Case Reports

Aortic Dissection Caused by Percutaneous Coronary Intervention:

2 New Case Reports and Detailed Analysis of 86 Previous Cases

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Aortic dissection, a rare sequela of percutaneous coronary intervention, can be fatal when it is not recognized and treated promptly. Treatment varies from conservative management to invasive aortic repair and revascularization. We report the cases of 2 patients whose aortic dissection was caused by percutaneous coronary intervention. In addition, we present detailed analyses of 86 previously reported cases. Aortic dissection was most often seen during intervention to the right coronary artery (in 76.7% of instances). The 2 most frequently reported causes were catheter trauma (in 54% of cases) and balloon inflation (in 23.8%). The overall mortality rate was 7.1%. We conclude that most patients can be treated conservatively or by means of stenting alone, with no need for surgical intervention. ***(Tex Heart Inst J 2016;43(1):52-60)***

Key words: *Angioplasty, balloon, coronary/adverse effects; aneurysm, dissecting/diagnosis/etiology/radiography/surgery/therapy; aorta/injuries; cardiac catheterization/adverse effects/methods; coronary disease/therapy; coronary vessels/injuries; iatrogenic disease; intraoperative complications/etiology; stents; treatment failure/outcome*

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Aortic dissection is a rare and potentially fatal sequela of percutaneous coronary intervention (PCI). The exact prevalence of aortic dissection after PCI is unknown, because occurrences might be unreported. The first case was reported in 1992.[1] We found 86 published instances[1-62] and have categorized these in detail. In addition, we present 2 new cases of aortic dissection consequent to PCI, and we discuss their specific treatment.

Case Reports

Patient 1

A 52-year-old hypertensive man presented with acute inferior ST-segment-elevation MI (STEMI). He had a distant history of inferior myocardial infarction (MI) that had been treated with placement of a drug-eluting stent. At the current presentation, he was immediately taken for cardiac catheterization. Initial views of the left coronary system with use of a 6F Judkins left (JL)4 diagnostic catheter revealed no significant lesions. Views of the right coronary artery (RCA), examined with use of a 6F Judkins right (JR)4 diagnostic catheter, showed occlusion of the original proximal RCA stent. The diagnostic catheter was immediately removed, and a 6F JR4 guide catheter was used without difficulty to engage the RCA. A 180-cm ASAHI Prowater Flex guidewire (Abbott Vascular, part of Abbott Laboratories; Abbott Park, Ill) was inserted into the RCA but could not cross the culprit lesion. This wire was exchanged for a 190-cm HI-TORQUE WHISPER guidewire (Abbott Vascular), and the lesion was successfully crossed with support from a 1.5 × 15-mm Maverick™ Over-the-Wire Balloon Catheter (Boston Scientific Corporation; Natick, Mass). Two brief inflations were done at pressures of 12 atm within the stent for 10 s each. The wire was upgraded to a 300-cm ASAHI Prowater Flex wire while the Maverick balloon was still inside the artery. The patient reported chest pain, and his systolic blood pressure (SBP) fell to 78 mmHg. The balloon was removed. An angiogram showed dissection of the proximal RCA, extending retrograde into the right aortic cusp and ascending aorta (Fig. 1). In addition, slow flow and evidence of thrombus were noted in the RCA. A PRONTO V3 extraction catheter (UDG Healthcare plc; Dublin, Ireland) was immediately inserted, and manual-aspiration thrombectomy was performed. Then, a 3.5 × 28-mm VISION® bare-metal stent (Abbott Vascular), deployed in the proximal RCA at a pressure of 12 atm, was extended into the ostium to seal the dissection flap (Fig. 2).

The patient was started on a dopamine infusion. Within minutes, his hemodynamic status improved and chest pain resolved, so the dopamine was discontinued. A post-stenting angiogram showed significant stenosis distal to the stent, but we did not believe the stenosis to be the cause; given the acute STEMI and eventful course, we instead suspected a role of spasm and distal embolization. We intended to obtain another angiogram in a few weeks, to reevaluate that lesion.

