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Original Studies

Iatrogenic Coronary Artery Dissections Extending Into and Involving the Aortic Root

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We set out to determine the incidence of iatrogenic coronary artery dissection extending into the aorta and to characterize the aortic lesions. We reviewed the data from 43,143 cardiac catheterizations from September 1993 through September 1999 and found 9 coronary artery-aortic dissections for an overall incidence of 0.02%. Four of these patients were undergoing treatment for acute myocardial infarction (AMI) and aortic dissection was more common than for non-AMI patients (0.19% vs. 0.01%, $P < 0.0006$). Histologic analysis of tissue samples from 2 cases revealed age related changes only and no evidence of predisposing pathology. Patients with limited aortic involvement were successfully managed with stenting of the coronary dissection entry point whereas aortic dissection extending up the aorta >40 mm from the coronary os required surgical intervention. *Cathet. Cardiovasc. Intervent. 51:387–393, 2000.* © 2000 Wiley-Liss, Inc.

INTRODUCTION

Coronary artery dissection is a well recognized complication of coronary angiography and angioplasty [1]. Rarely, dissection involving the aortic root may also develop (2–11). In a report on 21,000 coronary angioplasties representing the combined experience of several interventional cardiologists, there were four acute aortic dissections for an incidence of 0.02% [6]. Two of these cases required surgical repair. In another report describing 3 cases of catheter induced ascending aortic dissection the incidence was 0.02% for diagnostic angiography and 0.07% for coronary angioplasty cases [5]. Only 1 of the previously reported cases had pathologic examination of the dissected aorta [8]. This case had cystic medial necrosis (CMN) of the aorta and this condition was felt to have caused the dissection. We set out to determine the incidence of aortic dissection during cardiac catheterization and percutaneous coronary intervention (PCI) at our institution. We also sought to identify predisposing factors, characterize the lesions, and ascertain potential predictors of outcome.

METHODS

We retrospectively examined the data from 43,143 cardiac catheterizations and PCIs performed at William Beaumont Hospital, a tertiary cardiac referral center, from September 1993 through September 1999. There were 20,475 PCI's including 2,106 during acute myocardial infarction (AMI). Our computerized search of the database yielded 32 cases in that "aorta" was listed under complications. We then evaluated the individual procedure report and cine film for each case and identified 9 patients in which iatrogenic aortic dissection occurred as a consequence of coronary angiography or PCI. Data collection included age, gender, type of procedure performed, instrumentation used, and acuity of the procedure. Cine radiographic review of each case was undertaken to identify the PCI, procedural step and anatomical disruption associated with the aortic dissection. In the statistical analysis of incidence between groups we used both Chi-square and Fisher's exact test to improve the validity of P values. Diagnostic and therapeutic interventions performed in response to the development of the dissection were evaluated for each case as was peak CPK, length of stay, and final outcome. Histologic evaluation including elastic stain was done on aortas from the two surgically resected cases. Lesions that might predispose to dissection such as cystic medial necrosis (CMN) were sought. When present, these changes were graded according to published criteria [13]. In an effort to better classify the combination coronary artery-ascending aorta dissections, the cases we identified were divided into

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TABLE I. Proposed Classification for Coronary Dissection With Retrograde Extension Into the Aortic Root

Proposed classification	Extent of aortic involvement in the dissection
Class I	Involving the ipsilateral cusp
Class II	Involving cusp and extending up the aorta less than 40 mm
Class III	Involving cusp and extending up the aorta greater than 40 mm

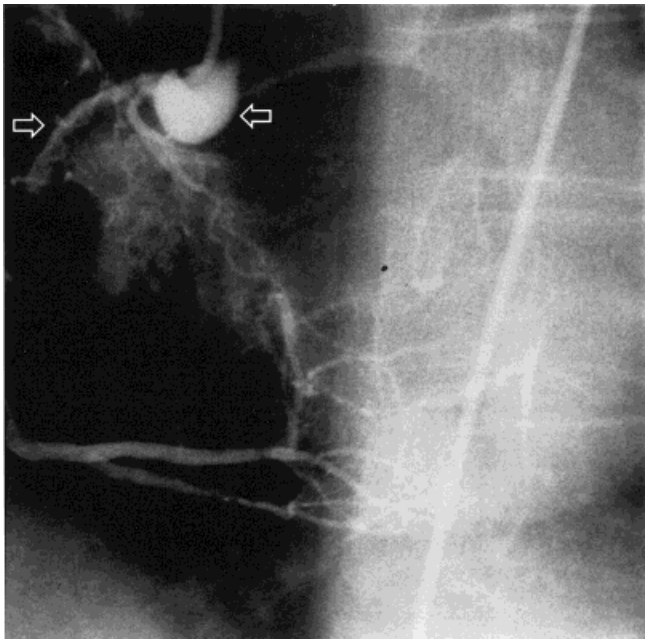

Fig. 1. Case 8 with Class 1 dissection from right coronary artery into right coronary cusp (arrows), JR4 guide. Successfully treated with stent and discharged home on Day 2.

