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Meta-Analysis

The efficacy and safety of patent ductus arteriosus stent versus surgical aortopulmonary shunt in the management of babies with duct-dependent circulation: a meta-analysis and review of literature

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ABSTRACT

This meta-analysis aims to comprehensively assess the efficacy and safety of both patent ductus arteriosus (PDA) stents and surgical aortopulmonary shunt (APS) as the initial palliative measures in babies relying on ductal-dependent circulation. This review is essential to compare the outcome of relatively newer catheter-based PDA stent procedure with a surgical APS. By synthesizing existing literature, this review aims to provide insights to inform clinical practice and enhance patient care in this challenging clinical scenario. The methodology involved an extensive search of PubMed and Embase databases using specific keywords and terminology related to mortality, procedural outcomes, and postprocedural complications following PDA stent and APS in cyanotic congenital heart defects (CHD) patients. Six retrospective observational studies met the criteria, with 757 patients included. The analysis showed comparable mortality rates between PDA stents and APS. However, PDA stents were associated with decreased risks of mechanical circulatory support, postprocedural complications, and shorter hospital stays, mechanical ventilation, and intensive care unit stays compared to APS. Notably, patients with pulmonary atresia scheduled for biventricular surgery were more prevalent among those receiving PDA stents. In conclusion, while the risk of mortality is similar between PDA stents and APS, PDA stents offer advantages such as shorter hospital stays and reduced complications. Patient characteristics also vary, with a higher prevalence of intact ventricular septum among those receiving PDA stents.

Keywords: Patent ductus arteriosus, Aortopulmonary shunt, Duct-dependent circulation

INTRODUCTION

The occurrence of CHD in various studies ranges from approximately 4 per 1,000 to 50 per 1,000 live births.[1] Among CHD, duct-dependent lesions constitute a significant proportion.[2] Individuals with ductus-dependent lesions typically exhibit normal birth weight and appear healthy upon initial examination. However, their condition may suddenly deteriorate upon closure of the duct, manifesting as symptoms such as rapid breathing (tachypnea), difficulty breathing (dyspnea), grunting, flaring of nostrils, a pale or ashen complexion, and cyanosis. Physical examination may reveal a hyperactive precordium, rapid heart rate (tachycardia), low blood pressure (hypotension), weak or absent pulses in the femoral arteries, a single second heart sound (S2), and an audible systolic heart murmur.[3]

The neonates with ductal dependent circulation require palliative therapies for maintaining ductal patency allowing them bridging to definitive correction.[4,5] The conventional palliative therapy was PGE1 infusion

followed by surgical APS.[6] Modified Blalock-Taussig (B-T) shunt is a most common Surgical APS in practice. It remains to be most commonly used palliative procedures for infants with duct dependent circulation.[7] But the mortality rate following the neonatal modified Blalock-Taussig shunt is high.[8] Alternative to surgical APS catheter-based Ductus stenting is coming as a promising intervention. PDA stent is less invasive than APS and babies don't need cardiopulmonary bypass during their early vulnerable stage, so they can recover faster.[9,10] However, using a PDA stent also has the risk of procedural complications and a higher likelihood of needing further treatments.[11]

Comparisons between the PDA Stent and APS is a topic of interest among the pediatric cardiac surgeons and physicians. There have been few multicentre retrospective studies. A meta-analysis boosts the number of observations, enhancing statistical power and providing a more objective evaluation of the evidence level. Thus, this study is aimed to conduct a meta-analysis to compare the outcomes after PDA stent and APS in CHD with duct dependent circulation.

Aim

A comprehensive analysis between surgical APS and PD stent in the palliative management of duct dependent circulation is conducted. This review aims to evaluate the efficacy and safety of PDA stent procedures in managing duct-dependent circulation.

