

Iatrogenic Aortic Dissection: A Review

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Abstract

Acute aortic dissection (Stanford Type A) is a life-threatening medical emergency associated with a high rate of early mortality (57 percent) without surgical intervention. During coronary catheterization, it occurs at a rate of 0.02 percent to 0.06 percent. There are no clear guidelines regarding the optimal management of this fatal condition. The critical importance of preventing dissection propagation by stenting the dissection's entrance in the coronary artery had been emphasized in prior review articles. Iatrogenic aortic dissections that do not involve the coronary arteries can be managed conservatively and closely followed-up with repeated imaging.

Keywords: Acute aortic dissection, iatrogenic acute aortic dissection, iatrogenic aortic dissection, iatrogenic ascending aortic dissection, Stanford Type A

INTRODUCTION

Acute aortic dissection (Stanford Type A) is an important medical emergency having a high rate of early mortality (57 percent) without surgical intervention.^[1] The DeBakey and Stanford classification systems for aortic dissection are frequently used.^[2,3] The Stanford classification categorizes all dissections that involve the ascending aorta as type A, regardless of the primary intimal tear location, and all other aortic dissections as type B.^[2-5] Spontaneous dissection of the ascending aorta occurs nearly twice as frequently as descending dissections^[6-8] and the right lateral ascending aortic wall is most commonly affected^[9] with aortic arch involvement occurring in up to 30% of cases.^[10] Dissection of the aorta caused by iatrogenic factors can occur infrequently as a catastrophic complication of coronary angioplasty.^[11,12]

Iatrogenic aortic dissection resulting from coronary catheterization occurs at a rate of 0.02 percent to 0.06 percent.^[11,12] It had been reported that the incidence of iatrogenic aortic dissection is 1.9 percent in difficult cases involving percutaneous coronary intervention on chronic total occlusion.^[13] Unfortunately, there are no clear guidelines exist regarding the optimal management of this fatal condition.

The preferred treatment for spontaneous aortic dissection is surgical management.^[1] Nevertheless, emergent surgical

correction of iatrogenic aortic dissection after coronary angiography or percutaneous coronary interventions is especially difficult due to concurrent anticoagulants used during the procedure and myocardial ischemia caused by co-existing coronary artery disease.

REVIEW OF LITERATURE

Dunning *et al*^[11] originally proposed a system of classification depending on the extension of involvement: Class 1 (4 patients) confined to the coronary cusp, Class 2 (3 patients) expand less than 4cm up the ascending aorta, and Class 3 (2 patients) expand distally for more than 4cm. Their study consists of nine patients with a cumulative incidence of 0.02 percent (0.19 percent in acute myocardial infarction). All nine cases involved an extended retrograde RCA dissection to the aortic root, and Amplatz guide catheters were used in 44% of cases. The four patients in Class 1 were treated successfully with the placement of a coronary stent and medical treatment. One of the Class 2 cases was effectively managed with emergency bypass surgery, while the other two were

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managed medically. While both Class 3 cases required emergency operation and died, both presented before catheterization with myocardial infarction. The authors suggest that Class 1 and Class 2 cases be treated with a coronary stent and/or medical treatment, while Class 3 cases should be treated surgically.

Numerous reports have discussed the advantages of non-surgically treating even severe iatrogenic aortic dissection resulting from percutaneous coronary intervention, using coronary stenting and/or conservative management^[12,14-20] as summarized in [Table 1]. Núñez-Gil *et al.* studied 74 patients who developed aortocoronary dissections as a result of cardiac catheterization (20% of whom had Dunning Class 3 dissections).^[12] They demonstrated favorable outcomes with coronary stent and/or medical treatment, with 69 subjects (93 percent) remaining asymptomatic after a median of five years of follow-up. During early follow-up, only three patients (4%) need cardiac surgery and two (3%) died from aortic dissection sequelae. In five patients, subsequent imaging revealed a fully healed aorta (7 percent). The authors conclude that once the early critical phase of an iatrogenic aortic dissection is passed smoothly, the aorta heals completely without long-term complications and the dissection's entrance into the coronary artery should be sealed with stenting. Iatrogenic aortic dissections that do not involve the coronary arteries can be managed conservatively and closely followed-up with repeated imaging, whereas those with significant symptoms, propagating dissections,

or obstructing the coronary flow may require surgical intervention.

