Routine left atrial catheterization for the post-operative management of cardiac surgical patients: is the risk justified?

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Abstract

Objective: To assess the risk/benefit ratio, including cost, associated with routine left atrial catheterization for the post-operative management of patients after cardiac surgery. Methods: From November 1991 to June 1998, out of 6187 open heart procedures performed at our institution, 5815 patients (94%) receive a left atrial monitoring line inserted invasively by a unique and reproducible technique. Catheters were removed on the first or second postoperative day before chest tube removal. A subgroup of 385 patients (7%) were switched to a Swan-Ganz catheter postoperatively. Results: A total of 14 patients suffered a complication related to the left monitoring line (0.24%). Bleeding necessitating transfusion occurred in 10 patients (0.17%), seven of whom required surgical reexploration (0.12%). Catheter retention occurred in four cases (0.07%), requiring a mediastinal reexploration in one and a minimally invasive procedures in three, for removal. No other complications related to the presence of a left atrial line emerged in this series. Apart from providing crucial hemodynamic information on a routine basis, in nine selected patients (0.15%) in a low cardiac output state with increased pulmonary vascular resistance and right ventricular failure, the left atrial line was used as a preferential route for catecholamine infusion, with significant hemodynamic improvement. Conclusions: Complications of left atrial monitoring catheters in cardiac surgery do occur but at a very low and acceptable rate. No mortality was correlated to their use in our series. Complication rate can be further lowered by a meticulous management of the device. The wealth of information and therapeutic options offered by this line appears to outweigh the associated risk.

Keywords: Left atrial line; Pressures monitoring; Pulmonary vascular constriction; Open heart operations; Postoperative care

1. Introduction

Monitoring of left atrial pressure after cardiac surgical procedures is a well known useful tool for optimizing hemodynamic performance [1,2]. In selected patients in a low cardiac output state with increased pulmonary vascular resistance and right ventricular failure, left atrial catheters have also been used as an advantageous route for catecholamine administration [3].

Despite the widespread utilization of left atrial catheters after cardiac surgery in the last decade, concerns still remain about their routine use due to the reported risks of hemorrhage following catheter removal [1,2], mechanical interference of the line with valve prosthesis in the mitral position [4], systemic gaseous microemboli during left atrial catheter insertion [5], and retained catheter fragments [6]. Several techniques have been reported to minimize the possible risks associated with left atrial catheter use [7–13], but a word of caution has also been spent to confine its utilization only to selected cases in order to lessen the potential sequelae. Selected use of left atrial lines has also become less common since surgeons acquired confidence in the safety and reliability of pulmonary artery catheters, whose use however, is not totally risk-free either [14–22]. Furthermore, the cost of this device routinely utilized in a large volume practice should not be underestimated [15].

In order to assess the risk/benefit ratio including cost, associated with the procedure, the experience with the routine use of left atrial monitoring lines after cardiac surgery at a tertiary care university hospital over the last 7 years was critically reviewed. The purpose of this study is to propose a rationale scheme for their continued use.

2. Material and methods

From November 1991 to June 1998, 6187 open heart procedures were performed at the Division of Cardiovas-
circular Surgery of the University of Verona. Since 1991, to optimize patient management, we have adopted a posture of rather intensive intraoperative and postoperative hemodynamic monitoring, with few exceptions limited to straightforward cases (i.e. secundum atrial septal defect, minor procedures limited to the right sided heart). Indeed, beside the use of conventional central venous monitoring lines, the 94% of our patients \((n = 5815)\) received a left atrial monitoring line at the time of the operation, including neonates and infants undergoing correction of complex congenital heart diseases \((2.9\%)\). Seventy-three patients in our series \((1.2\%)\) had a Swan-Ganz catheter inserted preoperatively \((\text{Arrow International Inc., Reading, PA, USA})\) and did not get a left atrial line at the time of surgery.

