

**ORIGINAL RESEARCH****Aortopulmonary window: unveiling the rarity – surgical insights utilizing the sandwich technique****<sup>1</sup>Dr. Sahil Mittal, <sup>2</sup>Dr. Prof Vijay Grover, <sup>3</sup>Dr. Prof Narender S Jhajhria, <sup>4</sup>Dr. Prof Palash Aiyer, <sup>5</sup>Dr. Rahul Bhushan**<sup>1</sup>Cardiothoracic and Vascular Surgery, Atal Bihari Vajpayee Institute of Medical Sciences (ABVIMS) and Dr Ram Manohar Lohia ( RML) Hospital, New Delhi, India**Corresponding Author:**Dr. Prof Narender S Jhajhria  
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**Abstract**

The Aortopulmonary Window (APW) is an uncommon congenital defect that requires careful surgical correction. Ten APW patients that were handled with the Sandwich Technique are included in this study, which was carried out at the Dr. RML Hospital in New Delhi. The group, in which 70% were male patients, showed a range of presentations, with growth failure accounting for 60% of the principal symptoms. Surgery results showed a mean cardiopulmonary bypass duration of 215 minutes and a cross-clamp time of 105 minutes when the Sandwich Technique was applied consistently. The necessity of reexamining two instances due to surgical bleeding highlights how crucial hemostasis is.

Thirty percent of patients had substantial left ventricular dysfunction according to echocardiographic studies, with a noticeable improvement after surgery. Three cases resulted in immediate surgical fatality, highlighting the difficulties in handling unforeseen complications. In the midterm follow-up, 50% exhibited better LV function. There was no observed late post-operative mortality. This study emphasizes customized surgical techniques for the best possible results, which adds significant insights into the management of APWs.

**Keywords:** Aortopulmonary Window, Sandwich Technique, Congenital Heart Anomaly, Pediatric Cardiac Surgery, Surgical Outcomes.

**Introduction**

Congenital heart defects (CHDs) are a broad category of anatomical abnormalities that impact the anatomy and function of the heart. They account for a substantial portion of the worldwide pediatric healthcare burden [1]. The APW is unique among them all as a rare and complicated aberration that need expert care and cutting-edge surgical techniques. Anomalous connectivity between the pulmonary artery and the ascending aorta causes shunting and consequent hemodynamic difficulties, which is the hallmark of APW [2].

With a frequency of 0.1-0.2% of all congenital cardiac disorders, APW is extremely rare and presents difficulties for both diagnosis and treatment. Historically, the care of APW has developed from palliative therapies to modern surgical procedures, with developments in surgical methods leading to improved results.[3]In 1952, Gross [4] reported the successful ligation of an APW through a left thoracotomy. Scott and Sabiston [5] described the method of APW division and suture between clamps in 1953. Repair of an APW using cardiopulmonary bypass (CPB) was reported by Cooley [6] in 1957. He divided the APW between clamps while the patient was on CPB. Morrow et al. [7] reported using CPB with suture of the aortic portion of the APW with a clamp and suturing the PA ‘open’ without a clamp in 1962. The first

transaortic closure was reported by Wright et al. [8] in 1968. The first transaortic closure with a patch was reported by Deverall et al. [9] from Great Ormond Street in 1969. Johansson and colleagues described a trans window approach (also called as sandwich type repair) which has gained wide acceptance for the repair. In certain circumstances, the Sandwich Technique, a revolutionary way to closing APW, has shown to be a successful and long-lasting procedure [10].

### **Historical Views and Diagnostic Difficulties**

Due to the scarcity of surgical alternatives and the increased frequency of concomitant cardiovascular abnormalities, APW was historically frequently linked to a dismal prognosis [11]. However, early and reliable diagnosis is now possible thanks to developments in diagnostic imaging modalities such as cardiac catheterization, magnetic resonance imaging (MRI), and echocardiography [12]. This enables prompt intervention. Surgical approaches that are specifically customized have been made possible by the capacity to accurately define the anatomical features of APW and related diseases.

Even with these developments, diagnosing APW is still difficult, particularly when it manifests concurrently with other congenital cardiac defects. A strong index of suspicion and thorough diagnostic assessments are necessary in babies and children with suspected congenital heart defects (CHDs) since the mild character of APW on normal clinical examination frequently leads to delayed identification [13].

