Cocaine-associated Chest Pain: How Common Is Myocardial Infarction?

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Abstract. **Objective:** Prior studies addressing the incidence of acute myocardial infarction (AMI) in patients with cocaine-associated chest pain have found divergent results. Previous prospective studies, which found approximately a 6% incidence of AMI, have been criticized for selection bias. This study sought to determine the rate of AMI in patients with cocaine-associated chest pain. **Methods:** All patients seen in an urban university-affiliated hospital between July 1996 and February 1998 were identified by ICD-9 medical records search for cocaine use and chest pain/acute coronary syndromes. In this system, all faculty admit all patients with cocaine-associated chest pain for at least 23-hour observation periods. Data collected included demographics, medical and cocaine use history, presenting characteristics, hospital course, cardiovascular complications, and diagnostic tests using a 119-item closed-question data instrument with high interrater reliability. The main outcome measure was AMI according to World Health Organization (WHO) criteria. **Results:** There were 250 patients identified with a mean age of 33.5 ± 8.5 years; 77% were male; 84% were African American. Of 196 patients tested, 185 had cocaine or cocaine metabolites in the urine (94%). The incidence of cardiac risk factors were: hypercholesterolemia, 8%; diabetes, 6%; family history, 34%; hypertension, 26%; tobacco use, 77%; prior MI, 6%; and prior chest pain, 40%. Seventy-seven percent admitted to cocaine use in the preceding 24 hours: crack, 85%; IV, 2%; nasal, 6%. Twenty-five patients (10%) had electrocardiographic evidence of ischemia. A total of 15 patients experienced an AMI (6%; 95% CI = 4.1% to 8.9%) using WHO criteria. Complications were infrequent: bradydysrrhythmias, 0.4%; congestive heart failure, 0.4%; supraventricular tachycardia, 1.2%; sustained ventricular tachycardia, 0.8%. **Conclusion:** The incidence of AMI was 6% in patients with cocaine-associated chest pain. This result is identical to that found in prior prospective studies. **Key words:** cocaine; acute coronary syndrome; acute myocardial infarction; emergency department; electrocardiogram. ACADEMIC EMERGENCY MEDICINE 2000; 7: 873–877

COCAINE use is associated with a 24-fold increased risk of myocardial infarction during the hour immediately after use.[1] Acute myocardial infarction (AMI) due to cocaine occurs in patients with and without diseased coronary arteries.[2–4] Although recent data suggest that cocaine-associated chest pain is infrequently ischemic in nature,[5] chest pain remains the most frequent cocaine-associated emergency department (ED) complaint.[6] Previous studies have found a widely divergent incidence of AMI in patients with cocaine-associated chest pain, largely due to selection bias.[7–10] The COCHPA (Cocaine Associated Chest Pain) trial was the largest multicenter study to prospectively evaluate the incidence of cocaine-associated myocardial infarction.[11] That study determined the prevalence to be 6%.[11]

The purpose of this study was to determine the frequency of AMI in patients presenting to the ED with cocaine-associated chest pain syndromes. The study ED had a clear-cut widely-adhered-to policy of admitting all patients with cocaine-associated chest pain syndrome. As a result, the uniform clinical pathway for management of these patients is a useful setting to determine the incidence of AMI without the selection bias observed in prior studies.

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METHODS

Study Design. This was a retrospective cohort study of patients with chest pain in the setting of recent cocaine use. The hospital's institutional review board approved this study.

TABLE 1. Demographic and Historical Characteristics of the Study Patients

Age—mean ± SD (years)	33.5 ± 8.5
Gender—male	192 (77%)
Race	
African American	208 (84%)
Hispanic	3 (1%)
White	24 (10%)
Other/unknown	15 (6%)
Cardiac risk factors	
Hypertension	64 (26%)
Hypercholesterolemia	21 (8%)
Family history of coronary artery disease	86 (34%)
Diabetes mellitus	14 (6%)
Tobacco use	192 (77%)
Past medical problems	
Chest pain	100 (40%)
Myocardial infarction	16 (6%)
Congestive heart failure	4 (2%)
Arrhythmias	2 (1%)

Study Setting and Population. Patients who presented to an urban university-affiliated trauma center with an annual ED census of 55,000 were eligible for enrollment. It was departmental policy during the study period that all ED faculty admit all patients with cocaine-associated chest pain for a period of at least 23 hours. A computer-assisted medical records search was performed to identify patients presenting to the ED between July 1, 1996, and February 28, 1998. Patients were identified by cross-referencing the *International Classification of Diseases, Ninth Revision* (ICD-9) codes for chest pain and myocardial infarction with those for cocaine and/or drug abuse. This list of patients was then compared with an ED log that included all admitted patients, to ensure appropriate capture. Patients were included in the study if they had a documented history of cocaine use within the week prior to presentation or a urine toxicology screen that revealed cocaine or cocaine metabolites; had a chief complaint of anterior, precordial, or left-sided chest discomfort less than 12 hours in duration; and were aged 18 years or older.

