Ryan Romans, MD

Ryan Romans is an interventional pediatric cardiologist at Children's Mercy Kansas City. He is also a member of the Cardiac High Acuity Monitoring Program (CHAMP) that cares for neonates and infants with single ventricle heart disease. Lastly, he is involved in the pre- and post-operative care of neonates in and infants undergoing cardiac surgery as a member of the cardiology consult team.

Patent Ductus Arteriosus: Transcatheter vs. Surgical Closure in 2022

Ryan Romans, MD, FSCAI
Interventional Pediatric Cardiology
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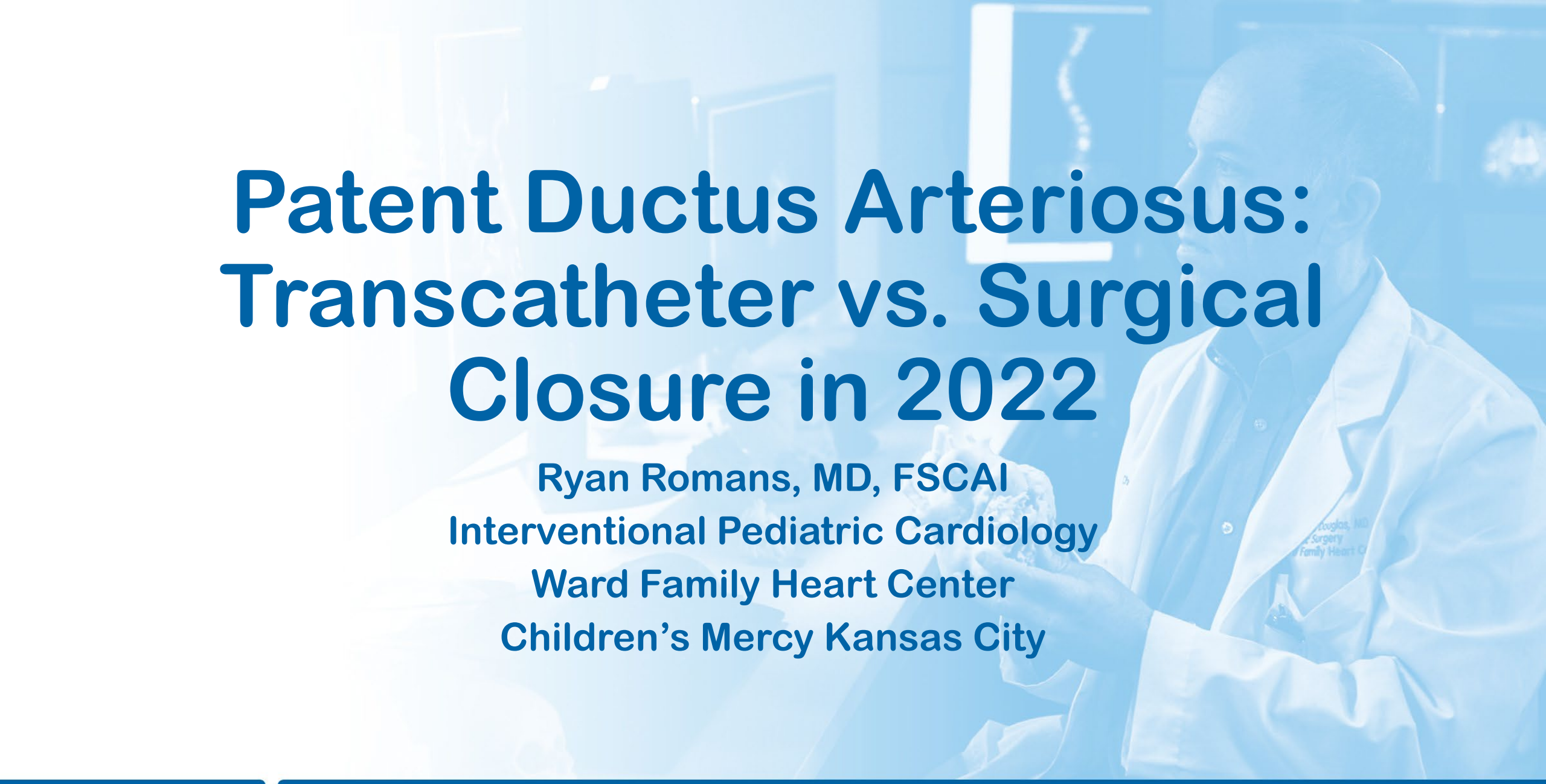


