

Pulmonary artery banding using polytetrafluoroethylene; Choice of material

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Editorial

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Pulmonary artery (PA) banding was introduced by Muller and Dammann in 1952 as a palliative operation for patients with congenital heart defects characterized by high pulmonary blood flow and pressures in situations that the definite surgical repair of congenital heart defects should be deferred.¹ This operation was suggested to protect the pulmonary vascular bed from irreversible changes until the main cardiac pathology could be corrected by definitive cardiac surgery. They removed a wedge-shaped segment from the wall of the PA and reduced the lumen size by suturing the edges together, followed by banding the PA with a 1-cm wide band composed of several layers of polyethylene film sutured over cotton umbilical tape.¹ Pulmonary artery banding has recently gained interest and mainly used in infants with complex defects where mortality of early repair is prohibitive or where the Fontan procedure is the only "repair" possible.

Since that time, Muller and Dammann's original technique has been greatly modified and many other banding materials have been utilized including cellophane, silk, cotton umbilical tape, nylon, Teflon, and Dacron.² These materials can cause reaction in the PA wall and surrounding tissue, leading to severe fibrosis, stricture, cutting through the vessel wall, incorporation, and calcification.³ These reactions and complications make debanding procedure more difficult or impossible, necessitate additional procedures for PA reconstructions and increase the risk of the final corrective procedure. None the less, pulmonary artery banding will continue to be an important palliative procedure in some neonates with cardiac disorders, too small to allow definitive correction of their defects.

The difficulty and complications encountered when we attempted to deband some types of materials led us to utilize polytetrafluoroethylene (PTFE) strip and report our experience to demonstrate the effectiveness and outcome

produced by PA banding with this material.

The authors usually prefer a left anterolateral thoracotomy through the third or fourth intercostal space. However, if a concomitant closure of patent ductus arteriosus (PDA) and/or repair of coarctation of aorta are required a left lateral thoracotomy is performed. Usually, the third intercostal space is entered; the pericardium is opened only at its superior border over the great arteries, with care taken to leave it intact over the ventricular mass and the ductus or ligamentum arteriosum is dissected and ligated. The tissue plane between ascending aorta and PA is dissected out over a limited area halfway between the sinutubular junction of the pulmonary trunk and origin of the right pulmonary artery (RPA). The site of band placement is carefully selected in the mid portion of the main pulmonary artery (MPA) trunk, and distortion or injury to the pulmonary valve or impingement on the branch pulmonary arteries is avoided. Aggressive dissection in this area is discouraged because it increases the chance of migration of the band over time. Once circumferential access to the pulmonary trunk is achieved, the band is prepared and placed around it. A 3-mm-wide strip is cut and fashioned from a relatively thick (0.4 to 0.6 mm) PTFE sheet. Width of band material should be broad enough to minimize erosion through the PA wall.

The degree of constriction depends on the underlying cardiac lesion and balance of systemic and pulmonary blood flow. Once the band is positioned, the systemic and the PA pressures are continuously monitored. The surgeon then gradually reduces band circumference, evaluating both band gradient and oxygen saturation (SaO₂) as end points. When the band adjusts to its final circumference, its two ends are fixed and sutured together. The band is also anchored with 5-0 Prolene suture to the PA adventitia to prevent band

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migration. The MPA is handled very carefully because it is often dilated, thin-walled, and susceptible to injury.

Pulmonary artery banding takedown is usually performed at the time of the intracardiac repair through a median sternotomy. The PTFE band is simply dissected free from surrounding tissue. The band can almost always be cut and removed without damaging the underlying artery and simple band removal may be all that is necessary. Adequate diameter of pulmonary trunk is usually obtainable without need for any PA reconstruction.

The authors have experience with more than 280 patients with pulmonary hypertension who underwent PA banding with expanded PTFE over 9-year period from June 2007 to October 2016. Our preliminary series included 360 patients in whom other materials had been used during PA banding from 1997 to 2007. Indication to perform PA banding was infants too small to allow definitive correction of their defect with the presence of a clinically and instrumentally significant pulmonary hypertension, not amenable to non-surgical therapy.

Although total corrections of cardiac anomalies are being performed in smaller infants, PA banding is still used as a palliative surgical procedure for some congenital cardiac defects. Nowadays, PA banding is clinically considered not only for classical indications like functionally univentricular cardiac pathologies, but also for more controversial cases like multiple ventricular septal defects (VSD), complete atrioventricular septal defects (AVSD), and transposition of great arteries (TGA).^{4,5}

The value of short-term PA banding in certain congenital cardiac anomalies is no longer debatable. Interest is now focused on how to minimize the complications of PA banding and how to perform complete debanding when it is time for corrective procedure of the cardiac anomaly.

There have to date been few studies specifically addressed the choice of band material for PA banding. In an animal study by Stark et al.⁶ different materials such as plaited silk, Teflon tape, cotton umbilical tape, and nylon tape were used in swine for pulmonary artery banding. Microscopically documented damage to PA seemed to be related to the degree of constriction but not to the width of the band or to the material from which it was made. In another animal study by Cordell and Suh,² cotton umbilical tape, Teflon tape, or 2 different thicknesses of silastic tape reinforced with Dacron were used in piglets. They concluded that silastic tape, reinforced with Dacron tricot, is the most

suitable material with least tissue damage employed for pulmonary artery banding.

In our preliminary series of non-PTFE band material, when the band would remain in place longer than 6 months, the area of banding usually became stenotic and required reconstruction in 65% of cases. This repair could be achieved by resection of scarred segment and end-to-end reanastomosis of the proximal and distal of main PA or by vertical incision of the PA followed by pericardial or synthetic oval-shaped patch repair of the arteriotomy.

The authors have specified their technique by using expanded PTFE strip with inert nature in order to obviate the PA banding morbidity and complications. When PTFE was applied for PA banding, the fibrosis and reaction of the tissue to the band was minimal during debanding. When total correction is planned, the PTFE band could be pulled easily through the tunnel of fibrous capsule formed around it. In all patients, the band could be removed easily through formed smoothly surfaced tunnel after cutting the PTFE band and removal of fixation sutures. The pulmonary trunk showed a certain amount of distensibility after debanding without damaging effect on internal surface of the artery.

In patients banded with PTFE, pulmonary artery banding takedown can be performed very comfortably and debanding of PTFE lets the pulmonary artery to expand without any scar formation or fibrosis and none of our patients in this group required PA or valve repair.

In conclusion, with our experience, safety and favorable results of pulmonary artery banding with PTFE strip should result in a more widespread use of this material to obviate the PA banding complications.

Conflict of Interests

Authors have no conflict of interests.

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