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# Partial Heart Transplantation for Congenital Heart Disease. A Narrative Review of Current Knowledge and Future Directions

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**ABSTRACT**

**Background.** Partial heart transplantation (PHT), also referred to as living valve replacement, is an emerging surgical strategy for irreparable valvular defects. By implanting viable donor valve tissue, PHT provides grafts capable of somatic growth, addressing a key limitation of conventional prosthetic valves in pediatric patients, in whom the lack of growth potential necessitates repeated reoperations.

**Aim.** This review aims to introduce the concept of partial heart transplantation to a broader clinical audience and to summarize current clinical experience. We discuss indications, technical considerations, and organizational challenges associated with PHT in infants, and outline potential applications in older children and adults.

**Methods.** A structured literature search was conducted in databases using selected keywords related to partial heart transplantation and congenital heart disease. Because the available evidence remains early and heterogeneous, a narrative review approach was adopted with

SANRA quality criteria. The included literature consisted mainly of case reports, case series, and review articles.

**Results.** The largest reported case series included 19 patients who underwent PHT between April 2022 and December 2024. Replacement of semilunar valves was associated with significant annular growth and preserved valvular function during follow-up. At the time of publication, none of the transplanted valves required explantation due to graft failure. Early observations suggest that, owing to the relatively low immunogenicity of cardiac valves, immunosuppressive requirements after PHT may be lower than those required after orthotopic heart transplantation.

**Conclusion.** Evidence for PHT is currently limited to small cohorts with short follow-up. Multicenter collaboration and standardized registry-based data collection will be essential to define indications, evaluate long-term outcomes, and establish the role of PHT within contemporary valve replacement strategies.

**Keywords**: Partial Heart Transplantation, Congenital Heart Disease, Living Valve Transplantation, Valve Replacement, Allografts, Immunosuppression Therapy

## INTRODUCTION

Congenital heart disease (CHD) is the most common type of major birth defect worldwide, affecting approximately 8–9 per 1,000 live births, which corresponds to roughly 1% of all newborns globally[1]. Approximately one-third of heart defects affect the heart valves [2]. Despite significant advances in pediatric cardiac surgery, effective treatment of severe heart valve dysfunction, particularly in cases requiring valve replacement, is not fully accomplishable. So far, the treatment of irreparable heart valves involved valve replacement with an implant, Ross pulmonary autotransplantation, or conventional orthotopic heart transplantation. These methods may be appropriate for adults and older children, but in infants are associated with many additional risk factors and considerable limitations[3]. Bioprosthetic valves in children are affected by accelerated valve degeneration, and they are rarely available in pediatric sizes suitable for neonates and infants. Mechanical valves, although resistant to degeneration, require constant anticoagulation therapy. Anticoagulation in children is challenging due to numerous dietary limitations, difficulties in maintaining stable therapeutic ranges, and limited compliance. Consequently, children with mechanical valves often suffer from valve thrombosis, thromboembolism, and bleeding episodes [4].

The current standard for treatment of semilunar heart valves in neonates and children is an antibiotic-preserved or cryopreserved homograft. The vast majority of implants are

cryopreserved homografts, as they do not contain viable cells and can be stored for much longer [5]. However, all currently available valve substitutes lack the ability to grow. This inevitably leads to repeated reoperations in childhood. Semilunar valves increase approximately threefold in diameter from birth to adulthood, resulting in at least 5 or 6 surgical reinterventions before an adult-sized valve can be accommodated [1].

Ross pulmonary autotransplantation is a procedure used in the treatment of severe aortic valve defects. Pulmonary autografts contain viable cells, which allows them to grow and self-repair, limiting the need for reoperations. Nevertheless, the Ross procedure requires a structurally normal native pulmonary valve, which may not be present in patients with complex congenital heart defects. Furthermore, pulmonary autografts placed in the systemic (aortic) position are exposed to higher pressures and may progressively dilate, leading to late dysfunction and reintervention. Additionally, replacement of the pulmonary valve with a homograft introduces the risk of pathology in a second valve position[6,7]. Importantly, outcomes of the Ross procedure in neonates are less favorable than in older children, with higher early mortality and reintervention rates reported particularly in anatomically complex cases. These considerations limit its universal applicability in the youngest patients.