METHODS

The preferred reporting items for systematic reviews and meta-analyses (PRISMA) statement was followed in the execution of this systematic review and meta-analysis.[12] Upon reasonable request, the corresponding authors provided the data supporting the study's conclusions. An a priori protocol was used in this systematic review. We ran a thorough search across the Embaze and PubMed databases. Studies assessing mortality, procedural outcomes, and postprocedural complications following PDA stent and APS in patients with cyanotic CHD and DDPBF were sought found using specific keywords and a comprehensive vocabulary. Blalock-Taussig-Thomas shunts and other systemic pulmonary artery shunts were among the APS surgeries. The following criteria had to be met in order for a subject to be included: (1) a comparison research design between PDA stent and APS; (2) participants should have DDPBF and single ventricle physiology or biventricular CHD (tetralogy of Fallot). (3) at least ten individuals have received PDA stent. Included were only research that were published between 2005 and 2020. The study excluded research that 1) didn't compare PDA stent and APS procedures or involved participants with different conditions or ages. 2) They also left out studies published before 2005 or after 2020, those with incomplete data or unclear findings, and 3) any not in English if language fluency was needed.

Data extraction

The research title, abstract, and full-length articles were used by five authors to independently and individually screen all identified studies to see if they satisfied the screening criteria. Independent data extraction was done by two authors. The Covidence systematic review program (Veritas health innovation, Melbourne, Australia) was utilized to facilitate data extraction and multi-reviewer screening in parallel. A different author evaluated disagreements between 2 reviewers about study eligibility, while another author reviewed disagreements between 2 reviewers regarding data extraction.

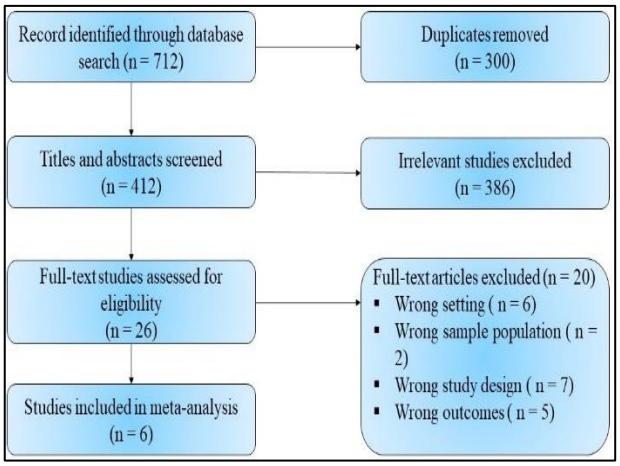

Figure 1. The studies for meta-analysis.[13]

Methodological quality and risk of bias assessment

No randomized trials could be found. Using the Newcastle-Ottawa technique, the observational studies' risk of bias was assessed. This technique analyzed how research subjects were similar, how the result was measured, how participants were chosen from the population of interest, and, if relevant, the duration and quality of follow-up. The risk of bias in the studies was categorized as high-risk (1-3 points), intermediate-risk (4-5 points), or low-risk (6-7 points). A second reviewer settled all of the disagreements.

Statistical analysis

The R program, version 4.0.3, was used for all statistical analyses. The sample mean and standard deviation were ascertained in accordance with the Cochrane handbook for systematic reviews of interventions for studies that provided the median and the first and third quartiles. The Chi-square test with Yates' continuity correction was used to evaluate common diagnoses of tetralogy of Fallot, pulmonary atresia with intact ventricular septum (PA-IVS), and biventricular and single ventricle repair. Mean differences with 95% confidence intervals (CI) were used to evaluate continuous variables. Total number of events and patients as reported in each individual study was used to compute odds ratio (OR) with 95% CI for event rate

data. Hazard ratios (HR) were calculated for mortality outcome and risk of unplanned reinterventions to take event timing into consideration. Additionally, adjusted HR that corrected for other significant factors in multivariable survival analysis were applied to avoid bias, even though not all trials adjusted for covariates. We used random-effects models to pool impact estimates since we expected variation between trials. Between-study variance was estimated using the DerSimonian-Laird estimator, and the 95% CI was computed using the Jackson technique. Fix-effects models were also run in order to evaluate how reliable results were. Sensitivity studies were also conducted to evaluate the robustness of the findings: for continuous outcome data, Paule-Mandel estimate was used, and for binary outcome data, limited maximum likelihood estimator. A CI for the between-study variance was estimated using Q-profile approach. P<0.05 was used to indicate statistical significance.

Using an Egger test and a visual funnel plot, publication bias was evaluated.[14] In addition, "trim and fill" approach was employed to investigate if the estimations were significantly altered by hypothetically absent research.

