Partial Heart Transplant in Pediatric Congenital Valve Disease: A Systematic Review of Early Clinical and Translational Evidence

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Introduction: Valve replacement in neonates and infants with congenital heart disease. Current prostheses are static, unable to grow involving the children into a high - risk cycle repeated operations. Partial heart transplant (PHT), or living valve replacement, has emerged as a novel approach in which viable donor semilunar valves are transplanted under immunosuppression, allowing for growth and remodeling. This systematic review synthesizes the available clinical and translational evidence on PHT in pediatric patients.

Methods: A systematic search of PubMed, Embase, Cochrane, and Scopus (2000–2025) was performed using the terms "partial heart transplant," "living valve transplant," and "pediatric valve replacement." Eligible studies included human clinical reports, translational models, and trial protocols. Two reviewers independently screened and extracted data on patient characteristics, surgical technique, valve growth, function, survival, and complications. Risk of bias was assessed using ROBINS-I.

Results: The initial search identified 1,443 records across PubMed, Embase, Cochrane, and Scopus. After removal of duplicates and screening, 289 full-text articles were assessed for eligibility. Ultimately, 7 studies met inclusion criteria. These comprised one case report, one case series of 19 infants, one long-term follow-up of semilunar valves transplanted in infancy, one clinical trial protocol, one translational piglet model, one narrative review, and one surgical hypothesis paper.

The case series, representing the largest clinical experience to date, demonstrated that transplanted valves not only maintained function but also exhibited measurable growth over a median follow-up of 26 weeks. Annular diameters increased from 7 to 14 mm in the aortic position and from 9 to 17 mm in the pulmonary position, while leaflet length also expanded appropriately. No valve-related reinterventions were required, and tacrolimus-based immunosuppression was well tolerated. The single case report corroborated feasibility in a neonate with truncal valve dysfunction. Long-term follow-up of semilunar valves transplanted during infant heart transplantation confirmed sustained growth and excellent function at 10 years, supporting the biological plausibility of PHT durability. The translational piglet model reinforced feasibility by demonstrating valve viability and growth despite prolonged cold storage. The trial protocol and expert perspectives emphasized both the transformative potential of PHT and the challenges that remain, particularly regarding donor allocation, immunosuppression, and regulatory frameworks.

Conclusion: This systematic review demonstrates that PHT is feasible, safe, and uniquely capable of growth in pediatric patients with congenital valve disease, representing a paradigm shift in valve replacement. However, current evidence is limited to single-center experiences and small cohorts. Robust multicenter studies and long-term follow-up are essential to validate durability, optimize immunosuppression, and explore applicability in diverse healthcare settings.