Children's Mercy KANSAS CITY

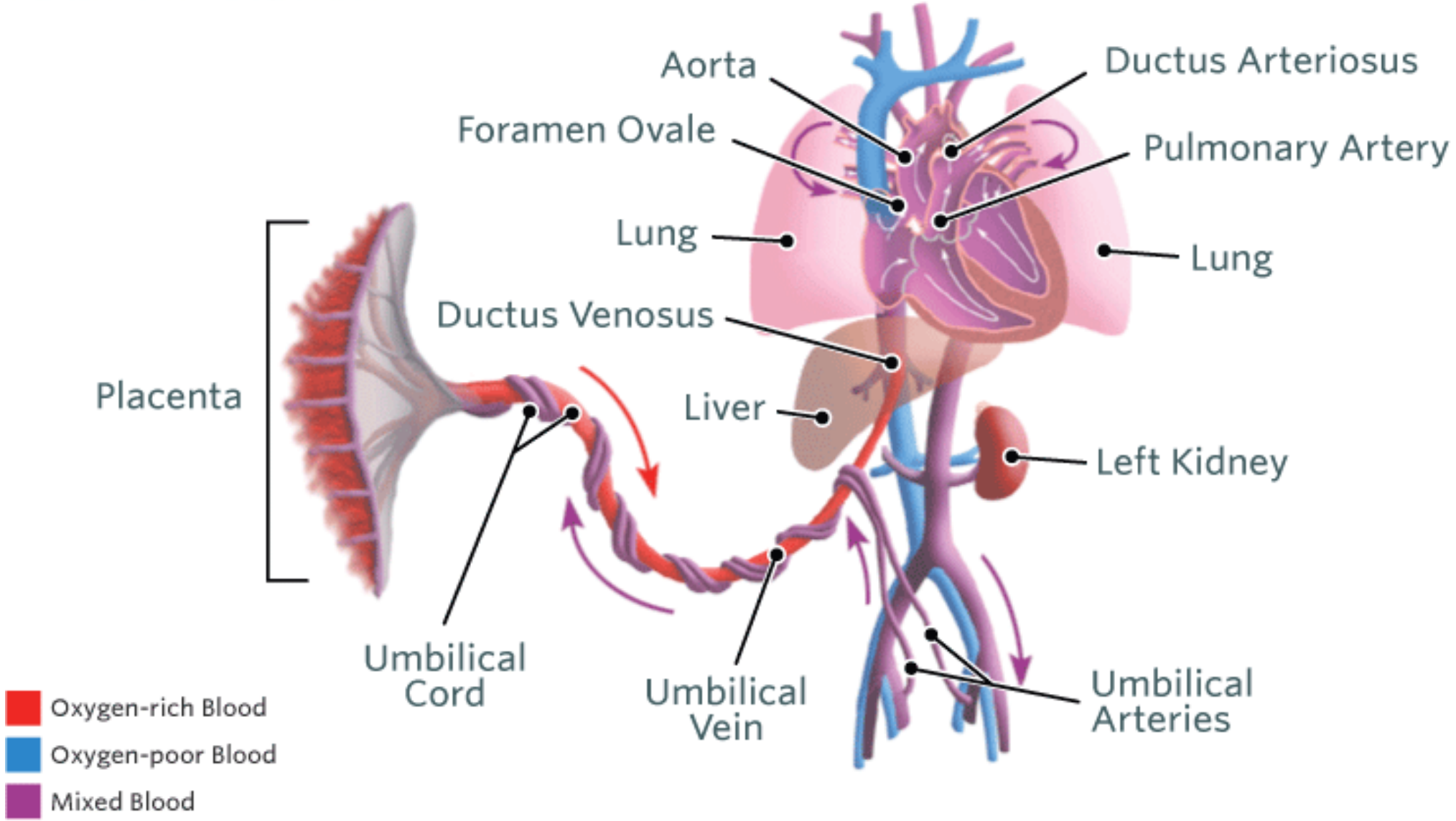
Disclosure Slide

- I have no pertinent financial relationships to disclose

Outline

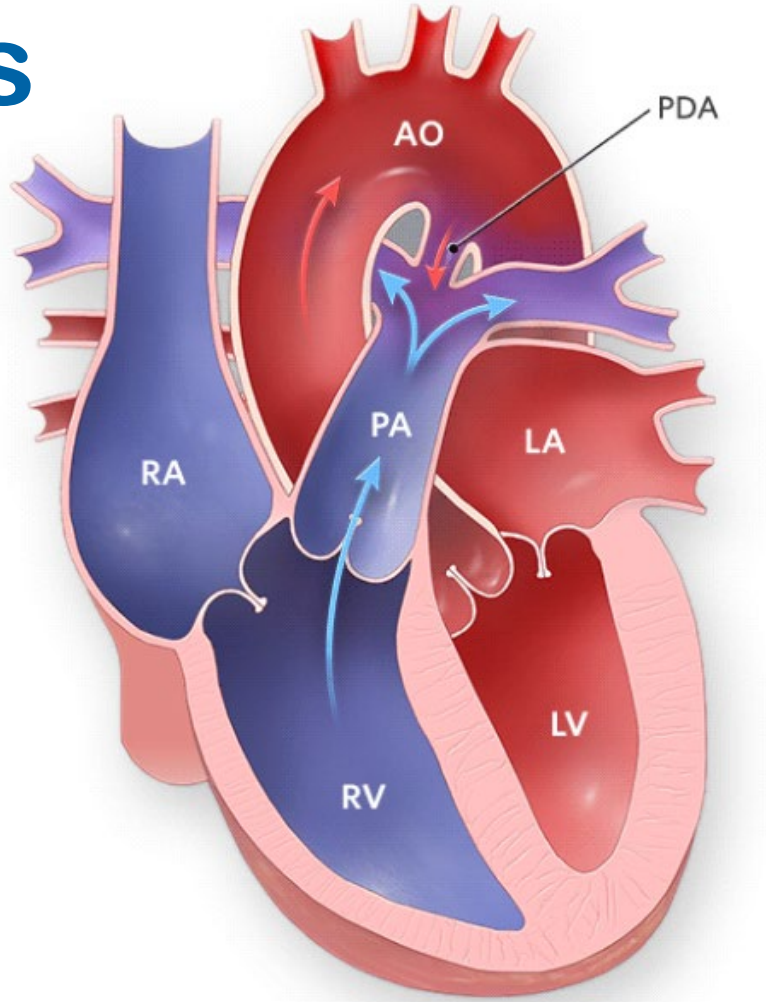
- Anatomy and Physiology
- Clinical symptoms
- Indications for closure
- Transcatheter versus surgical closure
- Case example

Fetal Circulation



Patent Ductus Arteriosus

- Occurs in 2-8 per 1000 live births.
- More common in premature infants
  - 45% of infants < 1750 grams
  - 80% of infants < 1200 grams
- 30 times more common in those living at high altitude (> 4500m)



Spontaneous closure

- Functional closure (24-72 hours)
  - Loss of PGE from placenta
  - Higher oxygen levels
- Anatomic closure (2-3 weeks)
  - Smooth muscle contraction leads to cell destruction and fibrosis
  - Ligamentum arteriosum

Left to Right Shunt Physiology

- Communication between systemic and pulmonary circulations
  - Intracardiac (ASD, VSD)
  - Extracardiac (PDA, AP window)
- Increased pulmonary blood flow
- Volume loaded heart
- Normal oxygen saturations
  - Pass CCHD screen

Clinical Symptoms in Neonates

- Heart murmur
- Heart failure symptoms
  - Tachypnea, tachycardia, pulmonary congestion, poor feeding, diaphoresis with feeds, poor weight gain
- Compromised systemic perfusion
  - IVH, NEC, renal dysfunction
- Hypoxia
  - Pulmonary edema
  - Pulmonary hypertension with right-to-left shunt

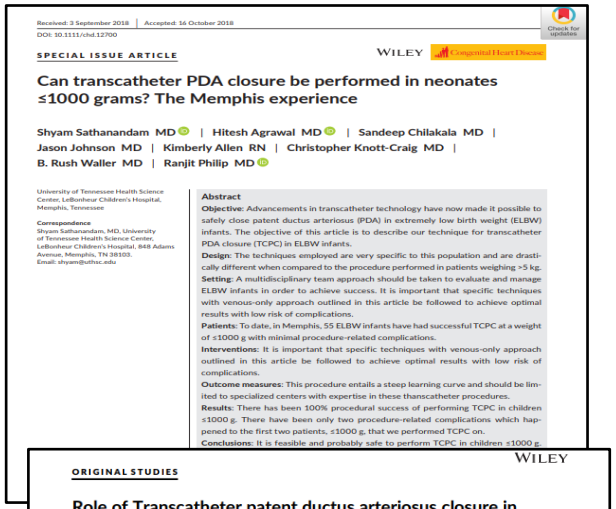
Indications for Closure

- Audible murmur
- Heart failure symptoms
- Left heart dilation
- Elevated RV and PA pressures without right-to-left shunting

PDA Closure in Premature Infants

- Balance of disease risk versus procedural risk
  - How much morbidity is attributable to PDA
- Timing
  - Prophylactic, early before symptoms, or late after symptoms
- Type of closure
  - Medical, transcatheter, or surgical

PDA Closure in Premature Infants



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SPECIAL ISSUE ARTICLE

WILEY Congenital Heart Disease

Can transcatheter PDA closure be performed in neonates ≤1000 grams? The Memphis experience

Shyam Sathanandam MD | Hitesh Agrawal MD | Sandeep Chilakala MD | Jason Johnson MD | Kimberly Allen RN | Christopher Knott-Craig MD | B. Rush Waller MD | Ranjit Philip MD

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Abstract

Objective: Advancements in transcatheter technology have now made it possible to safely close patent ductus arteriosus (PDA) in extremely low birth weight (ELBW) infants. The objective of this article is to describe our technique for transcatheter PDA closure (TCPC) in ELBW infants.

Design: The techniques employed are very specific to this population and are drastically different when compared to the procedure performed in patients weighing >5 kg.

Setting: A multidisciplinary team approach should be taken to evaluate and manage ELBW infants in order to achieve success. It is important that specific techniques with venous-only approach outlined in this article be followed to achieve optimal results with low risk of complications.

