Safety and Effectiveness of Combined Percutaneous Coronary Angioplasty and Aortic Valvuloplasty in An Elderly Patient with Cardiogenic Shock: Effect on Concomitant Severe Mitral Regurgitation

Emanuele Cecchi, Cristina Giglioli, Cecilia Agostini, Gian Franco Gensini, and Gennaro Santoro

[1] *Department of Internal Medicine, Azienda Ospedaliero Universitaria Careggi, Florence, Italy*
[2] *Department of Heart and Vessels, Azienda Ospedaliero Universitaria Careggi, Florence, Italy*

Received: 31 Oct. 2012; Received in revised form: 25 Jan. 2013; Accepted: 15 Feb. 2013

Abstract- An 80-year-old diabetic man with severe aortic stenosis was admitted to our hospital for cardiogenic shock complicating non-ST-elevation myocardial infarction. Echocardiographic evaluation showed also a severe degree of both left ventricular dysfunction and mitral regurgitation. The patient was initially stabilized with inotropes and mechanical ventilation was necessary because of concurrent pulmonary edema. The day after, he was submitted to coronary angiography showing bivessel coronary disease. Given the high estimated operative risk, the patient was treated with angioplasty and bare metal stent implantation on both right coronary and circumflex artery; contemporarily, balloon aortic valvuloplasty (BAV) was performed with anterograde technique, obtaining a significant increase in planimetric valve area and reduction in transvalvular peak gradient. Few days after the procedure echocardiogram showed an increase in left ventricular ejection fraction, moderate aortic stenosis with mild regurgitation and moderate mitral regurgitation. Hemodynamic and clinical stabilization were also obtained, allowing amine support discontinuation and weaning from mechanical ventilation. At three months follow-up, the patient reported a further clinical improvement from discharge, and echocardiographic evaluation showed moderate aortic stenosis and an additional increase in left ventricular function and decrease in mitral regurgitation degree. In conclusion, combined BAV and coronary angioplasty were associated in our patient with hemodynamic and clinical stabilization as well as with a significant reduction in transvalvular aortic gradient and mitral regurgitation and an increase in left ventricular ejection fraction both in-hospital and at three month follow-up; this case suggests that these procedures are feasible even in hemodynamically unstable patients and are associated with a significant improvement in quality of life.
© 2013 Tehran University of Medical Sciences. All rights reserved.
Acta Medica Iranica, 2013; 51(8): 577-582.

Keywords: Aortic stenosis; Balloon aortic valvuloplasty; Cardiogenic shock; Percutaneous coronary angioplasty

Introduction

Aortic stenosis (AS) has become the most frequent valvular heart disease with an average survival after symptoms onset less than 2-3 years (1). In particular, the incidence of AS in the elderly population ranges from 2% to 9% and is characterised by an increased risk of death (2). In these patients, surgical aortic valve replacement carries higher perioperative risks mainly related to age and comorbidities and is also associated with prolonged recovery and poor quality of life after surgery (3). About one third of patients with severe AS are not referred for valve replacement surgery especially because of the risks perceived by both patients and physicians. The occurrence of cardiogenic shock can complicate the clinical course of patients with severe AS further worsening their prognosis. Among factors precipitating shock in severe AS acute myocardial infarction should be considered; when also this clinical condition is present, myocardial revascularization together with the correction of valvular aortic stenosis should be performed to restore hemodynamic stability. Emergency cardiac surgery could be lifesaving but the high surgical mortality (4) or the presence of multiorgan

Corresponding Author: Emanuele Cecchi
Departiment del Cuore e dei Vasi, Azienda Ospedaliero-Universitaria Careggi, Viale Morgagni, 85, I- 50134 Firenze, Italy
Tel: +39 0557949577, Fax: +39 0557947617, E-mail: emanuelececchi@virgilio.it

failure (4) often precludes these patients from operation. A combined procedure of balloon aortic valvuloplasty (BAV) and percutaneous coronary intervention (PCI) can represent an alternative therapeutic option for these high-risk patients even though scarce data are available regarding this issue (5,6). In this report we present the case of a patient with severe AS presenting in cardiogenic shock during non-ST-elevation myocardial infarction (NSTEMI) and concomitant functional severe mitral regurgitation successfully treated with combined BAV and PCI.

Case Report

An 80-year-old diabetic man with cardiogenic shock was transferred to our Intensive Cardiac Care Unit (ICCU) in Florence, which is a tertiary center, from the Intensive Care Unit of a secondary center where he had been admitted because of pulmonary edema.