Orthotopic heart transplantation (OHT) may appear to be a comprehensive solution, as it simultaneously addresses multiple cardiac defects and provides a viable organ capable of growth. However, the availability of suitable heart donors, particularly for neonates and infants, remains limited. This creates an urgent need to reserve whole-heart transplantation for patients with complex defects involving ventricular dysfunction. Moreover, heart transplantation requires lifelong immunosuppression, which is associated with numerous adverse effects and long-term complications.

Partial Heart Transplant (PHT) is a novel procedure that creates a different approach for the treatment of infants with irreparable heart valve dysfunction. It is based on the implantation of viable donor valve tissue that retains cellular integrity and the capacity for growth following excision and reimplantation, as confirmed experimentally[4]. Compared with heart transplantation, PHT involves transplantation of only the necessary valve structures, while the native ventricles are preserved. Preserving ventricles reduces the risk of graft ventricular dysfunction and allows more efficient utilization of scarce heart donors only for patients with ventricular failure. It also creates the possibility of using domino and split-root procedures within PHT. Moreover, partial heart transplants may require less immunosuppression than whole-organ transplantation (Tabl.1)[8].

Table 1. Differences Between Heart Transplantation, Partial Heart Transplantation, and Cryopreserved Homograft

| | Heart Transplantation | Partial Heart Transplantation (PHT) | Cryopreserved Homograft |
|---|---|---|---|
| **Graft** | Whole heart | Heart valve/tissue | Heart valve/tissue |
| **Donor** | Organ donor | Organ donor | Cadaveric donor |
| **Tissue matching** | Yes | Unknown | No |
| **Ischemic time tolerated** | Short | Short to moderate | Long |
| **Immunosuppression** | High | Low | None |
| **Growth capacity** | Yes | Yes | No |

The main aim of this review is to introduce the concept of partial heart transplantation to a broader clinical audience of surgeons, cardiologists and researchers and to critically summarize the current state of knowledge, including the 19 reported clinical cases to date [5]. Furthermore, we discuss indications and practical considerations for PHT in neonates and infants, explore its potential applicability in older children and adults, and address the ethical, logistical, and organizational challenges associated with this therapeutic strategy.

## RESEARCH MATERIALS AND METHODS

Because the literature on partial heart transplantation (PHT) is early and heterogeneous, we adopted a narrative review approach that incorporated transparent literature searches and source selection in accordance with the SANRA quality criteria [9].

A structured literature search was conducted independently by researchers in PubMed, Scopus, and Web of Science databases. The following key terms were used: “partial heart transplantation,” “living valve transplantation,” “congenital heart disease,” “congenital heart defect,” and “valve replacement”. The search included publications available up to February 2026 and was limited to articles published within the preceding five years.

A two-track approach was followed: (1) for clinical evidence on PHT, all studies were included starting from the first reported human procedures; (2) for clinical and organizational background, selected guideline documents, registry analyses, and state-of-the-art reviews were incorporated.

The synthesis included studies reporting PHT in humans (case reports, case series, and conceptual or organizational analyses). Animal models were considered solely as biological background (e.g., graft preservation and viability) and not as evidence of clinical efficacy.
Due to the early stage of PHT investigation, no high-quality evidence, such as meta-analysis or systematic reviews have been published yet.

## PUBLISHED CLINICAL EXPERIENCE

The first partial heart procedure was performed in April of 2022 in Duke. The recipient was a 17-day-old male with truncus arteriosus and severe truncal valve regurgitation [10]. The procedure was technically successful, and follow-up demonstrated appropriate somatic growth of the transplanted conduit with preserved valvular function. Subsequently, a case series of the first 19 patients undergoing PHT between April 2022 and December 2024 was reported from a single high-volume pediatric cardiac surgery and transplant center in the United States[5]. To date, this represents the largest systematically analyzed and published clinical cohort. Patient characteristics are summarized in Table 2 [11].

