AUCTORES
Globalize your Research

Cardiology Research and Reports
Choukri Moulay Achrafa *

Open Access

Research Article

Balloon valvuloplasty for pulmonary stenosis: Experience of Mohammed VI University Hospital of Marrakech

Ztati Mohameda, Choukri Moulay Achrafa*, Ait Yahya Abdelkarima, Joumana El Masriouia, El Jamili Mohamed, El Karimi Salouaa, El Hattaoui Mustaphaa

Cardiology Department, Mohammed VI University Hospital of Marrakech, Morocco.

***Corresponding Author:** Choukri Moulay Achrafa, Cardiology Department, Mohammed VI University Hospital of Marrakech, Morocco.

Received date: October 23, 2024; **Accepted date:** November 04, 2024; **Published date:** November 15, 2024

Citation: Ztati Mohameda, Choukri Moulay Achrafa, Ait Yahya Abdelkarima, Joumana El Masriouia, El Jamili Mohamed et al., (2024), Balloon valvuloplasty for pulmonary stenosis: Experience of Mohammed VI University Hospital of Marrakech, *Cardiology Research and Reports*, 6(6); **DOI:10.31579/2692-9759/146**

Abstract

Introduction: Pulmonary stenosis (PS) is a common congenital heart disease that obstructs the blood flow from the right ventricle (RV) to the pulmonary artery (PA). Percutaneous balloon valvuloplasty is the first-line treatment for this disease, and the outcomes depending on the anatomical characteristics of the right ventricle and the pulmonary artery.

Objectives: To conduct an epidemiological study, investigate the circumstances of pulmonary stenosis diagnosis, evaluate the diagnostic role of Doppler echocardiography, and determine the therapeutic role of interventional treatment.

Methods: This descriptive retrospective study involved patients with PS followed in the functional exploration department of Mohammed VI University hospital of Marrakech between March 2024 and June 2024.

Results: Three patients were included. The presenting symptoms were dyspnea with paroxysmal palpitations in two patients and feeding difficulty in one patient. All patients had an ejection systolic murmur in pulmonary area. Balloon dilatation was successfully performed in all patients, with the saturation increasing from an average of 93% to 97%.

Conclusion: Percutaneous balloon treatment for pulmonary stenosis is a safe and effective alternative with few complications and good immediate results.

Keywords: pulmonary stenosis; balloon valvuloplasty; congenital heart disease; hemodynamic evaluation; interventional cardiology

Introduction

Pulmonary stenosis or valvular pulmonary stenosis is a relatively common congenital heart defect that can occur in isolation or more commonly in association with other congenital heart defects. Pulmonary stenosis was defined as an obstruction at the level of the right ventricle outflow tract, the pulmonary valve ring, or the pulmonary valve leaflets or within the main pulmonary arteries and branches [23]. It can be isolated in 7% to 12% of patients but is more commonly associated with other congenital heart defects in 25% to 30% of these patients [24]. Symptomatic patients are usually those with moderate or severe pulmonary stenosis. They typically experience exertional dyspnea or fatigue, depending on the severity of the obstruction and the compensatory capacity of the heart [1]. Percutaneous balloon angioplasty is a good alternative to surgery. First described by Kan et al [2,3], percutaneous balloon valvuloplasty has satisfactory short- and long-term results, depending on the anatomy of the pulmonary valve and the compliance with the right ventricle [4]. However, despite initial procedural success, some patients will later require additional intervention.

In this work, we report the experience of the cardiology department of Mohammed VI university hospital of Marrakech in treating pulmonary stenosis. The objective of this study was to conduct an epidemiological retrospective study, investigate the circumstances of pulmonary stenosis diagnosis, evaluate the diagnostic role of Doppler echocardiography, and determine the therapeutic role of interventional treatment.