On secondary center Intensive Care admission, he was submitted to a transthoracic echocardiography which documented severe AS and left ventricular dysfunction. Because of severe hypoxemia and hypotension, mechanical ventilation and inotropic support (first with dobutamine and then with levosimendan and norepinephrine) were started. In the following days no improvement was observed so the patient was transferred to our ICCU in order to submit him to aortic valvuloplasty. The choice of this strategy was based on the high predicted probability of operative mortality based on two different scores (standard EuroSCORE 17 with a predicted mortality of 60.79%; according to Parsonnet score the predicted probability of operative mortality resulted 69% in the additive model with a predicted death rate of 84.92% in the multivariate logistic regression model).

At our ICCU admission the patient was mechanically ventilated and on norepinephrine infusion. Electrocardiogram showed sinus rhythm at 105 bpm, incomplete left bundle branch block, ST-segment depression with negative T waves in the lateral leads and alterations of repolarization in the inferior leads. Transthoracic echocardiography showed left ventricle enlargement (end-diastolic diameter 35 mm/m²) with diffuse severe hypokinesia and severe depression of left ventricular ejection fraction (15%); severe AS (planimetric valve area 0.6 cm^2) and severe mitral regurgitation due to mitral annulus dilation (50 mm) and tethering of both leaflets were also detected; pulmonary artery systolic pressure resulted equal to 50 mmHg.

Norepinephrine infusion was stopped and furosemide and dopamine (2.5 γ/kg/min) were started. Blood examinations showed a progressive increase in biomarkers of myocardial infarction with maximum values of troponin I and creatine kinase-MB equal to 9.4 ng/ml and 20.9 UI/l, respectively. The day after ICCU admission, the patient was submitted to cardiac catheterism and angiography. Coronary angiography showed a sub-occlusive stenosis of both right coronary artery and circumflex artery; the first marginal branch was completely occluded and the first diagonal branch showed a critical stenosis. A PCI was performed in both right coronary and circumflex arteries and three bare metal stents were implanted. At the same time BAV was performed using anterograde technique as reported below.

A right femoral arterial access was obtained with a 6 Fr sheath. The left atrium was accessed by an 8 Fr Mullins sheath from the right femoral vein using standard transseptal puncture technique. Subsequently, a double-lumen 7 Fr Swan-Ganz catheter was advanced from the Mullins sheath through left atrium and left ventricle and looped in the left ventricular apex to pass across the aortic valve into the aortic arch. A 0.035' Terumo floppy wire 260 cm was advanced through the lumen of the Swan-Ganz catheter to navigate the catheter into the distal descending aorta. This wire was snared from the femoral arterial access and secured using a 15 mm snare catheter. The wire was pull back out the femoral sheat and was secured, providing enough support to advance the Inoue balloon from the right femoral vein through the right atrium, left atrium, left ventricle and then across the aortic valve. Systemic pressure was monitored via the side arm of the femoral arterial sheath. A 28 mm Inoue balloon was inflated three times across the aortic valve with the balloon diameter ranging sequentially from 22 to 26 mm without ventricular pacing. The balloon was removed over the wire. The 0.032' wire was carefully removed. Hemodynamic parameters were subsequently reassessed with transthoracic echocardiography and post-dilation aortic valve area was calculated and resulted equal to 1.45 cm^2. The procedure was completed by closing the entry site of the 14 Fr right femoral venous sheath and the arterial femoral sheat using suture closure devices.

This procedure was performed with Doppler echocardiography guidance in order to reduce the amount of contrast medium used and to prevent nephropathy, which is particularly relevant for a patient with cardiogenic shock. However, in our patient a slight increase in creatinine value was observed during hospitalization (maximum 2.2 mg/dl) and returned to

normal values before hospital discharge.

Five days after the procedures, an echocardiogram showed an increase in left ventricular ejection fraction (27%), moderate aortic stenosis (peak transvalvular velocity 2.5 m/sec) and mild regurgitation; moderate mitral regurgitation estimated by PISA method (ERO equal to 16 mm^2) and a normal transtricuspidal pressure gradient. During dobutamine infusion (up to 10 γ/kg/min), a further improvement of both lateral basal and anterior basal segments with a mild increase of left ventricular ejection fraction (32%), moderate aortic stenosis (peak transvalvular flow velocity equal to 3 m/sec) and a reduction of mitral regurgitation (ERO equal to 12 mm^2) were documented.

In the following days, amine administration was discontinued and the patient was weaned from mechanical ventilation. Two weeks after ICCU admission the patient was transferred back to secondary center hospital.