Study Protocol. All aspects of the medical record were reviewed to obtain information for documentation using a previously described closed-question data collection instrument with excellent interrater reliability for all predictor and outcome variables.[12] Emergency physicians maintained the option of using a template for "chest pain" complete with risk factors and chest pain characteristics that otherwise may have been difficult to retrieve in a retrospective manner. In cases where reports were dictated and information was missing, documentation from the cardiologist's consultation and houseofficer history and physical examinations were utilized. For the minority of cases with missing demographic information despite these retrieval methods, the private physician was contacted and questioned regarding specific missing information. Demographic data included the age, sex, and ethnic group. Historical items noted were the cardiac risk factors, past cardiac history, previous chest pain, and prescription medication use. The time of last cocaine use, route of use, and results of urine toxicology (if sent for toxicologic analysis) were also recorded.

Chest pain was characterized by duration, quality, and location. Associated symptoms of nausea, vomiting, dyspnea, syncope, diaphoresis, or palpitations were recorded if documented. The presences of hypertension, hypotension, bradycardia, tachycardia, and fever at presentation were noted.

The initial electrocardiogram (ECG) was classified into one of six categories using a previously described closed question format.[13] The categories were normal; nonspecific, including early repolarization abnormalities; abnormal but not diagnostic of ischemia; ischemia; or suggestive of acute myocardial infarction.

Cardiac isoenzyme levels were obtained for all patients upon presentation, and then at eight-hour intervals for a total of 24 hours. The presence or absence of myocardial infarction was defined by World Health Organization (WHO) criteria,[14] with creatine kinase–MB (CK-MB) enzyme levels twice the institutional normal value, with a typical rise and fall. In addition, AMI was classified as Q-wave or non-Q-wave and by location according to the ECG.

The hospital course and occurrence and timing of complications such as congestive heart failure, ventricular tachycardia, supraventricular tachydysrythmias, and bradydysrythmias were recorded.

Data Analysis. Data were entered in Microsoft Access 97 (Microsoft, Inc., Redmond, WA) and imported into SPSS for Windows 9.0 (SPSS Inc., Chicago, IL) for statistical analysis. Continuous variables are reported as means ± SD. Categorical variables are reported as the percentage frequency of occurrence. Ninety-five percent confidence intervals are reported for our main outcome, presence of AMI.

RESULTS

We identified 259 patients with cocaine-associated chest pain. Nine patients were discharged from the ED despite a protocol requiring admission. The remaining 250 patients composed the study group.

The nine patients who excluded from the study did not differ significantly from admitted subjects based on age, gender, ethnicity, or cardiac risk factors. Although the subsequent complication rate of the nine patients who were discharged is unknown, all nine were known to be alive at the conclusion of the study period.

The mean age of the study patients was 33.5 ± 8.5 years. There were 192 men (77%) and 58 women (23%). The racial distribution was African American, 208 patients (84%), White, 24 patients (10%), Hispanic, three patients (1%), and other/unknown, 6%. The patients had a mean of 1.5 ± 1.1 traditional cardiac risk factors, with tobacco being the most common risk factor. Demographic characteristics and cardiac risk factors are summarized in Table 1.

All patients either admitted to using cocaine within seven days of presentation or had cocaine metabolites in the urine. Precise historical data regarding cocaine use were available for all but three patients. The most recent use of cocaine was within the preceding 24 hours in 193 patients (78%) and within the preceding four hours in 57 patients (22%). Of the 196 patients who had urine toxicologic studies performed, 185 (94%) were found to have cocaine or cocaine metabolites. Cocaine was most commonly used through inhalation of crack (91%).

The location and quality of chest pain and frequency of associated symptoms are summarized in Table 2. Most patients had substernal pain and most described their pain as pressure/squeezing or tightness, although atypical presentations were also common. The most common associated symptom was dyspnea, but diaphoresis and nausea occurred in more than a fourth of the patients.

