Intra-aortic Balloon Counterpulsation in Patients With Severe Cardiac Dysfunction Undergoing Abdominal Operations

Vafa Shayani, MD; William C. Watson, BS; M. Ashraf Mansour, MD; Neil Thomas, MD; Jack Pickleman, MD

Objective: To assess the effectiveness of intra-aortic balloon counterpulsation (IABC) as adjunctive treatment in patients undergoing abdominal operations.

Design: Retrospective review of patient medical records to determine the incidence of mortality following abdominal surgery and the incidence of complications from IABC.

Setting: University-based, tertiary care hospital.

Patients: Sixty-eight patients who underwent an abdominal operation and IABC during the same hospitalization were divided into the following groups: Group 1, IABC initiated prior to operation to enhance perioperative cardiac function; group 2, IABC used to treat cardiogenic shock in a patient who subsequently required an operation while undergoing IABC; and group 3, IABC device inserted and removed for treatment of cardiogenic shock in a patient who subsequently required an operation within 30 days of removal of the device.

Main Outcome Measures: The incidence of mortality in IABC-supported patients and IABC-related complications.

Results: In group 1, excluding 3 patients who died following emergency operation, 26 patients underwent nonemergency procedures and had a 12% mortality rate. In group 2, 5 of 6 patients who underwent emergency operations died, whereas 3 of 4 patients who required only urgent operations survived. In group 3, 18 (62%) of 29 patients who underwent urgent or emergent operations died postoperatively. Thirteen patients experienced complications related to IABC; there were no deaths and no limbs were lost to ischemia.

Conclusions: This is the largest reported series looking at the utility of IABC as adjunctive treatment for patients undergoing abdominal operations. The outcome for those patients requiring emergency operations remains poor, but it is likely that more liberal use of IABC in patients with severe cardiac dysfunction who require nonemergency operations may improve patient outcome.

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INTRA-OARTIC BALLOON counterpulsation (IABC) has been successfully employed as a means of improving cardiac function in patients with cardiogenic shock not responsive to inotropic therapy.1-5 Patients with compromised cardiac function undergoing major operative procedures are at great risk for postoperative mortality.6-9 Elective use of IABC in patients with preexisting cardiac dysfunction in need of major noncardiac operations may provide intraoperative hemodynamic support and reduce the risks of postoperative cardiac complications.10-12 The benefits of the use of IABC, however, need to be balanced against the inherent risks associated with its use. In addition, there is significant expense associated with the use of IABC, requiring thoughtful patient selection. Preoperative insertion of IABC devices in patients with severe left ventricular dysfunction undergoing coronary artery bypass grafting (CABG) has been shown to be cost-effective, improve survival, and reduce length of hospital stay.12,13 However, no large series yet has addressed the use of IABC as a bridge to recovery from major abdominal operations in patients with significant cardiac dysfunction. This study assessed the effectiveness of IABC as adjunctive treatment in patients undergoing a variety of abdominal procedures.

RESULTS

GROUP 1

Twenty-nine patients with compromised cardiac function underwent insertion of the IABC device to enhance cardiac function prior to undergoing their abdominal operation (Table 1). The nature and frequency of hospital stay.12,13 However, no large series yet has addressed the use of IABC as a bridge to recovery from major abdominal operations in patients with significant cardiac dysfunction. This study assessed the effectiveness of IABC as adjunctive treatment in patients undergoing a variety of abdominal procedures.

This article is also available on our Web site: www.ama-assn.org/surgery.
PATIENTS AND METHODS

We reviewed the medical records of 98 patients who underwent an abdominal procedure and IABC during the same hospitalization between January 1984 and July 1996. Thirty patients were excluded from the study. Sixteen patients were excluded because a groin exploration following insertion of the IABC device was recognized in the database as an abdominal operation; 5 patients sustained thoracoabdominal trauma, requiring thoracic and abdominal exploration followed by insertion of the IABC device; 3 patients were excluded because IABC was initiated after combined cardiac and abdominal procedures; 3 were excluded because the abdominal procedure was performed more than 30 days after the discontinuation of IABC; and 1 patient was excluded because the abdominal procedure involved harvest of a splenic artery used for CABG. The remaining 68 patient records were retrospectively reviewed.

