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Catheter-Induced Coronary Artery Dissection: Risk Factors, Prevention and Management

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ABSTRACT: Guide catheter-induced dissection of the coronary arteries is an uncommon but potentially catastrophic complication of diagnostic and interventional cardiac catheterization. Several factors placing the individual at higher risk of this complication have been identified. We discuss these risk factors and utilize them to propose methods to prevent dissections. Management options of coronary artery dissection are also discussed.

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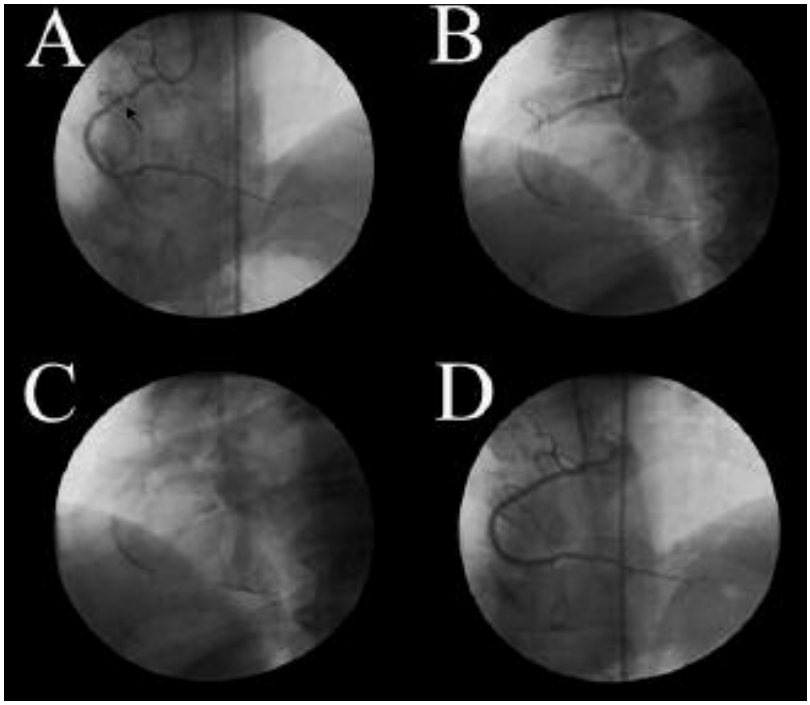

Figure 1. *Catheter-induced dissection of the right coronary artery.* (A) *Diagnostic angiogram demonstrates a 90% lesion in the RCA (arrow).* (B) *Extensive dissection of the RCA antegrade from the catheter results in occlusion in the mid-RCA. A wire is seen distally in the vessel, but it cannot be determined if the wire is in the true lumen or false lumen.* (C) *Contrast injection through an over-the-wire balloon confirms the position of the balloon catheter in the true lumen.* (D) *Extensive stenting of the artery restores patency and TIMI-3 flow.*

Catheter-induced coronary artery dissection is an uncommon complication of percutaneous coronary intervention and cardiac catheterization, but when it occurs, the outcomes can be devastating. The exact incidence remains unknown, with some suggesting it may be underreported.[1] There are numerous reports of retrograde dissection into the aortic root in the literature, as this subgroup appears to capture the imagination more than the more common antegrade dissections. However, the outcomes of antegrade coronary artery dissection caused by coronary catheters can also be catastrophic. Still, there remains a paucity of data regarding the incidence, risk factors and management of iatrogenic catheter-induced dissection of coronary arteries per se. Additionally, the natural history of catheter-induced coronary artery dissection is incompletely described, but published reports describe varied outcomes. The choice of treatment, therefore, when confronted with catheter-induced coronary artery dissection, is currently made on a case-by-case basis, with no evidence-based guidelines to assist the operator. We present a case of catheter-induced coronary dissection and review the risk factors for this complication in order to highlight methods to avoid its occurrence. We also discuss the literature on management options when it does occur.