The institutional procedure for the placement and maintenance of the left atrial catheter as well as for its removal, was reviewed over this seven years period. In all instances, a 16-gauge radiopaque polyethylene catheter \((19\text{-gauge in patients below 15 kg body weight})\) \((\text{Becton Dickinson Vascular Access, Sandy, UT, USA})\) was inserted through a blade hole in the center of a 3-0 Prolene \((\text{Ethicon Inc., Somerville, NJ})\) non-pledgeted suture \((5-0 \text{ Prolene in patients below 15 kg of body weight})\). The site of insertion was located not on the right superior pulmonary vein directly as reported by others \([10]\), but rather anteriorly, in the groove developed between the posterior right and anterior left atrial walls \((\text{Sondegard groove})\) \((\text{Fig. 1a})\), caring to recruit with the suture line all the soft tissue around the site of puncture for hemostatic purposes \((\text{Fig. 1b})\). Before line insertion, the same site was routinely used for left ventricular venting during the surgical procedure.

As an exception, after procedures on the mitral valve, the catheter was inserted through the suture line utilized for closure of the left atrium, taking care to diverge its direction towards the pulmonary veins, keeping inside the atrium the minimal length for appropriate monitoring.

The catheter line was always inserted filled up with saline solution to minimized the risk of gaseous microemboli. The procedure was always accomplished when still on cardio-pulmonary by-pass, under no ventilation and inserting the catheter into a filled heart in order to prevent the entrainment of gaseous microemboli of particular importance in patients with low left-sided filling pressure \([5]\). The left atrial line was routinely attached to a pressure transducer in the operating room to guide during weaning from cardiopulmonary bypass. Freedom to move the catheter relative to the myocardial tissue as well as its function, and the position of the line itself, was always manually confirmed before chest closure. Upon arrival in the Intensive Care Unit \((\text{ICU})\) the left atrial line was aspirated and attached to a transducer to monitor pressure continuously. A heparin flush \((1000 \text{ units of heparin added to 500 ml of Ringer’s lactate})\) was then maintained at a flow rate of 3 ml/h. The position of the catheter tip was confirmed by chest roentgenogram before clinical assessment were made and therapeutic modalities initiated. The catheters remained sutured to the skin during their period of utility in the ICU. Almost all catheters were removed on the first or second postoperative day before chest tube removal. In no cases the duration of monitoring with a left atrial catheter was prolonged beyond 72 h since insertion. All non-functioning catheters were promptly removed at any stage during the postoperative period. In patients requiring additional hemodynamic information and/or an expected prolonged period of hemodynamic monitoring \( (>72 \text{ h})\), the line was removed and switched to a Swan-Ganz catheter. High left atrial pressure and/or abnormal coagulation values have not been consid-
The use of these lines was found to be consistent over the 7 years to which this analysis refers.

For the purpose of this study, the registry of all perioperative complications in the patients operated upon between November 1991 and June 1998, was reviewed and all the sequelae related to insertion, management, and removal of a left atrial catheter were noted.

### 3. Results

The availability of a left-atrial monitoring line offered a tremendous benefit in the intra- and postoperative management of our patients on a routine basis. Together with all the parameters commonly available, direct continuous measurement of left ventricular filling pressure particularly during weaning off cardiopulmonary bypass and then in the ICU, promptly indicated the most appropriate volume and/or drug administration. This allowed to optimize management including promotion of further investigation when appropriate (i.e. for sudden increase of left atrial pressure and/or evidence of mitral valve regurgitation) with subsequent treatment upgrading.

In our series, a subgroup of 385 patients (6%) were switched to a Swan-Ganz catheter in the postoperative period in order to acquire additional hemodynamic information or in view of a long expected period of need for hemodynamic monitoring.

In nine selected patients (0.15%) left atrial lines were used as a preferential route for drugs infusion. The common patient hemodynamic profile was that of a diminished left ventricular contractility and increased right ventricular afterload, related to increased pulmonary vascular resistance. Left atrial catheter administration of epinephrine (associated with prostaglandin E1 infusion into a pulmonary catheter in five cases) improved myocardial performance without increasing right ventricular afterload, as shown by contemporary mean pulmonary artery pressure monitoring.

A total of 14 patients suffered a complication clearly related to the left monitoring line, for an overall complication rate of 0.24%. The complications identified were broken down into two general types: (1) bleeding occurring after catheter removal; (2) catheter retention.