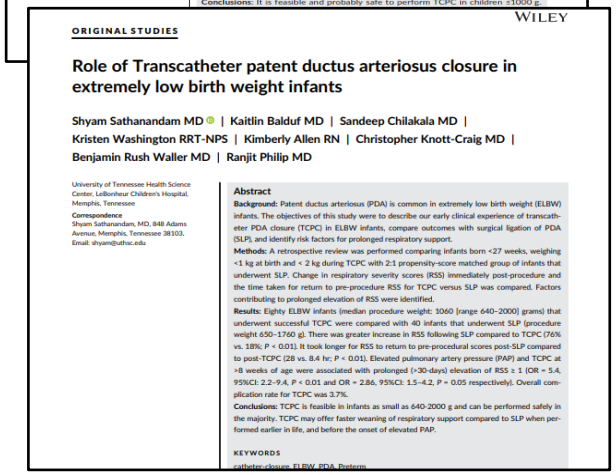
Patients: To date, in Memphis, 55 ELBW infants have had successful TCPC at a weight of ≤1000 g with minimal procedure-related complications.

Interventions: It is important that specific techniques with venous-only approach outlined in this article be followed to achieve optimal results with low risk of complications.

Outcome measures: This procedure entails a steep learning curve and should be limited to specialized centers with expertise in these thanscatheter procedures.

Results: There has been 100% procedural success of performing TCPC in children ≤1000 g. There have been only two procedure-related complications which happened to the first two patients, ≤1000 g, that we performed TCPC on.

Conclusions: It is feasible and probably safe to perform TCPC in children ≤1000 g.



ORIGINAL STUDIES

WILEY

Role of Transcatheter patent ductus arteriosus closure in extremely low birth weight infants

Shyam Sathanandam MD | Kaitlin Balduf MD | Sandeep Chilakala MD | Kristen Washington RRT-NPS | Kimberly Allen RN | Christopher Knott-Craig MD | Benjamin Rush Waller MD | Ranjit Philip MD

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Abstract

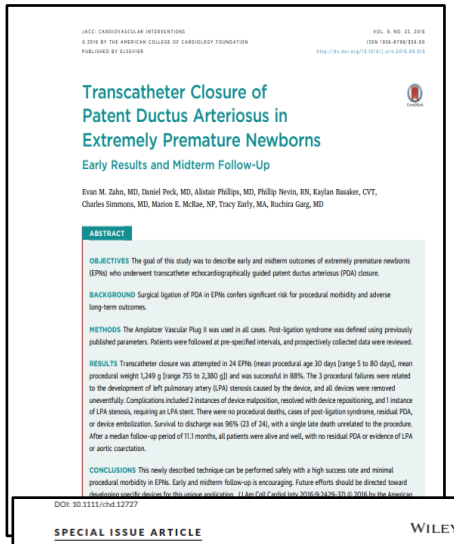
Background: Patent ductus arteriosus (PDA) is common in extremely low birth weight (ELBW) infants. The objectives of this study were to describe our early clinical experience of transcatheter PDA closure (TCPC) in ELBW infants, compare outcomes with surgical ligation of PDA (SLP), and identify risk factors for prolonged respiratory support.

Methods: A retrospective review was performed comparing infants born <27 weeks, weighing <1 kg at birth and < 2 kg during TCPC with 2:1 propensity-score matched group of infants that underwent SLP. Change in respiratory severity scores (RSS) immediately post-procedure and the time taken for return to pre-procedure RSS for TCPC versus SLP was compared. Factors contributing to prolonged elevation of RSS were identified.

Results: Eighty ELBW infants (median procedure weight: 1060 [range 640–2000] grams) that underwent successful TCPC were compared with 40 infants that underwent SLP (procedure weight 650–1760 g). There was greater increase in RSS following SLP compared to TCPC (76% vs. 18%; $P < 0.01$). It took longer for RSS to return to pre-procedural scores post-SLP compared to post-TCPC (28 vs. 8.4 hr; $P < 0.01$). Elevated pulmonary artery pressure (PAP) and TCPC at >8 weeks of age were associated with prolonged (>30-days) elevation of RSS ≥ 1 (OR = 5.4, 95%CI: 2.2–9.4, $P < 0.01$ and OR = 2.86, 95%CI: 1.5–4.2, $P = 0.05$ respectively). Overall complication rate for TCPC was 3.7%.

Conclusions: TCPC is feasible in infants as small as 640-2000 g and can be performed safely in the majority. TCPC may offer faster weaning of respiratory support compared to SLP when performed earlier in life, and before the onset of elevated PAP.

KEYWORDS
catheter-closure, ELBW, PDA, Preterm



JACC: CARDIOVASCULAR INTERVENTIONS
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Transcatheter Closure of Patent Ductus Arteriosus in Extremely Premature Newborns

Early Results and Midterm Follow-Up

Evan M. Zahn, MD, Daniel Peck, MD, Alistair Phillips, MD, Phillip Nevin, RN, Kaylan Basaker, CVT, Charles Simmons, MD, Marion E. McRae, NP, Tracy Early, MA, Ruchira Garg, MD

ABSTRACT

OBJECTIVES The goal of this study was to describe early and midterm outcomes of extremely premature newborns (EPNs) who underwent transcatheter echocardiographically guided patent ductus arteriosus (PDA) closure.

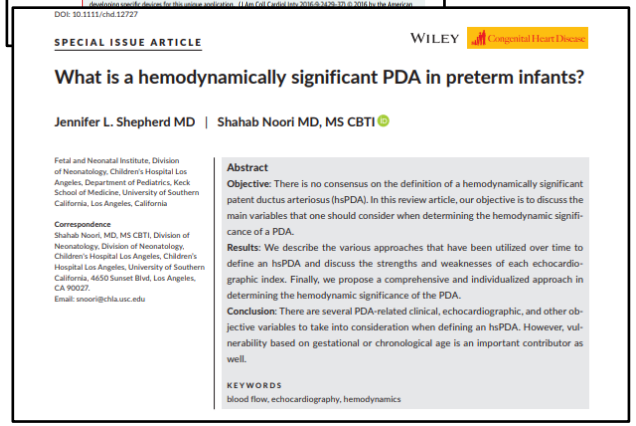
BACKGROUND Surgical ligation of PDA in EPNs confers significant risk for procedural morbidity and adverse long-term outcomes.

METHODS The Amplatzer Vascular Plug II was used in all cases. Post-ligation syndrome was defined using previously published parameters. Patients were followed at pre-specified intervals, and prospectively collected data were reviewed.

RESULTS Transcatheter closure was attempted in 24 EPNs (mean procedural age 30 days [range 5 to 80 days], mean procedural weight 1,249 g [range 755 to 2,380 g]) and was successful in 88%. The 3 procedural failures were related to the development of left pulmonary artery (LPA) stenosis caused by the device, and all devices were removed uneventfully. Complications included 2 instances of device malposition, resolved with device repositioning, and 1 instance of LPA stenosis, requiring an LPA stent. There were no procedural deaths, cases of post-ligation syndrome, residual PDA, or device embolization. Survival to discharge was 96% (23 of 24), with a single late death unrelated to the procedure. After a median follow-up period of 11.1 months, all patients were alive and well, with no residual PDA or evidence of LPA or aortic coarctation.