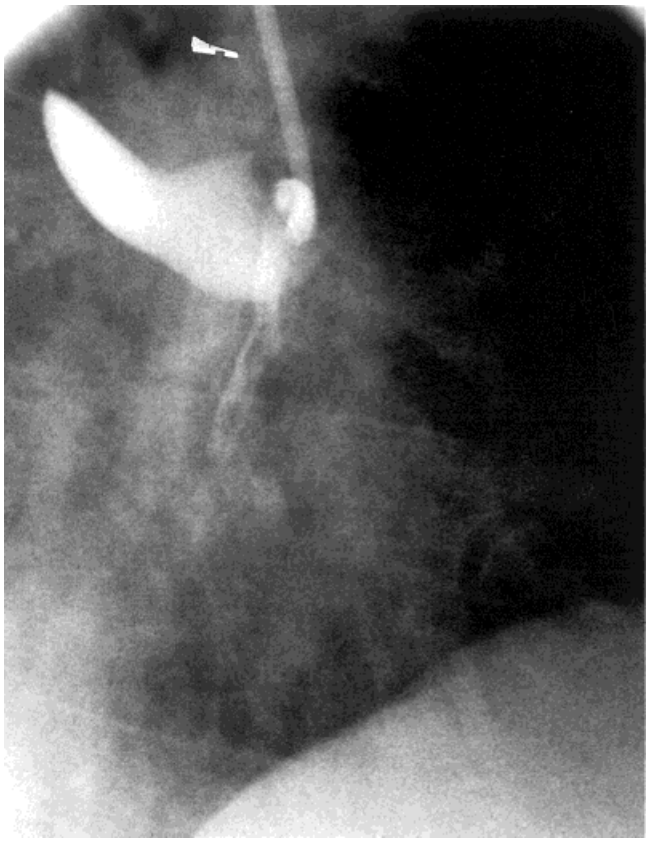

Fig. 2. Case 5, Class 2 dissection occurring during diagnostic angiography in an acute myocardial infarction. Right coronary artery could not be wired and bypass was performed. Patient went home Day 6. JR4 catheter.

three classes (Table I). Class 1 was defined as a focal dissection restricted to the coronary cusp (Fig. 1) and Class 2 extends up the aorta but <40 mm (Fig. 2,3). Class 3 is the most extensive dissection extending from the coronary cusp up the ascending aorta >40 mm (Fig. 4,5). We also applied our classification scheme to previously reported cases where images were available for evaluation [2–5, 8–11].

RESULTS

Of the 43,143 total cardiac catheterizations performed there were 9 cases of iatrogenic aortic dissections for an incidence of 0.02% (Table II). All 9 cases were the result of dissection of the right coronary artery (RCA) extending into the aortic root in a retrograde fashion. Case 7 was a right brachial approach and all the rest were from the standard right femoral artery approach. Four dissections occurred in patients being treated for an acute myocardial infarction (AMI), giving an incidence of 0.19% (Table III). Two of these dissections developed during initial diagnostic angiography, whereas in the other two it occurred during PCI. The other 5 dissections developed during procedures not performed for AMI with only one of these during planned diagnostic angiography (<0.01%). Comparing total acute and elective cases, there was a significant increase in aortic dissection in procedures performed for AMI (0.19%) compared with non-AMI procedures (0.01%), $P < 0.0006$. The incidence of dissection during PCI when both AMI and elective cases were combined was 6 in 20,472 or 0.03 %. There was also an increase in aortic dissection during diagnostic imaging during AMI compared to non-AMI procedures (incidence 0.10% in AMI vs. <0.01 % non-AMI, $P < 0.01$). Peak CPK values, shown in Table IV along with other clinical data, were elevated in only once case and that was likely due to the infarction before catheterization.

The aortic component of the dissections were all Stanford type A (DeBakey type 1 or 2) involving the ascending aorta. Applying our classification scheme allowed more precise description of the coronary artery

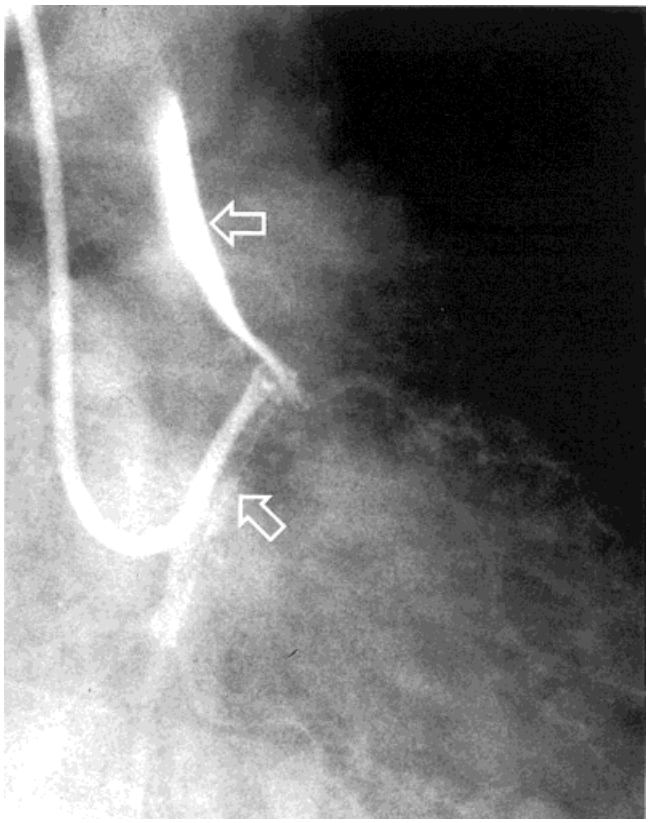

Fig. 3. Case 7 with proximal right coronary artery stent at origin of Class 2 dissection. AL1 guide. Patient was discharged home the next day.