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Case Presentation

A 61-year-old male with a history of dyslipidemia and gastroesophageal reflux disease was admitted with unstable angina. Cardiac catheterization showed a 90% proximal left anterior descending (LAD) coronary artery stenosis and a right coronary artery (RCA) proximal 90% stenosis and mid-vessel 50% stenosis (Figure 1A). Two-vessel percutaneous coronary intervention (PCI) was the preferred treatment strategy. The LAD was treated with angioplasty and stenting, which was uncomplicated. The RCA was engaged with a 6 Fr Launcher Judkins Right 4 (JR4) guiding catheter (Medtronic, Inc., Minneapolis, Minnesota) which was unable to gain adequate engagement, and so was changed for a 6 Fr Launcher Noto guide catheter (Medtronic).

The first fluoroscopic test injection demonstrated a spiral dissection from the catheter to the mid-RCA where there was occlusion of flow, and the patient suddenly complained of severe chest pain. There was ST-segment elevation in the inferior leads of the electrocardiogram (ECG). A Luge™ soft-tip guidewire (Boston Scientific Corp., Natick, Massachusetts) was rapidly inserted, and a Maverick® 2.5 x 9 mm over-the-wire balloon catheter (Boston Scientific) was advanced into the artery to beyond the occlusion (Figure 1B). Position within the true lumen was confirmed by contrast injection through the balloon catheter (Figure 1C). The artery was stented with 3 Cypher® sirolimus-eluting stents (Cordis Corp., Miami, Florida) 2.5 x 28 mm, 2.75 x 33 mm and 3.0 x 33 mm from the distal to proximal segments. The procedural result was excellent with TIMI-3 flow distally, no residual stenosis and resolution of the patient's chest pain and ECG changes (Figure 1D). There was no postprocedural cardiac enzyme elevation, and the patient was discharged the following day.

Discussion

The incidence of iatrogenic coronary artery dissection at the time of cardiac catheterization or percutaneous coronary intervention is not known. Catheter-induced dissection with retrograde extension to the aortic root, a feared complication of cardiac catheterization, is rare and has been estimated to occur in approximately 0.008 to 0.02% of diagnostic catheterizations and 0.06 to 0.07% of percutaneous coronary interventions,[2,3] but the overall incidence of catheter-induced dissections remains unknown. The natural history of coronary artery dissections is varied. In some cases, dissections lead to acute closure of the vessel with resultant myocardial infarction.[4] In other circumstances, retrograde extension of the dissection back to involve the aorta can occur,[5,6] and in some cases, dissections of the coronary artery have been associated with persistently normal (TIMI-3) flow into the distal arterial bed, with no damage to the heart muscle, and have healed without any intervention.[7] It is this wide variety of potential clinical outcomes that hampers attempts to standardize treatment for iatrogenic coronary artery dissections. It is critical, therefore, that each clinical scenario is evaluated on its own merits. A number of features mandate immediate revascularization, but in other situations, an expectant approach can be considered. We discuss the salient features of catheter-induced coronary artery dissection and propose an approach to this clinical situation.

Risk factors for catheter-induced coronary artery dissection. A number of factors are associated with increased risk for coronary artery dissection:

1. Left main disease. Left main disease has been demonstrated as a risk factor for catheter-induced dissection, as well as being associated with poor outcomes. Devlin and colleagues detailed the association of left main disease, and even left main calcification in the absence of visible atherosclerosis and catheter-induced dissection of the left main coronary artery.[8] In the same series, 14 of the 20 left main dissections were due to contact of the catheter with the plaque. This highlights the importance of using catheters that are appropriately sized, positioned and coaxially aligned with the artery.
2. The use of Amplatz-shaped catheters.[6]
3. Catheterization for acute myocardial infarction.[6]

Possible, but not definite, factors that have been suggested to increase the likelihood of coronary artery dissection include:

1. Catheter manipulations.[9]
2. Vigorous contrast injection.[4]
3. Deep intubations of the catheter within the coronary artery.[9]
4. Variant anatomy of the coronary ostia.[10]
5. Vigorous, deep inspiration.[11]

Prevention of catheter-induced coronary artery dissection. Some of the above factors are modifiable, such as choice of guide catheter and handling techniques, whereas others cannot be altered, such as acute myocardial infarction. In these cases, awareness of the potential risk may aid in rapid recognition of complications, and therefore potentially improve the speed with which definitive therapy may be instituted.

