Ex-vivo hemodynamic assessment of expanded Polytetrafluoroethylene Tri-Leaflet Pulmonary Valves

Objective: Handmade tri-leaflet valves using expanded polytetrafluoroethylene (ePTFE) have been considered a viable option for pulmonary valve replacement. While some studies have performed ex-vivo testing of adult sized valves, data on pediatric sized ePTFE valves is lacking. Our aim was to evaluate pediatric sized ePTFE valves and use their ovine counterparts as comparison to assess valve performance.

Methods: Tri-leaflet valves were constructed using 0.1mm ePTFE Gore-Tex membrane ranging from 14-20mm in size and were sutured into Gore-Tex conduits (1). Ovine pulmonary valves were harvested and ranged from 14-20mm. Valve sizes were linked to age group and testing conditions to simulate pulmonary valve conditions (2,3). Hydrodynamic testing was done using a pulse duplicator (HDTi-6000, BDC laboratories). Percent Regurgitation fraction (RF%), Closing volume (CV%), closing volume duration (CVd, sec), and Peak gradient (PMax, mmHg) were collected from Statys®.

Results: Within the ovine and ePTFE groups: 14mm,16mm, and 18mm valves had comparable RF%, CV%, CVd, and PMax respectively. All valves were able to sustain goal cardiac output. Intergroup comparisons: Ovine valves had significantly lower RF% than ePTFE valves (14mm:4vs9%; 16mm: 6vs14%; 18mm: 4vs10%; 20mm: 6vs14%; p<0.05, Figure). CVd was significantly lower for all ovine valves except 18mm (14mm:0.04vs0.06sec;16mm:0.05vs0.07sec; 20mm:0.07vs0.09sec; p<0.05 for all). PMax was not significantly different between groups (14mm:37vs24mmHg; 16mm: 27vs27mmHg; 18mm:26vs27mmHg; 20mm:13vs12mmHg).

Conclusion: ePTFE valves offer a viable option for pulmonary valve replacement given similar PMax as native tissue valves. However, ovine valves offer better metrics of leaflet function (RF%, CV%, and CVd) indicating further room for improvement in ePTFE valve design. Modifications in suturing technique, and thinner synthetic materials may help improve leaflet coaptation. Further work is needed to understand the interplay between material choices, leaflet design, and hemodynamic function, especially at smaller valve sizes.

References