Three groups of patients were identified based on the timing and purpose of the IABC in relation to the abdominal procedure. In group 1 (n=29), IABC was initiated prior to the abdominal operation to enhance cardiac performance in patients with known cardiac dysfunction. In group 2 (n=10), IABC devices were initially inserted to treat cardiogenic shock refractory to inotropic therapy and the patients subsequently required an abdominal operation. In group 3 (n=29), IABC devices were placed for acute cardiovascular support and an abdominal procedure was performed within 30 days of IABC termination. In addition, all of the abdominal procedures were classified as elective, urgent, or emergent. An operation was defined as elective if delay in operative management was not expected to result in immediate morbidity. An urgent operation was defined as one that was delayed only until the patient’s hemodynamic state was optimized. An emergency operation was performed immediately after abdominal pathology was identified. Additionally, among the 68 patients included in this study, the complications associated with insertion of the IABC devices were reviewed. The McNemar $\chi^2$ test of statistical significance (Sigmastat for Windows, Jandel Scientific, Corte Madera, Calif) was used to determine significant differences in mortality attributable to the type of operative procedure or the degree of urgency of the operation.

Of the operative procedures performed are demonstrated in Table 2. Overall mortality in this group was 21%, but the mortality rate in the elective group was significantly lower ($P<.01$) than either the urgent or emergent group (Figure 1). The only death in the elective group was caused by ventricular fibrillation 4 days following a right hemicolectomy for adenocarcinoma. The 2 deaths in the urgent group were attributed to cardiac arrest 2 days after abdominal surgery for bowel ischemia. All 3 patients requiring emergent abdominal operations (open cholecystectomy for acute cholecystitis, exploratory laparotomy for colonic infarction, and a total colectomy for perforated diffuse diverticulitis disease) died despite preoperative insertion of IABC pumps; 2 patients of sepsis and 1 of an upper gastrointestinal tract hemorrhage. The degree of urgency of the operative procedure correlated significantly with mortality rate. However, the type of operation performed did not independently affect the incidence of mortality in this group of patients (McNemar $\chi^2$ test).

GROUP 2

Ten patients had indwelling IABC devices when operated on for abdominal pathology (Table 1). The nature and frequency of the operative procedures performed are demonstrated in Table 2. The overall mortality rate in this group was 70% (Figure 2). In 4 patients, IABC was instituted emergently following a cardiac procedure. All 4 of these patients ultimately died. No differences in the incidence of mortality were seen based on the urgent or emergent na-

Table 1. Types of Abdominal Operations Performed With Intra-Aortic Balloon Counterpulsation Support*

<table>
<thead>
<tr>
<th>Type of Operation</th>
<th>Group 1</th>
<th>Group 2</th>
<th>Group 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elective</td>
<td>10</td>
<td>7</td>
<td>10</td>
</tr>
<tr>
<td>Urgent</td>
<td>17</td>
<td>3</td>
<td>13</td>
</tr>
<tr>
<td>Emergent</td>
<td>12</td>
<td>0</td>
<td>16</td>
</tr>
</tbody>
</table>

*See “Patients and Methods” section for description of patient groups.

Table 2. Types of Abdominal Operations Performed With Intra-Aortic Balloon Counterpulsation Support*

<table>
<thead>
<tr>
<th>Type of Operation</th>
<th>Group 1</th>
<th>Group 2</th>
<th>Group 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exploratory laparotomy</td>
<td>1</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Gastric procedure</td>
<td>2</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>Bowel resection</td>
<td>11</td>
<td>2</td>
<td>12</td>
</tr>
<tr>
<td>Cholecystectomy</td>
<td>13</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Other</td>
<td>2</td>
<td>0</td>
<td>2</td>
</tr>
</tbody>
</table>

*See “Patients and Methods” section for description of patient groups.

Figure 1. Group 1. Mortality in patients undergoing intra-aortic balloon counterpulsation for cardiovascular support during abdominal operations.
nature of the operation (McNemar \( \chi^2 \) test). In addition, the nature of the operative procedure performed did not affect the mortality rates (McNemar \( \chi^2 \) test). Four of the deaths in group 2 were attributed to sepsis and 3 to cardiopulmonary arrest. The 4 septic deaths were caused by bowel ischemia subsequent to a low blood flow state.

