Acute Aortic Dissection Related to Crack Cocaine

Priscilla Y. Hsue, MD; Cynthia L. Salinas, MD; Ann F. Bolger, MD; Neal L. Benowitz, MD; David D. Waters, MD

Background—Although single case reports have described acute aortic dissection in relation to cocaine use, this condition is not widely recognized, and the features of cocaine-related aortic dissection have not been defined.

Methods and Results—We reviewed all available hospital charts from 1981 to 2001 with the ICD-9 diagnosis of aortic dissection. Among the 38 cases of acute aortic dissection, 14 (37%) were related to cocaine use. Crack cocaine was smoked in 13 cases and powder cocaine was snorted in 1 case. The mean interval between cocaine use and the onset of symptoms was 12 hours (range, 0 to 24). Patients with cocaine-related dissection were much younger and more likely to undergo surgery compared with patients with aortic dissection without cocaine use. Most in the cocaine group were black, with a history of untreated hypertension. However, the two groups did not differ in other respects, including dissection type.

Conclusions—In an inner city population, acute aortic dissection in the setting of crack cocaine use is common, presumably as a consequence of abrupt, transient, severe hypertension and catecholamine release. This diagnosis should be considered in cocaine users with severe chest pain. (Circulation. 2002;105:1592-1595.)

Key Words: aorta ■ cocaine ■ catecholamines

It is estimated that 25 million Americans have used cocaine, and 1.5 million use it on a regular basis. Cocaine use is associated with a variety of cardiovascular manifestations including hypertension, myocardial infarction and ischemia, coronary vasospasm, arrhythmias, and cardiomyopathy. According to data compiled from the Drug Abuse Warning Network (DAWN), cocaine is the most frequently mentioned illicit drug in emergency room visits. Approximately 5 million people annually undergo evaluation in emergency departments in the United States for acute chest pain. The proportion of these episodes that are related to cocaine use is difficult to determine; however, in one study from 1 suburban hospital and 3 urban hospitals, cocaine use was documented in 17% of patients under the age of 60 years who were admitted with chest pain. The evaluation of chest pain after cocaine use is complicated by the unreliability of the ECG for diagnosing myocardial infarction and the low rate of myocardial infarction among patients with suggestive symptoms.

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Acute aortic dissection is an uncommon cause of chest pain. However, early recognition is crucial because if left untreated, the mortality rate is 35% at 24 hours, 50% at 48 hours, and 80% by 2 weeks. In our experience in an urban hospital serving uninsured patients, acute aortic dissection is commonly associated with antecedent cocaine use. However, only single cases of cocaine-related acute aortic dissection have been described in the medical literature. The purpose of our study was to determine the frequency of cocaine use in acute aortic dissection patients presenting to our hospital and to compare the clinical features of patients who have dissection with and without cocaine use.

Methods

Practice points

- Acute aortic dissection is an uncommon cause of chest pain.
- Early recognition is crucial because if left untreated, the mortality rate is high.

Patient Selection

We reviewed the available charts of all patients hospitalized with the ICD-9 code diagnosis of aortic dissection (441.00 to 441.03) between 1981 and 2001 at San Francisco General Hospital. Of the 38 cases identified, the 27 patients hospitalized between 1995 and 2001 inclusive represent a consecutive series; some charts of potential cases before 1995 were not available. In all cases, the diagnosis was confirmed by transesophageal echocardiography, MRI or CT scanning, age, sex, ethnicity, cocaine use (including frequency, duration, and route), hypertension, other coronary risk factors, medications, presentation (including time of onset of symptoms from most recent cocaine use and blood pressure and heart rate on admission), type of dissection, treatment, and in-hospital outcome were recorded. Left ventricular hypertrophy was diagnosed by standard electrocardiographic or echocardiographic mass criteria. Cocaine use was determined on the basis of self-report. Urine toxicology was positive for cocaine in 9 of the 14 cocaine-related cases and was not measured in the other 5; only 2 patients in the noncocaine group were tested, and both were negative. Two of the urine screens that were positive for cocaine were also positive for morphine, and one of the negative...
Clinical Features of Aortic Dissection Patients With and Without Cocaine Use