Table 2. Individual Clinical Characteristics of the First 19 Patients Undergoing Partial Heart Transplantation

| CASE NO. | AGE AT SURGERY | PRIMARY DIAGNOSIS | SURGICAL STRATEGY |
|---|---|---|---|
| **1** | <1 month | Truncus arteriosus | Double-root replacement |
| **2** | <1 month | Truncus arteriosus | Pulmonary root (pulmonary position) |
| **3** | <1 month | Truncus arteriosus with interrupted arch | Split-root aortic root (pulmonary position) |
| **4** | <1 month | Truncus arteriosus | Pulmonary root (pulmonary position) |
| **5** | 2–4 months | Dysplastic pulmonary valve with hypoplastic aortic valve | Domino double-root replacement |
| **6** | 2–4 months | Tetralogy of Fallot with pulmonary atresia | Domino pulmonary root (pulmonary position) |
| **7** | 2–4 months | Tetralogy of Fallot with pulmonary atresia | Domino pulmonary root (pulmonary position) |

| | | | |
|---|---|---|---|
| **8** | 1–2 months | Tetralogy of Fallot with pulmonary atresia | Split-root pulmonary root (pulmonary position) |
| **9** | <1 month | Critical aortic stenosis | Split-root aortic root (aortic position) |
| **10** | 2–4 years | Critical aortic stenosis | Domino 'living Ross' strategy |
| **11** | 8–16 years | Aortic atresia (post Damus–Kaye–Stansel) | Domino aortic root (pulmonary position) |
| **12** | 8–16 years | Aortic insufficiency and stenosis (post Ross) | Domino aortic root (aortic position) |
| **13** | 2–4 years | Aortic atresia (post Damus–Kaye–Stansel) | Domino aortic root (pulmonary position) |
| **14** | 1–2 months | Tetralogy of Fallot with pulmonary stenosis (post repair) | Domino aortic root with branch PA arterioplasty |
| **15** | 1–2 years | Tetralogy of Fallot with absent pulmonary valve | Domino pulmonary root (pulmonary position) |
| **16** | 30–35 years | Bicuspid aortic valve with severe insufficiency | Domino 'living Ross' strategy – Ross with aortic root in pulmonary position |
| **17** | 8–16 years | Truncus arteriosus | Domino double-root replacement |
| **18** | <1 month | Truncus arteriosus | Domino pulmonary root (pulmonary position) |
| **19** | 4–8 years | Severe aortic valve insufficiency (post arch repair) | Split-root domino 'living Ross' strategy – Ross with aortic root in pulmonary position |

The median age of recipients was 97 days (range: 2 days - 34 years). Eighteen members were pediatric, and one was an adult. 47% of participants were female - 9 cases and 53% of participants were male - 10 cases. No patients were excluded or lost to follow-up. The median follow-up was 26 weeks [11].

Among the 19 patients with irreparable congenital semilunar valve dysfunction, three underwent transplantation of both semilunar valves, seven received a living pulmonary valve

allograft in the pulmonary position, two underwent living aortic valve replacement in the aortic position, and seven received a living aortic valve allograft in the pulmonary position.

Efficacy was primarily assessed using serial transthoracic echocardiography, with measurement of annular diameter and leaflet length over time. To better evaluate growth potential in pediatric-size implants, detailed growth analysis was performed in the initial cohort of nine infants. All measurements were obtained by a blinded pediatric cardiologist using standardized imaging planes to ensure consistency[11].

In the early postoperative period, the median aortic valve annulus measured 7 mm and the pulmonary valve annulus 9 mm. At the last follow-up, median annular diameters increased to 14 mm for the aortic valve and 17 mm for the pulmonary valve. Both aortic and pulmonary annular diameters demonstrated statistically significant growth ($P = 0.004$). Comparable increases were observed in leaflet length measurements.