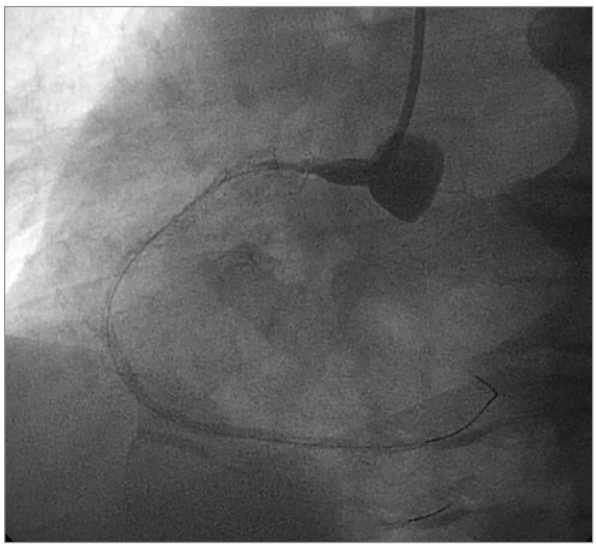

Fig. 1 *Patient 1. Coronary angiogram (left anterior oblique view) reveals stent thrombosis and shows dissection of the proximal right coronary artery with retrograde extension into the aorta.*

Supplemental motion image is available for Figure 1.

Fig. 2 *Patient 1. Coronary angiogram (left anterior oblique view) after ostial-proximal right coronary artery stenting shows obliteration of the dissection flap and restoration of coronary flow.*

Supplemental motion image is available for Figure 2.

The patient was transferred to the coronary care unit for monitoring. The next day, a transesophageal echocardiogram showed no dissection or hematoma. The patient was discharged from the hospital 4 days later in stable condition and was lost to follow-up thereafter.

Patient 2

A 68-year-old man with a history of hypertension presented for coronary angiography because of chest pain and abnormal results of a stress test. A diagnostic angiogram with use of a 6F JL4 catheter revealed significant stenosis of the mid left circumflex coronary artery (LCx). We used a 6F Extra Back-Up 4.0 guide catheter to engage the left main coronary artery (LMCA), crossed the lesion with a 0.014-in Hi-Torque Whisper wire, and performed angioplasty with a 2 × 15-mm Mini Trek Coronary Dilatation Catheter (Abbott Vascular). Subsequently, we deployed a 2.5 × 15-mm Xience V® everolimus-eluting stent (Abbott Vascular) across the lesion at a pressure of 16 atm and postdilated it with use of a 3 × 15-mm noncompliant Quantum™ balloon (Boston Scientific).

During the final postinterventional angiography, the patient reported severe chest pain, and his SBP fell to 60 mmHg. At that moment, the angiogram revealed dissection of the LMCA, starting from the point of contact of the guide catheter with antegrade extension into the LCx and retrograde into the aortic root (Fig. 3). This was followed by no-flow phenomenon. We attributed the dissection to roofing of the tip of the guide catheter combined with a forceful contrast injection. The wire had come out of the LCx at that point; therefore, to

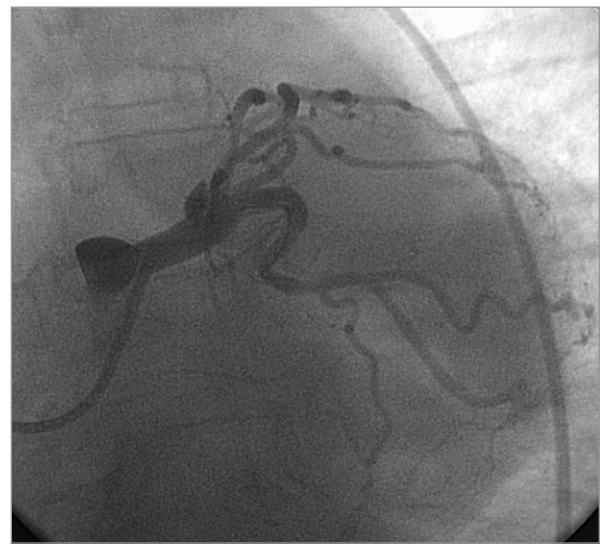

Fig. 3 *Patient 2. Coronary angiogram (left anterior oblique caudal view) shows left main dissection with antegrade extension into the aortic cusp and retrograde into the left circumflex coronary artery.*

Supplemental motion image is available for Figure 3.

avoid its entry into the false lumen, we placed it in the left anterior descending coronary artery (LAD). We immediately deployed a 3 × 33-mm XIENCE drug-eluting stent in the LMCA (this long stent extended to the LAD) to seal the origin of the dissection flap, and Thrombolysis In Myocardial Infarction-3 blood flow was restored in the coronary arteries (Fig. 4). We then inserted an intra-aortic balloon pump; however, the patient's hemodynamic status and vital signs had already begun to improve.