RESULTS

After the initial search produced 712 studies, all abstracts were examined. After 26 papers were read in their entirety, 6 studies were deemed eligible for analysis. Table 1 provides an overview of the included research. A total of 767 patients with DDPBF, 223 (32.1%) had PDA stents implanted, and 513 (67.9%) had surgical APS implantation. For PDA stents and APS, the average age at first intervention was 22 days and 29 days, respectively (p=0.18). In the PDA stent group, PA-IVS was more prevalent than in the APS group (39.6% versus 21.2%, p<0.001). The percentage of patients having a tetralogy of Fallot diagnosis did not change significantly between the two groups (8.9% versus 14.2%, p=0.196). A total of 594 patients were divided into two groups according to whether biventricular or single ventricle repair was anticipated in the future. When comparing the PDA stent group to the APS group, there was a greater percentage of predicted biventricular repair (57.9% versus 46.6%, P=0.007). Furthermore, two investigations classified individuals according to the existence of antegrade pulmonary blood flow. Antegrade pulmonary blood flow was seen in more PDA stent-wearing patients (52.3 versus 38.2%, p<0.001) than APS-wearing patients.

Table 1 shows characteristics of patients included in meta-analysis, detailing parameters as no. of patients, average age at 1st intervention, prevalence of PAIVS, diagnosis of tetralogy of Fallot, percentages of predicted biventricular repair and existence of antegrade pulmonary blood flow, comparing between PDA stent and APS groups.

Table 1: Over view of included studies.

Author, year, and study type	Inclusion period	No. of patients	Age (days) at intervention	Cardiac diagnoses	Outcomes reported
Amoozgar, 2012, multicenter[15]	2009-11	PDA stent=15 APS=20	PDA stent median 20 days (range 4-180) APS median 37 days (range 6-330)	PDA stent: TOF, PA (n=2, 13%), PA, VSD (n=5, 33%), PA (n=3, 20%), TGA, VSD, PS (n=1, 7%), MA, PA (n=1, 7%), TA, PA (n=2, 13%), AVSD, PA (n=1, 7%) APS: TA, PS/PA (n=4, 20%), single ventricle, PA (n=2, 10%), TOF (n=4, 20%), PA, VSD (n=8, 40%), ASD, PS (n=1, 5%), DORV, PS (n=1, 5%)	1. Mortality 2. complications 3. LOS, total 4. pulmonary artery growth: dimensions, Nakata index
Bentham, 2018, multicenter[16]	2012-15	PDA stent=83 APS=171	PDA stent median 8 days (25^{th}-75^{th} percentile: 4-13) APS median 8 days (25^{th}-75^{th} percentile: 5-15)	PDA stent: PA, IVS (n=23, 28%), TA (n=5, 6%), complex TGA/DORV (n=15, 18%), TOF (n=6, 7%), DORV (n=6, 7%), PA, VSD (n=22, 27%), Ebstein anomaly (n=2, 2%), DILV (n=1, 1%), Other (n=5), unbalanced AVSD (n=3, 4%) APS: DORV (n=17, 10%), PA, VSD (n=31, 18%), TOF (n=18, 10%), PA, IVS (n=32, 18%), unbalanced AVSD (n=7, 4%), Ebstein anomaly (n=2, 1%), DILV (n=6, 3%), TA (n=17, 10%), complex TGA/DORV (n=24, 14%), other (n=24)	1. Mortality/ survival 2. LOS, total 3. LOS, ICU 4. mechanical ventilation 5. reinterventions 6. ECMO 7. pulmonary artery growth: dimensions, Nakata index, pulmonary artery symmetry index
Glat, 2018, multicenter[17]	2008-2015 (PDA stent) 2012-2015 (APS)	PDA stent=106 APS=251	PDA stent Median 9 days (25^{th}-75^{th} percentile: 5-15) APS median 6 days (25^{th}-75^{th} percentile: 4-15)	PDA stent: PA, VSD (n=18, 17%), TA, PA/PS (n=5, 5%), Isolated PS (n=10, 9%), PA, IVS (n=47, 44%), PS, VSD (n=26, 25%) APS: PA, IVS (n=50, 20%), PS, VSD (n=62, 25%), PA, VSD (n=99, 39%), TA, PA/PS (n=39, 16%), isolated PS (n=1, 1%)	1. Mortality 2. complications 3. LOS, total 4. LOS, ICU 5. mechanical ventilation 6. reinterventions 7. ECMO 8. pulmonary artery growth: Nakata index, pulmonary artery symmetry index

Continued.

