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A Method to Ease Removal of Surgically Introduced Intra-Aortic Balloon Counterpulsation Catheters

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ABSTRACT

Background: A surgical cut-down may be necessary when an emergency intra-aortic balloon counterpulsation catheter insertion has to be performed. Closure requires reopening the wound to extract the catheter and close the arteriotomy, or a graft has to be presutured to allow simple ligation. These methods are cumbersome. A method permitting rapid surgical access and easy removal in an intensive care unit is highly desirable. Such an insertion technique that, after insertion, includes placement of transcutaneous hemostatic purse-string sutures was evaluated.

Method: All intra-aortic balloon catheter insertions done between August 1996 and March 2000, where all patients underwent an attempt at percutaneous intra-aortic balloon insertion, were evaluated. Failure to insert the balloon percutaneously was followed by direct surgical exposure and insertion with the placement of 2 transcutaneous purse-string sutures. The balloon pump catheter was removed when deemed appropriate and hemostasis was achieved by compression (percutaneous), or by tying of the preplaced sutures followed by compression. Patients were followed and both groups were compared with respect to mortality and vascular complications and any other complications were noted.

Results: There were 157 intra-aortic balloon insertions. Surgical introduction was required in 9 (5.7%) cases. These represent 17.3% of all emergency introductions. There was no statistical difference in original diagnosis, mortality, or vascular complications. The survivors (8/9) have been followed up for a mean of 2.8 years with no late complications.

Conclusions: The removable transcutaneous suture method permits easy intra-aortic balloon catheter insertion and easy removal in an intensive care unit. This method has not been associated with complications in the follow-up period (mean 2.8 years).

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INTRODUCTION

Intra-aortic balloon pump insertion is preferably done using a percutaneous Seldinger technique. This is possible if adequate arterial access is achieved permitting the introduction of a guide wire. Femoral pulses may not be palpable in cardiogenic shock or when the patient is being unsuccessfully weaned from cardiopulmonary bypass. A "floppy" or "slippery" artery, especially in an obese patient, may not permit an adequate vascular access forcing emergency surgical exposure. This may be avoided by preplacement of a guide wire or a cannula monitoring femoral arterial pressure in high-risk cases. In cases where such foresight has not been exercised, open surgical placement via a femoral arteriotomy or through a presutured graft is the traditional method. These methods require formal surgical re-exposure to extract the catheter and close the arteriotomy. This may be done in the intensive care unit or in the operating room. Surgical re-exposure involves additional expenditure and the use of extra personnel. Thus, a method that permits rapid open exposure but allows easy removal in the intensive care unit is highly desirable. This method should be easily reproducible, safe, and should permit early discharge when deemed feasible. We describe such a technique in this report of a patient cohort study.

MATERIALS AND METHODS

All cases of intra-aortic balloon insertion that were performed between August 1996 and March 2000 in Sri Jayadeva Institute of Cardiology, were evaluated in this study. These included all cases irrespective of case type, indication (including prophylactic insertions), or whether performed by surgical or medical services. An attempt at percutaneous

insertion (preferably sheathless) was always attempted and if it failed, direct surgical access was attempted.

Direct surgical access is obtained by a vertical femoral incision exposing the femoral vessels. The common femoral artery is looped. An oval purse-string suture using a double-armed 5/0 surgilene (Sherwood Medical, St Louis, MO, USA) is placed with its long axis parallel to the long axis of the vessel to prevent constriction on tightening (Figure 1, ◎). The femoral arterial lumen is accessed by needle puncture (preferred method) or a small arteriotomy within the purse-string suture. A guide wire–dilator system is passed through the needle or arteriotomy. The intra-aortic balloon (9.5-Fr True Sheathless or 9.5-Fr PERCOR STAT-DL; Datascope Corp, Fairfield, New Jersey, USA) is inserted over the guide wire to place it in the standard infra-subclavian position and balloon pumping is initiated. A second purse-string suture with 5/0 surgilene is placed around the first purse-string suture with entry and exit points 180 degrees from the original purse-string suture. Care is taken not to transfix the intra-aortic balloon while placing the second suture and it helps to temporarily switch the balloon pump off during suture placement. A single throw of a surgeon's knot is placed with both sutures. Both arms of the respective sutures are passed through subcutaneous fat and skin on either side of the incision and then passed in the manner of a vertical mattress suture. The ends of each pair of sutures are clipped with a hemoclip after removing the needles. The subcutaneous fat is closed with 2/0 Dexon (Sherwood Medical, St Louis, MO, USA) up to the catheter exit site. The skin is closed with subcuticular 3/0 Dexon (Sherwood Medical, St Louis, MO, USA) up to the catheter exit site. A vertical mattress suture using 2/0 surgilene is placed through the remaining unopposed skin and subcutaneous fat but is not tied and the ends are clipped with a hemoclip. A sterile dressing is placed after rolling the free sutures over sterile needle caps and the wound is covered with an iodine-impregnated plastic dressing (Ioban; 3M Health Care, St Paul, MN, USA).