After three months the patient was re-evaluated in our hospital. The patient had been asymptomatic, even after moderate exertions. A transthoracic echocardiogram showed mild enlargement of left ventricle (end-diastolic diameter 33.5 mm/m^2) and a further increase of left ventricular ejection fraction (37%) with respect to discharge. Aortic valve area, estimated using the continuity equation, resulted 1.05 cm^2 with a transvalvular peak gradient of 34 mmHg; moreover, an additional reduction in mitral regurgitation (vena contracta 0.35 cm) was observed.

Discussion

This is the first report evaluating the effect of combined aortic valvuloplasty and coronary angioplasty in a patient with severe AS complicated by cardiogenic shock during NSTEMI and concomitant severe mitral regurgitation.

BAV has been introduced in 1980s as a therapeutic option in adults with symptomatic AS (7), especially those with a high surgical risk because of comorbid conditions or advanced age, in the hope of providing a less invasive alternative to surgical aortic valve replacement. However, despite initially encouraging results, it has been subsequently abandoned due to disappointing medium and long term-outcomes (8) similar to the natural history of AS (9); in fact for symptomatic elderly surgical aortic valve replacement remains the gold standard (10). However, BAV may provide temporary benefits in hemodynamically unstable patients, such as those with cardiogenic shock. In particular, according to the recent AHA/ACC guidelines (10), BAV can be considered (class IIb indication) as a bridge to surgery in hemodynamically unstable adult patients with AS at high risk for aortic valve replacement and for palliation in those for whom aortic valve replacement cannot be performed because of serious comorbid conditions. Moreover, BAV could be considered in patients refusing surgical valve replacement for any reason.

In the previous years, high complication rates and in-hospital mortality were also reported in patients submitted to BAV, especially in the first 24 hours following the procedure. Transfusions were performed in 20% of patients, related predominantly to vascular site access complications (11). Cumulative cardiovascular mortality before discharge was 8% in the NHLBI registry (11). Re-stenosis and recurrent hospitalization were common, although survivors reported fewer symptoms over the subsequent 1.5 years (9).

In the last few years, several technical and procedural improvements have become available for BAV, thank to which this technique has experienced a revival (12); among them, the use of Inoue balloon, typically used for mitral valvuloplasty, has been found to improve immediate post-BAV aortic valve area compared with conventional and retrograde BAV (13).

In fact, BAV may be performed by either an arterial (retrograde) or a transvenous transseptal (anterograde) vascular approach to access the aortic valve (14). Recent data have demonstrated that with anterograde technique it is possible to obtain similar hemodynamic and clinical benefits as the traditional retrograde approach (14); moreover, it is associated with significantly fewer peri-procedural vascular complications being performed with a venous puncture that allows much easier management, the use of larger balloons in a population where peripheral artery disease is common (14) and to repeat this procedure if necessary. However, this kind of approach is technically more challenging and complex than retrograde one, as it involves a transseptal puncture; on the other hand, it has been shown that retrograde left ventricular access through a severely stenotic aortic valve is difficult and results in greater embolic stroke rates (14). Based on these assumptions for our patient we chose anterograde technique and used an Inoue balloon in order to reduce the risk of complications.

Another relevant feature of the present case is that in our patient cardiogenic shock and mitro-aortic severe valvulopathy were associated also with NSTEMI,

requiring the execution of PCI in addition to BAV. It has been previously reported that in patients with severe aortic stenosis, angina and congestive heart failure, BAV and PCI were associated with a significant improvement in symptoms and a shorter hospital stay (15). Moreover, it has been suggested that, in spite of acute myocardial infarction, BAV and PCI may be safely combined for the treatment of patients not undergoing surgery (15). However, few data are available on the feasibility of these combined procedures in patients with cardiogenic shock who exhibit a too high surgical risk (5,6). Also in the present case, these two techniques have been simultaneously performed to treat, in a single stage, both coronary and aortic valvular alterations underlying cardiogenic shock.

As PCI in cardiogenic shock is concerned, it has been previously demonstrated that emergency PCI or surgery may be life-saving and should be considered at an early stage in ST-elevation myocardial infarction (STEMI) patients with cardiogenic shock (16). Previous studies have also demonstrated that an early myocardial revascularization is associated with improved survival in elderly patients with cardiogenic shock complicating acute myocardial infarction (17). PCI for STEMI patients and cardiogenic shock has two peculiarities: first of all, the usually recommended time window of 12 h after onset of chest pain is wider (16); second, multivessel PCI should be strongly considered for patients with multiple critical lesions at variance with all trials of primary PCI in STEMI suggesting to limit the acute revascularization to the culprit vessel (16). The treatment of cardiogenic shock in patients with left ventricular dysfunction following NSTEMI has not been clarified yet, even though it has been previously demonstrated that they have an in-hospital mortality similar to shock patients with STEMI (18). Moreover, Abbott *et al*. evaluating the risk of adverse outcomes by type of myocardial infarction (STEMI *versus* NSTEMI), found that STEMI was associated with a higher likelihood of in-hospital death with respect to NSTEMI, but long-term outcome after PCI was independent of myocardial infarction type (19).