Notably, the median follow-up in the later and older cohort is less than 90 days. The growth of transplanted valve annulus and leaflets was not anticipated in this cohort due to the nature of the implanted valves and the age of recipients.

Across the entire cohort, mild regurgitation of the transplanted aortic valve in the left ventricular outflow tract (LVOT) position was observed in two patients, and mild regurgitation of the transplanted pulmonary valve in the right ventricular outflow tract (RVOT) position was observed in two patients. No severe valve dysfunction was reported. No major complications directly attributable to immunosuppression were documented; however, two patients required dose reduction due to renal injury. One patient underwent reoperation for RVOT stenosis caused by calcification of cryopreserved tissue used as a hood proximally to the pulmonary living heart transplant. Intraoperatively, the PHT tissue itself was neither calcified nor stenotic. At the time of publication, no transplanted PHT valves had been explanted due to graft failure.

Beyond the Duke experience, additional pediatric centers have reported performing PHT procedures, including the Medical University of South Carolina, Columbia University, Dell Children's Medical Center, Boston Children's Hospital, and Loma Linda University[8]. However, most of these cases have been described primarily in press reports without detailed peer-reviewed clinical data and therefore cannot be incorporated into formal statistical analyses [12-15].

## TECHNICAL ASPECTS AND IMMUNOSUPPRESSION

Donor selection in partial heart transplantation (PHT) was based primarily on anatomical matching, with valve annular dimensions assessed by transthoracic echocardiography. In

selected cases, advanced utilization strategies were employed, including domino partial heart transplantation and split-root procurement. Detailed descriptions of three domino PHT recipients and three split-root PHT recipients performed between May and August 2023 have been published. These cases are summarized in Table 2, with more comprehensive procedural characteristics provided in Tables 3 and 4 [16].

Table 3. Clinical Characteristics of Reported Domino Partial Heart Transplantation

| Case No. | Donor Source | Intermediate (Domino) Donor Diagnosis | Final Recipient Diagnosis | Type of Transplanted Tissue |
|---|---|---|---|---|
| **1** | Neonatal DCD donor with preserved semilunar valves | Ischemic cardiomyopathy with functional semilunar valves | Biventricular outflow tract obstruction | Double root replacement |
| **2** | Neonatal DCD donor with preserved semilunar valves | Hypoplastic left heart syndrome with functional pulmonary valve | Tetralogy of Fallot with membranous pulmonary atresia | Pulmonary root replacement |
| **3** | Neonatal DCD donor with preserved semilunar valves | Left coronary atresia with functional semilunar valves | Tetralogy of Fallot with membranous pulmonary atresia | Pulmonary root replacement |

*Abbreviations: DCD – donation after circulatory death*

Table 4. Clinical Characteristics of Reported Split-Root Partial Heart Transplant

| Case No | Donor Source | Recipient 1 | Type of PHT Intervention 1 | Recipient 2 | Type of PHT Intervention 2 |
|---|---|---|---|---|---|
| **1** | Neonatal donor heart (procured at external institution) | Neonate with truncus arteriosus and interrupted arch | Aortic homograft used for RV–PA conduit reconstruction | Uknown - external instituton | Unknow - external instition |
| **2** | Neonatal DCD donor | Neonate with critical aortic stenosis | Aortic root replacement | Infant with tetralogy of Fallot, pulmonary atresia, and VSD | Pulmonary homograft used for RV–PA conduit |

*Abbreviations: DCD – donation after circulatory death; RV – right ventricle; PA – pulmonary artery; VSD ventricular septal defect*

After procurement, the valves were stored for up to 75 hours in a storage solution at 4°C, consistent with data suggesting that the valves tolerate prolonged cold ischemia [17]. The median ischemic time in a series of 19 cases was 501 minutes (range, 83-1316 minutes). From a technical perspective, the PHT procedure was largely based on established principles of cryopreserved homograft valve replacement, while incorporating selected concepts from the Ross pulmonary autotransplantation procedure. In this context, a modified “living Ross” strategy was implemented in certain patients, in which the conventional Ross procedure was augmented by implantation of a living partial heart transplant conduit in the right ventricle to pulmonary artery position [18].