CONCLUSIONS This newly described technique can be performed safely with a high success rate and minimal procedural morbidity in EPNs. Early and midterm follow-up is encouraging. Future efforts should be directed toward

DOI: 10.1111/chd.12727



SPECIAL ISSUE ARTICLE

WILEY Congenital Heart Disease

What is a hemodynamically significant PDA in preterm infants?

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Abstract

Objective: There is no consensus on the definition of a hemodynamically significant patent ductus arteriosus (hsPDA). In this review article, our objective is to discuss the main variables that one should consider when determining the hemodynamic significance of a PDA.

Results: We describe the various approaches that have been utilized over time to define an hsPDA and discuss the strengths and weaknesses of each echocardiographic index. Finally, we propose a comprehensive and individualized approach in determining the hemodynamic significance of the PDA.

Conclusion: There are several PDA-related clinical, echocardiographic, and other objective variables to take into consideration when defining an hsPDA. However, vulnerability based on gestational or chronological age is an important contributor as well.

KEYWORDS
blood flow, echocardiography, hemodynamics

Hey, Doctor, Leave the PDA Alone

William E. Benitz, MD

At a meeting of the Section of Pediatrics of the Royal Society of Medicine in October 1958, Dr Burnard[1] reported the first observation that prematurity is associated with persistence of the murmur of patent ductus arteriosus (PDA), and that the latter is associated with dyspnea. Reinforced by subsequent confirmation, the concept developed that prolonged ductal patency in preterm infants is pathologic and therefore requires treatment. The hypothesis that left-to-right ductal shunting associated with persistent PDA is a direct cause of the various adverse outcomes overrepresented in preterm infants with PDA has become deeply ingrained in theory and practice, despite absence of supporting evidence. Randomized controlled trials over 4 decades have demonstrated that early, routine intervention to close the PDA in preterm infants fails to ameliorate risk of those outcomes, casting doubt on this hypothesis.[2] The pervasive conviction that it is correct, however, resulted in open-label treatment of at least some control subjects in most treatment trials and in nearly all recent case series of observational management. The available data, therefore, cannot entirely exclude the possibility that a select group of preterm infants with PDA might benefit from medical, surgical, or interventional catheter closure of the PDA. In addition, available evidence only demonstrates absence of benefit with respect to outcomes that have been measured, and cannot exclude other potential benefits, such as reduction in the rate or severity of pulmonary hypertension associated with bronchopulmonary dysplasia, avoidance of late pulmonary venous stenosis, or some other outcome that has not been considered in trials done to date.

The report in this issue,[3] from 2 institutions in Europe, adds substantial new information to this conversation. With due respect to the limitations imposed by the retrospective observational study design, this is the first description of the natural history of ductal closure in preterm infants from more than a single center, the largest such series to date, and the only series in which serial echocardiography was performed for all subjects for the duration of hospitalization. In this cohort of 280 very low birth weight (VLBW) infants managed without interventions to close the PDA, spontaneous closure occurred before discharge in 237 (85%). Rates of intraventricular hemorrhage, periventricular leukomalacia, bronchopulmonary dysplasia, and necrotizing enterocolitis in the entire VLBW birth cohort (368 infants) compared favorably to contemporaneous data from Vermont-Oxford Neonatal Network centers, supporting the argument that noninterventional management is, at a minimum, relatively safe, and suggesting that development of sequelae is not simply a function of the duration of left-to-right ductal shunting. These conclusions must be tempered by recognition that 17 (6%) of the 297 eligible infants were treated to close the PDA, so this study cannot permit conclusions about safety of truly universal nonintervention. The criteria for treatment in those cases are not stated, so this report also cannot guide selection of infants who might benefit from treatment. The results reported by Sung et al,[4] in which there was no apparent excess mortality or morbidity in 97 infants

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Opinions expressed in these commentaries are those of the author and not necessarily those of the American Academy of Pediatrics or its Committees.

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SPECIAL ISSUE ARTICLE

WILEY Congenital Heart Disease

PDA: To treat or not to treat

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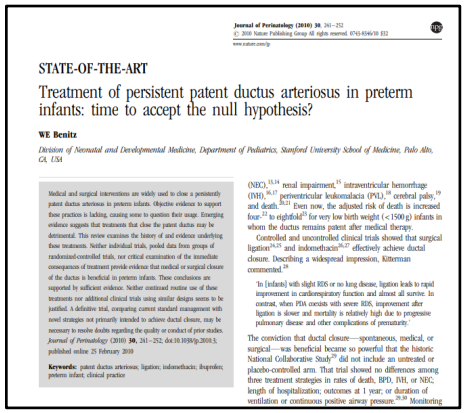
Abstract

Management of patent ductus arteriosus in extremely preterm infants remains a topic of debate. Treatment to produce ductal closure was widely practiced until the past decade, despite lack of evidence that it decreases morbidities or mortality. Meta-analyses of trials using nonsteroidal anti-inflammatory drugs have shown effectiveness in accelerating ductal closure, but no reduction in neonatal morbidities, regardless of agent used, indication, timing, gestational age, or route of administration. Surgical ligation closes the ductus but is associated with adverse effects. Recent experience with conservative approaches to treatment suggest improved neonatal outcomes and a high rate of spontaneous ductal closure after discharge. Careful postdischarge follow-up is important, however, because potential adverse effects of long-standing aortopulmonary shunts may be an indication for catheter-based ductal closure. Identification of extremely preterm infants at greatest risk of potential harm from a persistently patent ductus, who may benefit most from treatment are urgently needed.

KEYWORDS
bronchopulmonary dysplasia, indomethacin, patent ductus arteriosus, preterm



Journal of Perinatology (2010) 30, 261–252
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STATE-OF-THE-ART

Treatment of persistent patent ductus arteriosus in preterm infants: time to accept the null hypothesis?

WE Benitz

Division of Neonatal and Developmental Medicine, Department of Pediatrics, Stanford University School of Medicine, Palo Alto, CA, USA

Medical and surgical interventions are widely used to close a persistently patent ductus arteriosus in preterm infants. Objective evidence to support these practices is lacking, causing some to question their usage. Emerging evidence suggests that treatments that close the patent ductus may be detrimental. This review examines the history of and evidence underlying these treatments. Neither individual trials, pooled data from groups of randomized-controlled trials, nor critical examination of the immediate consequences of treatment provide evidence that medical or surgical closure of the ductus is beneficial in preterm infants. These conclusions are supported by sufficient evidence. Neither continued routine use of these treatments nor additional clinical trials using similar designs seems to be justified. A definitive trial, comparing current standard management with novel strategies not primarily intended to achieve ductal closure, may be necessary to resolve doubts regarding the quality or conduct of prior studies.
Journal of Perinatology (2010) **30**, 261–252; doi:10.1038/jp.2010.5; published online 25 February 2010

Keywords: patent ductus arteriosus; ligation; indomethacin; ibuprofen; preterm infant; clinical practice

(NEC),[13,14] renal impairment,[15] intraventricular hemorrhage (IVH),[16,17] periventricular leukomalacia (PVL),[18] cerebral palsy,[19] and death.[20,21] Even now, the adjusted risk of death is increased four-[22] to eightfold[23] for very low birth weight (<1500 g) infants in whom the ductus remains patent after medical therapy.