After discussion between the cardiologists and the patient's family, the patient was sent for coronary artery bypass grafting (CABG). This solution was proposed because of uncertainty about the progression of the dissection, despite the patient's hemodynamically stable status after stenting. After a 2-week hospitalization, he was discharged in stable condition.

Discussion

During PCI, iatrogenic aortic dissection occurs in 0.02% to 0.07% of cases.[10] We searched the English-language medical literature for relevant reports. Our PubMed search terms were "aortic dissection," "iatrogenic dissection of aorta," "coronary angiography," "percutaneous coronary intervention," and "angioplasty." We found 86 cases of aortic dissection caused by percutaneous coronary angiography or PCI (Table I).[1-46] Ten of those occurred during attempted intervention on chronic total occlusion (Table II),[36,47-55] and 7 were in patients who had histories of CABG (Table III).[56-62] Of the 86 cases, 26 (30.2%) occurred during emergency catheterization. The extent of dissection was mentioned in 85 instances. The dissection was limited to the aortic root in 33 (38.8%), the ascending aorta in 35 patients (41.1%), the aortic arch in 11 (12.9%), and the descending aorta in 6 (7.1%).

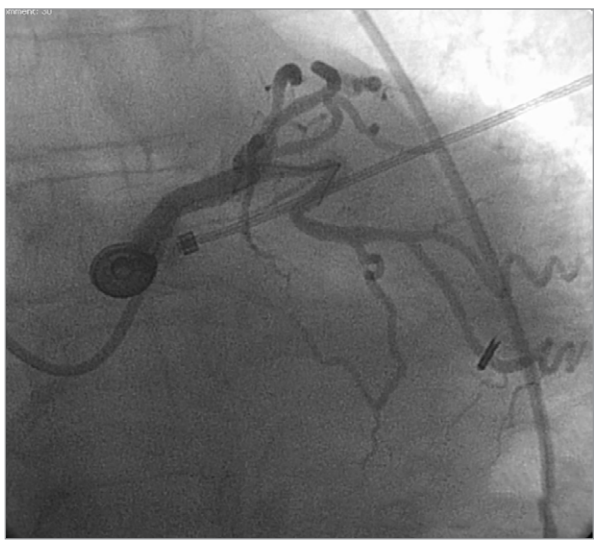

Fig. 4 *Patient 2. Coronary angiogram (left anterior oblique caudal view) after left main stenting shows obliteration of the dissection flap and restoration of coronary flow.*

Supplemental motion image is available for Figure 4.

Of the outcomes reported in 85 occurrences, 6 patients died—3 who were treated conservatively and 3 who underwent surgery (7.1%). In those 6 patients, the dissection extended to the ascending aorta in 4, the aortic arch in one, and the descending aorta in one. As for the 3 deaths in the conservatively treated patients, the cause was unknown in one.[1] The second refused surgery after a failed attempt to stent the origin of the dissection, and he died of refractory ventricular tachycardia and fibrillation from reinfarction.[12] The third had renal failure due to extension of the dissection to the descending aorta; surgery was deemed too risky, and he died 4 months later of cardiogenic shock.[17] The deaths of 2 of the 3 surgically treated patients were attributed to postoperative multiorgan failure,[6,10] and the third died in the operating room when weaning from cardiopulmonary bypass failed.[10]

Iatrogenic aortic dissections occurred during interventions to the RCA in 66 patients (76.7%), the LAD in 10 (11.6%), the LCx in 6 (7%), the LMCA in 3 (3.6%), and the obtuse marginal branch in 1 (1.2%). The probable cause of dissection was reported in 63 instances: catheter trauma in 34 patients (54%), balloon inflation in 15 (23.8%), and contrast injection in 13 (20.6%). Of note, wire trauma was the reported cause of dissection in only 7 patients (11.1%).

