Ductal closure with radiofrequency energy; outcomes of the first series

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ABSTRACT

Using radiofrequency energy for closure of the patent ductus arteriosus (PDA) has been reported by us previously. In this article we report the early and late outcome of the first group in whom patent ductus arteriosus has been occluded with radiofrequency. Six children with PDA were enrolled. The procedure was successful in five cases and transient hoarseness was observed in 2 cases as the only complication.

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1. Introduction

Patent ductus arteriosus is a well-known congenital heart disease. Medium to large patent ductus arteriosus inflict a burden to the heart and should be closed. Closure of the small silent patent ductus arteriosus is controversial while some physicians apprehensive for the potential infection. Since many years ago various devices are available for ductal closure. Although device closure of the patent ductus arteriosus is highly successful with low complications, many parents are afraid of putting a foreign object in the body of their kids. On the other hand, device dislocation is still a considerable matter. Considering the above-mentioned aspects, we used the potential of radiofrequency energy for ductal closure. First, we used the energy for vascular closure in animal model1 and then reported the first in-human case in which the ductus had been closed with radiofrequency.2 Hereby, we are reporting our early experiences with the novel technique.

2. Methods

All procedures contributing to this work comply with local and international ethical standards including Helsinki declaration of 1975, as revised in 2008.

Six Children (2 male) with patent ductus arteriosus smaller than 3 mm were included. The age range was from 7 to 73 months, and the weight range was from 5.8 to 14 kg. All procedures were done under sedation and local anesthesia. We had open heart surgery room with all equipment including extracorporeal membrane oxygenation (ECMO) system nearby our catheterization room. A 5-Fr pigtail catheter was advanced to the aorta and a contrast injection was performed before the procedure in the lateral view. For the first case 6-Fr ablation catheter (Blazer II HTD, Boston, Massachusetts, United States of America) and for the others a 7-Fr ablation catheter (Stinger, Boston, Massachusetts, United States of America) were used. Based on our previous experiences and documentations in Pediatric electrophysiology laboratory and animal laboratory,1 Radiofrequency energy (Maestro, Boston, Massachusetts, United States of America) with a power of 45 W and a temperature level of 65 °C was applied for 2 min. During radiofrequency application, multiple injections of small amounts of contrast media were done to rule out extravasation. After 2 min, the radiofrequency was stopped and contrast injection at the same volume and velocity as the first one was done for showing the final result.

Transthoracic echocardiography was done for all cases just after the procedure, the day after, and then at months 1, 3, 6, and 12 for all. Annual follow up visits and echocardiography was done thereafter up to 5 years post procedure.
Fig. 1. Angiograms of the cases in whom ductal occlusion with radiofrequency energy was tried. Panel A showed pre-procedural and panel B showed post-procedural angiogram.
4. Discussion

Cases could have some advantages including avoiding foreign body implantation, shortening the procedural and fluoroscopy times, precluding the risk of device dislocation, spares the patient from implantation, shortening the procedural and duration of radiofrequency energy tolerated by the nerve, to avoid permanent injury. In a report of radiofrequency application in renal artery, one vascular dissection was reported amongst 153 cases; however, the direct role of radiofrequency energy for that complication has not been confirmed. Other possible complications are to be investigated.

The method, in current situation, could not however be a substitute for device closure of large patent ductus arteriosus and other large collateral vessels. The maximum vessel size in which the radiofrequency energy could be effective for closure is not clear. In our experience, the ductal size in the only unsuccessful case was not greatly larger than the others. Other factors such as the ductal structure could be implicated.

5. Conclusion

Radiofrequency energy could be used as a possible tool for closing small patent ductus arteriosus. The method could be extrapolated to various clinical scenarios like closure of collateral vessels, feeder vessels to tumors or bleeders etc.

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Declaration of competing interest

All authors have none to declare.

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References

1. Dalili M. Radiofrequency energy for vascular closure: a novel technique with multiple applications [Internet]. Cardiol Young. 2014;24(1):158–160.
2. Dalili M. Ductal closure with radiofrequency energy: the first in-human report [Internet]. Cardiol Young. 2015;25(5):999–1001.
3. Uncu H, Ocak FT, Karaca S, Badak TO, Ozsoyler I. Comparison of mid-term results of 980 nm wavelength endovenous laser ablation and radiofrequency ablation in varicose vein surgery [Internet]. Turk J Thorac Cardiovasc Surg. 2015;23(4):678–682.
4. Haines DA. Biophysics of radiofrequency lesion formation. In: Huang, ed. Catheter Ablation of Cardiac Arrhythmias. Elsevier Inc.; 2006:14–18.
5. Holmes Jr DR, Monahan RH, Packer D. Pulmonary vein stenosis complicating ablation for atrial fibrillation: clinical spectrum and interventional considerations. JACC Cardiovasc Interv. 2009;2:267–276.
6. Castaño A, Crawford T, Yamazaki M, Avula UM, Kalifa J. Coronary artery pathophysiology after radiofrequency catheter ablation: review and perspectives. Heart Rhythm. 2011;8:1975–1980.
7. Yan J, Wang C, Du R, Yuan W, Liang Y. Pulmonary vein stenosis and occlusion after radiofrequency catheter ablation for atrial fibrillation. *Int J Cardiol.* 2013;168:e68–e71.

8. Demelo-Rodriguez P, Del Toro-Cervera J, Andrés-Del Olmo B. Haemoptysis and pulmonary vein stenosis after ablation for atrial fibrillation: pathophysiology and therapeutic options. *Arch Bronconeumol.* 2013;49:366–367.

9. Viles-Gonzalez JF, de Castro Miranda R, Scanavacca M, Sosa E, d’Avila A. Acute and chronic effects of epicardial radiofrequency applications delivered on epicardial coronary arteries. *Circ Arrhythm Electrophysiol.* 2011;4:526–531.

10. Josephson ME. Electrophysiologic investigation: technical aspects. In: *Clinical Cardiac Electrophysiology.* New York: LippincottWilliams & Wilkins; 2008:7.

11. Krum H, Barman N, Schlach M, et al. Catheter-based renal sympathetic denervation for resistant hypertension: durability of blood pressure reduction out to 24 months. *Hypertension.* 2011;57:911–917.