Controlled and uncontrolled clinical trials showed that surgical ligation[24,25] and indomethacin[26,27] effectively achieve ductal closure. Describing a widespread impression, Kitterman commented.[28]

> 'In [infants] with slight RDS or no lung disease, ligation leads to rapid improvement in cardiorespiratory function and almost all survive. In contrast, when PDA coexists with severe RDS, improvement after ligation is slower and mortality is relatively high due to progressive pulmonary disease and other complications of prematurity.'

The conviction that ductal closure—spontaneous, medical, or surgical—was beneficial became so powerful that the historic National Collaborative Study[29] did not include an untreated or placebo-controlled arm. That trial showed no differences among three treatment strategies in rates of death, BPD, IVH, or NEC; length of hospitalization; outcomes at 1 year; or duration of ventilation or continuous positive airway pressure.[29,30] Monitoring

Universal
Prophylactic

Selective or
Case-by-case

Rarely, if ever,
Intervene

LOVE WILL.

Children's Mercy
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CMH Typical Treatment Algorithm

- Is a moderate (or larger) PDA present?
- Is the PDA causing symptoms?
- Are the symptoms medically manageable?
- Contraindications to medical therapy?
- Contraindications to interventional therapy?
- Which intervention do you want?

Transcatheter versus Surgical Closure

- Surgical Ligation
  - Post PDA ligation syndrome
  - Vocal cord paralysis
  - Scoliosis
  - LPA ligation
- Transcatheter device closure
  - Not a great option on HFOV
  - Risk of aortic and LPA obstruction
  - Case reports of vocal cord paralysis
  - Requires transport to cardiac catheterization lab (most centers)

Transcatheter versus Surgical Closure

Journal of the American Heart Association

ORIGINAL RESEARCH

Trend and Outcomes for Surgical Versus Transcatheter Patent Ductus Arteriosus Closure in Neonates and Infants at US Children's Hospitals

Michael T. Kuntz, MD; Steven J. Staffa, MS; Dionne Graham, PhD; David Faraoni, MD, PhD; Philip Levy, MD; James DiNardo, MD; Nicola Maschietto, MD, PhD; Viviane G. Nasr, MD, MPH

BACKGROUND: Pharmacologic therapy for patent ductus arteriosus closure is not consistently successful. Surgical ligation (SL) or transcatheter closure (TC) may be needed. Large multicenter analyses comparing outcomes and resource use between SL and TC are lacking. We hypothesized that patients undergoing TC have improved outcomes compared with SL, including mortality, hospital and intensive care unit length of stay, and mechanical ventilation.

METHODS AND RESULTS: Using the 2016 to 2020 Pediatric Health Information System database, characteristics, outcomes, and charges of patients aged <1 year who underwent TC or SL were analyzed. A total of 678 inpatients undergoing TC (n=503) or SL (n=175) were identified. Surgical patients were younger (0.1 versus 0.53 years; $P<0.001$) and more premature (60% versus 20.3%; $P<0.001$). Surgical patients had higher mortality (1.7% versus 0%; $P=0.02$). Using inverse probability of treatment weighting by the propensity score, multivariable-adjusted analyses demonstrated favorable outcomes in TC: intensive care unit admission rates (adjusted odds ratio [OR], 0.2; 95% CI, 0.11–0.32; $P<0.001$); mechanical ventilation rates (adjusted OR, 0.3; 95% CI, 0.19–0.56; $P<0.001$); and shorter hospital (adjusted coefficient, 2 days shorter; 95% CI, 1.3–2.7; $P<0.001$) and postoperative (adjusted coefficient, 1.2 days shorter; 95% CI, 0.1–2.3; $P=0.039$) stays. Overall charges and readmission rates were similar. Among premature neonates and infants, hospital (adjusted difference in medians, 4 days; 95% CI, 1.7–6.3 days; $P<0.001$) and postoperative stays (adjusted difference in medians, 3 days; 95% CI, 1.1–4.9 days; $P=0.002$) were longer for SL.

CONCLUSIONS: TC is associated with lower mortality and reduced length of stay compared with SL. Rates of TC continue to increase compared with SL.

Key Words: cardiac catheterization ■ cardiovascular surgical procedure ■ cost ■ outcomes ■ patent ductus arteriosus

Surgical Versus Percutaneous Closure of PDA in Preterm Infants: Procedural Charges and Outcomes

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PDA
Surgical ligation
Device closure
Preterm infants
Procedural charges

ABSTRACT

Background: Studies comparing percutaneous closure of patent ductus arteriosus (PDA) with surgical ligation tend to exclude premature infants and have not assessed procedural charges. We compared our contemporary outcomes and charges of device closure to surgical ligation of PDA in preterm infants.

Material and methods: Preterm infants who underwent isolated PDA closure during their newborn hospitalization (January 2014 to September 2017) were grouped based on intention to treat (surgery *versus* device closure). Patient demographics, procedural details, and immediate postprocedural outcomes were compared. Procedural charges for device closure *versus* surgical ligation were compared.

Results: Compared with the device group ($n = 33$), patients undergoing surgical ligation ($n = 39$) were younger, smaller, and required more preoperative support ($P < 0.05$). The procedure time was shorter for surgical ligation ($P < 0.01$). Although there was no procedural mortality in either group, the complication rate was higher for device closure than for surgical ligation (15.2% *versus* 0%; $P = 0.02$). The proportion of patients returning to preprocedural respiratory support by 48 h after procedure was similar. There was a higher proportion of surgical patients who required increased inotropic support in the first 24 h after procedure ($P = 0.19$). The procedural charges for transcatheter device closure were twice as expensive as those for surgical ligation.

Conclusions: In our early experience with percutaneous PDA closure, we found a percutaneous approach in preterm infants feasible and well tolerated. Both surgical ligation and device closure were associated with perioperative or postoperative complications. Procedural charges were higher for percutaneous closure, driven by device charge and catheterization room utilization. Further investigation is needed to establish guidelines for first-line therapy for PDA closure in preterm infants, including cost-benefit analysis.

Surgical PDA Ligation

- First successful ligation by Gross in 1939
- Left posterolateral thoracotomy
- Left lung must be down for some length of time
- Locate PDA and place surgical clip on PDA

Transcather PDA Device Closure

- Portsman first to close PDA via cardiac catheterization in 1967
- Significant amount of R&D over the next several decades developing coils and devices
- AMPLATZER duct occluder FDA approved in 2003
  - Still currently in use
  - Off-label in patients < 6 months old

Trascatheter Device Closure in Premature Infants

Catheterization and Cardiovascular Interventions 85:240–248 (2015)

A Novel Technique for Transcatheter Patent Ductus Arteriosus Closure in Extremely Preterm Infants Using Commercially Available Technology

Evan M. Zahn,[1,3*] MD, Phillip Nevin,[3] RN, Charles Simmons,[2] MD, and Ruchira Garg,[1,3] MD

Objectives: To describe a new technique for transcatheter patent ductus arteriosus (PDA) closure in extremely preterm infants using commercially available technology. **Background:** PDA in premature neonates continues to be a significant clinical problem contributing importantly to both morbidity and mortality. Surgical ligation and medical therapy both have their drawbacks. **Material and Methods:** Hospital records and catheterization reports of all premature neonates (< 32 weeks gestation) who underwent transcatheter PDA closure between March 2013 and February 2014 were reviewed. Particular attention was paid to procedural details, complications, and short and mid-term outcomes. **Results:** Six premature infants born at gestational ages ranging between 26 and 31 weeks (median, 26 weeks) underwent attempted transcatheter PDA closure using the Amplatzer Vascular Plug II (AVP II). Median age and weight was 21.5 days (16–80 days) and 1,180 g (870–2,240 g), respectively. Fluoroscopy and echocardiography were used to guide device. Contrast angiography was not used in any patient. Complete closure was achieved in all patients with no major procedural complications. Median fluoroscopy and procedural times were 9.4 (0–19.5) and 51.5 (33–87) min, respectively. All patients were alive at the time of this report. There were no instances of device migration, left pulmonary artery (LPA), or aortic coarctation. **Conclusions:** This preliminary study demonstrates that transcatheter PDA closure can be successfully performed in extremely preterm neonates using currently available technology with a high success rate and a low incidence of complications. This report also describes a novel transvenous approach using a combination of echocardiography and judicious use of fluoroscopy to avoid arterial access in this fragile patient population.