When removal is contemplated, balloon pumping is stopped. A fentanyl (1 mg/kg) bolus is given. Distal femoral compression is applied and the catheter is withdrawn; free bleeding is allowed, following which proximal compression and retrograde bleeding is allowed (medical embolectomy) [Rodigas 1985]. After adequate backbleeding, the 5/0 purse-string sutures are pulled and tied over the skin. The femoral bleeding stops and distal pulses are inspected. The 2/0 Surgilene suture is tied and a dressing is placed. Compression is applied over the femoral site for half an hour and the patient is instructed to not move the limb for 6 hours after which he is allowed full ambulation. The tie-over sutures are extracted on the tenth postoperative day (the sutures are pulled out in toto or, failing that, are pulled and cut flush to the skin and allowed to retract).

All patients were followed during routine postoperative visits and at 6 monthly intervals. Survivors were specifically questioned about claudication and examined for femoral pseudoaneurysms and any other complications.

Statistical analysis compared the percutaneously-inserted group with the surgically-inserted group. The two groups were compared using Fisher's exact test. The analysis was done using GraphPad Prism™ software (GraphPad Software, Inc., San Diego, CA) with 95% confidence intervals.

RESULTS

There were 157 patients who received intra-aortic balloon counterpulsation. There were 9 surgical introductions and all of these were emergency introductions. The remaining 148 introductions were percutaneous, of which 43 (29.05%) were emergency introductions. The 2 groups were comparable with respect to mortality and the original disease necessitating intra-aortic balloon counterpulsation. There was no statistically significant difference in vascular complications. The incidence of emergency introductions was statistically significant between the 2 groups ($p = 0.0189$) because they were all performed surgically. One patient in the surgically-introduced group died on the postoperative day 11 due to a stroke. This was unrelated to the balloon introduction. He had the balloon removed on postoperative day 3 and suture removal on postoperative day 10. Both of these procedures were uneventful. The remaining 8 patients have been followed for a mean of 2.8 years. The patients have no claudication and there has been no pseudoaneurysm formation.

Eight patients in the percutaneous group had vascular complications. One patient had an aortic dissection and died due to retroperitoneal bleeding. One patient required embolectomy due to distal embolisation after removal of the balloon catheter. Six patients have some degree of claudication which has lasted for more than 6 months and 1 patient has associated femoral neuralgia. However, the difference in the vascular complication rates did not reach statistical significance.

DISCUSSION

Open surgical introduction was the original method of introduction of intra-aortic balloon catheters [Kantrowitz 1968]. The advent of percutaneous introduction permitted widespread use of these catheters, which had been originally confined to surgical patients [Bregman 1980]. Use of these new techniques was at the cost of a slightly higher vascular complication rate [Gottlieb 1984, Goldberg 1987]. It is hoped that the vascular complication rates will fall with the introduction of smaller-diameter catheters and sheathless insertion techniques [Nash 1991, Eltchaninoff 1993, Tatar 1993], which may permit the placement of appropriate-size catheters even in vessels with small lumens.

Blind introduction by experienced operators based on recognized anatomical landmarks, femoral pulse palpation, or the use of a Doppler flow pencil may permit needle–guide wire–balloon placement in a large percentage

of patients. If the possibility of intra-aortic balloon pulsation is anticipated, a guide wire or cannula monitoring femoral arterial pressure may be placed to permit easy vascular access. Despite these methods, there are a number of patients who require open femoral placement. These are usually obese patients with cardiogenic shock or patients who cannot be weaned from CPB and do not have palpable pulses. These patients require introduction of the balloon catheter via an arteriotomy or via a presutured graft. Removal requires surgical re-exploration to remove the balloon catheter and to close the arteriotomy. The graft may be removed or ligated or transected and oversewn. The blind stump of the graft may be associated with problems. Shifting the patient to the operating room along with open surgical removal adds to the costs of the procedure.