Material

This was a retrospective study involving three patients who underwent percutaneous balloon dilatation for pulmonary stenosis, followed at the cardiology department of CHU Mohammed VI of Marrakech over a period of three months, from March 2024 to June 2024. The patients varied in sex and age. All patients underwent clinical examination, echocardiography for diagnostic confirmation, right ventricular ventriculography, and pulmonary artery arteriography. The limited sample size is because of the first hospital's experience in this field. Broader studies are scheduled for the coming years, once a more substantial number of patients will be documented.

Methods

A retrospective study focused on patients with pulmonary stenosis over a three-month period. Clinical and operative data of the surgical patients were collected from the following manual sources:

- Medical records archives
- Operative reports archives

Patients with supravalvular stenosis, significant infundibular stenosis, or pulmonary stenosis associated with complex congenital heart defects were excluded. Clinical characteristics of the patients, including age at discovery, sex, weight, intervention delay, clinical presentation at admission, saturation, and hemodynamic status were collected. Electrocardiographic and echocardiographic characteristics were also analyzed. The state of the pulmonary valve and the pressure gradient between the RV and the pulmonary artery were also analyzed. Percutaneous pulmonary dilatation was performed under general anesthesia. A right femoral vein puncture was performed with the placement of a 6 French sheath. After the puncture, a right coronary catheter (Judkins Right: Jr) 4 was advanced from the right femoral vein to the pulmonary artery. Right ventricular pressure and the peak-to-peak RV-PA gradient was measured. Right ventricular angiography was performed by automatic injection of a low-osmolarity contrast agent at 15 cc/sec through this coronary catheter. This procedure allows for the evaluation of the RV anatomy and simultaneous opacification of the pulmonary bed. A 0.035 coronary guidewire was advanced after crossing the pulmonary orifice was crossed distally into one of the PA branches. The balloon diameter was equal to 120% of the diameter of the pulmonary ring measured by echocardiography and/or angiography. The balloon was positioned across the valve, and the operator proceeded with balloon inflation until partial disappearance of the pulmonary imprint was achieved, followed by rapid deflation and RV opacification to evaluate the final result. Percutaneous balloon valvuloplasty was considered successful when the residual gradient is less than 50 mmHg with an oxygen saturation greater than 90% in the absence of complications. Immediate monitoring was performed after dilatation, with evaluation of post-dilatation oxygen saturation, the RV-PA gradient, and pulmonary regurgitation post-dilatation by echocardiography. Procedural or immediate post-procedural complications were immediately recorded. Follow-up parameters included saturation and echocardiographic parameters (RV compliance, pulmonary regurgitation, pulmonary ring diameter, and RV-PA gradient).

Results

a. Epidemiological characteristics

The mean age was 21 years (ranging from 2 to 44 years). Two patients were female. The mean weight of our patients was 406 kg (ranging from 17 kg to 55 kg). The mean intervention time (time between diagnosis and pulmonary dilatation) was 35 months (ranging from 15 days to 9 months after diagnosis). All pregnancies were carried out at term. The presenting symptoms were dyspnea with paroxysmal palpitations in two cases and feeding difficulty in one patient. All patients had an ejection systolic murmur in the pulmonary area. The baseline oxygen saturation was 93% on average (ranging from 84% to 99%). An electrocardiogram showed regular sinus rhythm in all patients, with right axis deviation, RVH, and RAH in one patient.

b. Echocardiographic characteristics

•Right Ventricle

Right ventricular hypertrophy was present in all patients, and was associated with one patient with right ventricular dilation and limited function.

•Pulmonary Valve

The “dome sprayer” appearance of the pulmonary valves was observed in all the patients, dysplastic appearance in one patient. The mean pulmonary ring diameter was 153 mm (ranging from 11 to 177 mm).