After line removal, correlated bleeding necessitating transfusion occurred in 10 patients, seven of whom required surgical reexploration and suturing of the insertion site, performed emergently in the ICU in one case. In all these cases (none after mitral valve replacement), the cause of bleeding was believed to correlate with a sub-optimal technique utilized for line positioning. Entrapment of the catheter at the time of line removal required surgical revision in four cases with mediastinal reexploration in one case and a less invasive procedure limited to the rectus fascia, performed in the ICU, in three (Table 1).

No other complications related to the presence of a left atrial line emerged in our series. In particular, no major neurologic impairment was evident in any of our patients in the postoperative period that could not be related to conventional sources of central nervous system morbidity during cardiac surgery, although a continuous monitoring of gaseous or particulate microemboli was not undertaken.

### 4. Discussion

The monitoring of left atrial pressure is a useful method for proper evaluation of left ventricular pre-loading. Integrated with right atrial and, when indicated, pulmonary artery pressure, left atrial pressure monitoring pilots the management of volume and vasoactive therapy in the postoperative period of most cardiac surgical patients [1–3]. Despite the routine use of left atrial catheter worldwide, a consistent number of reports have focused over the last decade on various complications related to its use, and a word of caution has been spent to limit it to selected cases [4–13]. This tendency has prompted us to analyze retrospectively our experience with left atrial monitoring line routinely used at our institution since 1991.

Our 7-year series, involving more than 5800 left atrial monitoring catheters demonstrates the overall safety of this device, managed according to the rules reported. Intraoperatively, careful preparation of the insertion site (Sondegard groove), meticulous tailoring of the suture purse-string, insertion of a filled-up catheter when still on by-pass under no ventilation into a filled heart, confirmation of its mobility at the insertion site, and appropriate patient closure, all significantly minimized catheter related morbidity. Nursing personnel orientation on the scrupulous management of this lines appears also mandatory to contain complications.

Overall complication rate in our series was 0.24%. Only one patient required reexploration on an emergency basis. Indeed, close monitoring of patients after catheter removal, anticipating of any bleeding complications, with rapid resuscitation if necessary, will further increase the safety of this monitoring method.

Although it is difficult to quantify the data made available by these lines, we have found them extremely useful and have based a myriad of therapeutic decisions and interven-
tions on the information derived from them. Furthermore, in
a subgroup of critical patients (0.15%) the left atrial line
showed very useful for interventional purposes allowing
direct left atrial administration of epinephrine thus providing
improvement of myocardial performance with less
effect on right ventricular afterload.

All patients showing evidence of gross neurologic
dysfunction postoperatively in our series (1.8%), had clear
pre- and/or perioperative risk factors for stroke. These data
together with a meticulous management of the lines seem to
suggest a minimal impact of the procedure on neurological
outcome, although routine monitoring of microembolism
and sensitive neurologic testing were not performed.

Several studies of patients during cardiac surgery however,
have shown that relatively large numbers of gaseous micro-
emboli can be entrained into the systemic circulation with-
out causing an adverse neurological outcome [5,23±27].
Further, the number of microemboli entrained by left atrial
catheterization and catheter flushing has been shown to be
far less than the number caused by routine aortic cannula-
tion and the initiation of left ventricular ejection after bypass
[5].

In an era of cost containment and efficient resource utili-
ization the possibility to limit the expense for routine patient
monitoring still providing a good quality care should not be
underestimated. In this view, left atrial line should be
regarded as an intermediate tool, limiting the use of
Swan-Ganz catheters only to selected cases.

In conclusion, complications of left atrial monitoring
catheters in cardiac surgery do occur but at a very low
and acceptable rate. No mortality was correlated to their
use in our series. Complication rate can be further lowered
by a meticulous management of the device. The wealth of
diagnostic and prognostic data and even therapeutic options
obtained by this manner seems to outweighs the associated
risk. Left atrial line use appears also favorable in term of
costs containment compared to other invasive methods to
provide information on left ventricular pre-loading. The
letter should be limited to selected cases.

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