The Preponderance of Posterior Circulatory Events Is Independent of the Route of Cardiac Catheterization

Gary R. Keilson, MD; William J. Schwartz, MD; and Lawrence D. Recht, MD

Background and Purpose: Central nervous system complications of cardiac catheterization are most often attributed to embolic events that occur at the time of catheter manipulation. Nevertheless, the reason that over 50% of these events are localized to the posterior circulation remains unexplained. One potential explanation offered for this preponderance is the use of the brachial artery approach. In this report, we examined the relation between the route of catheterization and central nervous system complications.

Summary of Report: We retrospectively analyzed all central nervous system complications that occurred after cardiac catheterization through a femoral route at our institution over a 3 1/2-year period. Thirteen patients were identified as having central nervous system complications. Using defined criteria, posterior circulatory events still accounted for at least 54% of central nervous system complications.

Conclusions: The preponderance of posterior circulatory events is apparently independent of the route of catheterization. Furthermore, given the array of neurological symptoms and their often complete resolution, we feel it is unlikely that embolism is the sole pathophysiological mechanism involved in these events.

Cerebral or cerebrovascular events occur in approximately 0.2% of patients undergoing cardiac catheterization and are felt to occur most frequently as a result of embolism. However, unlike embolic strokes in the general population, more than 50% of cardiac catheterization-associated events involve the vertebrobasilar circulation. One proposed explanation for this predominance is that as the catheter is passed from the axillary to the subclavian artery, it is manipulated in the area near the origin of the vertebral artery. Thus, emboli preferentially enter the posterior circulation. Kosmorsky et al reasoned that if this were so, the use of a femoral approach would result in a lower incidence of posterior circulatory events. Because such an approach is primarily used at our institution, we tested this proposition.

Subjects and Methods

Between January 1987 and July 1990, 3,880 cardiac catheterizations were performed at University of Massachusetts Medical Center. Using a computerized data base in which all neurological admissions and consultations are recorded, we accessed all patients for whom neurological consultations were obtained within 48 hours after femoral cardiac catheterization. Medical records were obtained, and demographic characteristics, neurological signs, symptoms, and eventual outcomes were recorded for all patients. For a patient to be classified as having had a posterior circulatory event, one or more of the following had to be present: vertigo, diplopia, cortical blindness, internuclear ophthalmoplegia, limb ataxia, or nystagmus. Symptoms or signs of anterior circulatory events included aphasia and neglect. Although hemiparesis and homonymous hemianopsia may also reflect posterior circulatory disturbance, we classified them as manifestations of anterior circulation events. For other symptoms and signs, such as nonlocalizable ocular symptoms, confusion, or memory loss, involved circulation could not be determined.

Results

In the study period, 13 patients (0.3%) were identified for whom neurological consultation was requested for a central nervous system (CNS) disturbance that occurred after a cardiac catheterization was performed through a femoral route.

Table 1 summarizes the pertinent characteristics of this group. There were seven women and six men whose ages ranged from 45 to 85. Complications occurred either during catheterization (six patients) or within 3 hours after completion of catheterization (seven patients). Neuroophthalmologic signs and symptoms (diplopia, nystagmus, internuclear ophthalmoplegia, field cut), present in 62% of patients, represented the most common group of symptoms and signs encountered. Other commonly encountered symptoms and signs included confusion (23%), vertigo (23%), limb ataxia (15%), dysarthria (15%), and hemiparesis (15%).

The CNS symptoms and signs resolved completely within 48 hours in all but two patients. The only significant persistent deficits were a completed midbrain stroke in an...
85-year-old woman and a right homonymous hemianopsia and Wernicke's aphasia in a 79-year-old man. The latter patient subsequently improved slowly but had not returned to normal when last evaluated 5 days after the event. Either computed tomographic (five patients) or magnetic resonance imaging (one patient) scans were obtained in six patients at a median interval of 10 hours (range, 3–96 hours) after the event. Interestingly, despite clinical improvement in most patients, notable abnormalities including two cerebellar infarctions, one right brain infarction, and one left posterior cerebral artery infarction were observed. The radiographic abnormalities correlated well with the initial clinical findings in all cases. Only two patients (33%) had negative scans.

