Iatrogenic Pathology of the Aorta After Interventional Cardiology Procedures

Jose Alberto de Agustin,1* Jose Juan Gomez de Diego,1 Patricia Mahia,1 Pedro Marcos-Alberca,1 Carlos Almeria,1 Jose Luis Rodrigo,1 Maria Luaces,1 Ivan Javier Nunez-Gil,1 Carlos Macaya,1 and Leopoldo Perez de Isla1

1Department of Cardiology, San Carlos University Hospital, Madrid, Spain

*Corresponding author: Jose Alberto de Agustin, Department of Cardiology, San Carlos University Hospital, Madrid, Spain. Tel: +34-91303394, Fax: +34-913033290, E-mail: albertotutor@hotmail.com

Received 2015 September 07; Revised 2015 September 29; Accepted 2015 October 10.

Abstract

Context: In this review, we tried to evaluate the incidence, prognosis and treatment options in patients with iatrogenic pathology of the aortic artery due to interventional procedures in cardiology. Evidence Acquisition: Our search strategy involved an investigation in the PUBMED database for every available article in peer reviewed journals between 1975 and 2015, for subjects related to iatrogenic pathology of the aortic artery, following interventional procedures in cardiology (coronary angiography or angioplasty, trans-catheter aortic valve implantation (TAVI) or intra-aortic balloon pump (IABP) counterpulsation placement). Results: Iatrogenic pathology of the aorta is a rare, but potentially lethal complication of invasive vascular techniques. The development of these complications should be considered in cases of unexplained hypotension, acidosis or lower limb ischemia after catheter-based interventions. With increased experience, most of the vascular complications associated with the transfemoral approach may be managed percutaneously. Conclusions: With the increase in interventional procedures in cardiology, iatrogenic pathology of the aorta is seen more frequently, and every cardiologist should know how to diagnose and treat this group of diseases.

Keywords: Aorta Artery, Iatrogenic Disease, Dissection, Aortic Rupture

1. Context

With the increase in interventional procedures in cardiology, the incidence of iatrogenic pathology of the aorta (rarely seen before) has increased. Every cardiologist should know how to diagnose and treat this group of diseases. In this review, we tried to evaluate the incidence, prognosis and treatment options for patients with iatrogenic pathology of the aortic artery due to interventional procedures in cardiology.

2. Evidence Acquisition

Our search strategy included a search of the PUBMED database for every available article in peer reviewed journals between 1975 and 2015, for subjects related to iatrogenic pathology of the aortic artery, following interventional procedures in cardiology (coronary angiography or angioplasty, trans-catheter aortic valve implantation (TAVI) or intra-aortic balloon pump (IABP) counterpulsation placement). We assessed case reports, case series and registries. We focused on the articles that were completely or partially relevant to aortic dissection or aortic rupture. Finally, 56 papers were collected, however, 11 papers were excluded in the critical appraisal process and 45 remained for review.

3. Results

We have classified iatrogenic pathology of the aortic artery into three groups depending on the interventional procedures performed, as follows:

3.1. Complications of Coronary Angiography or Coronary Angioplasty

In the last decades, the number of aortic dissections after invasive procedures has increased. Iatrogenic aortic dissection, although rare, is a major complication in
invasive vascular techniques. The development of iatrogenic aortic dissection should be considered, particularly when a patient develops unexplained acidosis or lower limb ischemia after catheter-based interventions. With respect to this complication, few studies are available in the literature, and the data that are available are limited to small case series or isolated single-center case reports. The cases reported many years ago are difficult to extrapolate to our practice because different accesses, materials and techniques are used now (1-4). Dunning et al. (3) published a study of nine patients with iatrogenic coronary artery dissections extending into and involving the aortic root. The authors suggested that stenting was usually sufficient to solve the problem when a coronary artery was involved, but in some cases surgery was warranted. However, such a complex surgery, aortic or coronary, in a patient who is often under the influence of strong antithrombotic drugs could have catastrophic results (5). In 2002, the international registry of aortic dissection reported that of 723 patients included in the registry, 26 patients had iatrogenic aortic dissection, 18 patients (69%) after a major surgery, and 7 patients (27%) catheter derived (6). Considering this registry, the epidemiological features were different from spontaneous forms, as they identified atherosclerosis, diabetes mellitus and hypertension as predisposing factors for iatrogenic aortic dissection. Moreover, they reported that iatrogenic forms present a poor prognosis with high mortality, even worse than the spontaneous forms, despite surgery. However, some recent records such as the German Registry for acute aortic dissection type A showed that mortality in iatrogenic forms could be similar to spontaneous forms (7). Recently, Nunez-Gil et al. (8) analyzed the incidence, characteristics and long-term prognosis of iatrogenic forms of type A aortic dissection caused by cardiac catheter-based interventions. They found that in >100,000 procedures, the incidence was 0.06%. This pathology was more prevalent in males (67.6%) and the mean age was 66.9 ± 10.8 years. The complication occurred when trying to engage the right coronary artery in 47 patients, the left main artery in 30 patients and after other maneuvers in two patients, mostly complex therapeutic procedures (78.4%). A coronary artery was involved in 45 patients (60.8%). Thirty-five patients underwent an angioplasty and stent implantation, three had cardiac surgery and 36 were managed conservatively. Two patients died of cardiogenic shock after the dissection. After a median follow up of 31.2 months (range, 16.4 - 104.8 months), none of the remaining patients developed complications as a result of the dissection (progression, ischemia, pain or dissection recurrence). There were no differences in the combined major adverse cardiac event variables after stratification for access point (femoral/radial). This is the largest series described, for a median of five years, showing that after the acute phase the spontaneous evolution of this complication is excellent, in contrast with data from previous studies. Interestingly, this happened even though the majority of patients presented with acute coronary syndrome, and many continued receiving antithrombotic treatment, something that would be unthinkable in a spontaneous form or even a postsurgical form. The profile of the patient who develops this rare complication was a man beyond the sixth decade with cardiovascular risk factors, mostly atherosclerotic and ischemic, who underwent a complex procedure, sometimes with difficult coronary catheterization, generally therapeutic. The investigators classified aortic dissections during cardiac catheterization into two main types: an antegrade form, usually with an entry point inside a coronary artery, and a retrograde form, which usually seals alone without further treatment with the collaboration of the antegrade aortic blood flow. Based on the data reported, for retrograde, non-coronary-related iatrogenic aortic dissections, it seems reasonably safe to maintain a conservative approach under strict monitoring by imaging techniques to detect potential problems early. If a coronary artery is involved, frequently as an entry point, that is usually enough to seal the dissection at that spot with a stent (big dissections, flow compromise) (9, 10). The conclusions of this interesting study were that iatrogenic catheter dissection of the aorta is a rare complication that carries an excellent short-term and long-term prognosis with the adoption of a conservative, nonsurgical approach. These findings are congruent with a recent report by Kim et al. (11), pointing out the fact that an acute retrograde type A aortic dissection presents a more favorable prognosis than antegrade dissections (spontaneous).

3.2. Iatrogenic Aortic Pathology Following Trans-Catheter Aortic Valve Implantation (TAVI)

Trans-catheter aortic valve implantation (TAVI) has become an established treatment for patients with symptomatic aortic valve disease deemed inoperable or at high risk for conventional surgical aortic valve replacement (12-13). Although it is a less invasive catheter-based procedure, this evolving technology is associated with a wide range of potential complications, some often fatal. Prevention, early recognition and effective treatment of these complications will significantly improve the outcome of this procedure and are essential prerequisites before being extended to lower-risk patient subsets. Aortic complications, such as aortic dissection and perforation, have been reported in 0% to 1.9% of patients undergoing transfemoral TAVI (14-21). The presence of mobile plaque, excessive calcification or extreme tortuosity of the descending thoracic
aorta are risk factors for these complications. The presence of an acute angle between the descending thoracic aorta and the aortic arch may also contribute to their occurrence. Therefore, careful evaluation and selection of the access site should seriously consider the benefit-risk ratio of TAVI and must be discussed on a case-by-case basis.

Acute rupture of the descending aorta (Figure 1) is a catastrophic condition that, if left untreated, almost invariably has a lethal outcome. This complication should be suspected in cases of unexplained hypotension during catheter advancement, after exclusion of other known causes of hemodynamic compromise. The demonstration of a left pleural effusion may be a clue to the diagnosis. The diagnosis is challenging and relies on available imaging modalities such as angiography and 3D transesophageal echocardiography. Treatment options include placement of a covered stent and ultimately surgical repair (22). Surgery for the lesions of the descending thoracic aorta still has a relatively high morbidity and mortality, which is largely dependent on the etiology and extent of the aortic lesion. Whereas mortality rates of 14% - 28% have been reported for surgical repair of traumatic aortic rupture (23-26), ruptured thoracic aneurysms and aortic type B dissections complicated by perforation or end-organ failure have a surgical mortality rate exceeding 50% (27-29). However, with increased experience most of the vascular complications associated with the transfemoral approach may be managed percutaneously. Endovascular therapy by implantation of thoracic stent grafts represents a good therapeutic alternative for this complication. Considering the relatively short procedural time and the minimally invasive approach of this technique, it has excellent potential for use in emergency cases with active bleeding from perforation sites in the descending aorta, especially in patients with high surgical risk (30-32).