Among the 34 reports of guide-catheter trauma, the sizes and types of catheters were specified in 23 and 27 instances, respectively. Eighteen of the 23 occurrences involved sizes larger than 6F (8F=6 and 7F=12), and the remaining 5 occurred in association with the 6F size. The catheter types reported most often as causes of dissection were the Amplatz left (in 11 cases) and the JR (in 9).

Stenting as sole treatment for aortic dissection was performed in 46 patients (53.5%). Aortic repair, CABG, or both followed stenting in another 9 cases (10.5%). Seventeen patients (19.8%) underwent aortic repair and CABG. A conservative approach was adopted in 19 patients (22.1%), and CABG alone was performed in 3 patients (3.5%).

There are no guidelines for treating aortic dissection caused by PCI. Dunning and colleagues[10] proposed surgical intervention if a dissection extended more than 4 cm into the ascending aorta. However, patients whose dissections extended even to the aortic arch have been successfully treated conservatively, or nonsurgically by means of stenting. The most important factors that guide treatment are the patient's hemodynamic stability and the practitioner's rapidity in stenting the origin of the dissection, to prevent the dissection from expanding.

TABLE I. Reports of Aortic Dissection Caused by Percutaneous Coronary Intervention

Reference	No. Pts.	Age (yr), Sex	Culprit Vessel	Emergency Procedure?	Guide	Wire	Probable Cause of Dissection	Area of Aorta Affected	Treatment	Outcome
Varma V, et al.[1] (1992)	1	55, F	RCA	Yes	—	—	Catheter	Ascending	Conservative	Death
Moles VP, et al.[2] (1992)	2	48, M	LAD	No	—	Magnum	Wire	Root	Conservative	Uneventful
		61, M	RCA	No	AL 8F	Magnum	Catheter	Descending	Aortic repair and CABG	Uneventful
Carter AJ and Brinker JA[3] (1994)	3	70, M	RCA	—	AL2 8F	—	Catheter and contrast injection	Ascending	Conservative	Uneventful
		57, F	RCA	—	JR4 8F	—		Ascending	Conservative	Uneventful
		48, M	RCA	No	JR4 6F	—		Ascending	Conservative	Uneventful
Ochi M, et al.[4] (1996)	1	72, F	LAD	No	—	—	Catheter	Arch	Emergency CABG	Uneventful
Seifein HB, et al.[5] (1996)	1	48, M	RCA	No	JR4 8F	HTF	Balloon inflation	Root	Stenting and CABG	Uneventful
Perez-Castellano N, et al.[6] (1998)	4	67, F	RCA	No	—	—	Contrast injection	Root	Stenting	Uneventful
		52, M	RCA	No	—	—	Contrast injection	Root	Conservative	Reinfarction
		56, M	RCA	No	—	—	Balloon inflation	Ascending	Aortic repair and CABG	Death
		64, M	RCA	No	—	—	Stenting	Root	Stenting	Uneventful
Bae JH, et al.[7] (1998)	1	55, M	RCA	No	JR4 7F and 6F	HTF	Wire	Ascending	Stenting	Uneventful
Yeih DF, et al.[8] (1999)	1	71, F	LAD	Yes	JL4 7F	—	Balloon inflation	Ascending	Conservative	Uneventful
Sutton AG, et al.[9] (2000)	1	52, M	RCA	No	El-Gamal	—	Catheter	Arch	Aortic repair and CABG	Uneventful
Dunning DW, et al.[10] (2000)	9	77, F	RCA	No	JR4 9F	HTF	—	Root	Stenting	Uneventful
		57, F	RCA	Yes	AL1 8F	HTF and CPT	—	Ascending	Stenting, aortic repair, and CABG	Uneventful
		61, F	RCA	Yes	JR4 7F	HTF	—	Arch	Stenting, aortic repair, and CABG	Death
		61, M	RCA	No	AL1 8F	HTF and Roto C	—	Root	Stenting	Uneventful
		42, M	RCA	Yes	JR4 8F	—	—	Ascending	Stenting	Uneventful
		63, M	RCA	Yes	AL2 9F	—	—	Arch	Stenting, aortic repair, and CABG	Death
		55, M	RCA	No	AL1 8F	HTF	—	Ascending	Stenting	Uneventful
		50, M	RCA	No	JR4 8F	—	—	Root	Stenting	Uneventful
		75, M	RCA	No	JR4 8F	HTF	—	Root	Stenting	Uneventful
Ahmed AA, et al.[11] (2001)	1	45, M	RCA	No	JR4	HTF	Balloon inflation	Arch	Stenting and aortic repair	Uneventful
Yip HK, et al.[12] (2001)	7	68, M	RCA	No	JR4 7F	HTF	Balloon inflation	Root	Stenting	Uneventful
		80, M	RCA	No	AL2 7F	HTF	Thrombectomy system	Root	Stenting	Uneventful
		73, M	RCA	Yes	JR4 7F	HTF	Balloon inflation	Ascending	Conservative	Death
		62, F	RCA	No	JR4 7F	HTF	Balloon inflation	Root	Stenting	Restenosis
		68, F	LAD	Yes	JR4 7F	HTF	Balloon inflation	Ascending	Aortic repair and CABG	Uneventful