The median operative was 294 minutes. The median intensive care and hospital lengths of stay were 9 days and 13.5 days, respectively.

Immunosuppressive regimens in partial heart transplantation (PHT) were derived from modified protocols used in ABO-incompatible pediatric orthotopic heart transplantation. This approach was adopted because PHT involves implantation of viable donor tissue and therefore carries a theoretical risk of immune-mediated injury. Standard therapy consisted of weight-adjusted tacrolimus, mycophenolate mofetil, and corticosteroids (methylprednisolone)[10].

The lowest level of immunosuppression that was found to be safe in heart transplantation is tacrolimus monotherapy [19]. Similarly, in several cases, immunosuppressive therapy after

PHT procedure was limited to tacrolimus with trough levels 6 to 10 ng/mL for the first 12 months and 4 to 8 ng/mL thereafter.

In one reported case, due to complications unrelated to the PHT procedure, immunosuppression must have been discontinued. Although in 23-months follow-up, the implanted living valve continued to grow and remained functional.

## INDICATIONS

Current clinical experience with partial heart transplantation (PHT) is limited to replacement of semilunar valves. The most compelling indication for PHT has been identified in pediatric patients requiring aortic valve replacement who are considered suboptimal candidates for the Ross procedure. Another target group are children in whom avoidance of complications associated with conventional valve substitutes is in particular desirable. These include double valve surgery, autograft dilation in case of the Ross procedure, homograft reoperation, degeneration and outgrowth of bioprosthetic valves, and risk of thromboembolism or bleeding episodes in case of mechanical valves [4]. These complications are at the highest risk in neonates and young children, meaning these groups benefit the most from PHT procedure.

To date, the most frequent congenital heart defects in partial heart transplantation recipients are: truncus arteriosus (N=9) and Tetralogy of Fallot with membranous pulmonary valve atresia (N=3). Less common indications have involved: congenital aortic stenosis, pulmonary atresia and D-transposition of the great arteries with left ventricular outflow tract obstruction [20].

## ORGANIZATIONAL AND ETHICAL ISSUES

Partial heart transplantation (PHT) presents organizational and regulatory considerations that differ from both cryopreserved homograft implantation and orthotopic heart transplantation. Because PHT involves implantation of viable donor tissue and necessitates systemic immunosuppression, it functionally corresponds to solid-organ transplantation. However, PHT does not fully meet the established criteria of vascular composite allotransplantation (VCA), and at present, no distinct regulatory classification has been formally assigned to this procedure. Consequently, its positioning within existing transplant governance and allocation frameworks remains incompletely defined [8].

A primary organizational consideration concerns donor utilization. Existing allocation systems, including those governed by UNOS/OPTN in the United States and Eurotransplant in Europe, were developed for whole-organ transplantation and do not include a centralized pathway

dedicated to partial heart transplantation. To date, reported sources of graft material for PHT have included donor hearts declined for orthotopic transplantation as well as tissues obtained through domino and split-root strategies. Integration of these approaches into existing allocation systems requires coordination across procurement organizations and transplant centers.

Consent processes also require adaptation. Donor families should be informed about the possibility of partial graft use, including split-root procurement. In domino procedures, additional clarity is required regarding the use of explanted viable tissue from the primary transplant recipient.

From an ethical perspective, organ allocation principles are defined based on beneficence, nonmaleficence, justice, and autonomy. Beneficence and nonmaleficence are related and mean that in PHT advantages should maximally outweigh potential risks. Justice is applicable for equal and fair allocation of donor hearts and autonomy is closely connected to the consent process in PHT. Ethical domains of PHT are summarized in Table 5 [21].