Most patients had a normal blood pressure, pulse, respiratory rate, and temperature. Only 24% had systolic hypertension, 15% had diastolic hypertension, and 16% were tachycardic. The remainder of the presenting vital signs are summarized in Table 3.

Normal ECGs were obtained for only 67 patients (27%). One hundred twenty-five patients had nonspecific changes (50%), of whom 41 (34%) had early repolarization changes. Thirty-three patients (13%) had abnormal but nondiagnostic ECGs; six patients had ischemia known to be old (2%); ten patients (4%) had ECGs with ischemia not known to be old; and nine patients (4%) had ECGs suggestive of AMI.

Myocardial infarction was diagnosed in 15 patients (6%: 95% CI = 3.1% to 8.9%). Nine patients had initial ECGs consistent with AMI, four patients had ischemic changes, and two patients had normal or nondiagnostic ECGs. All patients diagnosed as having AMI had at least one elevation in CK-MB to more than two times the upper limit of normal, and all met standard WHO criteria for diagnosis of AMI. Eight AMIs (53%) were anterior in location, six were inferior, and in one the location was indeterminate. Nine of the AMIs (60%) were Q-wave infarctions.

Twenty-four patients were initially admitted to the coronary care unit (CCU). They had a mean CCU length of stay of 2.7 ± 1.9 days. The mean total hospital stay for all patients was 2.2 ± 2.0 days. All 250 patients survived until discharge. Complications were infrequent. They included bradydysrythmias in one patient (0.4%), congestive heart failure in one patient (0.4%), supraventricular tachycardia in three patients (1.2%), and sustained ventricular tachycardia in two patients

TABLE 2. Chest Pain Characteristics

Location	
Substernal	191 (76%)
Left-sided only	33 (13%)
Right-sided only	4 (2%)
Other/unknown	22 (11%)
Quality	
Pressure/tightness/squeezing	138 (55%)
Sharp/stabbing	56 (22%)
Aching/dull	14 (6%)
Burning/indigestion	7 (3%)
Other/unknown	35 (14%)
Pleuritic component	27 (11%)
Associated symptoms	
Shortness of breath	154 (62%)
Diaphoresis	121 (48%)
Palpitations	33 (13%)
Nausea	69 (28%)
Vomiting	19 (8%)
Syncope	15 (6%)

TABLE 3. Vital Signs at the Time of Presentation

Systolic blood pressure	
>140 mm Hg	59 (24%)
91–139 mm Hg	190 (76%)
<90 mm Hg	1 (0.4%)
Diastolic blood pressure	
>90 mm Hg	38 (15%)
≤90 mm Hg	212 (85%)
Pulse	
>100 beats/min	40 (16%)
60–100 beats/min	205 (82%)
<60 beats/min	5 (2%)
Respiratory rate	
>25 breaths/min	10 (4%)
10–25 breaths/min	240 (96%)
<10 breaths/min	0
Temperature > 38°C	4 (2%)

(0.8%). No complication occurred more than 12 hours after ED arrival.

DISCUSSION

Previous studies that have sought to determine the incidence of cocaine-associated myocardial infarction have been limited by selection bias. Retrospective studies have found an incidence of AMI ranging from 0% to 31%.[7–9] Two prospective studies have also been criticized for selection bias; however, the incidence of AMI in both studies was 5–6%.[10,11] The present study was a retrospective case series, but it occurred in a hospital with a uniform admission practice for all patients with cocaine-associated chest pain, decreasing the likelihood of selection bias.

Zimmerman et al. found that three of 48 cocaine-associated chest pain patients (6%) who were admitted to the CCU sustained an AMI.[7] Gitter et al. reported no AMI in their cohort of 101 cocaine-associated chest pain patients admitted to monitored beds.[8] Furthermore, 47 of the 101 patients (46.5%) in the Gitter study had incomplete cardiac marker testing, and ten patients had no enzyme tests performed. In contrast, Amin et al. found that 22 of 70 patients (31%) admitted with cocaine use and chest pain had sustained an AMI.[9] The authors did not enroll ED patients who were discharged home, selecting more acutely ill patients for study enrollment. Amin et al. also reported that the average time from cocaine use to the onset of chest pain was 18 hours. Therefore, the apparent association between cocaine use and myocardial infarction may have simply reflected a high prevalence of cocaine use in the community, and not necessarily a cause-and-effect relationship.