Key words: congenital heart disease; vascular occlusion

PDA closure in 6 preterm infants (median weight 1.1 kg) with Amplatzer Vascular Plug II

Catheterization and Cardiovascular Interventions 89:1051–1058 (2017)

Initial Clinical Experience with the Medtronic Micro Vascular Plug™ in Transcatheter Occlusion of PDAs in Extremely Premature Infants

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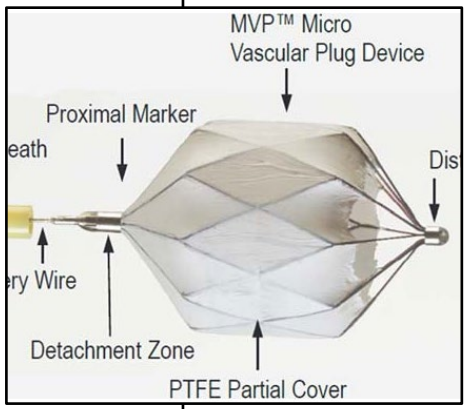
Objectives: To describe the early multicenter, clinical experience with the Medtronic Micro Vascular Plug™ (MVP) for the occlusion of patent ductus arteriosus (PDA) in premature infants. **Background:** The MVP is a large diameter plug that can be delivered through a microcatheter for occlusion of abnormal blood vessels. **Methods:** A Retrospective review of PDA embolization procedures performed in two centers using the MVP was performed. **Results:** Fifteen premature infants underwent attempted PDA occlusion using the MVP. The gestational age and birth weight were 25.6 ± 2.5 weeks and 735 ± 251 g, respectively. The median weight and age at the time of the procedure were 1,210 g (700–3,500 g) and 4.5 weeks (2–12 weeks), respectively. Median procedure and fluoroscopy times were 45 and 6.5 min, respectively. The median radiation and contrast doses were 19.7 mGy and 2.4 mL/kg, respectively. Antegrade occlusion was successfully achieved in 13 patients <2 kg with only femoral venous access aided by echo guidance. The two patients >2 kg had arterial access and attempted retrograde occlusion; one of which was unsuccessful due to the PDA being short and wide. Complete closure was observed in 13 of 14 successful procedures (93%), with one patient having a small residual shunt that was not seen on follow-up. There were no complications related to the procedure or noted during follow-up (Median 11 months). **Conclusions:** The MVP is a new, large-diameter vascular embolization device that may be useful for the occlusion of PDA in extremely small, premature infants.

Key words: patent ductus arteriosus; Micro Vascular Plug™; premature

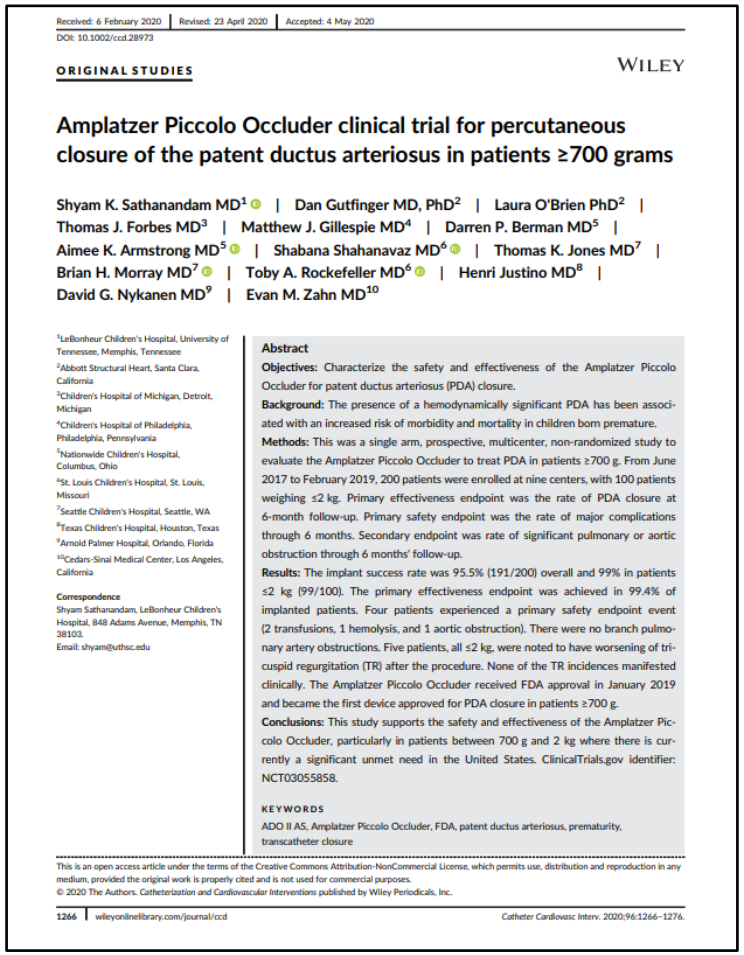


PDA closure in 15 preterm infants (median weight 1.2 kg) with Medtronic Microvascular Plug

Amplatzer Piccolo™ Occluder Device Trial

- Non-randomized prospective trial at 9 US centers in premature infants ≥700 grams
- Primary endpoint-PDA closure at 6 months
- Secondary endpoints-LPA and aortic obstruction
- PDA ≤ 4 mm in diameter, ≥ 3 mm length
- Placed through a 4 French delivery system

Amplatzer Piccolo™ Occluder Device Trial



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ORIGINAL STUDIES

WILEY

Amplatzer Piccolo Occluder clinical trial for percutaneous closure of the patent ductus arteriosus in patients ≥700 grams

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Abstract

Objectives: Characterize the safety and effectiveness of the Amplatzer Piccolo Occluder for patent ductus arteriosus (PDA) closure.

Background: The presence of a hemodynamically significant PDA has been associated with an increased risk of morbidity and mortality in children born premature.

Methods: This was a single arm, prospective, multicenter, non-randomized study to evaluate the Amplatzer Piccolo Occluder to treat PDA in patients ≥700 g. From June 2017 to February 2019, 200 patients were enrolled at nine centers, with 100 patients weighing ≤2 kg. Primary effectiveness endpoint was the rate of PDA closure at 6-month follow-up. Primary safety endpoint was the rate of major complications through 6 months. Secondary endpoint was rate of significant pulmonary or aortic obstruction through 6 months' follow-up.