<table>
<thead>
<tr>
<th></th>
<th>Cocaine (n=14)</th>
<th>No Cocaine (n=24)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (±SD), y</td>
<td>41±8.8</td>
<td>59±12</td>
<td>0.000002</td>
</tr>
<tr>
<td>Male sex</td>
<td>8/14 (57%)</td>
<td>17/24 (71%)</td>
<td>0.39</td>
</tr>
<tr>
<td>Cigarette smoking</td>
<td>14/14 (100%)</td>
<td>10/19 (53%)</td>
<td>0.0025</td>
</tr>
<tr>
<td>Black race</td>
<td>11/14 (79%)</td>
<td>9/22 (41%)</td>
<td>0.027</td>
</tr>
<tr>
<td>History of hypertension</td>
<td>11/14 (79%)</td>
<td>17/24 (71%)</td>
<td>0.60</td>
</tr>
<tr>
<td>No antihypertensive drugs</td>
<td>7/11 (64%)</td>
<td>7/15 (47%)</td>
<td>0.39</td>
</tr>
<tr>
<td>Left ventricular hypertrophy</td>
<td>10/14 (71%)</td>
<td>14/22 (64%)</td>
<td>0.63</td>
</tr>
<tr>
<td>Systolic blood pressure, mm Hg</td>
<td>191±41</td>
<td>173±40</td>
<td>0.20</td>
</tr>
<tr>
<td>Diastolic blood pressure, mm Hg</td>
<td>95±28</td>
<td>96±27</td>
<td>0.97</td>
</tr>
<tr>
<td>Heart rate, bpm</td>
<td>87±23</td>
<td>91±18</td>
<td>0.59</td>
</tr>
<tr>
<td>Mediastinal widening on chest x-ray</td>
<td>10/13 (77%)</td>
<td>11/19 (58%)</td>
<td>0.27</td>
</tr>
<tr>
<td>Aortic insufficiency</td>
<td>5/14 (36%)</td>
<td>4/20 (20%)</td>
<td>0.31</td>
</tr>
<tr>
<td>Time to diagnosis, h</td>
<td>3.3±1.9</td>
<td>5.3±3.6</td>
<td>0.12</td>
</tr>
<tr>
<td>Type A dissection</td>
<td>6/14 (43%)</td>
<td>9/21 (43%)</td>
<td>1</td>
</tr>
<tr>
<td>Aortic surgery</td>
<td>9/14 (64%)</td>
<td>5/23 (22%)</td>
<td>0.0007</td>
</tr>
<tr>
<td>Length of stay, days</td>
<td>6.7±3.9</td>
<td>4.1±5</td>
<td>0.082</td>
</tr>
<tr>
<td>In-hospital death</td>
<td>4/14 (29%)</td>
<td>4/23 (17%)</td>
<td>0.42</td>
</tr>
</tbody>
</table>

Values for some of the denominators are incomplete because of missing data. Values are shown as number of patients (%) or mean ± SD.

cocaine screens was positive for benzodiazepines. This study was approved by the Committee on Human Research at the University of California, San Francisco.

Statistical Analyses
The clinical features of patients with aortic dissection, with and without cocaine use, were compared by means of the χ² or Student’s t test. A value of P<0.05 was considered statistically significant. No adjustment was made for multiple testing.

Results
Thirty-eight cases of acute aortic dissection were identified. Of these, 14 (37%) were associated with cocaine use. Crack cocaine was smoked in 13 cases and powder cocaine was snorted in 1 case. The mean interval between cocaine use and the onset of chest pain or other symptoms was 12 hours but ranged from 0 to 24 hours. All patients in the cocaine group reported use within 24 hours, whereas none of the patients in the noncocaine group reported any past use. The chronicity of cocaine use either could not be accurately determined or was not recorded in most cases. The pattern of aortic dissection was type A in 6 cases and type B in 8. Moderate or severe aortic insufficiency based on echocardiographic data was present in 5 cases, including 1 who underwent emergency pericardiocentesis for tamponade. In 2 of the 5 patients, aortic insufficiency was probably unrelated to the aortic dissection because the dissection involved only the descending aorta (type B).