Author, year, and study type	Inclusion period	No. of patients	Age (days) at intervention	Cardiac diagnoses	Outcomes reported
Mallula, 2015, single center[18]	2006-2013	PDA stent=13 APS=16	PDA stent Median 7 days (range 2-13) APS median 5 days (range 2-28)	PDA stent: PA, IVS (n=13,100%) APS: PA, IVS (n=16, 100%)	1. Mortality 2. complications 3. reinterventions 4. LOS, total 5. mechanical ventilation
McMullan, 2014, single center[19]	2002-2011	PDA stent=13 APS=42	PDA stent Median 13 days (range 4-43) APS median 12 days (range 2-218)	PDA stent: Unbalanced AVSD (n=2, 15%), TOF (n=1, 8%), PA (n=8, 62%), Complex arterial transposition (n=2, 15%) APS: PA (n=12, 29%), Ebstein anomaly (n=3, 7%), TA (n=4, 10%), DORV (n=7, 17%), TOF (n=7, 17%), complex arterial transposition (n=8, 19%), unbalanced AVSD (n=1, 2%)	1. Survival 2. complications 3. reinterventions
Santoro, 2009, Single center[20]	2003-2009	PDA stent=13 APS=14	PDA stent Mean 22±39 days (range 1-84) APS mean 21±30 days (range 7-76)	PDA stent: TOF (n=2, 15%), complex CHD with PA/PS (n=5, 38%), PA, IVS (n=6, 46%) APS: TOF (n=6, 43%), complex CHD with PA/PS (n=6, 43%), PA, IVS (n=2, 14%)	1. Pulmonary artery growth: Nakata index, pulmonary artery dimension z-scores.

Table 2: Characteristics of patients included in the meta-analysis.

Parameter	PDA stent group	APS group	P value
No. of patients	223	513	-
Average age at first intervention (days)	22	29	0.18
PA-IVS prevalence (%)	39.6	21.2	<0.001
Tetralogy of Fallot diagnosis (%)	8.9	14.2	0.196
Predicted biventricular repair (%)	57.9	46.6	0.007
Antegrade pulmonary blood flow (%)	52.3	38.2	<0.001

These tables summarize the key statistical data presented in the results section of the study.

Procedural complications

There have been three studies that claim procedural success rates of 85% with PDA stents. Following APS, perioperative haemorrhage, surgical wound exploration, and arrhythmia were frequently reported procedural consequences. Stroke, thrombosis, early reoperation, cardiac failure, mediastinitis, multiorgan malfunction, seizure, lung collapse, chylothorax, and pulmonary congestion and bleeding were less often reported problems.[15,19] Procedure-related problems for individuals undergoing PDA stent included ductal spasm and access-related vascular damage. Arrhythmias were observed and reported by one research less frequently (1.6%). Stent migration, bacteremia, right ventricular perforation, and duct dissection were rare side effects of PDA stents that were documented as isolated cases. In four research, procedural complications were compared. 10.9% of the PDA stent group and 21.3% of the APS group experienced problems. When comparing PDA stent to APS, there was a lower risk of procedural complications (OR, 0.45; [95% CI, 0.25-0.81]; p=0.008; I 2=0%). This finding was supported by the sensitivity analysis (OR, 0.45; [95% CI, 0.25-0.81]; p=0.008) and the fixed-effects model (OR, 0.43; [95% CI, 0.24-0.76]; p=0.004).

Reinterventions

For the purpose of treating cyanosis following PDA stent or APS, four trials compared unscheduled reinterventions. In the APS group, the pooled proportion of unplanned reintervention rate was 22.7%, whereas in the PDA stent group, it was 25.6%. Compared to APS, PDA stents were linked to a greater risk of unscheduled reinterventions for the treatment of cyanosis, while this difference was not statistically significant (HR, 1.39; [95% CI, 0.70-2.78]; p=0.35; I 2=68%). Comparable results were found for the sensitivity analysis (HR, 1.44; 95% CI, 0.65-3.19]; p=0.37) and fixed-effects model (HR, 1.16; [95% CI, 0.82-1.64]; p=0.40).