The technique described in this paper has proven to be rapid and easy. Introduction in an unstable patient is quick and permits rapid institution of balloon counterpulsation. Removal requires minimum equipment that is present in any surgical intensive care unit. This method of intra-aortic balloon insertion also permits early discharge due to the presence of the removable suture. The procedure has been devoid of complications so far and, though the number of patients is still small, may prove to be a useful technique in the surgeon's armamentarium.

The study was limited by the small sample size of surgical insertions and the inherent nature of surgical insertion that prevented blinded assessment.

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REVIEW AND COMMENTARY

1. Editorial Board Member AR11 writes:

This is an interesting technique, not previously described (to my knowledge). This would be nice to keep in one's techniques to use when necessary.

It is unclear why, if groin incision is already present, open removal would be so costly and difficult to arrange? Why not just re-op previous incision (in ICU) and extract device?

Authors' Response by Prasanna Simha, MCh:

Though the groin incision is present, formal closure of an arteriotomy would necessitate use of a trained assistant/OR Nurse and equipment for closing the arteriotomy which would add to the costs. Depending on local ICU protocols, this may even translate to shifting the patient to the operating room, especially if the patient is in a medical ICU.

2. Editorial Board Member AU34 writes

I believe that more detailed analysis is need for the early complications.

Authors' Response by Prasanna Simha, MCh:

The small number of cases having vascular complications did not permit valid conclusions to be made. To allow an alpha error of 5% our calculation was that we needed 1,400 balloon insertions.

3. Editorial Board Member MB134 writes:

This is a well documented, practical method dealing with one isolated issue. A written description of the suture technique would have been better supported if illustrated with drawings or an actual photograph.

Authors' Response by Prasanna Simha, MCh:

A drawing has been submitted with the original manuscript. A photograph would have been definitely better but the hurried nature of the insertions did not permit photography.

4. Editorial Board Member LO23 writes:

This is a clear concise study on the insertion of IABP's, outlining an inexpensive adjuvant technique. The authors should comment on their selection of a vertical incision as opposed to a better healing incision parallel to the groin crease.

Authors' Response by Prasanna Simha, MCh:

The vertical incision was chosen as a matter of convenience and for rapid access in an emergency situation. It also permits easy placement of the transcutaneous sutures. A horizontal incision could definitely be also be used in such a situation.

5. Editorial Board Member NC124 writes:

Even in the emergency setting where a groin cut-down has to be done, most times the balloon is introduced to the arterial system, with the needle, wire and dilators forming the percutaneous tract, so practically, the IABP remains the same (just with a soft tissue cut-down). We have utilized over 300 balloon catheters over the last 5 years and in about 10% of the cases, a cut-down has to be done, however, when removed, we use the same technique as with the ones placed percutaneously, without any complications.

Authors' Response by Prasanna Simha, MCh:

We agree that a partial soft tissue cut down does definitely allow palpation of an "imperceptible" pulse and permits cannulation. We have used this on occasions. A Doppler flow pencil may at times obviate the need for a skin incision too. There are some patients who are so vasoconstricted that the femoral arteries are not palpable and may also be so "slippery." They may also collapse with the minimal pressure required for palpation especially at low pressures during unsuccessful attempts while delinking from cardio pulmonary bypass. Needle placement may then be impossible. We believe that our method may be useful in addressing this subgroup of patients.

We have done color Doppler imaging of the femoral artery after 10 days of suture extraction in one case recently and compared it to a similar case with percutaneous insertion at the same time frame. The luminal regularity was striking in the surgically placed case compared to the percutaneously placed case. Probably, the pursestring suture allows rapid endothelial bridging of the arterial defect ensuring a smoother endothelial surface compared to the slower bridging after extraction of the percutaneously placed catheter. This may translate to an advantage if the number of insertions are large. At present it is only conjectural. We had estimated that we need at least 1,400 balloon insertions to demonstrate a statistically significant difference between any sutureless technique versus the present one.