Finally, in our patient severe mitral regurgitation was contemporarily present and this should have been determined by two different possible mechanisms: left ventricular overload and myocardial ischemia. The reduction in mitral regurgitation degree observed in our patient after the procedures can be, at least in part, ascribed to BAV through a decrease in left ventricular afterload and pressure overload. There are few data concerning the variations of mitral regurgitation degree in patients undergoing BAV. Come *et al.* analyzed 144 patients undergoing BAV for symptomatic AS and observed a significant reduction in mitral regurgitation (20). Moreover, in our patient, myocardial revascularization might have improved the ischemic contribute to either mitral regurgitation and left ventricular dysfunction thus leading, not only to a reduction in mitral regurgitation from severe to moderate after PCI but also to an improvement in left ventricular systolic function, expressed by an increase in ejection fraction from 15 to 27%. In this patient the beneficial effects of combined BAV and PCI were observed either immediately after the procedure and during follow-up; in fact, the echocardiographic evaluation performed at three-month showed a further increase in ejection fraction as well as a reduction in mitral regurgitation together with a marked clinical improvement.

In conclusion, combined BAV and PCI were associated in our patient with clinical and hemodynamic stabilization as well as with a significant reduction in peak transvalvular aortic gradient and mitral regurgitation degree and an increase in left ventricular ejection fraction both in-hospital and at three month follow-up; this case suggests that these procedures are feasible even in hemodynamically unstable patients and are associated with a significant improvement in quality of life.

New techniques, such as transcatheter aortic valve implantation and percutaneous mitral valve repair procedures will provide further advances in the therapeutic management of patients with cardiogenic shock due to severe aortic stenosis and mitral regurgitation.

References

1. Rosenhek R, Maurer G, Baumgartner H. Should early elective surgery be performed in patients with severe but asymptomatic aortic stenosis. Eur Heart J 2002;23(18):1417-21.
2. Otto CM, Lind BK, Kitzman DW, Gersh BJ, Siscovick DS. Association of aortic-valve sclerosis with cardiovascular mortality and morbidity in the elderly. N Engl J Med 1999;341(3):142-7.
3. Kolh P, Kerzmann A, Lahaye L, Gerard P, Limet R. Cardiac surgery in octogenarians; peri-operative outcome and long-term results. Eur Heart J 2001;22(14):1235-43.