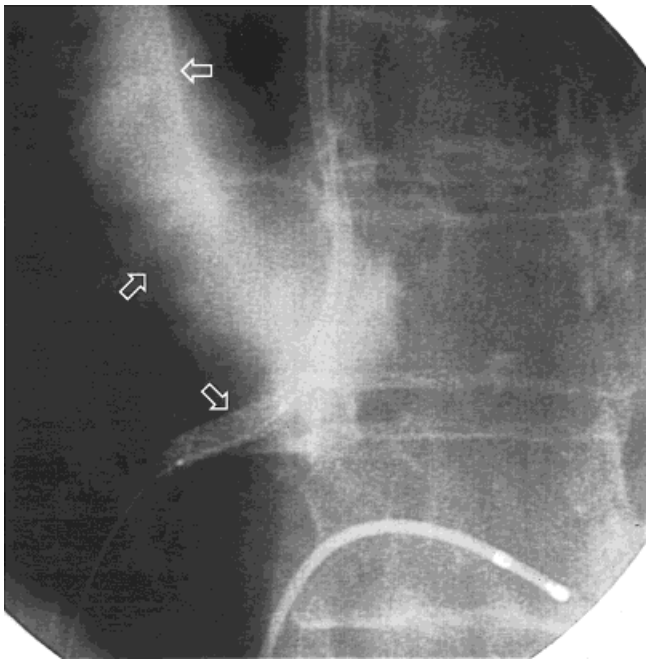

Fig. 4. Case 3, Class 3 dissection. JR4 guide. Stent was placed in proximal right coronary artery (lower arrow) but extra-luminal contrast outlines a widening dissection of the ascending aorta (middle and upper arrows).

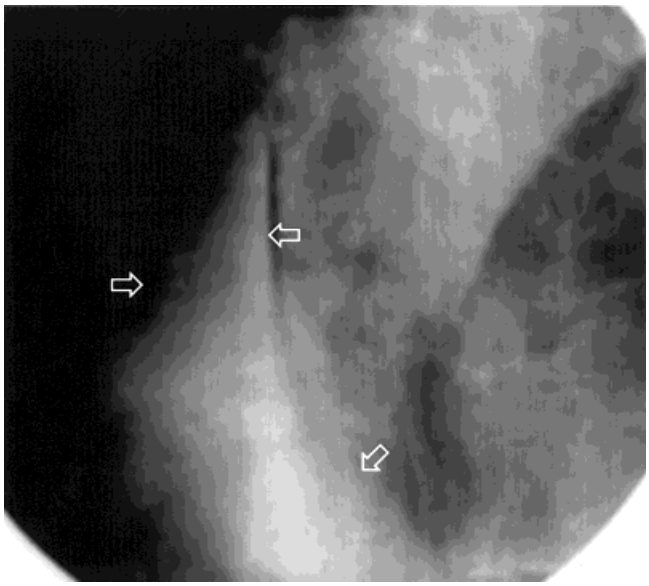

Fig. 5. Another view of Case 3 showing extension of the dissection into the aortic arch. The dissection flap and width are readily identified (arrows). The patient was taken emergently to surgery but was unable to be weaned from bypass and died.

aortic dissections. There were two or more examples of each class among the 9 cases in our study. Two dissections, Cases 3 and 6, extended from the RCA up the aorta to the innominate artery and the aortic arch. The other seven dissections were less extensive. The two cases of Class 3 aortic dissection extended to the aortic arch and had the worst outcome (Table V). All four of the Class 1 dissections were managed medically and had an excellent outcome. One patient with Class 2 dissection (Case 5) went to surgery but this was primarily for coronary bypass and not for repair of the dissection. The coronary and aortic dissections occurred during diagnostic angiography before the RCA could be wired, necessitating surgical revascularization wherein the aortic dissection was repaired with two pledgeted sutures and three vessels were bypassed. Three of the four dissections in AMI patients went to surgery and two of these cases were Class 3 dissections. Of the patients undergoing surgery, one recovered uneventfully and was discharged from the hospital, one was unable to be weaned from bypass and died in the operating room, and the third patient died 32 days later with multi-system organ failure. None of the dissections in elective cases were Class 3 and no elective case required surgery (Table IV). The non-AMI patients were all Class 1 or 2. They were successfully managed with coronary stenting of the entry to the dissection and followed with close observation and medical therapy.

Follow-up included trans-esophageal echo (TEE) in Case 2, 2-D echo and computed tomography (CT) in

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