The critical importance of preventing dissection propagation by stenting the dissection's entrance in the coronary artery had been emphasized in prior review articles of iatrogenic Stanford type A aortic dissections.^[14,15] Shah *et al.*^[14] included in their study 86 patients, 65 (76%) of them had undergone placement of a coronary stent and/or medical treatment, with three patients died. Aortic repair alone or in conjunction with coronary artery bypass grafting was done in the remained 21 (24%) patients. Three patients died among those who had undergone surgical treatment. Carstensen *et al.*^[15] included in their study 67 patients, 55 (82 percent) of them undergone coronary stent and/or medical treatment. There were two deaths (4%) in those managed non-surgically and three deaths (25%) in those managed surgically.

Additionally, Yip *et al.*^[21] describe a case series of 7 patients, 6 of them had a retrograde iatrogenic dissection of the aorta from the right coronary artery and one from the left coronary arteries to the ipsilateral coronary sinus, which was the result of balloon inflation in five cases, guiding catheter in one case, and thrombectomy catheter in one case. In five patients, iatrogenic aortic dissection was localized to the coronary sinus and expanded into the ascending part of the aorta in two. All five patients of the localized type were successfully treated with the placement of a coronary stent. A Thallium perfusion scan six months later revealed a defect in perfusion in two

Table 1: Summary of reports suggesting the advantages of non-surgically treating even severe iatrogenic aortic dissection resulting from percutaneous coronary intervention, using coronary stenting and/or conservative management

Authors & Year	Number of patients	Artery involved	Dissection extension	Recommendation and conclusion
Abbasi <i>et al.</i> ^[16] 2020	1	RCA	Class 3	All classes of iatrogenic aortic dissection can be managed conservatively in hemodynamically stable patients.
Chi <i>et al.</i> ^[17] 2018	1	RCA	Class 3	Conservative management had a favorable clinical outcome in Class III iatrogenic aortic dissection following PCI
Shah <i>et al.</i> ^[14] 2016	86	• RCA – 66 • LAD – 10 • LCx – 6 • LMS – 3 • OM – 1	• Root – 33 • Ascending aorta 35 • Arch – 11 • Descending aorta – 6	Most patients can be managed conservatively or solely through stenting, without requiring surgical intervention
Roumy <i>et al.</i> ^[18] 2016	1	RCA	Class 3	Even when the ascending iatrogenic aortic dissections are large, uncomplicated cases can be successfully managed with medical therapy.
Tam <i>et al.</i> ^[19] 2016	1	RCA	Class 3	Conservative management may be appropriate for a subset of patients with significant iatrogenic aortic dissections
Zafar <i>et al.</i> ^[20] 2016	1	RCA	Class 3	Nonsurgical management of iatrogenic aortic dissection has a role to play, particularly in high-risk surgical candidates with severe comorbidities or unfavorable anatomy.
Núñez-Gil <i>et al.</i> ^[12] 2015	74	• RCA – 42 • LCA – 30	• Class 1 – 45 • Class 2 – 12 • Class 3 – 15	With a conservative approach, there is an excellent short- and long-term prognosis.
Carstensen <i>et al.</i> ^[15] 2008	67	Not all reported	Limited – 39 Extended – 28	Urgent stenting of the coronary ostium should be strongly considered in all cases (regardless of the dissection location), as it may avoid the need for high-risk emergent surgical aortic repair.

patients with angina and right coronary artery restenosis on coronary angiography. The remaining three individuals had normal scans and without symptoms. Placement of a coronary stent was failed in one patient with the extended type, who then declined surgery and died. The other patient required emergency surgery and was successfully treated. The authors conclude that prompt coronary stenting should be performed to seal the aortocoronary dissection's entry site and avoid its extension, and surgical management is necessary for those with severe iatrogenic aortic dissection and the development of complications. Placement of a coronary stent remains beneficial for patients' stabilization before surgery.

Another recent case report^[22] emphasizes the critical importance of using the appropriate imaging (CT scan) to secure a correct diagnosis when iatrogenic aortic dissection is suspected but missed on conventional contrast images, as well as the critical role of hemodynamic control.