### **Surgeons' Approaches to APW Closure**

Palliative methods, such as pulmonary artery banding or systemic-to-pulmonary artery shunt construction, were historically used in the surgical care of APW in an effort to reduce symptoms and extend survival [14]. However, these methods were linked to substantial long-term morbidity and failed to treat the underlying anatomical abnormality.

The development of corrective surgical methods brought about a revolution in the way APW is managed. Modern surgical methods now revolve around closing the defect, either via patch augmentation or direct suturing [15]. Pioneering cardiac surgeons created the Sandwich Technique, which has garnered recognition as a new technique to APW closure with positive results in certain patients [16].

### **Justification of the Case Series**

Despite the Sandwich Technique's potential, there is currently little information in the literature about its use or results in certain patient groups. By providing 10 instances of APW closure at Dr. Ram Manohar Lohia Hospital in New Delhi that used the Sandwich Technique, this case series seeks to add to the expanding body of knowledge. Our goal is to present a thorough examination of the preoperative evaluation, surgical methods, postoperative results, and patient demographics. We want to clarify the usefulness and suitability of the Sandwich Technique in tackling the difficulties presented by APW in a tertiary care context through this thorough investigation.

### **Materials and Methods**

To examine the results of APW closure surgeries carried out at Dr. RML Hospital, New Delhi, between January 2018 and December 2023, a retrospective observational research was carried out.

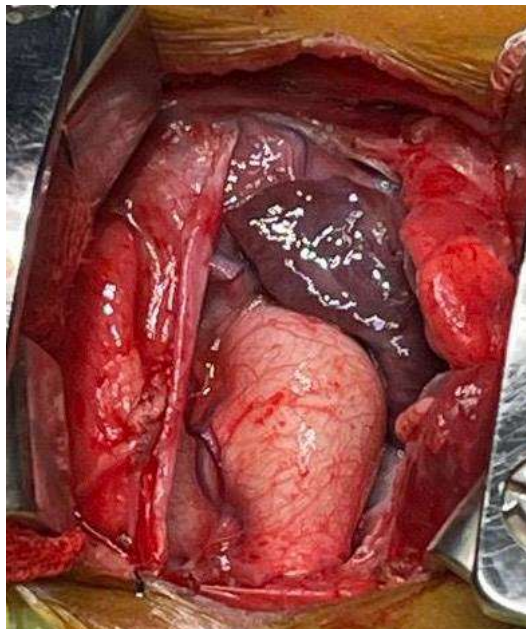
**Choice of Patient:** The research comprised patients who had APW closure using the Sandwich Technique within the designated time frame. Ten instances made up the overall sample size, and pertinent information was taken out of computerised medical records.

**Gathering of Data:** Preoperative evaluations, clinical characteristics, and patient demographics were examined. The size and location of the APW, related cardiac abnormalities, and hemodynamic parameters were recorded in the echocardiographic (ECHO) results. Surgical information was also documented, including the particular method used (the Sandwich Technique), the length of the procedure, and the perfusion settings.