The clinical features of patients with aortic dissection with and without cocaine use are compared in the Table. Cocaine users were younger and more likely to be black, and all smoked cigarettes. Hypertension had been diagnosed in 10 of the 11 black cocaine users and in the one Latino cocaine user. Ten of these 11 patients had documented left ventricular hypertrophy, and at least 7 of them were not taking their prescribed antihypertensive medication. Even though the proportion of type A and B dissections were similar in the cocaine and noncocaine patients, fewer patients in the noncocaine group received aortic surgery. Surgery was not performed in 5 type A dissections unrelated to cocaine because of combinations of advanced age, severe comorbidities, and hesitation on the part of patients, their families, or the surgeon. For other clinical features not included in the Table, such as presenting symptoms, the two groups were similar and the features were as expected for patients with acute aortic dissection.

Discussion
Acute aortic dissection was associated with recent crack cocaine use in more than one third of all cases in this study. The typical patient with cocaine-related aortic dissection is younger and more likely to be black, compared with other patients with aortic dissection, and has untreated hypertension and left ventricular hypertrophy. Aortic dissection should be considered as a possible diagnosis in recent cocaine users who have severe chest pain.

Previous Studies
Myocardial ischemia and infarction are widely recognized complications of cocaine use; however, acute aortic dissection is less well appreciated. Cocaine is not listed among the factors related to acute aortic dissection in most textbooks. Single cases of aortic dissection have previously been reported. Rashid et al.12–16 tabulated 11 previous case reports in 1996, in addition to their own case. They noted that most patients were young and had untreated or poorly treated hypertension. As with acute dissections unrelated to cocaine, the location of the dissection appears to be approximately equally divided between types A and B, both in our series and
in previously reported cases.\textsuperscript{12–16} In addition to aortic dissection, acute coronary dissection has also been reported in the setting of cocaine use.\textsuperscript{17,18}

**Pathophysiological Mechanisms**

Acute aortic dissection requires an inherent weakness of the aortic media, such as chronic hypertension or a connective tissue disorder, and sudden changes in hemodynamic shear stress. In our study, 11 of the 14 cocaine users (79\%) had hypertension, whereas 7 (64\%) were not taking prescribed antihypertensive medications. Cocaine stimulates central neural sympathetic outflow and blocks the reuptake of catecholamines in the synaptic clefts, producing sustained adrenergic stimulation.\textsuperscript{19} The resulting increases in heart rate, blood pressure, and myocardial contractility would theoretically increase the risk of aortic dissection, particularly if baseline arterial pressure were elevated.

Cocaine, through synaptic stimulation and release of endothelin, also induces vasoconstriction\textsuperscript{20} and may be prothrombotic in humans.\textsuperscript{21,22} If these processes occurred in the vasa vasorum, the aortic wall could theoretically be weakened.

Cigarette smoking has been reported to increase the vasoconstriction associated with cocaine use.\textsuperscript{23} All 14 of our patients with cocaine-related dissection smoked cigarettes. Whether this is a causative factor or merely a reflection of the habits of crack cocaine users is unknown. Alcohol and heroin were also used with cocaine by some of our patients. Cocaethylene, a cocaine metabolite formed only in the presence of ethanol, profoundly decreased myocardial contractility and stroke volume in the dog,\textsuperscript{23} a response that might theoretically protect against dissection. In an autopsy series, methamphetamines were found in 7 of 35 patients with acute aortic dissections.\textsuperscript{24} None of our patients reported amphetamine use, although urine samples were not always tested to rule out this possibility.

Thus, the mechanism by which cocaine predisposes patients to acute aortic dissection is most likely multifactorial, involving the effects of chronic hypertension, cigarette smoking, and cocaine use on atherosclerosis, medial necrosis, and acute hemodynamic stress.