Table 5. Ethical Domains in Partial Heart Transplantation

| Ethical Domain | Considerations in Partial Heart Transplantation |
|---|---|
| **Autonomy** | Requires detailed informed consent due to the evolving nature of the procedure. |
| **Beneficence** | Potential allocation of organs rejected from orthotropic heart transplantation. Sufficient organ stewardship. |
| **Nonmaleficence** | Reduced immunosuppression requirements. |
| **Justice** | Potentially reduced waiting time for a transplant. |

## DISCUSSION

Current clinical experience with partial heart transplantation (PHT) remains limited to early single-center reports and small case series; nevertheless, the conceptual framework and initial outcomes suggest that PHT may evolve into a recognized therapeutic strategy for selected congenital semilunar valve defects. The principal biological advantage of PHT lies in the implantation of viable donor valve tissue with preserved cellular integrity and growth potential. Unlike cryopreserved homografts and mechanical valves, which are acellular and lack growth potential, viable PHT tissue demonstrates annular and leaflet enlargement over time, as documented in early echocardiographic follow-up of the initial clinical cohort ($P = 0.004$ for

annular growth)[11]. Potentially it may reduce the need for serial reoperations that are otherwise inevitable in infants and young children receiving fixed-diameter implants[3].

Compared with bioprosthetic valves, which undergo accelerated structural degeneration in pediatric patients, and mechanical valves, which require lifelong anticoagulation with associated thromboembolic and hemorrhagic risks, PHT offers a biologically integrated alternative that may avoid both structural deterioration and chronic anticoagulation burden. The absence of mandatory vitamin K antagonist therapy may be particularly relevant in infants, adolescents with limited compliance, and women contemplating pregnancy.

When compared with the Ross procedure, PHT may provide specific advantages in anatomically complex congenital heart disease. The Ross operation requires a structurally normal pulmonary valve and exposes the autograft to systemic pressure, predisposing to progressive dilation and potential reintervention. Additionally, Ross converts single-valve pathology into a two-valve disease process by necessitating right ventricular outflow tract reconstruction. In contrast, PHT permits selective replacement of the diseased valve without sacrificing native pulmonary tissue and may therefore avoid autograft-related dilation and secondary homograft degeneration. Importantly, early mortality and reintervention rates after the Ross procedure are reported to be higher in neonates and complex anatomies, limiting its universal applicability in this age group [7].

Relative to orthotopic heart transplantation (OHT), PHT preserves native ventricular function and avoids complete organ replacement in patients without myocardial failure. Lifelong immunosuppression remains mandatory after OHT because immune-mediated injury primarily targets myocardial tissue and may lead to graft failure. In contrast, cardiac valves appear to exhibit lower immunogenicity, likely due to reduced cellularity and progressive recipient endothelialization [24]. Current clinical experience indicates that tacrolimus monotherapy may be sufficient in selected PHT recipients, and in one reported case, discontinuation of immunosuppression did not compromise graft growth or function at 23 months of follow-up [11]. These observations suggest that the immunologic burden of PHT may be substantially lower than that of whole-organ transplantation, although long-term data remain necessary.

To date, most of reported PHT procedures have involved replacement of semilunar valves in the pediatric population. A single adult case has been reported: a 34-year-old patient with severe bicuspid aortic valve insufficiency who underwent domino PHT. This experience indicates that PHT may be applicable not only to lethal congenital heart defects but also to progressive congenital or acquired valvular diseases presenting later in adulthood. Furthermore,

in January 2025, the first human mitral PHT was performed at Duke University, although follow-up data are not yet available [21]. This milestone supports the feasibility of transplanting additional viable cardiac structures.

Beyond isolated valve replacement, PHT-derived conduits have already been proposed as a biological alternative in Fontan circulation for single-ventricle physiology. The current extracardiac Fontan procedure typically uses expanded polytetrafluoroethylene (ePTFE) grafts to connect the inferior vena cava to the pulmonary arteries. These synthetic conduits lack growth potential and are vulnerable to thrombosis, stenosis, leading to progressive venous congestion, potentially contributing to end-organ dysfunction [23]. In contrast, viable PHT conduits may retain the capacity for somatic growth and endothelial remodeling, theoretically reducing the risk of thrombotic and stenotic complications[24].