Length of stay and duration of mechanical ventilation

Four studies and two ICU studies provided data on hospital-wide length of stay (LOS). ICU length of stay (LOS) for patients with a PDA stent was 4.03 days less than for those with an APS (95% CI, -5.99 to -2.07; p<0.001). It showed comparable results in the sensitivity analysis (mean difference: -4.03; 95% CI, -5.99 to -2.07]; p<0.001) and fixed-effects model (mean difference: -4.08; [95%; p<0.001). The fixed effects model (mean difference: -4.36; [95% CI, -5.85 to -2.87]; p<.001) and sensitivity analysis (mean difference: -7.21; p=0.038)

also revealed that PDA stent use was related with a lower overall hospital LOS by 5.54 days (95% CI=-9.20 to -1.88; p=0.003; 2=78%). Furthermore, length of postprocedural mechanical ventilation was documented in three investigations. PDA stent shown to have a greater advantage in duration of postprocedural mechanical ventilation, with a mean difference of 3.41 days (95% CI, -5.29 to -1.52; p<0.001). The fixed-effects model yielded similar result (mean difference: -2.26; p<0.001).

PDA stent showed shorter postprocedural mechanical ventilation in sensitivity analysis, but difference was not statistically significant (mean difference: -5.09; p=0.07).

Mortality and ECMO support

The PDA stent group saw a pooled death rate of 8.2%, whereas the APS group experienced a pooled mortality rate of 11.8%. In the PDA stent group (HR, 0.7; p=0.50; I 2=54%), the mortality hazard was lower than in the APS group, but there was no statistically significant difference between the two groups. The results of postprocedural ECMO assistance were documented in two trials. After PDA stent compared to APS, ECMO assistance was less common (OR, 0.27; p=0.02; I 2=0%). Comparable results were obtained from sensitivity analyses (HR, 0.71; p=0.49 for mortality and OR, 0.27; p=0.02 for ECMO support). Consistent results were also shown by the fixed-effect models (OR, 0.27; p=0.02 for ECMO support and HR, 0.80; p=0.49 for mortality).

Pulmonary artery size and symmetry

Between the PDA stent and APS groups, there was no discernible difference in the Nakata index (standardized mean difference [SMD], 0.09; [95% CI-0.20 to 0.37]; p=0.55). Additionally, there was no difference between the two groups' pulmonary artery symmetry as determined by the symmetry index (SMD, 0.38; p=0.25). Moreover, identical findings were obtained using fixed-effects models (SMD, 0.14; p=0.20 for the symmetry index and SMD, 0.17; p=0.10 for the Nakata index). The sensitivity analysis revealed similar results (SMD, 0.08; p=0.57 for the symmetry index and SMD, 0.46; p=0.36 for the Nakata index).

Quality assessment and publication bias

According to the Newcastle Ottawa scale, all included studies had a minimal risk of bias, scoring at least six points. The funnel plots demonstrated publication bias. Our pooled estimates were not significantly altered by the extra analyses that employed the "trim and fill" strategy in order to account for hypothetical "missing" studies.

DISCUSSION

Six studies were included in this meta-analysis of a substantial amount of published literature to analyse the outcomes of PDA stent and APS in patients with cyanotic CHD and DDPBF. This study additionally included covariates when appropriate. This research showed that there was no statistically significant difference between the two methods for treating cyanosis in terms of risk of death or unanticipated reinterventions. In terms of numbers, the APS group had a greater risk of death, whereas the PDA stent group had a higher risk of unplanned reintervention. Shorter lengths of stay in the intensive care unit and hospital, as well as fewer days spent on mechanical ventilation, were linked to PDA stent use. Crucially, there was no discernible statistical difference between the two groups' pulmonary artery symmetry and size. Additionally, this study shows that the PDA stent group had higher rates of antegrade pulmonary blood flow, projected future biventricular repair, and PA-IVS diagnosis as compared to APS group.