GROUP 3

Twenty-nine patients underwent abdominal operations within 30 days of IABC termination (Table 1). The nature and frequency of the operative procedures performed are demonstrated in Table 2. The overall mortality in this group was 62% (Figure 3). There were 17 urgent and 12 emergent operations performed, with a mortality rate of 53% and 75%, respectively (\( P = .09 \)). Mortality in this group was attributed to cardiopulmonary arrest (n=10) or sepsis with multisystem organ failure (n=8). The nature of the operative procedure did not independently affect the incidence of mortality in this group (McNemar \( \chi^2 \) test).

Finally, in each of the 3 groups, the patients are stratified based on the nature of their underlying cardiac disease.

Table 3. Patient Classification Based on Predisposing Cardiac Conditions*

<table>
<thead>
<tr>
<th>No. of Patients</th>
<th>Group 1</th>
<th>Group 2</th>
<th>Group 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute MI</td>
<td>11 (3)</td>
<td>4 (2)</td>
<td>14 (10)</td>
</tr>
<tr>
<td>CHF</td>
<td>11 (2)</td>
<td>1 (1)</td>
<td>8 (6)</td>
</tr>
<tr>
<td>Cardiomyopathy</td>
<td>7 (1)</td>
<td>4 (3)</td>
<td>6 (2)</td>
</tr>
<tr>
<td>Arrhythmia</td>
<td>0</td>
<td>1 (1)</td>
<td>1 (1)</td>
</tr>
</tbody>
</table>

*See “Patients and Methods” section for description of patient groups. Numbers in parentheses represent deaths. MI indicates myocardial infarction; CHF, congestive heart failure.

The 4 types of cardiac dysfunction identified include: (1) myocardial infarction, diagnosed at hospital admission or during the same hospitalization; (2) congestive heart failure characterized by right-sided ventricular dysfunction; (3) end-stage cardiomyopathy with biventricular dysfunction; or (4) refractory cardiac arrhythmia (Table 3).

COMPLICATIONS

Thirteen of the 68 patients included in this study suffered complications of IABC device insertion. Eleven patients had thrombosis of the femoral artery, with 2 subsequent embolizations to the great toe. All patients were treated with anticoagulant therapy and recovered without further sequelae. Another patient with femoral artery thrombosis developed thrombophlebitis requiring antibiotic therapy in addition to anticoagulants. This patient recovered fully as well. Two patients developed wound infection at the site of IABC device insertion. These patients were treated with antibiotics and wound care and recovered without further complications. There were no deaths directly caused by IABC device insertion and no limbs were lost.

COMMENT

There is a paucity of information regarding the use of IABC to support patients requiring general surgical operations. The goal of the present study was to examine the utility of IABC in patients with compromised cardiac function in need of major abdominal surgery. Intra-aortic balloon counterpulsation has been used successfully to provide circulatory support for patients in cardiogenic shock.1-5 Patients with compromised cardiac function requiring major operative intervention are at higher risk of postoperative cardiac complications than patients with normal cardiac function.1-9

Our study provides the largest reported experience with elective use of IABC in patients with significant cardiac dysfunction in need of an abdominal operation (group 1). The overall mortality rate of 21% (6/29) for this group compares favorably with that reported in patients not treated with IABC.6,9,14,15 The mortality rate is even lower (12%) among the 26 patients who had elective or urgent abdominal surgery with preoperative use of IABC. This observation sharply contrasts with the eventual outcome for the 3 patients who underwent emergent abdominal surgery, all of whom ultimately died following complicated hospital courses. Although only suggested by our data, it is quite likely that reinstitution of IABC in the group 3 patients might have decreased...
the cardiac mortality seen in those patients, as 10 (34%) of 29 of these patients died of cardiac causes. Likewise, the 8 patients in this group who died of multiorgan system failure and the sequelae of a low-flow state may have benefited from IABC. Finally, when stratified for the type of underlying cardiac disease (Table 3), the incidence of mortality among the patients with recent myocardial infarction is higher among the group 3 patients as compared with the group 1 patients (P = 0.05, Fisher exact test), further raising the possibility of improved outcome with elective reinstitution of IABC in this subgroup of patients.