•Doppler echocardiographic criteria

The maximum RV-PA gradient measured by Doppler echocardiography at the pulmonary valve level averaged 121 mmHg (ranging from 78 to 204 mmHg). The right ventricular pressure (RV pressure) averaged 113 mmHg (ranging from 90 to 140 mmHg).

c. Pulmonary Dilatation Technique

Pulmonary dilatation was performed in all patients under general anesthesia. This procedure was performed immediately with a dedicated balloon in all patients. A right femoral vein puncture was performed with the placement of a 6F introducer. An FR4 diagnostic catheter was advanced on a 0.035 guide (Hydrophile) into the trunk of the pulmonary artery. An exchange over a long PTFE guide (Starter 260 cm) was performed with the placement of a 5F pigtail catheter into the pulmonary artery. Pulmonary arteriography (15 ml/s) was performed in profile incidence. Angiographic measurement of the pulmonary ring was performed. A TYSHAK II dilatation balloon was advanced. Pulmonary valve dilatation was performed at 4 atm. Control arteriography and invasive hemodynamic measurements of the RV-PA gradient were performed. Percutaneous valvuloplasty was successfully performed in all patients (RV-PA gradient < 50 mmHg). The success rate is estimated at 100%. SpO2, which was 84% in one patient, increased to 96%, raising the average SpO2 from 93% to 97%. A decrease in the VD-AP gradient was noted in all our patients. This gradient decreased on average from 99 mmHg before dilation to 30 mmHg after dilation. A decrease in RV pressure was noted in all our patients. The RV pressure decreased on average from 113 mmHg to 57 mmHg (Table I).

d. Complications

Complications were recorded in all three patients. These included 2 patients with moderate pulmonary insufficiency and 1 patient with bronchospasm related to anesthesia, both of which had a favorable outcome.

Oxygen saturation	
Pre-procedural	93%
Post-procedural	97%
Pulmonary valve	
Dysplastic PV (yes/no)	1/2
RV-PA Gradient (mmHg)	
Pre-procedural	99 mmHg
Post-procedural	30 mmHg

RV pressure (mmHg)	
Pre-procedural	113 mmHg
Post-procedural	57mmHg

Table I: Pre and post-procedural outcomes

Discussion

The dilatation was successfully performed on three patients. The type of anesthesia varies among authors. For instance, Alsawah [5], Yucel [6], and Tabatabei [7] also performed general anesthesia, while Zeevi et al. [8], Fedderly et al. [9], and Sullivan et al. [10] opted for local anesthesia in all patients in their series. Ladusan et al. [11], in a study involving a series of 15 patients, performed general anesthesia in eight patients and local anesthesia in seven patients.

Several approaches can be used during right heart catheterization. We used a right femoral vein approach in all our patients. Zeevi [8] and Gournay [12] used the same technique in their series. Alsawah [5] used the right femoral vein approach in 55% of his population and the umbilical route in 44% of cases. A heparin bolus was also administered to all our patients at a dose of 50 IU/kg. This heparin premedication has also been described by Kan [3] and Zeevi [8].

To cross the pulmonary valve, we used a right coronary catheter of the right Judkins (JR) type. Gournay et al. [12] reported the same technique. Difficulty in crossing the stenotic valve orifice with the catheter tip during pulmonary dilation has been noted by some authors [8,13,15]. We encountered this problem in one patient in our series. Immediately after dilation, a decrease in ventricular pressure was observed in our patients. The right ventricular pressure decreased on average from 113 to 57 mmHg, a reduction of 46%. The right ventricular outflow tract (RVOT) gradient decreased on average from 99 mmHg to 30 mmHg, a reduction of 61%. This finding has been reported by several authors [12,11,9,15,17-18].

Several clinical, echocardiographic, and hemodynamic parameters have been studied to determine immediate procedural success [1,12]. According to published series reported in the literature, the success rate of percutaneous balloon valvuloplasty varies from 58 to 98% [1,12,9,6-8,16,19]. The main causes of percutaneous valvuloplasty failure cited by different authors are failure to cross the pulmonary valve, failure of balloon progression, unfavorable valve anatomy (dysplasia, annular hypoplasia), right ventricular (RV) hypoplasia, and reduced RV compliance, which partly accounts for the persistence of cyanosis [12,7,17].