Three prospective studies have addressed the incidence of AMI in patients with cocaine-associated chest pain. Tokarski et al. found that eight of 42 patients (19%) with cocaine-associated chest pain and normal or nonspecific ECGs had elevated cardiac markers.[10] However, they enrolled a convenience sample, and patients with ischemic ECGs were excluded. Several patients in this cohort had CK levels that returned to baseline after the first set of markers was elevated, making interpretation of their data difficult. Only 5% of patients in this study actually met WHO criteria for AMI.

The prospective multicenter study of patients with cocaine-associated chest pain (COCHPA) was specifically designed to reduce the likelihood of selection bias.[11] Patients were prospectively enrolled regardless of ED disposition at six municipal hospital sites. They found the incidence of AMI to be 6% in patients with cocaine-associated chest pain. Although the study was designed to eliminate selection bias, it has been criticized because some of the participating sites had lower-than-expected enrollment rates and the study methodology did not have methods to ensure that all potential study subjects were captured.

Kontos et al. evaluated a cohort of patients with cocaine-associated chest pain with resting sestamibi imaging.[5] They found that six of 69 (8.5%) patients admitted to the CCU sustained an AMI; while only 2.5% of their whole cohort of 241 patients sustained an AMI. Moreover, negative resting sestamibi imaging predicted an excellent 30-day survival. The authors report that myocardial ischemia is infrequently the cause of cocaine-associated chest pain in patients who undergo early perfusion imaging, suggesting that discharge may be a possible alternative to routine admission in low-risk patients with normal perfusion scans.[5]

LIMITATIONS AND FUTURE QUESTIONS

The present study found the incidence of AMI in patients with cocaine-associated chest pain to be 6%. Since departmental policy during the study period mandated hospital admission for patients presenting with a chief complaint of chest pain with cocaine use, we believe that the sample presented is representative of the patient population. We were able to screen ED logs to identify patients who may have been discharged from the ED in contradistinction to the ED policy. Only nine such patients were identified, and they had similar demographic and clinical characteristics to those of the patients included in the study group. Although retrospective chart review is inherently subject to some limitations, we used a data collection instrument that has been shown to have excellent interrater reliability for both predictor and outcome variables.[12]

Our criteria specifically required chest pain as a chief complaint, in addition to recent cocaine use. Therefore, it is possible that patients presenting without chest pain, yet having symptoms consistent with ischemia (e.g., dyspnea, palpitations, shortness of breath), were missed. In addition, we cannot be certain that coding errors did not occur. However, all charts with an ICD-9 code for AMI, both with and without cocaine use, were reviewed for the 19-month study period to minimize over- or undercoding.

During the study period, it was departmental policy that toxicologic screens were included as part of the cardiac profile for patients ≤50 years of age without traditional risk factors. These criteria were selected because previous studies have shown that cocaine use in patients >50 years of age who present to the ED with chest pain is only 2%.[15] Therefore, it is possible that a small number of patients >50 years of age with chest pain who used

cocaine were not captured. We assume that the 6% of patients who admitted to cocaine use but had a negative toxicologic screen either purchased a mislabeled or heavily adulterated substance, or presented within seven days of use, but beyond the sensitivity window for the assay to capture the metabolite.

We used the WHO criteria for diagnosis of AMI, and all patients with an ultimate diagnosis of AMI had CK-MB elevations to higher than 20 IU/L, although our criteria required only two times normal, or 10 IU/L. Therefore, we cannot be certain that a very small number of patients who sustained non-Q-wave myocardial infarctions were missed. Our patient composition was similar to prior studies of this patient population. They were young, predominantly male (76%), cigarette smokers (77%), with chronic cocaine abuse.[5–12] Other than tobacco use, traditional risk factors for coronary artery disease were present less frequently than among patients with chest pain presumed to be of ischemic origin.[4,7,9,16]

Although low-risk groups of traditional patients who may be safely admitted to intermediate care units have been identified,[17] a group of cocaine-associated chest pain patients who can be safely released from the ED based on explicit criteria has not been validated.[18] Hollander et al. have suggested that patients without ischemic ECGs who have negative marker studies and no complications during a 12-hour observation period have only a 1.6 per 1,000 patient risk of subsequent adverse events.[12,18] The present study confirms these data. No patient had an adverse event more than 12 hours after ED arrival. Studies regarding the safety of a nine-hour rule-out protocol followed by stress testing in low-risk patients are forthcoming.

CONCLUSIONS

This study validates the results of the COCHPA study. Patients presenting to the ED with cocaine-associated chest pain have approximately a 6% incidence of myocardial infarction. Given the apparent low risk of complications, future studies may find that following a short ED observational rule-out period, stress testing in low- to intermediate-risk patients may obviate the need for admission.

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