The PDA stent was shown to have a numerically decreased risk of mortality; however, this difference was not statistically significant. Furthermore, fewer procedural problems, postprocedural ECMO assistance, mechanical breathing, and a shorter length of stay in the hospital were linked to PDA stents. Compared to 11% following PDA stent implantation, the APS technique carries a potential 21% procedural complication risk. In the PDA stent group, procedural problems are often less severe and potentially fatal. Therefore, it was not unexpected that following PDA stent, there was a reduced requirement for ECMO assistance and mechanical breathing coupled with a shorter length of stay in the ICU and hospital. Additional research has demonstrated that PDA stent strategy is linked to decreased healthcare costs when compared to APS.[21] It is unknown how first palliation method will affect longer-term results, such as neuro-developmental consequences.

Although it was statistically greater in the PDA stent group, there was no discernible difference in the rate of unplanned reintervention to address cyanosis across the groups in this meta-analysis. The inclusion of planned reintervention operations takes precedence over the literature-described higher rate of reinterventions following PDA stent. We were unable to do a meta-analysis on the planned intervention rate since several papers did not include distinct planned intervention rates in the comparison. It's also possible that the groups' reintervention schedules differ from one another. According to Bentham et al the bulk of interventions in their APS group happened during the late inter stage time (need for an APS stent) and early inter stage era (need for an early shunt revision or switch to another source of pulmonary blood flow).[16] Reinterventions following PDA stent were primarily performed after the fact and used catheter-based techniques to either re-stent the patient's current stent or expand it with a balloon in order to prevent neointimal growth within the stent. Reinterventions may be responsible for certain late-occurring procedures, since they are usually meant to extend the period between the first palliation and the subsequent palliative operation or final surgery.

It is significant to highlight that this study discovered that patients with antegrade pulmonary flow, predicted biventricular repair, and PA-IVS had higher rates of PDA stent use. It is simpler to stent patients with PA-IVS since they typically have "straight" ductus arteriosus. A dual pulmonary blood flow source is provided by expected biventricular repair and antegrade pulmonary flow, which leads to more stable hemodynamics throughout the PDA stent surgery and fewer procedural problems overall. PDA stent implantation is now safe and practical in a wider range of CHD anatomy due to growing expertise with the device; some centres have begun placing PDA stents in all cyanotic new-borns with DDPBF. Additionally, in neonates who may be at high risk for heart surgery or who have several comorbidities, a PDA stent could be the better choice. But it's crucial to understand that, in cases when a PDA stent cannot be placed due to complicated PDA geometries, a surgical APS may be the best alternative for palliation. In the end, a detailed evaluation of the patient's ductus arteriosus architecture, clinical history, and surgical risk factors should be conducted. An individual selection between an APS and PDA stent should be made, taking institutional expertise into account.

Alsagheir et al recently conducted another meta-analysis to see if PDA stents were linked to better results than APS by combining data from six trials.[22] Our meta-analysis's results, which demonstrated improved postoperative morbidities following the PDA stent, such as shorter postprocedural hospital stays and fewer procedure problems, were in line with those of Alsagheir et al.[22] In the prior meta-analysis, the PDA stent group had a lower midterm death rate than in our research, where there was no statistically significant difference in mortality. Alsagheir et al on the other hand, combined relative risk ratios and unadjusted relative risk for mortality, which is devoid of covariate adjustment and time to event accounting.[22] In order to address this, we only presented adjusted ratios that took covariates into account and HR that took time to event into account. As the biggest multicentre trial included in this meta-analysis to date, Glatz et al results are similar with ours, showing no statistically significant difference in adjusted hazard of death.[17] Our meta-analysis is also different from the previous meta-analysis in that the Nakata index and the pulmonary artery symmetry index were used to assess the size and symmetry of the pulmonary arteries. This lends more credence to the hypothesis that there may be no difference in pulmonary artery development across intervention groups. Furthermore, group differences in frequent cardiac diagnoses and the percentage of predicted biventricular or single ventricular repair in this cohort were also shown by this meta-analysis.

