Removal of Iatrogenic Foreign Bodies within Cardiac Chambers and Great Vessels

By C. Walton Lillehei, Ph.D., M.D., Raymond C. Bonnabeau, Jr., M.D., and Sergio Grossling, M.D.

A NUMBER of cases of foreign bodies within the heart or pericardium have been reported in the last 100 years. Most of these communications, except for the series of Harken and Zoll,1 are based on single cases of a foreign body in the heart consisting of bullets,2-3 hypodermic needles,4-5 polyethylene catheters,6-7 and Puden7-9 and Holter valves.10 both utilized for the treatment of hydrocephalus patients.

A new means of production of foreign bodies within the heart or great vessels that has not been previously described, although undoubtedly other cases have occurred, is the breaking off of the tip of a metal stylet or catheter during the course of left heart catheterization.

Left heart catheterization has become an essential diagnostic technic since the advances made possible by open-heart surgery. However, this method has certain hazards and calculated risks that have been described.11-15 The foreign bodies of iatrogenic origins described in this report are rather uncommon, and we have had the opportunity to observe only six cases during the past 4 years.

Four cases of foreign body of the heart were incurred during left heart catheterization, and two other patients with Puden valve embolism into the heart were treated.

Two were produced during left heart catheterization by the transthoracic puncture technic described by Levy et al.13 One case was produced during a percutaneous right subclavian catheterization technic as has been described by Amplatz and Harner.12 Redesign of the flexible-tip stylet has reduced the likelihood of this complication.

One case was produced during a transseptal puncture.

These six cases are summarized briefly in table 1 and in more detail below.

Case Reports

Case 1

A 15-year-old boy had physical findings consistent with congenital aortic stenosis; consequently a transthoracic direct left heart catheterization was performed on August 17, 1961, under local anesthesia according to the technic described by Levy et al.13 The flexible metal stylet was introduced into the left ventricle through the needle and, under fluoroscopic guidance, attention was directed toward the aortic valve. After several seconds of manipulation with the flexible stylet, it was obvious that the terminal portion of the stylet had broken off within the left ventricular cavity. The Teflon catheter and the remainder of the stylet were withdrawn. The procedure was discontinued, and several chest x-rays were taken for localization of the broken portion of the stylet. It was obvious that the foreign body was lying in the outflow tract of the left ventricle, and its position appeared unchanged over a period of several hours (fig. 1). Therefore, the patient was returned in good condition to his room.

During the next 5 days he was treated with anticoagulants and his vital signs were carefully watched. These remained stable, and several more x-rays showed the foreign body in the same position.

On August 22, 1961, aortic valvular commissurotomy under direct vision with use of the pump oxygenator was carried out through midline sternotomy.

The stylet was readily removed from the left ventricular outflow tract without any difficulty (fig. 2). Examination, however, showed it to be

From the Department of Surgery, University of Minnesota Medical Center and Variety Club Heart Hospital, Minneapolis, Minnesota.

Supported by Life Insurance Medical Research Fund, U. S. Public Health Service Grant No. HE-00830, Anthony Barnett Fund, Benefactors Cardiovascular Research Fund, Maria and Joseph Gales Ramsey III Research Fund, Max Baer Cardiovascular Research Fund of Fraternal Order of Eagles, and American Cyanamid Co., Lederle International Fellowship (Dr. Grossling).
Table 1
Summary of Six Patients with Intracardiac or Great Vessel Foreign Bodies of Iatrogenic Origin