**Crack Cocaine**

Cocaine hydrochloride is a water-soluble, crystalline salt that is injected intravenously or snorted with absorption into the nasal mucosa. Crack cocaine is prepared by dissolving cocaine hydrochloride in water, mixing with baking soda, and heating. The resulting cocaine base precipitates into a hard mass (a “rock”) that is not water-soluble but which vaporizes at relatively low temperatures and thus can be smoked. Intranasal cocaine induces potent local vasoconstriction, slowing absorption, so that peak plasma concentrations are achieved after 30 minutes. In contrast, smoked crack cocaine is rapidly absorbed by the pulmonary vasculature, achieving peak plasma concentrations within 2 minutes, similar to the quick onset of action of intravenous cocaine.\textsuperscript{25} The euphoria from smoking crack is short-lived, lasting \(\approx 30\) to 45 minutes, leading to repeat use in a binge pattern. Therefore, the hemodynamic consequences of smoking crack, compared with intranasal cocaine, may be more pronounced, more abrupt in onset, and more repetitive.

Crack may therefore be the form of cocaine most likely associated with acute aortic dissection. Our data support this assumption, since crack was the form of cocaine used in 13 of our 14 patients, despite the fact that the ratio of intranasal or injection cocaine users to crack smokers is \(\approx 4:1\) in the United States.\textsuperscript{26} In inner city populations such as ours, this ratio is probably considerably lower.

**Susceptible Subgroup**

The most common predisposing factor for aortic dissection is systemic hypertension.\textsuperscript{10} The majority of our patients had a history of hypertension with left ventricular hypertrophy and were not taking antihypertensive medications. The initial systolic blood pressure was higher in cocaine users than in other patients with dissection, but the difference was not statistically significant. The hypertensive effect of crack cocaine may have dissipated by the time of admission or may have been overwhelmed by the catecholamine release related to severe pain.

Severe hypertension is more common in blacks than in whites, as is crack cocaine use. A 1998 survey yielded an estimate of 159,000 black men and 55,000 black women nationwide who admitted to smoking crack cocaine in the preceding month, compared with 50,000 non-Hispanic white men and 97,000 non-Hispanic white women.\textsuperscript{26} A majority of the blacks but few of the whites were 35 years of age or older and thus at higher risk for aortic dissection. Furthermore, in one study, male sex and black race predicted a greater cardiovascular response to smoked cocaine.\textsuperscript{27}

**Study Limitations**

Our study was retrospective, so information on cocaine use was not collected in a uniform way. Hospital records may be inaccurate. Patients may have denied drug use because of possible social stigma or fear. In one study of patients with chest pain who were examined in emergency departments, only 72\% of those with positive urine tests for cocaine admitted to cocaine use within the preceding week.\textsuperscript{7}

Our study is not helpful in determining the overall prevalence of cocaine-related aortic dissection. Although cocaine use was associated with more than one third of acute aortic dissections presenting to our hospital, this high proportion probably reflects a high rate of crack cocaine use and untreated hypertension in our patient population. We were unable to adjust for socioeconomic and other variables, and our results may not be applicable to other populations. The overall number of patients with aortic dissection in our study is relatively small because the condition is not common.

We were unable to follow our patients prospectively and thus do not know the long-term prognosis of cocaine-related dissection. Patients with aortic dissection who continue to use cocaine are at high risk of aortic rupture and death, based on the outcome of at least one of our cases and at least one other case described in the literature.\textsuperscript{13}

In conclusion, our findings suggest that crack cocaine is a common precipitating factor of acute aortic dissection in an inner city population and should be considered as a diagnosis...
in cocaine users who have chest pain. The typical patient with cocaine-related dissection tends to be younger and more likely to be black, compared with other patients with aortic dissection. The pathophysiological mechanism is most likely multifactorial, including structural changes induced by chronic hypertension and cigarette smoking as well as hemodynamic changes induced by crack cocaine use.

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References
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