According to our clinical criteria, the posterior circulation was involved in seven patients and the anterior circulation in one; in the remaining five, the signs or symptoms could not be localized (Table 1). Therefore, of those events that could be localized, 87% involved the posterior circulation. Even if all the uninterpretable events were to be attributed to anterior circulatory disturbances, posterior circulatory events would still be responsible for 54% of the cerebrovascular complications that followed femoral-approach cardiac catheterizations.

**Discussion**

Kosmorsky et al proposed that the high incidence of posterior circulatory events resulted from the right ante-cubital approach, and they speculated that the use of femoral catheters would decrease this predominance. In our series of patients in whom neurological complications occurred only after femoral catheterization, this prediction was not confirmed; posterior circulatory events still accounted for at least 54% of CNS complications.

Embolic has been the most frequently advanced etiology of catheter-associated cerebrovascular events. Therefore, in addition to catheter-induced embolism, local trauma to the vertebral artery, embolization from the left ventricle, and embolization from a carotid sheath clot have been offered as possible sources of these events. Nevertheless, given the still-unexplained preponderance of posterior circulatory events and the apparent lack of correlation with route of catheterization, it seems unlikely that embolism is the sole pathophysiological mechanism involved. In one study, emboli could be documented in only one sixth of patients with neurological sequelae of cardiac catheterization. Another study found a higher frequency of posterior circulatory events even after cardiac catheterization in patients with normal coronary arteries; because emboli would be expected to result more frequently in association with atherosclerotic vessels, this negative association is consistent with the contention that these events are not solely due to emboli.

The rapid resolution of CNS events after catheterization may suggest other etiologies. For example, vasospasm or a migrainous phenomenon could be invoked. Symptoms that were very suggestive of migraine or vasospasm developed in at least two of our cases after catheterization. A history of migraine might be an important factor in predisposing patients to visual disturbances during catheterization, although we could not ascertain this in our series. Alternatively, other complications such as cortical blindness may have been related to the administration of contrast agents, as has been noted to occur mainly after vertebral angiography. Considering the wide spectrum of events both in terms of their temporal profile and clinical characteristics, it seems probable, however, that no single factor is exclusively responsible for the pathogenesis of these complications.

**References**

1. Pepine CJ (ed): _Diagnostic and Therapeutic Cardiac Catheterization_. Baltimore, Md, Williams & Wilkins Co, 1989

**Table 1. Cerebrovascular Complications of Cardiac Catheterization at the University of Massachusetts Medical Center, 1987–1990**

<table>
<thead>
<tr>
<th>Patient</th>
<th>Age/sex</th>
<th>Symptoms and signs</th>
<th>Circulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>70/M</td>
<td>Nystagmus, skew deviation, ataxia</td>
<td>P</td>
</tr>
<tr>
<td>2</td>
<td>60/M</td>
<td>Nystagmus, vertigo, nausea, vomiting</td>
<td>P</td>
</tr>
<tr>
<td>3</td>
<td>70/M</td>
<td>Confusion, cortical blindness</td>
<td>P</td>
</tr>
<tr>
<td>4</td>
<td>56/F</td>
<td>Vertigo, dysarthria, limb ataxia</td>
<td>P</td>
</tr>
<tr>
<td>5</td>
<td>85/F</td>
<td>Internuclear ophthalmoplegia, hemiparesis</td>
<td>P</td>
</tr>
<tr>
<td>6</td>
<td>45/F</td>
<td>Nystagmus, nausea, vomiting, vertigo</td>
<td>P</td>
</tr>
<tr>
<td>7</td>
<td>68/F</td>
<td>Dysarthria, bilateral hand numbness</td>
<td>P</td>
</tr>
<tr>
<td>8</td>
<td>79/M</td>
<td>Wernicke's aphasia, field cut</td>
<td>A</td>
</tr>
<tr>
<td>9</td>
<td>52/F</td>
<td>Flashing lights, right eye</td>
<td>U</td>
</tr>
<tr>
<td>10</td>
<td>64/M</td>
<td>Paresthesias of face, arm, and leg</td>
<td>U</td>
</tr>
<tr>
<td>11</td>
<td>58/F</td>
<td>Confusion, left arm weakness, nausea</td>
<td>U</td>
</tr>
<tr>
<td>12</td>
<td>60/F</td>
<td>Blurred vision, left eye</td>
<td>U</td>
</tr>
<tr>
<td>13</td>
<td>70/M</td>
<td>Confusion</td>
<td>U</td>
</tr>
</tbody>
</table>

P, posterior; A, anterior; U, uncertain.
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