Implosion/Explosion of a Bentley Cardiotomy Reservoir during Autotransfusion with a Cell Saver

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Abstract

An implosion/explosion hazard exists in those institutions using a Bentley BCR 3000\textsuperscript{a} cardiotomy reservoir during autotransfusion if the wall vacuum is applied to the reservoir and the sucker tip becomes occluded for fifty or more seconds. A case report and preventive measures are presented.

Introduction

An estimated five million units of blood are used annually in the United States\textsuperscript{1}. Autotransfusion has been demonstrated to be useful adjunct to cardiac and major vascular surgery, and helps to alleviate some of this need\textsuperscript{1-11}. This is particularly true in patients with rare blood types, antibodies, or bleeding diathesis\textsuperscript{3-9}. The Haemonetics Cell Saver is a widely used autotransfusion system which incorporates the need for a cardiotomy reservoir to store excess fluid during the processing of aspirated blood. The Bentley BCR 3000 appears to be an excellent large volume, unfiltered reservoir for such an application. Applying line vacuum in the presence of an obstructed suction tip can give disastrous results hazardous to operating room personnel and patients. A review of the literature reveals that although cardiotomy reservoirs are not completely benign, no events of this nature have been previously reported\textsuperscript{12-14}

Case Report

A 16-year-old black female was admitted to St. Francis Medical Center following a two week course of antibiotic therapy for subacute bacterial endocarditis at an outlying institution. An echocardiogram showed vegetation or a valve structure flapping in and out of the aortic outflow tract. On admission to St. Francis Medical Center the patient was in marked congestive heart failure with florid pulmonary edema.

Cardiac catheterization done shortly following admission demonstrated: 1) Suspected aneurysm of the left coronary sinus of Valsalva, 2) 4+ aortic valvular insufficiency with markedly dilated left ventricle, 3) 2-3+ mitral valvular insufficiency with regurgitation from the aortic root injection, retrograde, into the left atrium, and 4) moderate pulmonary hypertension with pulmonary arterial pressure measured at 28/22 mm. Hg. and wedge of 18. Oximetrix Swan Ganz catheter\textsuperscript{b} showed a mixed venous saturation of 30%.

The patient was taken in shock from the heart catheterization laboratory to the operating suite. Operative findings were: 1) acute inflammatory exudative pericarditis, 2) flailing of two out of three coronary cusps of the aortic valve with multiple perforations, 3) abscess of the aortic valve ring which had penetrated into the mitral valve ring and eroded a hole in the anterior leaflet of the mitral valve, and 4) small abscess in the right sinus of Valsalva which had almost penetrated into the right atrium.

Operative procedures performed were: 1) debridement of various abscesses, 2) debridement and plication of the anterior leaflet of the mitral valve, and 3) replacement of the aortic valve with a mechanical prosthesis. The patient tolerated the procedure reasonably well and was withdrawn from cardiopulmonary bypass with only modest inotropic support. Profuse bleeding was noted from the epicardial and pericardial surfaces where dissection for exposure had been performed. This persisted despite the neutralization of heparin with protamine. Available stores of compatible blood were being quickly depleted and therefore autotransfusion was established in the usual fashion.
approximately fifteen minutes of autotransfusion, the reservoir "exploded," hurrying plastic fragments and blood for twelve to fourteen feet striking the surgeon and dripping blood from the light fixtures into the operating field and onto the aorta. Autotransfusion was immediately terminated and investigation into the incident was instituted. The patient survived with no apparent sequelae attributable to this misadventure although delayed infection could possibly occur secondary to this unusual event.

Discussion

The autotransfusion set up at St. Francis Medical Center was taken directly from the manufacturer's recommendation (Figure 1). The Haemonetics Cell Saver Open Heart Pack #CSP 225 and Suction Assembly #CSP 20" are used with the Bentley BCR 3000 reservoir and holder on a Cell Saver I. Wall suction was applied to the reservoir as there had been no previous recommendation by the manufacturer of the reservoir's inability to withstand this technique. This particular reservoir was chosen because it has a large volume and is not filtered. The product literature included with each reservoir does not quantitate the maximum allowable negative pressure that can be used.

The fact that the described incident occurred with both wall suction and volume removal by the Cell Saver pump were simultaneously occurring led us to conclude that the reservoir could not have been overpressurized. The only logical conclusion that we could formulate was that there had been sufficient vacuum to cause implosion. We feel this happened during a time when the tip of the sucker was inadvertently occluded by the patient's tissue. Bentley was contacted and they eventually advised us that they had received similar reports from other institutions. We were able to reproduce the implosion/explosion phenomena or severe implosion in randomly selected units after fifty to fifty-five seconds of vacuum on an otherwise sealed reservoir (see illustration).

Bentley Laboratories then recommended such interim measures as loosening one of the luer priming caps or needle insertion into the suction line to prevent this from recurring while they are working on design modifications to strengthen the reservoirs. Bentley is in the process of printing new product inserts which will specify the maximum allowable vacuum. We have incorporated Ohio vacuum regulators into our wall suction systems. However, if they are turned up to the "full" mode, they will also deliver sufficient vacuum to collapse the BCR 3000.

Clinical Perfusionists, Inc., an active perfusionist corporation with 5,000 procedures per year, also reported to us they had experienced this same event with Shiley reservoirs, so the phenomena is not limited to Bentley products. Clearly these reservoirs were designed to prevent explosion—not implosion.

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Figure 1: Diagram of autotransfusion circuit.

Figure 2: Outside reservoirs imploded/exploled at 52 seconds, while the middle one collapsed at 55 seconds.
Conclusion

Bentley has advised us that although their labs state that the "BCRs would withstand over 600 mm Hg of vacuum pressure—The recommended ratio is (now) 300 mm Hg." We strongly advise anyone who is using or contemplating using the BCR 3000 reservoirs in a cell saving application to invest in a quality vacuum regulator that can be adjusted to—300 mm Hg or less. Until other reservoirs state differently all suction should be less than line wall and controlled as stated.

References

17. Personal communication; Jerry Richmond, Vice President Clinical Perfusionist, Inc.