Similar to our study, AbdelMassih et al revealed; (1) a reduced risk of mortality [RR=0.585 [0.399-0.859], (p=0.006)], (2) a reduced risk of complications [RR=0.523 [0.318-0.860], (p=0.011), and (3) a reduced risk of ECMO use [R=0.267 [0.101-0.706] (p=0.008)], all in the stent group. Additionally, stent group showed higher post procedure oxygen saturation [SMD=1.307 [95% CI 1.065-1.550], (p<0.001)], and Nakata index [SMD=0.679 95% CI [0.513 to 0.845], (p<0.001)]. PDA stenting provides a good alternative to surgical APS with better post-procedure stability.[23]

In comparing our study findings with previous research, several key parameters emerge that shed light on the efficacy and safety profiles of PDA stent versus surgical APS (arterial pulmonary shunt) in treating cyanotic CHD with ductal-dependent pulmonary blood flow (DDPBF).

Firstly, mortality risk assessment is critical. While our study, akin to Alsagheir et al meta-analysis, demonstrated no statistically significant difference in mortality between PDA stent and APS groups, AbdelMassih et al presented a reduced risk of mortality in the stent group. Notably, our study, unlike Alsagheir et al analysis, employed adjusted ratios considering covariates and HR incorporating time-to-event data, possibly providing a more comprehensive understanding of mortality outcomes. This nuanced approach underscores the complexity of mortality risk assessment in these interventions.[22,23]

Secondly, the incidence of complications and the need for ECMO (extracorporeal membrane oxygenation) assistance are vital metrics. AbdelMassih et al found a reduced risk of complications and ECMO use in the stent group, aligning with our findings. However, it's important to note that our study, in contrast to AbdelMassih et al didn't specifically mention a statistically significant difference in ECMO use. This disparity underscores the importance of meticulous data analysis and interpretation when comparing outcomes across studies.[23]

Post-procedural stability, as indicated by oxygen saturation and indices of pulmonary artery development, emerges as another crucial parameter. Similar to AbdelMassih et al our study showed higher post-procedure oxygen saturation and Nakata index in the stent group, suggesting superior post-procedural stability with PDA stenting.[23] These findings highlight potential physiological advantages of PDA stenting in optimizing pulmonary circulation and oxygenation post-intervention.

Moreover, procedural complications and reintervention rates warrant attention. Our study and previous research consistently indicate lower risk of procedural complications with PDA stent compared to APS. However, rate of unplanned reinterventions, while statistically greater in PDA stent group in our analysis, didn't show discernible difference across groups in terms of addressing cyanosis. This underscores need for nuanced understanding of reintervention dynamics and their impact on long-term outcomes, which may vary based on patient characteristics and procedural nuances.

In summary, while our study corroborates several findings from previous research regarding the benefits of PDA stenting over APS in terms of mortality, complications, post-procedural stability, and procedural complications, nuanced differences in outcomes and methodological approaches across studies emphasize the importance of careful interpretation and synthesis of evidence in guiding clinical decision-making.

Limitations

All of the papers that made up this meta-analysis were retrospective in nature because of the nature of the clinical question. Confounders and variables may not have been taken into account in certain retrospective studies, but we have made an effort to reduce their impact in our study by utilizing adjusted HRs and ORs. Furthermore, the majority of patients included in this research had surgical APS, despite the increasing use of PDA stents. The preference to execute APS versus PDA stent and center variability may have an impact on this, which might bring selection bias into the included trials. Finally, not all individuals with DDPBF who have cyanotic CHD will have same cohorts. Due to variability in data reporting and low prevalence of certain diagnoses, not all forms of CHD with DDPBF were assessed.

CONCLUSION

The meta-analysis supported the practicality of PDA stents and APS as therapeutic alternatives by highlighting their similar effectiveness in reducing the risk of death. Notably, the use of PDA stents offers a number of unique advantages, such as shorter hospital stays and shorter oxygen therapy durations, which may improve overall patient outcomes. Furthermore, the therapeutic efficacy of PDA stent insertion is further supported by the apparent lower number of post-procedural problems associated with this procedure when compared to other therapies. Moreover, the available literature indicates that patients with certain conditions like PA-IVS and those scheduled for expected biventricular surgery after PDA stent implantation may present with distinct clinical features that call for customized management. This sophisticated knowledge emphasizes how crucial customized treatment plans are to maximizing results for those receiving these kinds of therapies.

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