neither is performed by the chief of the operating team himself, nor is usually described in the surgical record. However, directives as to the kind of suture materials, timing of fixing, methods of measuring the intracardiac length of the catheter, etc., are specific personal duties of the head of the operating team, not just she individual decision of a single member of the staff. Besides that, once established the impossibility in retrieving the left atrial line, the decision on whether or not to proceed to explorative surgery is up to a high-rank member of the team.

Last but not least, the possible levels of trapping of a left atrial catheter that resists to routine withdrawal are definite and very well known: skin and subcutaneous tissues, pericardium and external aspect of left atrial wall. To reach even the deepest of these locations does not carry more operative risks than those related to surgical hemostasis in case of bleeding from the insertion point of the same catheter at removal.

As a consequence, we believe that while the surgical drawing might have been reasonably omitted in the early postoperative stage, both not to expose the patient to more (but limited) surgical risk and on the basis of current knowledge at that time, the decision of leaving it in an intracardiac location after the patient had recovered and expecially after having known that the risk could have been actually lethal, must be judged as negligent.

References

1. Kouchoukos NT, Karp RB (1976) Functional disturbance following extracorporeal circulatory support in cardiac surgery. In: Ionescu MI, Wooler GH (eds) current techniques in extracorporeal circulation. Butterworths, London, p 252
2. Swan HJC, Ganz W, Forrester JS (1970) Catheterization of the heart in man with use of a flow-directed balloon-tipped catheter. New Engl J Med 283:447–451
3. Bechara FA, Pett SB, Jr, Wernly JA, Berman W, Jr, Dillon T (1984) Unusual complication of direct left atrial pressure monitoring line. J Thorac Cardiovasc Surg 88:1033–1035
4. Reyes LH, Ratzan KR, Rheinlander HF (1973) Serratia marcescens bacteremia originating from a catheter line in the left atrium after mitral valve replacement. J Thorac Cardiovasc Surg 65:241–244
5. Robles de Medina EO, Westerhof PW, Van Mill GJ, Huysmans HA, Schaepkens Van Riempst A (1977) Removal of a fragment of catheter entrapped in a Bjork-Shiley aortic valvular prosthesis. Chest 72:98–99
6. Win A, Pastore JO, Coletta D, Junda RJ (1980) Echocardiographic detection of a retained left atrial catheter. Am Heart J 99:93–95
7. Behl PR, Brown AH (1983) Late snaring of Lillehey-Kaster prosthesis by a fragment of left atrial monitoring catheter. Thorax 38:879–880
8. Behl PR, Hilton CJ, Holden MP (1984) Retrieval of left atrial catheters with a mediastinoscope. Thorax 39:479–480
9. Casarotto D, Bortolotti U, Betti D, Chioin R, Rizzoli G, De Mozzi P, Gallucci V (1979) Risultati della sostituzione valvolare con le protesi a disco oscillante di Bjork-Shiley e Lillehey-Kaster. Minerva Cardioangiol 27:1–6
10. Intonti F, Baruffi E (1985) Valutazione della valvola Bjork-Shiley. In: D'Alessandro LC (eds) Heart surgery. Scientificia Internazionale, Roma
11. Delle Donne R (1988) Personal communication
12. Browdie DA, Agnew RF, Hamilton CSJr (1978) Poppet jamming during mitral valve replacement. Ann Thorac Surg 28:591
13. Peacock EE, Jr (1974) Wound healing and wound care. In: Schwartz SI (ed) Principles of surgery. McGraw-Hill, New York

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