We recommend using appropriately sized and shaped catheters to avoid the contrast injection being directed at a plaque. Initial contrast injections should not be forceful until correct coaxial alignment of the catheter has been demonstrated. Contrast should not be injected if the pressure is damped, as this may be due to the catheter resting against a plaque in the artery. Finally, the choice of guide catheter is a risk-benefit tradeoff between extra backup and the possibility of deep intubation and subsequent coronary artery dissection. This decision must be at the operator's discretion and must be made on a case-by-case basis, however, the operator should be aware of the possibility of dissection when using more aggressive guide catheters.

Management of catheter-induced coronary artery dissection. The outcomes of coronary artery dissection, and therefore the management of the condition, depend on the patency of the distal vessel and the extent of propagation of the dissection. If there is compromise to the distal artery bed, such as acute closure of the artery, urgent revascularization is mandated to prevent infarction of that myocardial territory. This may be achieved by percutaneous coronary intervention (PCI) or coronary artery bypass graft (CABG) surgery, and the decision on which revascularization method is used must be at the discretion of the operators. There have been reports of successful outcomes with coronary artery stenting,[9,12,13] and CABG.[4,14,15] Similarly, even in the absence of acute vessel closure, if there is any suggestion of myocardial ischemia, such as new ECG changes or chest pain, urgent revascularization should also be undertaken to prevent myocardial infarction, as myocardial infarction may be seen even with TIMI-2 or -3 flow.[3] However, if the vessel remains patent, but a dissection is seen angiographically without obstruction to flow, then the therapeutic options are less clear. Conservative management of guide catheter-induced coronary artery dissection has met with successful outcomes in selected patients.[4,7] The choice of stenting versus conservative management is therefore made on a case-by-case basis.

The extent of propagation of the dissection may alter management decisions. Dissections may remain localized, or they may extend in the antegrade or retrograde directions, or