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TABLE I continued. Reports of Aortic Dissection Caused by Percutaneous Coronary Intervention

Reference	No. Pts.	Age (yr), Sex	Culprit Vessel	Emergency Procedure?	Guide	Wire	Probable Cause of Dissection	Area of Aorta Affected	Treatment	Outcome
Yip HK, et al., continued		63, M	RCA	Yes	AL2 6F	—	Catheter	Root	Stenting	Restenosis, then hospital discharge
		66, M	RCA	Yes	JR4 7F	—	Balloon inflation	Root	Stenting	Uneventful
Kao CL[13] (2002)	1	68, F	LAD	No	—	—	Balloon inflation	Ascending	Aortic repair and CABG	Uneventful
Hung MJ, et al.[14] (2002)	2	64, F	RCA	No	6F	—	Wire	Root	Stenting	Uneventful
		51, M	RCA	Yes	JR 6F	Extra-support	Wire	Root	Stenting	Uneventful
Maiello L, et al.[15] (2003)	1	48, F	RCA	No	JR 6F	HTF	Catheter and contrast injection	Ascending	Stenting	Uneventful
Bapat VN, et al.[16] (2003)	1	74, F	LAD	No	VL3	PT	—	Ascending	CABG	Uneventful
Ohara Y, et al.[17] (2003)	1	67, M	LMCA	Yes	JL4.5 7F	BMW	—	Descending	Conservative	Death
Doyle B and Juergens CP[18] (2004)	1	64, F	RCA	No	AL1 8F	CPT	Catheter	Ascending	Conservative	Uneventful
Kim JY, et al.[19] (2005)	1	67, M	RCA	No	Kimny 6F	Run-through	Catheter	Arch	Stenting	Uneventful
Masaki Y, et al.[20] (2005)	1	82, F	RCA	Yes	AL 6F	BMW	—	Root	Conservative	Uneventful
Porto I, et al.[21] (2005)	1	55, F	LCx	No	EBU L 3.5 and JL4	BMW	—	Ascending	Stenting and pericardial drain	Tamponade, then hospital discharge
Pascotto M, et al.[22] (2005)	1	35, M	RCA	No	—	—	—	Ascending	Stenting	Pericarditis, then hospital discharge
Rangel-Abundis A, et al.[23] (2005)	1	54, F	RCA	Elective	JL 8F	—	Catheter	Arch	Stenting, aortic repair, and CABG	Uneventful
Pohlel K, et al.[24] (2006)	1	62, F	RCA	Yes	JR4	—	Catheter	Root	Stenting	Uneventful
Minicucci F, et al.[25] (2006)	1	60, F	RCA	Yes	6F	—	Balloon inflation	Root	Stenting	Uneventful
Patel TM, et al.[26] (2006)	1	50, F	LAD	No	JL3.5 7F	BMW	Balloon inflation	Arch	Stenting	Uneventful
Papadopoulos DP, et al.[27] (2006)	1	52, M	RCA	Yes	JR4-Gr	—	Catheter and contrast injection	Ascending	Stenting	Uneventful
Wykrzykowska JJ, et al.[28] (2006)	1	65, F	LCx and OM	Yes	EBU L 3.5 7F	CPT and PT Graphix	—	Ascending	Stenting	Uneventful
Ciabatti N, et al.[29] (2007)	1	54, F	LAD	No	Muta L 3.5 6F	—	Catheter and contrast injection	Root	CABG	Uneventful
Colkesen AY, et al.[30] (2007)	1	79, F	RCA	Yes	JR 6F	—	—	Ascending	Conservative	Uneventful
Uyan C, et al.[31] (2008)	1	79, F	RCA	No	—	Floppy	Catheter	Root	Conservative	Uneventful
Wyss CA, et al.[32] (2008)	1	63, M	LCx	No	AL2 6F	—	Catheter	Descending	Aortic repair and CABG	Uneventful