Results: The implant success rate was 95.5% (191/200) overall and 99% in patients ≤2 kg (99/100). The primary effectiveness endpoint was achieved in 99.4% of implanted patients. Four patients experienced a primary safety endpoint event (2 transfusions, 1 hemolysis, and 1 aortic obstruction). There were no branch pulmonary artery obstructions. Five patients, all ≤2 kg, were noted to have worsening of tricuspid regurgitation (TR) after the procedure. None of the TR incidences manifested clinically. The Amplatzer Piccolo Occluder received FDA approval in January 2019 and became the first device approved for PDA closure in patients ≥700 g.

Conclusions: This study supports the safety and effectiveness of the Amplatzer Piccolo Occluder, particularly in patients between 700 g and 2 kg where there is currently a significant unmet need in the United States. ClinicalTrials.gov identifier: NCT03055858.

KEYWORDS
ADO II AS, Amplatzer Piccolo Occluder, FDA, patent ductus arteriosus, prematurity, transcatheter closure

TABLE 4 Outcomes

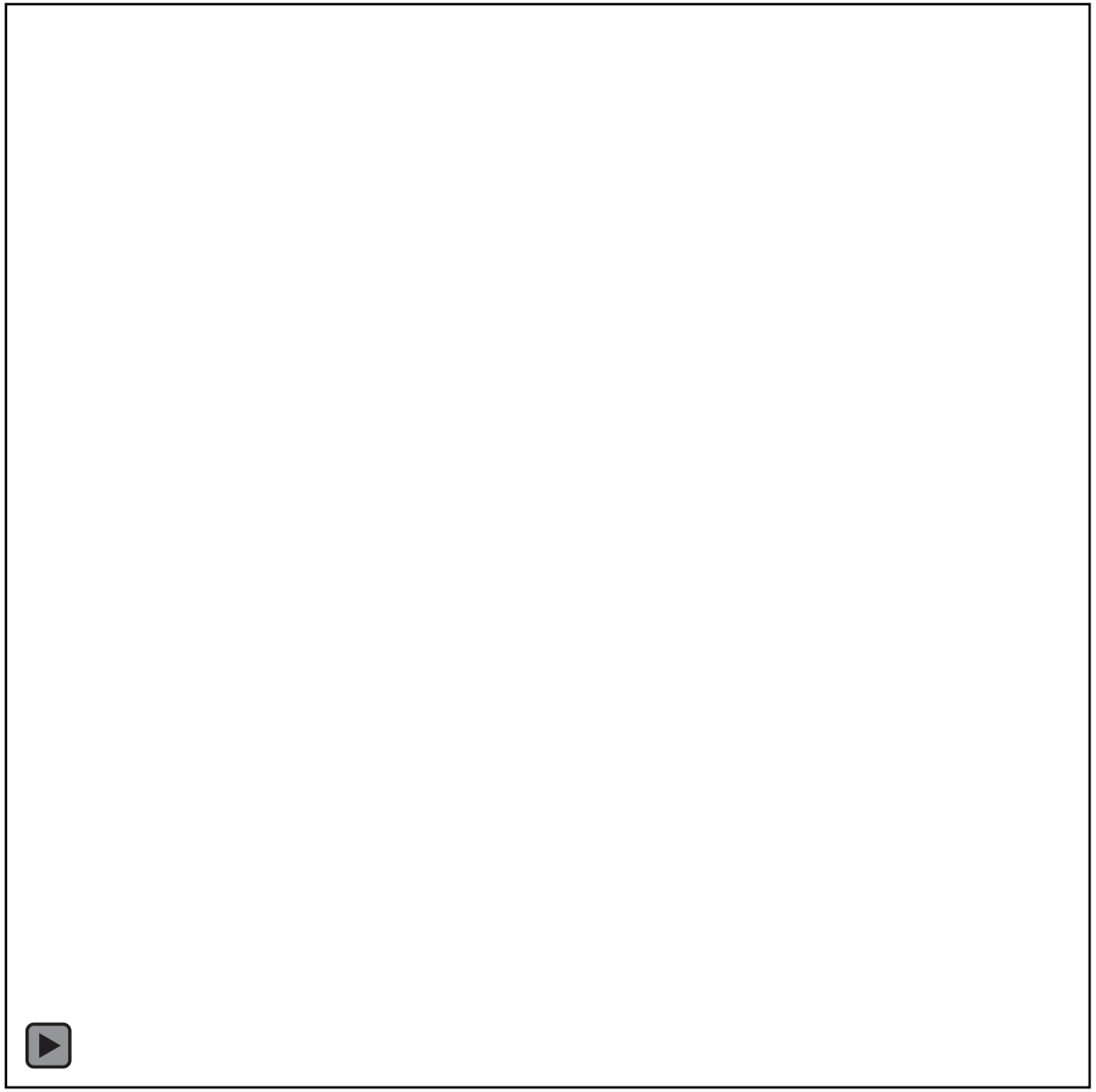
	≤2 kg (*N* = 100)	>2 kg (*N* = 100)	Total (*N* = 200)
Implant success (%)	99 (99.0%)	92 (92.0%)	191 (95.5%)
Intra-procedural device embolization rate (%)	2 (2.0%)	3 (3.0%)	5 (2.5%)
Post-procedure device migration rate (%)[a]	1/99 (1.01%)	1/92 (1.09%)	2/191 (1.05%)
Rate of effective closure at 6 months (%)[b]	89/89 (100.0%)	83/84 (98.8%)	172/173 (99.4%)
Rate of major complications through 180 days (%)	4/96 (4.2%)	0/98 (0%)	4/194 (2.1%)
Rate of clinically significant obstruction of the LPA or aorta through 6-months (%)[a]	2/99 (2.02%)	0/92 (0.0%)	2/191 (1.05%)
Rate of tricuspid valve regurgitation (%)	5 (5.0%)	0 (0.0%)	5 (2.5%)