In our series, we had no cases of valvuloplasty failures The most important factor determining valvuloplasty success is RV compliance, which is partly determined by the size of the right ventricular cavity [17]. RV noncompliance plays a significant role in worsening hypoxemia even after pulmonary dilation. It is secondary to myocardial ischemia and fibrosis of the RV elastic fibers due to elevated right ventricular pressure [17].

Minor complications following valvuloplasty have been reported in the literature, such as transient bradycardia and hypotension during balloon inflation [9], variable atrioventricular block without hemodynamic consequences [5], right bundle branch block [8], and transient ventricular arrhythmias occurring during passage through the infundibular portion of the RV [9,12,5,6,16]. Local complications can also occur at the access site, such as intimal dissection of the right iliac vein during balloon passage attempts [8].

he mortality rate reported in the literature following percutaneous valvuloplasty ranges from 0 to 14% [12,5,7,20,14,17]. These rates are lower than those for surgery, estimated at 20-25% [17]. Causes of mortality from valvuloplasty are generally due to infundibular perforation with hemopericardium and tamponade, or myocardial dissection occurring a few hours after the procedure [12,5,10,16]. The follow-up mortality rate ranges from 0 to 25% in the literature [8,10,6,7,14,20,21]. The restenosis rate varies in the literature from 0.1% to 41% [7,0,17,18,22]. In the case of postvalvuloplasty restenosis, a second valvuloplasty is indicated.

Study limitations

The limited sample size is because of the first center's experience in this field. Broader studies with predictive factors for reintervention are scheduled for the coming years, once a more substantial number of patients will be documented.

Conclusion

The experience of our center in pulmonary dilation for pulmonary stenosis demonstrates the efficacy and safety of this procedure as an alternative to surgery. Our results indicate a significant improvement in hemodynamic parameters and a reduction in clinical symptoms in the majority of treated patients. Complications were rare and generally minor, reinforcing the relevance of this intervention in managing pulmonary stenosis. Longer-term studies with larger patient numbers are needed to confirm these observations and refine therapeutic strategies.

Competing interests

The authors declare no competing interest.

Funding declaration

No funding.

References

1. Convertino VA, Wirt MD, Glenn JF, Lein BC. (2016). The Compensatory Reserve For Early and Accurate Prediction Of Hemodynamic Compromise: A Review of the Underlying Physiology. Shock. 45(6):580-590.
2. Kan J.s, White r.i, Mitchell s.e, gardner T.J. (1982). Percutaneous balloon valvuloplasty: a new method for treating congenital pulmonary-valve stenosis. n *engl J Med.* 307; 198: 540-542.
3. Kan J.s, White r. i, Mitchell s.e, anderson J.H, gardner T.J. (1984). Percutaneous transluminal balloon valvuloplasty for pulmonary valve stenosis. *Circulation.* 69: 554–560.
4. Caspi J, Coles Jg, Benson ln. (1990). Management of neonatal critical pulmonic stenosis in theballoon valvotomy era. *ann thorac surg*. 49:273-278.
5. Alsawah g.a, Hafez M.M, Matter M, abo-Haded H.M., rakha s, almarsafawy H. (2016). Balloon valvuloplasty for critical pulmonary valve stenosis in newborn: a single center ten- year experience. Prog *Ped Cardiol.* 43: 127–131.
6. Yucel i K, Bulut o M, Kucuk M, Balli s, (2016). Celebi a. intervention in patients with critical pulmonary stenosis in the ductal stenting era. *Pediatr Cardiol.* 37:1037- 1045.
7. Tabatabaei e, Boutin C, nykanen C, Freedom r.M, Benson l. (1996). Morphologic and haemodynamic consequences after percutaneous balloon valvotomy for neonatal pulmonary

stenosis: medium-term follow up. *J am Coll Cardiol.* 27: 473-478.