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TABLE I continued. Reports of Aortic Dissection Caused by Percutaneous Coronary Intervention

Reference	No. Pts.	Age (yr), Sex	Culprit Vessel	Emergency Procedure?	Guide	Wire	Probable Cause of Dissection	Area of Aorta Affected	Treatment	Outcome
Gasparini GL, et al.[33] (2008)	1	74, F	LAD	No	EBU L 4.0	—	Stent deployment	Root	Stenting	Uneventful
Cohen R, et al.[34] (2008)	1	42, M	RCA	Yes	AR 2.0 6F	—	Catheter	Ascending	Aortic repair and CABG	Uneventful
Hacibayramoglu M, et al.[35] (2008)	1	73, F	RCA	No	—	—	—	Descending	Stenting and aortic repair	Uneventful
Carstensen S and Ward MR[36] (2008)	3	82, F	LCx	No	EBU 3.5	—	Catheter	Root	Stenting	Uneventful
		57, M	RCA	No	JR4 and AL1	—	Catheter	Root	Stenting	Uneventful
		56, F	RCA	No	JR4	—	Balloon inflation	Ascending	Stenting	Uneventful
Ziakas AG, et al.[37] (2009)	1	54, M	RCA	No	—	—	Catheter	Descending	Stenting and aortic repair	—
Jarmoszewicz K, et al.[38] (2009)	1	70, F	RCA	Yes	—	—	—	Root	Stenting, aortic repair, and CABG	Uneventful
Brown RA and Purcell I[39] (2009)	1	57, M	RCA	Yes	AL1 6F	—	Catheter	—	Covered stenting	Uneventful
Ravandi A and Penny WF[40] (2011)	1	86, M	LMCA	Yes	MP 6F	BMW	Catheter	Ascending	Stenting	Uneventful
Tomassini F, et al.[41] (2011)	1	81, M	OM	No	EBU 3.5 6F	—	Catheter	Root	Stenting and pericardiocentesis	Pericardial effusion, then hospital discharge
Noguchi K, et al.[42] (2012)	1	66, M	LCx	Yes	EBU 3.5 6F	Rinato	Catheter	Descending	Aortic repair and CABG	Uneventful
Wykrzykowska JJ, et al.[43] (2012)	1	61, F	RCA	Yes	AL2	HT Pilot 50 and OCT	Contrast injection	Ascending	Conservative	Uneventful
Danzi GB, et al.[44] (2012)	1	73, F	RCA	No	JR 6F	—	Catheter	Ascending	Stenting	Uneventful
Lao EP, et al.[45] (2013)	1	77, F	LAD	No	—	—	Balloon inflation	Root	Stenting	Uneventful
Burstow D, et al.[46] (2013)	1	53, M	RCA	Yes	JR4 6F	—	—	Root	Conservative	Uneventful
Current cases	2	52, M	RCA	Yes	JR4 6F	APF	Catheter and balloon inflation	Ascending	Stenting	Uneventful*
		68, M	LMCA	No	JL4 6F	HT Whisper	Catheter and contrast injection	Root	Stenting and CABG	Uneventful