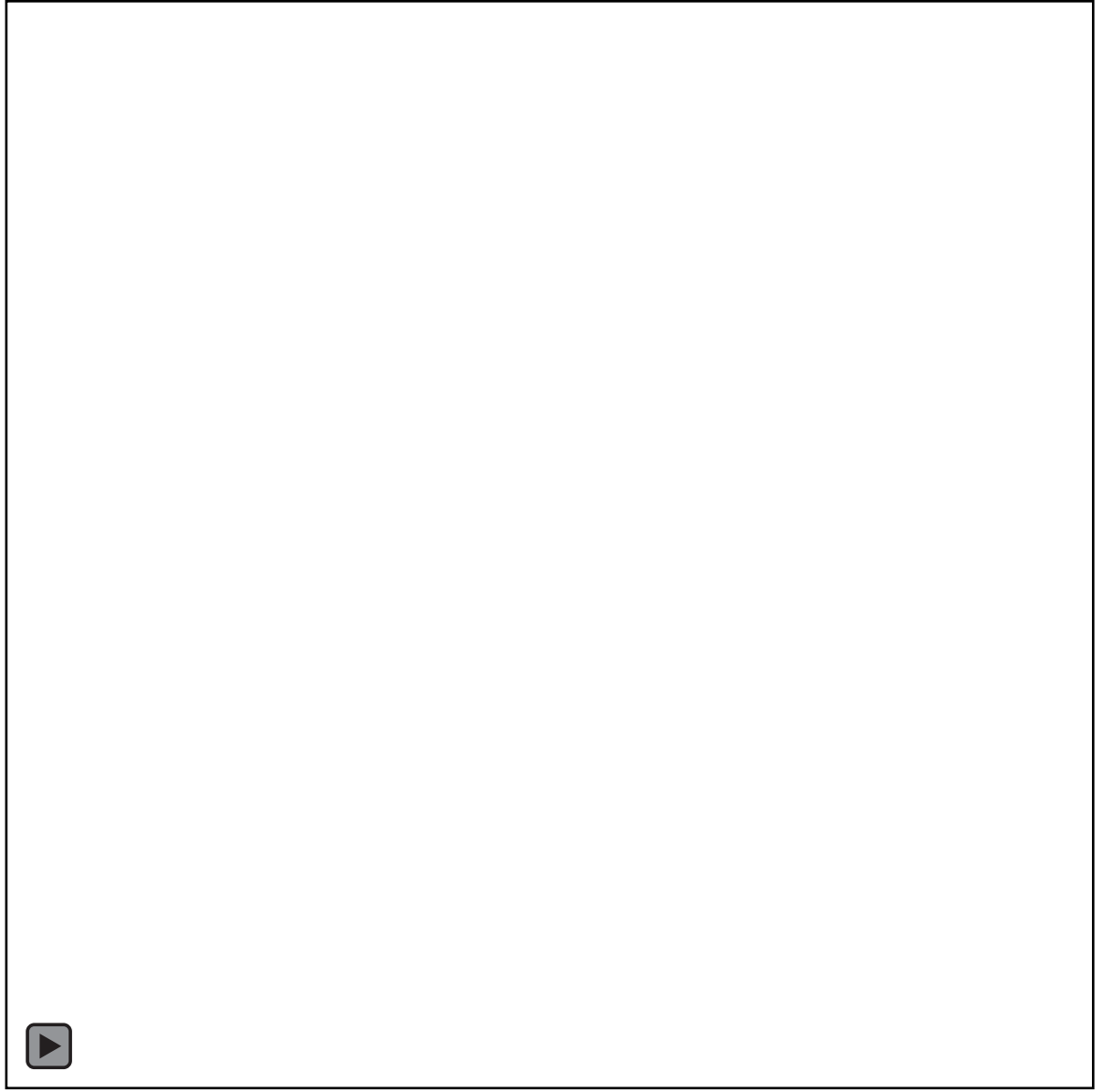
Note: Data presented as number of patients (percentage) for binary variables.
[a]Denominator is based on subjects with successful implant only.
[b]Only the sizes used are reported, the 03-06 size was not used.

Received FDA approval in January 2019

Case Example

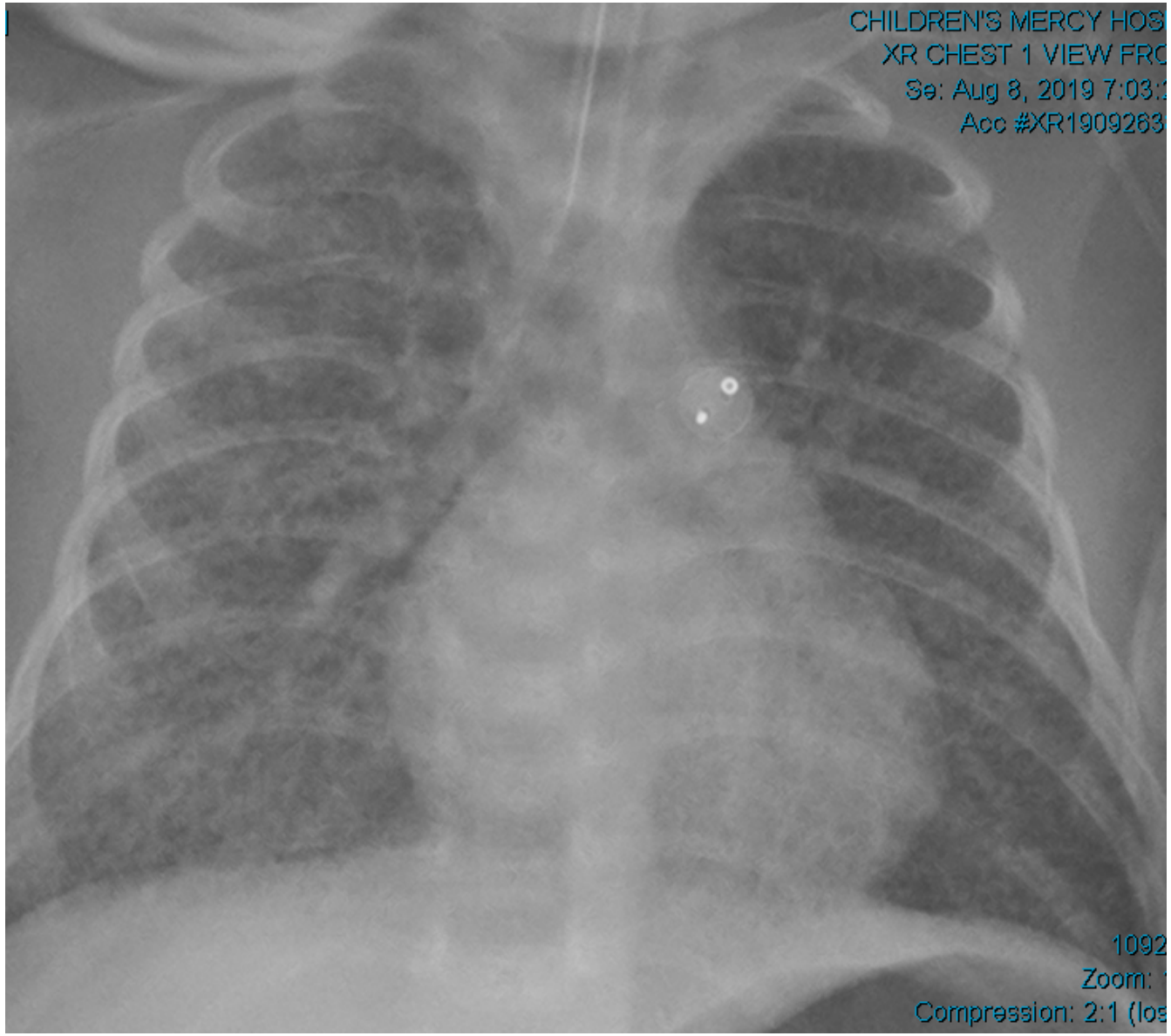
- 29 weeks EGA, birth weight 1.45 kg
- Poor respiratory effort, sats in the 50's on NIV
- Intubated at 4 min of life
- Surfactant x3
- HFOV for 14 days then switched to CMV
- Tylenol x 2 without significant change in large PDA
- Taken to cath lab on DOL 18





Case Outcome

- Extubated in 5 days
- Discharged home in 2 months on ¼ L O2
- PO ad lib 22 kcal/oz
- Follow-up ECHOs
  - No residual PDA
  - No LPA obstruction
  - No arch obstruction



Summary

- There are multiple options (medical, transcatheter, and surgical) to treat PDAs in premature infants
- The Piccolo is an FDA approved device designed for PDA closure in ELBW premature infants with extremely favorable outcomes
  - Not good for infants on HFOV, active infections, unstable infants who can’t be transferred to a center performing this procedure, and infants with LPA stenosis/aortic coarctation
- Working with industry is not bad-there are companies committed to improving CHD treatment

Special Thank You

- Dr. Toby Rockefeller
  - Starting our Piccolo PDA closure program in ELBW premature infants
  - Assisting with the preparation of this presentation

Questions?