8. Zeevi B, Keane J.F, Fellows K.e, lock J.e. (1988). Balloon dilation of critical pulmonary stenosis in the first week of life. J am CollCardiol. 11: 821–824.
9. Fedderly, r.T, lloyd T.r, Mendelsohn a.M, Beekman r.H. (1995). determinants of successful balloon valvotomy in infants with critical pulmonary stenosis or membranous pulmonary atresia with intact ventricular septum. *J am Coll Cardiol.* 25:460- 465.
10. Sullivan i.d, robinson P.J, Macartney F.J, Taylor J.F, rees P.g, et al.(1985).Percutaneous balloon valvuloplasty for pulmonary valve stenosis in infants and children. *B Heart J.* 54: 435–441.
11. Ladusans e.J, Qureshi s.a, Parsons J.M, arab s, Baker e.J, et al.(1990).Balloon dilatation of critical stenosis of the pulmonary valve in neonates. B Heart J. 6: 362–367.
12. Gournay V, Piéchaud J.F, delogu a, sidi d, Kachaner J. (1995). Balloon valvotomy for critical stenosis or atresia of pulmonary valvein newborns. *J am Coll Cardiol*. 26: 1725-1731.
13. Rao P.s. (1996). Balloon valvuloplasty in the neonate with critical pulmonary stenosis. *J am Coll Cardiol.* 27: 479-480.
14. Karagoz T, asoh K, Hickey e, Chaturvedi r, lee K, et al. (2009). Balloon dilation of pulmonary valve stenosis in infants less than 3 kg: a 20-year experience. *Catheter Cardiovasc interv.* 74: 753–761.
15. Luo F, Xu W.Z, Xia C.s, shi l.P, Wu X.J, et al. (2011). Percutaneous balloon pulmonary valvuloplasty for critical pulmonary stenosis in infants under 6 months of age and short and medium term follow-up. Chinese *J Pediatrics.* 49: 17–20.
16. Li H, li Y.F, li J.J, Zhang X, Xu Y.M, et al. (2008). Transcatheter intervention for critical pulmonary artery valvular stenosis and atresia with intact ventricular septum in neonates. *Chinese J Pediatrics.* 46: 860- 864.
17. Gildein H.P, Kleinert s, goh H.T, Wilkinson J.l. (1996).Treatement of critical pulmonary valve stenosis by balloon dilatation in theneonate. am *Heart J.* 135:1007- 1011.
18. Peterson C. schilthuis a dodge-Khatami, J. Hitchcock JF, Meijboom eJ, Bennink gB. (2003). Comparative long-term results of surgery versus balloon valvuloplasty for pulmonary valve stenosis in infants and children *ann Thorac surg.* 76:1078–1083.
19. Rothman a, Perry s.B, Keane J.F, lock J.e. (1990). early results and follow up of balloon angioplasty for branch pulmonary artery stenosis. *J am Coll Cardiol. 15*:1109-1117.
20. Shaath g, Mutairi M.a, Tamimi o, alakhfash a, abolfotouh M, et al. (2012). Predictors of reintervention in neonates with critical pulmonary stenosis or pulmonary atresia with intact ventricular septum. *Catheter Cardiovasc interv.* 79:659–664.
21. Hanley F.l, sade r.M, Freedom r.M, Blackstone e.H, Kirklin J.W. (1993).outcomes in critically ill neonates with pulmonary stenosisand intact ventricular septum: a multiinstitutional study. *J am Coll Cardiol.* 22:183–192.
22. Li H, li Y.F, li J.J, shi J.J, Zhang Z.W, et al. (2012). short-and mid-term outcomes of transcatheter intervention for critical pulmonary stenosis and pulmonary atresia with intact ventricular septum in neonates. Chinese J Pediatrics. 50: 925–928.
23. Heaton J, Horenstein M,Kyriakopoulos C.(2024). Pulmonary stenosis. StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing;
24. Federico M, Sofia M, Giulia P, Gianluca C, Rita P. (2023). Pulmonary Valve Stenosis: From Diagnosis to Current Management Techniques and Future Prospects. Vascular Health and Risk Management. 19:379–390. doi: 10.2147/VHRM.S380240.

DOI:10.31579/2692-9759/146