<table>
<thead>
<tr>
<th>Case no.</th>
<th>Age (yr.)</th>
<th>Diagnosis</th>
<th>Procedure</th>
<th>Type of foreign body and location</th>
<th>Treatment</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>15</td>
<td>Aortic stenosis, congenital</td>
<td>Percutaneous direct left heart catheterization</td>
<td>Tip of metal stylet in left ventricle</td>
<td>Removal by open-heart surgery and aortic valvuloplasty with heart-lung machine</td>
<td>Excellent</td>
</tr>
<tr>
<td>2</td>
<td>41</td>
<td>Arnold-Chiari malformation</td>
<td>Insertion of Pudenz-Holter valve</td>
<td>Pudenz-Holter valve into right ventricle and pulmonary artery</td>
<td>Caval occlusion and pulmonary arteriotomy for direct vision removal</td>
<td>Excellent</td>
</tr>
<tr>
<td>3</td>
<td>8/12</td>
<td>Hydrocephalus</td>
<td>Insertion of Pudenz-Holter valve</td>
<td>Pudenz-Holter valve into pulmonary artery</td>
<td>Caval occlusion and pulmonary arteriotomy for direct vision removal</td>
<td>Excellent</td>
</tr>
<tr>
<td>4</td>
<td>69</td>
<td>Coronary atherosclerosis</td>
<td>Percutaneous puncture and catheterization of right subclavian artery for coronary arteriography</td>
<td>Tip of metal stylet in right subclavian and artery</td>
<td>Removal by right subclavian arteriotomy</td>
<td>Excellent</td>
</tr>
<tr>
<td>5</td>
<td>35</td>
<td>Calcific aortic stenosis</td>
<td>Transseptal atrial puncture for left heart catheterization</td>
<td>Tip of metal stylet in right and left atrium</td>
<td>Removal by right atriotomy and aortic valve replacement by ball-valve prosthesis with heart-lung machine</td>
<td>Died after op.</td>
</tr>
<tr>
<td>6</td>
<td>9</td>
<td>Aortic stenosis, congenital, Postoperative 1 year</td>
<td>Percutaneous direct left heart catheterization for postoperative evaluation</td>
<td>Tip of metal stylet in left ventricle</td>
<td>Removal through left atriotomy with heart-lung machine</td>
<td>Excellent</td>
</tr>
</tbody>
</table>
covered with soft clot, despite the use of anticoagulants. This observation indicated to us that immediate removal of such foreign bodies, the patient’s condition permitting, was more desirable.

Postoperative convalescence was uneventful.

Case 2

A 41-year-old white woman had had an Arnold-Chiari malformation for approximately 11 years. In November 1961, a Pudenz-Holter valve was placed with good symptomatic relief. She was well for approximately 3 months, and then had recurrence of previous symptoms of rhinorrhea and diplopia. It was suspected that the Pudenz valve had become detached; this was confirmed when angiograms revealed the valve coiled within the right atrium and extending into the right ventricle (fig. 3). It was considered desirable to remove this valve prior to replacement of another one in the proper position.

On June 18, 1962, via midline sternotomy, the Pudenz valve was removed from the pulmonary artery during caval inflow occlusion and moderate hypothermia. No clots were found, and postoperative recovery was uneventful.

Case 3

An 8-month-old white boy had a Pudenz valve inserted into the right jugular vein on February 1, 1962. It functioned well for about a month at which time the inferior portion of the valve became loosened. A forward angiogram on May 4, 1962, showed the Pudenz valve lying in the right
ventricle and extending into the pulmonary artery (fig. 4).

On May 7, 1962, through a midline sternotomy, the foreign body from the pulmonary artery was removed during inflow caval occlusion and moderate hypothermia.

The patient tolerated this procedure very well, and recovery was uncomplicated.

Case 4

A 69-year-old white woman came to our hospital with a history of severe angina pectoris, peripheral edema, and dyspnea. Her electrocardiogram showed left bundle-branch block without definite infarct pattern. A clinical diagnosis of coronary artery disease was made. On May 4, 1962, coronary arteriogram was attempted under local anesthesia by way of the right subclavian artery approach by the Amplatz technic. The catheter guide wire broke off and remained in the right subclavian and innominate artery. X-rays clearly revealed the metallic foreign body (fig. 5). The same day, 2 hours later, the foreign body was removed through a right fourth thoracotomy and right innominate arteriotomy.

The patient was placed on anticoagulants and her postoperative recovery was uncomplicated.

Case 5

A 35-year-old white man on May 8, 1962, underwent right heart catheterization and aortography with a precatheterization diagnosis of severe aortic stenosis. A transseptal catheterization was performed with a Brockenbrough catheter. The left atrium was entered with only slight difficulty, but during the manipulation, the distal end of the stylet became detached and remained in a position across the atrial septum (fig. 6).

The patient was given anticoagulants and carefully watched. On May 23, 1962, through midline sternotomy and with use of the pump oxygenator, the wire stylet was removed through a right atriotomy. It had only minimal evidence of fibrin. Aortic valve replacement with a Starr-Edwards valvular prosthesis was performed. There was no evidence of functional disability due to the presence of the stylet in the chambers of the heart. The patient appeared to tolerate the immediate procedure very well, but several hours later in the postanesthetic recovery room, he developed
sudden ventricular fibrillation. He was massaged externally for 1 hour unsuccessfully. Permission for an autopsy was not granted.

This patient was the only fatality in this series, and there was no significant evidence that the foreign body contributed to the unfavorable result.

Case 6

A 9-year-old white boy underwent open-heart surgery for a bicuspid stenosed aortic valve on July 3, 1961. He was readmitted in July 1962 for routine postoperative catheterization.