AL = Amplatz left; APF = Asahi Prowater Flex; AR = Amplatz right; BMW = Balance Middleweight Universal; CABG = coronary artery bypass grafting; CPT = ChoICE PT; EBU = extra back-up; F = female; HT = high-torque; HTF = Hi-Torque floppy; JL = Judkins left; JR = Judkins right; LAD = left anterior descending coronary artery; LCx = left circumflex coronary artery; LMCA = left main coronary artery; M = male; MP = multipurpose; OCT = optical coherence tomography; OM = obtuse marginal branch; PT = platinum; Pts = patients; RCA = right coronary artery; VL = Voda left

*Patient was lost to follow-up after discharge from hospital.

TABLE II. Reports of Aortic Dissection during Percutaneous Coronary Intervention of Chronic Total Occlusion

Reference	Patient Age (yr), Sex	Guide	Wire	Probable Cause of Dissection	Area of Aorta Affected	Treatment
Kostov J and Stankovic G[47] (2003)	54, M	AL 8F	Conquest	Wire	Root	Conservative
Alfonso F, et al.[48] (2004)	46, M	—	Shinobi	Balloon inflation	Root	Stenting
Oda H, et al.[49] (2004)	70, M	AL17 and JR4	—	Catheter	Ascending	Stenting
Notaristefano S, et al.[50] (2005)	45, M	JR4	PT Graphix	Wire	Ascending	Stenting
Carstensen S and Ward MR[36] (2008)	64, F	JR4	HT intermediate	Wire	Ascending	Stenting
Bryniarski L, et al.[51] (2008)	67, M	JR 6F	—	Catheter and contrast injection	Root	Conservative
Mamas MA, et al.[52] (2008)	72, F	AL1	—	Catheter	Arch	Conservative
Park IW, et al.[53] (2008)	68, F	JR4 7F	HT Whisper	Catheter and contrast injection	Arch	Stenting
Santos M, et al.[54] (2011)	56, M	AL2 6F	Miracle 3	—	Ascending	Covered stent
Chunlai S, et al.[55] (2012)	59, F	JR4 7F	Pilot 50, Persuader 3, and floppy	Catheter	Ascending	Conservative

AL = Amplatz left; F = female; HT = Hi-Torque; JR = Judkins right; M = male; PT = platinum

The right coronary artery was the culprit vessel in each instance. All procedures were nonemergency. All outcomes were reported to be uneventful.

TABLE III. Reports of Aortic Dissection during Percutaneous Coronary Intervention in Prior CABG Patients*

Reference	Patient Age (yr), Sex	Culprit Vessel	Nature of PCI	Guide	Wire	Probable Cause of Dissection	Area of Aorta Affected	Treatment
Al-Saif SM, et al.[56] (2000)	67, F	LMCA	Nonemergency	JL 8F and AL	CPT and Extrasupport	—	Root	Stenting
Pentousis D, et al.[57] (2000)	63, M	RCA	Nonemergency	AL1 7F	Crosswire	Catheter and contrast injection	Ascending	Stenting
Goldstein JA, et al.[58] (2003)	62, M	RCA	Emergency	JR4 8F	BMW and Luge	—	Arch	Stenting
Abu-Ful A, et al.[59] (2003)	74, M	RCA	Elective	Zuma 7F	—	Catheter and contrast injection	Ascending	Covered stent
Pai RK, et al.[60] (2005)	58, M	RCA	Nonemergency	—	—	—	Ascending	Aortic repair and CABG
Cheng CC, et al.[61] (2008)	75, F	LCx	Elective	—	—	Stent manipulation	Root	Stenting
Garg P, et al.[62] (2009)	83, M	RCA	Nonemergency	AL 0.75 8F	PT Graphix	Catheter	Ascending	Stenting

AL = Amplatz left; BMW = Balance Middleweight Universal; CABG = coronary artery bypass grafting; CPT = ChoICE PT; F = female; JL = Judkins left; JR = Judkins right; LCx = left circumflex coronary artery; LMCA = left main coronary artery; M = male; PCI = percutaneous coronary intervention; PT = platinum; RCA = right coronary artery

*All outcomes were reported to be uneventful.

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