Aortic annulus rupture is another rare and lethal complication of TAVI, reported in about 1% of cases (33, 34). When it occurs, acute hemodynamic collapse frequently causes catastrophic outcomes. Emergent surgery is the only therapeutic option for this complication; however, most patients die before surgery.

3.3. Iatrogenic Aortic Pathology due to Intra-Aortic Balloon Pump (IABP) Counterpulsation

Intra-aortic balloon pumps are used to improve coronary artery perfusion in patients with acute cardiac decompensation resulting from myocardial infarction. When distended in diastole, the balloon causes increased pressure in the proximal aorta, thus, improving coronary artery perfusion, increased oxygenation of the myocardium and improved cardiac output. Forced deflation during systole decreases cardiac afterload, resulting in decreased left ventricular work and oxygen requirements. IABP counterpulsation is the first method of choice for mechanical assistance in patients with cardiogenic shock complicating acute myocardial infarction. With increasing experience, the original indications for IABP in cardiogenic shock due to acute infarction, such as postoperative severe low-output state or inability to wean from cardiopulmonary bypass, have been extended to include refractory unstable angina (35, 36), recurrent life-threatening tachyarrhythmias (37) and preoperative support in the presence of severe left ventricular dysfunction (38, 39). The benefits of the device are inarguable, but several complications associated with IABP insertion have been reported. Complications of IABP placement are seen in 8% - 29% of procedures and include limb ischemia, aortic dissection (Figure 2), mesenteric ischemia, renal insufficiency, neurologic complications, thrombocytopenia, bleeding and infection (40, 41). Most problems are vascular. Independent risk factors for vascular complications include female sex, diabetes, cigarette smoking, peripheral vascular disease and the prior use of antiplatelet drugs (42). Iatrogenic aortic dissection is a rare but potentially lethal complication following IABP insertions. Aortic dissection occurs in 1% - 4% of intra-aortic balloon pump insertions (39-43), and acute aortic dissection with visceral and spinal cord malperfusion is among the most rare and dreaded of the vascular complications. There also have been several reports of death subsequent to aortic perforation or dissection from the balloon (44, 45). In addi-
tion, the location of the IABP within the false lumen usually leads to poor intra-aortic balloon pump function, which usually manifests clinically with poor augmentation. Accordingly, whenever this is recognized, the balloon should be removed immediately. Generally, conservative medical treatment in patients with iatrogenic type B dissection is preferred if no complications, such as aneurysm formation and rupture, visceral ischemia or limb ischemia, occur. Awareness of the complications of balloon insertion, proper attention to the details of balloon management at the time of insertion and removal and continuous monitoring through a central-lumen balloon should decrease the incidence of these complications.

4. Conclusions

With the increase of the interventional procedures in cardiology, iatrogenic pathology of the aorta is seen more frequently, and every cardiologist should know how to diagnose and treat this group of diseases. Awareness of these complications, proper attention during catheter advancement and continuous monitoring should decrease the incidence of these complications.

Acknowledgments

We would like cordially to thank the colleagues from the coronary care unit and the interventional cardiology department, without whom this work would have been impossible.

Footnote

Authors’ Contribution: Study concept and design: Jose Alberto de Agustin, Leopoldo Perez de Isla; acquisition of data: Jose Alberto de Agustin, Jose Juan Gomez de Diego, Patricia Mahia, Pedro Marcos-Alberca; analysis and interpretation of data: Jose Alberto de Agustin, Carlos Almeria, Jose Luis Rodrigo, Maria Luaces, Ivan Javier Nunez-Gil; drafting of the manuscript: Jose Alberto de Agustin, Leopoldo Perez de Isla; critical revision of the manuscript for important intellectual content: Jose Juan Gomez de Diego, Patricia Mahia, Pedro Marcos-Alberca, Carlos Macaya, Leopoldo Perez de Isla; statistical analysis: Jose Alberto de Agustin, Leopoldo Perez de Isla; administrative, technical, and material support: Leopoldo Perez de Isla; study supervision: Carlos Almeria, Jose Luis Rodrigo, Maria Luaces, Ivan Javier Nunez-Gil, Carlos Macaya and Leopoldo Perez de Isla.

References