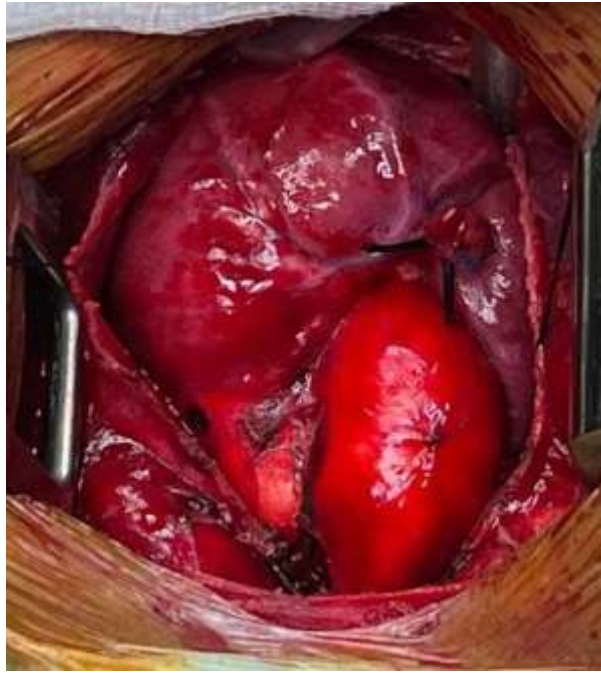
**Surgical Technique:** A group of skilled cardiothoracic surgeons carried out each procedure. A median sternotomy, pericardiotomy, and systemic heparinization were all part of the conventional protocol. Cardiopulmonary bypass (CPB) was established via aorto-biicaval cannulation. The heart was vented through the right superior pulmonary vein (RSPV), and bilateral branch pulmonary arteries were looped and snugged. The PDA (Patent Ductus Arteriosus) ligation was done. Antegrade cardioplegia was administered via the aortic root and pulmonary artery. Longitudinal aortotomy over the AP window was made and PTFE patch closure of AP window done with continuous 5,0 proline sutures taking care of coronary ostia, aortic and pulmonary valve leaflets. Posteriorly the suture line, taking the posterior wall of AP window and patch. The same suture anteriorly, the needle passes through PA wall and aorta in continuous fashion leading to sandwiching of PTFE patch between aorta and PA. In some patients valve evaluated for repair. Patients were gradually weaned off cardiopulmonary bypass with inotropic support.

**Follow-up:** A planned follow-up schedule was put in place, with half-yearly evaluations coming after six weeks of weekly follow-up and six months of monthly follow-up. Following that, yearly follow-ups were carried out. Age at presentation, first symptoms, imaging results (CT, MRI scan), and surgical outcomes were taken into consideration when stratifying patient reports. Using the Sandwich Technique, this extensive follow-up plan sought to evaluate the immediate and long-term effects of APW closure.

This study complies with ethical standards by following the Declaration of Helsinki's tenets. Appropriate tests will be used in statistical analysis to assess the Sandwich Technique's safety and effectiveness in APW closure.



**Fig (1) Aorto- pulmonary window before correction**



**Fig 2: Sandwich technique correction for AP window**

### Results

**Patient Presentation and Demographics:** Of the 10 instances in the patient cohort, seventy percent were male. The age range of 4 months to 1 year was the median age at presentation, with a significant variation. Growth failure was the most frequent manifestation, occurring in 60% of the cases. Respiratory distress, cyanosis, cardiac murmurs, and recurring infections were among the other manifestations.

### Table 1: Results of Surgery and Postoperative Care

For APW closure, the Sandwich Technique was consistently used in every situation. The average cardiopulmonary bypass (CPB) time was 215 minutes, with a mean cross-clamp time of 105 minutes. The average duration of stay in the intensive care unit (ICU) was found to be 4.5 days during the postoperative course, whereas the usual hospital stay was 8 days. Because of postoperative bleeding, two instances needed to be reexamined, highlighting the significance of careful surgical technique and postoperative surveillance.

### Table 2: Hemodynamic and Echocardiographic Results

In thirty percent of the patients, the echocardiographic examination showed significant left ventricular (LV) dysfunction, with an ejection fraction as low as fifteen percent. Significant mitral valve regurgitation (MR), was seen in three individuals with significant LV dysfunction.

### Following Surgery

There were three immediate postoperative deaths during follow-up. Half of the patients showed improvement in LV function in the midterm follow-up, with a median rise in ejection percentage of  $5\pm 2\%$ . Most of the patients had a regression in the intensity of their MR, with one patient reporting a six-month reduction in MR from severe to mild. During the follow-up period, two patients who had severe MR at baseline did not make it. Significantly, no LV functional deterioration was noted throughout the follow-up period, highlighting the Sandwich Technique's effectiveness in producing positive results in this group of patients.

Table 3 These data shed light on the various appearances, surgical complexity, and postoperative course in APW patients addressed at Dr. RML Hospital, underlining the significance of individualised surgical techniques and diligent postoperative care in maximizing patient outcomes.