Experimental preclinical models are being established to investigate the applicability and durability of PHT-derived patch tissue for pulmonary vascular reconstruction. The biological advantages of PHT tissue over nonviable materials, such as bovine pericardium or synthetic patches, may support the exploration of PHT not only in pulmonary vascular reconstruction but also in aortic arch reconstruction [22].

Literature has also proposed en bloc transplantation of the aortic root, mitral valve, and intervalvular fibrous body for complex conditions such as Shone's syndrome, characterized by multilevel left-sided obstruction. This strategy has the potential to improve long-term valve durability, decrease the risk of prosthesis-related complications, and provide a more physiologically integrated reconstruction compared to conventional double valve replacement. Beyond cardiac reconstruction, PHT may serve as a conceptual model for growth-capable tissue transplantation in other fields, including airway interposition grafting [11].

Expansion of PHT is also linked to donor utilization. According to Organ Procurement and Transplant Network (OPTN) data, 30–40% of pediatric donor hearts in the United States are not ultimately allocated, due to ventricular dysfunction, donation circumstances, or logistical factors [4]. Analysis of the United Network for Organ Sharing (UNOS) database identified 3,565 rejected donor hearts between January 2010 and September 2021 with recoverable valves [26].These data indicate a potential donor pool for PHT comprising organs unsuitable for whole-heart transplantation. Additional strategies, including domino transplantation using structurally intact valves from orthotopic heart transplant recipients and split-root techniques enabling a single donor heart to be utilized for multiple recipients, may further enhance organ stewardship [16, 27].

Recent experimental and clinical data suggest that PHT conduits can be preserved at 4°C for up to one week without compromising in vivo growth potential, in contrast to the approximately 6-hour procurement window typical for orthotopic heart transplantation [17, 28]. This extended tolerance to cold ischemia may facilitate broader geographic sharing, improved alignment of donor–recipient and more flexible surgical scheduling [22].

Surgical risk of PHT may be estimated based on homograft valve replacement and immunosuppressive complications are well characterized in orthotopic transplantation, however long-term outcome data specific to PHT remain limited [28, 29]. Partial heart transplantation is at an early stage of standardization and broader adoption. According to The Balliol Collaboration of surgeons and methodologists, the framework for the development and evaluation of surgical innovations can be collected as the IDEAL (idea, development, exploration, assessment, and long-term study)[30]. Currently, PHT is at the exploration stage, meaning collecting data about its benefits and utility in a wider population. It serves to reach consensus on indications and investigate possible complications and patient outcomes. Assessment, which means comparing PHT to conventional therapy and long-term observation focused on risk stratification are following stages of evaluation [22].

## CONCLUSION

Partial heart transplantation is a promising new treatment method for irreparable valve defects. Although current experience is mainly connected to congenital semilunar valves dysfunctions, in the future its applicability may be broader. By utilizing the adaptive capacity of viable tissue, PHT may decrease the frequency of reinterventions, improve long-term structural durability, and optimize outcomes in patients undergoing complex cardiovascular reconstruction. Moreover, clinical experience has shown that all these benefits may be achievable with minimal immunosuppression and, in exceptional cases, potentially without maintenance therapy.

Partial heart transplantation has the potential to expand the effective donor pool and increase the utility of available organs. Importantly, its application does not compromise hearts allocated for orthotopic transplantation. Strategies such as domino PHT, double-root PHT, and split-root PHT illustrate how these techniques may enhance donor efficiency while extending the therapeutic reach of cardiac transplantation.

Collectively, although current data remain preliminary, PHT represents a biologically plausible and surgically adaptable strategy that may bridge the gap between conventional prosthetic valve replacement and full-organ transplantation. Given the current single-center experience, multicenter collaboration and registry-based follow-up will be essential. Continued

translational research may support refinement of this approach, positioning PHT as a potential advancement in the congenital and structural heart surgery, particularly for patients with limited reconstructive options.

## DISCLOSURE

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During the preparation of this work, the authors used ChatGPT (OpenAI) to improve grammar

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