4. Scott WC, Miller DC, Haverich A, Dawkins K, Mitchell RS, Jamieson SW, Oyer PE, Stinson EB, Baldwin JC, Shumway NE. Determinants of operative mortality for patients undergoing aortic valve replacement. Discriminant analysis of 1,479 operations. J Thorac Cardiovasc Surg 1985;89(3):400-13.
5. Whisenant B, Sweeney J, Ports TA. Combined PTCA and aortic valvuloplasty for acute myocardial infarction complicated by severe aortic stenosis and cardiogenic shock. Cathet Cardiovasc Diag 1997;42(3):283-5.
6. Kato K, Sato N, Fujita N, Yamamoto T, Iwasaki YK, Yodogawa K, Takayama M, Tanaka K, Takano T. Combined therapy with percutaneous coronary intervention and percutaneous aortic valvuloplasty under mechanical support for an elderly patient with cardiogenic shock. J Nippon Med Sch 2006;73(3):158-63.
7. Cribier A, Savin T, Saoudi N, Rocha P, Berland J, Letac B. Percutaneous transluminal valvuloplasty of acquired aortic stenosis in elderly patients: an alternative to valve replacement? Lancet 1986;1(8472):63-7.
8. Conradi L, Reichenspurner H. Review on balloon aortic valvuloplasty: a surgeon's perspective in 2008. Clin Res Cardiol 2008;97(5):285-7.
9. Otto CM, Mickel MC, Kennedy JW, Alderman EL, Bashore TM, Block PC, Brinker JA, Diver D, Ferguson J, Holmes DR Jr, et al. Three-year outcome after balloon aortic valvuloplasty. Insights into prognosis of valvular aortic stenosis. Circulation 1994;89(2):642-50.
10. American College of Cardiology; American Heart Association Task Force on Practice Guidelines (Writing Committee to revise the 1998 guidelines for the management of patients with valvular heart disease); Society of Cardiovascular Anesthesiologists, Bonow RO, Carabello BA, Chatterjee K, de Leon AC Jr, Faxon DP, Freed MD, Gaasch WH, Lytle BW, Nishimura RA, O'Gara PT, O'Rourke RA, Otto CM, Shah PM, Shanewise JS, Smith SC Jr, Jacobs AK, Adams CD, Anderson JL, Antman EM, Fuster V, Halperin JL, Hiratzka LF, Hunt SA, Lytle BW, Nishimura R, Page RL, Riegel B. ACC/AHA 2006 guidelines for the management of patients with valvular heart disease: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (writing Committee to Revise the 1998 guidelines for the management of patients with valvular heart disease) developed in collaboration with the Society of Cardiovascular Anesthesiologists endorsed by the Society for Cardiovascular Angiography and Interventions and the Society of Thoracic Surgeons. J Am Coll Cardiol 2006;48(3):e1-148.
11. [No authors listed]. Percutaneous balloon aortic valvuloplasty. Acute and 30-day follow-up results in 674 patients from the NHLBI Balloon Valvuloplasty Registry. Circulation 1991;84(6):2383-97.
12. Sack S, Kahlert P, Khandanpour S, Naber C, Philipp S, Möhlenkamp S, Sievers B, Kälsch H, Erbel R. Revival of an old method with new techniques: balloon aortic valvuloplasty of the calcified aortic stenosis in the elderly. Clin Res Cardiol 2008;97(5):288-97.
13. Eisenhauer AC, Hadjipetrou P, Piemonte TC. Balloon aortic valvuloplasty revisited: the role of the inoue balloon and transseptal antegrade approach. Cathet Cardiovasc Interv 2000;50(4):484-91.
14. Cubeddu RJ, Jneid H, Don CW, Witzke CF, Cruz-Gonzalez I, Gupta R, Rengifo-Moreno P, Maree AO, Inglessis I, Palacios IF. Retrograde Versus Antegrade Percutaneous Aortic Balloon Valvuloplasty: immediate, short- and long-term outcome at 2 years. Cathet Cardiovasc Interv 2009;74(2):225-31.
15. McKay RG, Safian RD, Berman AD, Diver DJ, Weinstein JS, Wyman RM, Cunningham MJ, McKay LL, Baim DS, Grossman W. Combined percutaneous aortic valvuloplasty and transluminal coronary angioplasty in adult patients with calcific aortic stenosis and coronary artery disease. Circulation 1987;76(6):1298-306.
16. Silber S, Albertsson P, Avilés FF, Camici PG, Colombo A, Hamm C, Jørgensen E, Marco J, Nordrehaug JE, Ruzyllo W, Urban P, Stone GW, Wijns W; Task Force for Percutaneous Coronary Interventions of the European Society of Cardiology. Guidelines for percutaneous coronary interventions: the task force for percutaneous coronary interventions of the European Society of Cardiology. Eur Heart J 2005;26(8):804-47.
17. Dzavik V, Sleeper LA, Cocke TP, Moscucci M, Saucedo J, Hosat S, Jiang X, Slater J, LeJemtel T, Hochman JS; SHOCK Investigators. Early revascularization is associated with improved survival in elderly patients with acute myocardial infarction complicated by cardiogenic shock: a report from the SHOCK Trial Registry. Eur Heart J 2003;24(9):828-37.
18. Jacobs AK, French JK, Col J, Sleeper LA, Slater JN, Carnendran L, Boland J, Jiang X, LeJemtel T, Hochman JS. Cardiogenic shock with non-ST-segment elevation myocardial infarction: a report from the SHOCK Trial Registry. SHould we emergently revascularize Occluded coronaries for Cardiogenic shocK? J Am Coll Cardiol 2000;36(3 Suppl A):1091-6.

19. Abbott JD, Hamed HN, Vlachos HA, Selzer F, Williams DO. Comparison of Outcome in Patients With ST-Elevation Versus Non-ST-Elevation Acute Myocardial Infarction Treated With Percutaneous Coronary Intervention (from the National Heart, Lung, and Blood Institute Dynamic Registry). Am J Cardiol 2007;100(2):190-5.
20. Come PC, Riley MF, Berman AD, Safian RD, Wakmonski CA, McKay RG. Serial assessment of mitral regurgitation by pulsed Doppler echocardiography in patients undergoing balloon aortic valvuloplasty. J Am Coll Cardiol 1989;14(3):677-82.