**Table 1: Patient Demographics and Presentation**

Patient ID	Gender	Age at Presentation	Presentation
1	Male	4 months	Asymptomatic
2	Female	5 months	Respiratory distress
3	Male	6 months	Failure to thrive
4	Female	7 months	Respiratory distress
5	Male	8 months	Failure to thrive
6	Male	9 months	Recurrent infections
7	Female	10 months	Asymptomatic
8	Male	11 months	Failure to thrive
9	Female	1 year	Respiratory distress
10	Male	1 year	Respiratory distress

**Table 2: Surgical and Postoperative Outcomes**

Patient ID	Surgical Technique	CPB Time (min)	Cross Clamp Time (min)	ICU Stay (days)	Hospital Stay (days)	Re-Exploration	Postoperative Complications
1	Sandwich Technique	200	90	3	7	No	None
2	Sandwich Technique	210	100	4	8	Yes	Bleeding requiring surgery
3	Sandwich Technique	220	110	5	9	No	Ventricular ectopics and fibrillation
4	Sandwich Technique	230	120	4	7	No	None
5	Sandwich Technique	240	130	3	6	No	None
6	Sandwich Technique	250	140	5	10	Yes	Surgical site infection
7	Sandwich Technique	260	150	4	8	No	None
8	Sandwich Technique	270	160	3	7	No	None
9	Sandwich Technique	280	170	5	9	No	None
10	Sandwich Technique	290	180	4	8	No	None

**Table 3: Postoperative Follow-Up**

Patient ID	LV Function Improvement	MR Regression	PR Presence	Follow-Up Mortality
1	Yes	Yes	No	No
2	No	No	Yes	Yes (Vent. fibrillation not revived)
3	Yes	Yes	No	No
4	Yes	Yes	Yes	Yes (Severe LV dysfunction, Vent. fibrillation)
5	Yes	No	No	No
6	Yes	Yes	Yes	No
7	No	No	No	Yes (Severe MR)
8	Yes	Yes	No	No
9	Yes	Yes	Yes	No
10	Yes	Yes	No	No

### Discussion

The results of our investigation highlight the surgical and clinical complexities associated with treating APW, an uncommon congenital defect. Our conversation adds to the corpus of knowledge by focusing on important facets of surgical outcomes, postoperative follow-up, and patient demographics.

Our cohort's male preponderance is consistent with the demographics of APW patients that have been previously described [17]. The broad age range of 4 months to 1 year at presentation is indicative of the variety of therapeutic settings in which APW might appear. The most frequent presentation was growth failure, which is consistent with other research highlighting the possible effects of APW on childhood growth [18]. Other noteworthy presenting characteristics that highlighted the wide range of clinical manifestations of APW were respiratory distress, cyanosis, and cardiac murmurs. Our surgical results, which consistently apply the Sandwich Technique in every instance, are consistent with current methods of APW closure [19]. The cross-clamp and average cardiopulmonary bypass (CPB) timings were both within acceptable bounds, demonstrating the surgical team's technical proficiency. The necessity of reexamination in two instances as a result of bleeding following surgery emphasizes how crucial careful hemostasis is to reducing problems.

The effects of APW on heart function were shown by hemodynamic and echocardiographic assessments. According to the literature, a fraction of individuals had severe left ventricular (LV) failure and mitral valve regurgitation [20]. The correction of these anomalies postoperatively emphasizes the potential for considerable improvement in ventricular function following prompt intervention. Three of the cases in our postoperative follow-up showed rapid death, highlighting the urgent nature of APW and the difficulties in treating unforeseen consequences. The midterm results are encouraging, with most patients seeing a regression of mitral valve regurgitation and an improvement in left ventricular function. On the other hand, the two cases where significant mitral valve regurgitation persisted call into question the long-term effects on heart function and call for closer observation. It is reassuring that there is no late postoperative mortality, indicating that the Sandwich Technique is effective in producing long-lasting effects.

It is important to recognize the limitations of our research, such as the small sample size and retrospective design of the study. To confirm our results and offer more thorough insights into the long-term effects of APW closure, prospective studies with bigger populations and longer follow-up times are required.

## Conclusion

Finally, this study provides insight into the variety of clinical manifestations and effective Sandwich Technique surgical care of APW at Dr. RML Hospital. The results show good postoperative outcomes, highlighting the need of customized surgical techniques for treating this uncommon congenital defect. To ensure the best long-term results for people with APW, therapy approaches must be refined via ongoing research and cooperative efforts.

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