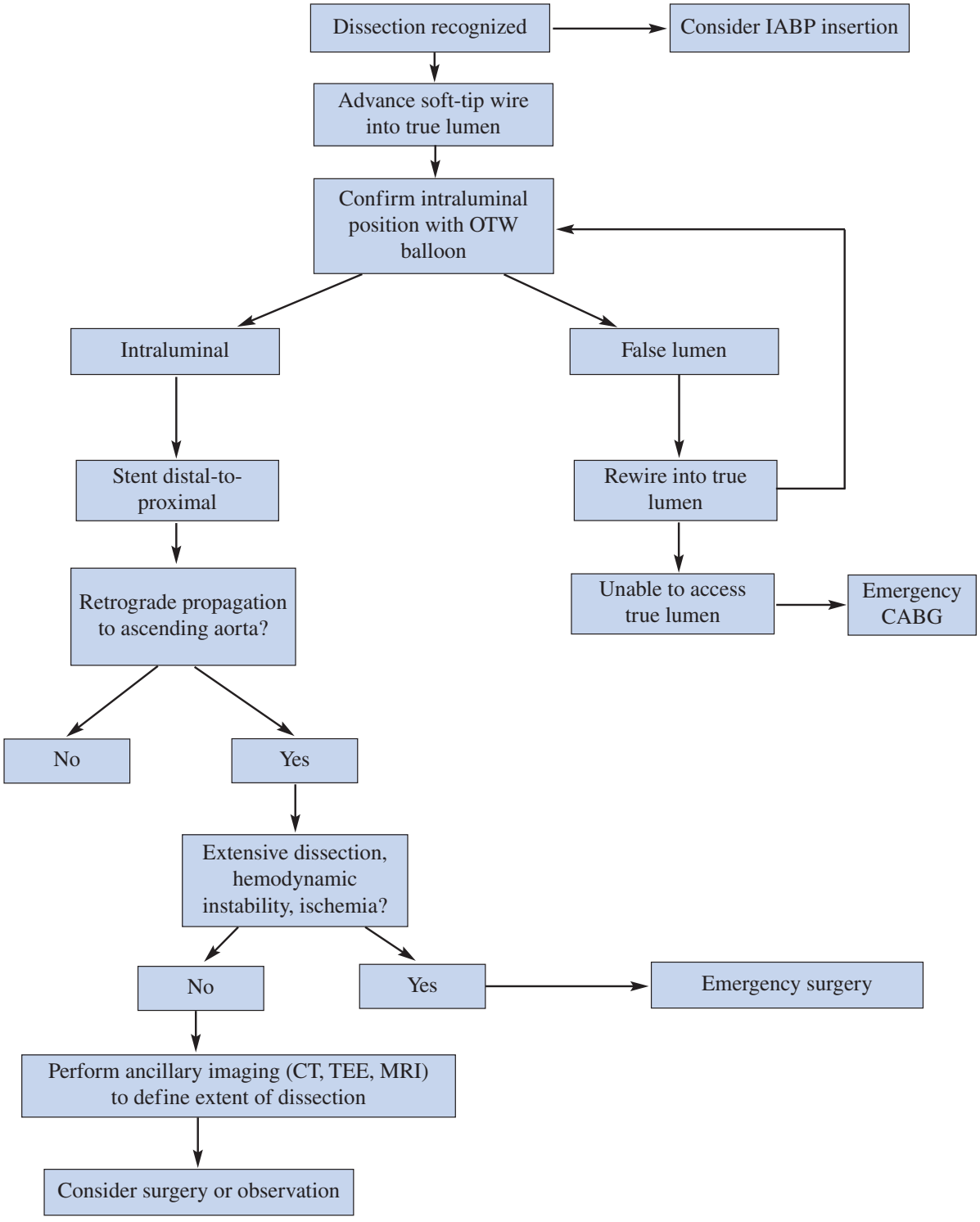

Figure 2. *Algorithm for risk assessment and treatment of guide catheter-induced coronary artery dissection.*

both. Localized dissection flaps have been successfully treated conservatively,[4] although others have described aggressive healing of these dissections, resulting in scar formation obstructing coronary flow.[16] There may, therefore, be some benefit to more definitive revascularization therapy at the time the dissection occurs in order to prevent this late stenosis. However, in this situation, there is not enough evidence to guide therapy, and the decision must be made individually for each patient, taking into account the risk of the procedure and subsequent antiplatelet therapy, versus the risks of treating the patient medically.

Extensive antegrade dissection can result in acute vessel closure and infarction of the vascular territory supplied by that artery. These dissections can often be treated by percutaneous intervention and, therefore, most operators would advocate that antegrade dissections be treated with PCI as soon as they are recognized. Soft-tip wires should be used to carefully attempt to access the true lumen,[12,17] and contrast should be injected through an over-the-wire balloon to confirm location in the true lumen. If the initial attempt fails and enters the false lumen, another soft-tip wire should be carefully manipulated into the true lumen.[17] Consideration should be given to insertion of an intra-aortic balloon pump (IABP). If there is any delay in restoration of flow, the cardiac surgeons should be consulted regarding urgent bypass surgery.

If there is retrograde propagation of the dissection to involve the aortic wall, the extent to which the aorta or its branches are involved will dictate the immediate management. Aorto-coronary dissections can remain localized to the sinus of Valsalva, or may extend into the ascending aorta.[2,3,18] They have even been described to extend to the aortic bifurcation.[19] It has been recommended that cases of localized aorto-coronary dissection not complicated by ischemia or hemodynamic instability can be managed conservatively.[1] However, if ischemia of any of the aortic branches occurs, if there is extensive dissection or if there is hemodynamic instability, urgent surgery is the treatment of choice. Retrograde dissection involving the aorta should be assessed on clinical grounds and by urgent transesophageal echocardiography in the catheterization laboratory or by urgent computed tomography scan. It is reasonable to attempt to seal the entry site of the dissection with PCI and stenting first, and then the extent of dissection can be assessed. A cardiac surgical opinion should be sought early. Any ischemia, hemodynamic compromise or extensive dissection should prompt immediate treatment with surgical repair of the aortic dissection. However, in the absence of these high-risk features, class I or II dissections may be managed conservatively.

A proposal has been made by Dunning and colleagues[6] for a classification system based upon the extent of aortic involvement: Class 1: the contrast staining involves only the coronary cusp; Class II: contrast extends up the aortic wall < 40 mm; Class III: contrast extends > 40 mm up the aortic wall. In their series, the extent of propagation of aortic dissection yielded prognostic information, with Class III dissections having uniformly poor outcomes. This classification may be useful for risk stratification.

We propose, in Figure 2, a management protocol for catheter-induced coronary artery dissection that takes into account the few known high-risk features and prognostic indicators to guide management. Hopefully, with careful attention to avoid known predisposing factors, this complication can be avoided where possible and, if encountered, can be managed in an appropriate and timely manner.

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