Gryko *et al*^[23] present a case of unstable angina with the previous implantation of a drug-eluting stent for the left circumflex artery and admitted later for planned coronary angiography due to the recurrence of chest pain (Canadian Cardiovascular Society class III). Utilizing the right radial approach, Coronary angiography was done that revealed a 90 percent stenosis. Aortic sinus dissection occurred during right coronary artery engagement using Amplatz Left catheter. The patient's hemodynamic status remained stable without symptoms. Then, two stents were implanted, the first sealing the dissection's entry site and the second distally using a guide extension catheter to minimize any trauma. Nitroglycerin infusion and a beta-blocker were used. The patient was discharged twelve days after percutaneous coronary intervention. A follow-up CT revealed a complete resolution of the hematoma after one month.

Another case report by Okuyama *et al*^[24] with a previous Stanford B aortic dissection undergoing coronary angiography for left ventricular dysfunction. Coronary dissection was noted in the right coronary artery ostium and progressively extended during percutaneous coronary intervention. The next day, despite the absence of symptoms, computed tomography was done and revealed a massive aortic dissection and gradual expansion of the false lumen. They performed a second percutaneous coronary intervention one week after the first one, using a stent dilated to 6.0 mm. The false lumen had disappeared completely three weeks after the second percutaneous coronary intervention.

The trans-radial approach is increasing in popularity in recent years because of its benefit over the femoral approach, which results in less patient discomfort and less bleeding, the ability to walk following the procedure, a short hospital stay, and even the same-day discharge. Another case report by Eshraghi *et al*^[25] using a radial

approach in a patient with a positive exercise ECG test. During coronary angiography and following the initial right coronary artery contrast injection, aortic dissection was noted with expansion to the ascending aorta with the development of chest pain. After a few minutes, the chest pain subsided and the ECG revealed no evidence of ischemia. Additionally, computed tomography reveals no aortic dissection or hematoma. The decision was made to use a watch-and-wait strategy with intensive antihypertensive therapy. After eight hours, chest pain was felt by the patient. The ECG revealed a junctional rhythm with no evidence of ischemia. After six hours, the blood pressure decreased and an ECG revealed atrial fibrillation, and coronary angiography was repeated using the radial approach. Right coronary injection demonstrated significant ostial narrowing. There was no SA node artery. From the ostium to the proximal right coronary artery, a stent was implanted with the restoration of normal flow. Two hours later, the patient's ECG showed a normal sinus rhythm with no chest pain.

There are several possible mechanisms responsible for this catastrophic event. Catheter trauma appears to cause dissection of the coronary artery with later retrograde progression into the aortic root via the subintima. Vigorous contrast medium injection by hand, improper catheter manipulation, and subintimal guidewire passage all have been suggested as causes of iatrogenic coronary dissection.^[21] Cystic media necrosis, congenital bicuspid and unicuspid aortic valves, atherosclerosis, Marfan syndrome, and hypertension are all risk factors.^[11,26] It had been reported that the risk of proximal right coronary artery dissection increased with the use of EBU, Amplatz or Kimmy guide catheter, atherosclerotic plaque presence, angulation of the proximal segment, and the presence of calcification.^[27]

A large percentage of patients who develop spontaneous aortic dissection have a pre-existing aortic disease. In comparison, patients with iatrogenic aortic dissection may have relatively normal aortic walls, which may allow for improved healing once the aortic dissection's entry site is sealed. Additionally, advanced atherosclerosis may constrict the plane of dissection. This may explain that patients with iatrogenic aortic dissection frequently respond favorably to stenting and/or conservative therapy.

CONCLUSION

As percutaneous coronary intervention has become more aggressive in the chronic total occlusion era, more and more complications have arisen from either aggressive guiding catheter use, wire trauma, or subintimal dissection near the coronary ostium resulting in aortic dissection. The aortic dissection incidence in a multicenter registry was 0.06% and was typically caused by catheter trauma. Sealing the breach as the site of coronary ostium with a

stent stabilizes the dissection. The great majority of these dissections can be treated conservatively.

Ethical consideration

Not applicable

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Conflicts of interest

Conflicts of interest do not exist.

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