A percutaneous transthoracic left ventricular puncture under local anesthesia was performed with use of the same technic previously described. Under fluoroscopy the spring stylet was guided into the left ventricle when the tip of the stylet broke off. The procedure was immediately discontinued. The remaining piece of the spring stylet was seen in the left ventricle in the vicinity of the mitral valve (fig. 7).

He was given anticoagulants and 2 hours later, a posterolateral thoracotomy was performed. The patient was heparinized and linked to the pump oxygenator. The heart was fibrillated electrically and moderate general body hypothermia was instituted. Through a left atriotomy, the tip of the spring stylet was removed from the left ventricle underneath the mitral valve.

His postoperative recovery was uneventful.

---

**Discussion**

Decker2 26 years ago stated that a foreign body of the heart should not be removed simply because of its presence. He also stated that there was no emergency in those patients who survived the original trauma. He placed the operative mortality rate at 50 per cent. However, during the years following, these ideas have changed substantially.

As far back as 1946, Harken and Zoll stated that intracardiac or vascular foreign bodies should be removed for the following reasons: to prevent embolus of the foreign body or associated thrombus, to reduce danger of bacterial endocarditis, to prevent recurrent pericardial effusions, to diminish incidence of myocardial damage, and to obviate pain or cardiac neurosis.

In five of our cases, open-heart surgery was employed, since it was the most feasible way to remove successfully these intracardiac foreign bodies. For two of these cases of intracardiac foreign bodies, bypass surgery was not considered necessary and only caval inflow occlusion with mild general body hypothermia was utilized.

The postoperative course of five of these six patients was completely uneventful. The one death, after aortic valve replacement for calcific stenosis, appeared related to the basic disease and not a consequence of removal of the foreign body.

The successful results obtained in our series are attributed mainly to prompt surgery and use of the heart-lung machine, which permits safe removal of the foreign body, when the position of the intracardiac foreign body was either less favorable or other definitive surgery was necessary. We think that better results are obtained when the operation is done earlier, thereby not giving time for clot formation.

When the surgical removal is not planned immediately for some significant reason, anticoagulant therapy is probably of some value.

To avoid the problem of embolization of Pudenz valves, more study might be devoted to methods of fixation. Likewise, valves of

---

**Figure 7**

Case 6. Broken metal stylet lying within left ventricle underneath mitral valve.
radiopaque substances should be used to facilitate accurate localization. As already mentioned, the flexible-tipped stylet has been redesigned to prevent the problems of fatigue fracture of this flexible tip, and no further breakages have occurred in the last 310 cases studied.

Summary
This paper reports six cases (age range 8 months to 69 years) of iatrogenic foreign bodies lodged within the heart or great vessels. Four cases were produced during left heart catheterization by breakage of a metal stylet, and two after the insertion of a Pudenz valve (for hydrocephalus) which embolized into the right ventricle and pulmonary artery.

In five of these patients, the foreign body was intracardiac (three in the left ventricle and two in the right ventricle and pulmonary artery) and the open-heart surgery was utilized for successful removal. In the sixth patient, the stylet was removed from the innominate artery via a closed procedure. Five of the six patients survived (including the youngest and oldest) and their postoperative course was uneventful. The one death followed removal of the right-left atrial foreign body and total aortic valve replacement for calcific stenosis, and failure appeared related to the basic disease rather than to the foreign body.

Such complications have rarely been reported in the literature. The high ratio of success, if treatment is prompt before the formation of clots (which is rapid), needs full appreciation, and emphasis is given to the benefits of prompt surgery for removal.

References
Removal of Iatrogenic Foreign Bodies within Cardiac Chambers and Great Vessels

C. WALTON LILLEHEI, RAYMOND C. BONNABEAU, JR. and SERGIO GROSSLING

_Circulation_. 1965;32:782-787
doi: 10.1161/01.CIR.32.5.782

_Circulation_ is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
Copyright © 1965 American Heart Association, Inc. All rights reserved.
Print ISSN: 0009-7322. Online ISSN: 1524-4539

The online version of this article, along with updated information and services, is located on the World Wide Web at:
http://circ.ahajournals.org/content/32/5/782

Permissions: Requests for permissions to reproduce figures, tables, or portions of articles originally published in _Circulation_ can be obtained via RightsLink, a service of the Copyright Clearance Center, not the Editorial Office. Once the online version of the published article for which permission is being requested is located, click Request Permissions in the middle column of the Web page under Services. Further information about this process is available in the Permissions and Rights Question and Answer document.

Reprints: Information about reprints can be found online at:
http://www.lww.com/reprints

Subscriptions: Information about subscribing to _Circulation_ is online at:
http://circ.ahajournals.org/subscriptions/