Another significant observation is made in the group of patients with an indwelling IABC device who required emergency abdominal operations. Five of 6 such patients died of cardiac complications postoperatively. The operative procedures in this group included open cholecystectomy (1, alive), total colectomy (1), exploratory laparotomy (3), and oversew of a bleeding gastric ulcer (1). In this era of cost containment, one might consider nonoperative management for this group of patients, who presumably have a grave prognosis with or without surgical intervention.

Our retrospective study did not allow us to identify all of the patients with preexisting cardiac dysfunction in need of major abdominal operations. Some of these patients might have gone on to recover from their operation without ever needing IABC or, conversely, many such patients might have suffered fatal cardiac events postoperatively without the use of IABC. Therefore, an accurate comparison of outcome between the 2 groups is not possible, considering the design of our study. Dietl et al.13 addressed this issue in a group of patients undergoing elective CABG. Their retrospective evaluation included all of the patients who underwent CABG during the study period. Among the patients classified as New York Heart Association class III and IV, those who underwent elective IABC had a much lower morbidity and mortality.13

The advantages of IABC in patients with significantly compromised cardiac function have to be balanced against the complications and costs associated with insertion of the IABC devices. Of the 68 general surgical patients who underwent IABC device placement during our study period, 13 suffered complications. Eleven of these complications were thromboembolic in nature and 2 were wound infections. Major limb ischemia occurred in 2 patients with thrombosis. Both cases were treated successfully without further complications. In addition, no patients died directly as a result of intra-aortic balloon placement. These results are comparable to those reported previously.2,16 We attribute the high incidence of thromboembolic events in our patients to our avoidance of anticoagulant therapy in the immediate postoperative period. We now employ a much more liberal approach to systemic anticoagulation in patients with indwelling IABC devices.

Our study was not designed to address the cost-effectiveness of IABC. However, Dietl and colleagues13 reported significant cost benefits in patients undergoing IABC prior to CABG with New York Heart Association class III or IV classification. An accurate cost comparison in patients undergoing abdominal operations would require either a prospective study or a retrospective study that would include all of the patients with significant heart disease undergoing an abdominal operation with or without perioperative IABC. Our study excluded all patients who did not undergo IABC.

In conclusion, we believe that more liberal use of IABC in patients with severe cardiac dysfunction who require elective and urgent abdominal operations may improve patient outcome. However, in critically ill patients requiring emergency operations with compromised cardiac function requiring IABC for hemodynamic support, the outlook remains grave.


REFERENCES

tend the subgroup analysis to those who had elective placement of an IABC device and elective operation, the mortality rate dropped to 12%.

For this society and its membership to be able to utilize these take-home concepts, I would like the authors to clarify certain points. First, in group 1 patients, patients who had undergone placement of an IABC device before intra-abdominal exploration, what were the trigger points that led to the placement of the IABC device? In other words, what were the cardia function parameters that led to the placement of the IABC device, and what were the cardiac function parameters that led to the removal of the pump? How long was the IABC device maintained, and what other tools were utilized to maintain cardiac function?

In groups 2 and 3, the mortality was high. Could the authors define the population who expired in the context of cardiac function? Are there predictable cardiac function parameters that are associated with mortality? Can we identify or pre-identify a set of factors that could avoid a futile process?

Third, the patients who had intra-abdominal exploration following the discontinuation of IABC had a mortality rate of 62%. Would they state that with replacement they would have done better? Have the authors performed analysis regarding the cardiac function parameters at 2 different time points, and were there any differences in this?

Last, this is an important observation. I think one realizes that as America “grays,” we as general surgeons or surgical intensivists will be facing many more patients with compromised cardiac function who will require elective operative intervention. How do the authors plan to identify the need to incorporate IABC into the management algorithm of patients with compromised cardiac function who require intra-abdominal exploration?

James A. Madura, MD, Indianapolis, Ind: I am pleased to be asked to discuss this interesting paper. However, I must say that initially I felt insecure that in Indiana we have not been using IABC, and I polled our cardiovascular surgeons, perfusionists, as well as similar people at our sister institutions in central Indiana and found out that we are not alone. I then did a quick literature search and found that the Loyola experience is truly unique. Most reports in the past 20 years have been anecdotal.

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