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Treatment sequencing for intracardiac masses in pregnancy: a 10-year retrospective cohort of 21 patients

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Treatment sequencing for intracardiac masses in pregnancy: a 10-year retrospective cohort of 21 patients

Running head: Intracardiac masses during pregnancy

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Abstract

Background: Intracardiac masses during pregnancy are rare, and treatment decisions must balance timely maternal surgery against fetal exposure to cardiopulmonary bypass (CPB). We evaluated a 10-year single-center experience, focusing on gestational-age-based treatment sequencing and maternal and pregnancy outcomes.

Methods: We retrospectively reviewed 21 women who underwent surgery for an intracardiac mass associated with pregnancy between April 2016 and July 2026. Strategies were classified by actual sequence: antenatal surgery with intended pregnancy continuation, delivery followed by cardiac surgery during the same anesthetic session, postpartum cardiac surgery, and concurrent early-pregnancy termination and surgery. Follow-up ended on 31 August 2026. Analyses were descriptive.

Results: Histopathology showed 19 myxomas, 1 hemangioma, and 1 lipoma. Antenatal surgery with intended pregnancy continuation was performed in 14 women at 15.8 ± 3.4 gestational weeks; delivery-prioritized management in 4 at 35–39 weeks; postpartum surgery in 2 at 49 and 57 days after delivery; and concurrent termination and surgery in 1 at 9 weeks. Mean CPB time was 55.9 ± 17.9 min; mean aortic cross-clamp time was 34.2 ± 16.1 min among 20 patients who underwent cross-clamping. There were 17 live births (81.0%), 3 terminations (14.3%), and 1 ongoing pregnancy (4.8%). No in-hospital maternal death or predefined major maternal perioperative complication occurred. Median maternal follow-up was 23.9 months (range, 1.3–124.1), with no death or tumor recurrence documented.

Conclusions: Individualized sequencing of cardiac surgery and delivery was associated with favorable observed outcomes in this selected surgical cohort. Antenatal resection may be considered before fetal maturity when maternal risk precludes waiting, whereas delivery before cardiac surgery may be appropriate near fetal maturity. These findings support multidisciplinary planning in experienced centers, while conclusions remain constrained by the observational design and small sample size.

Keywords: intracardiac mass; cardiac myxoma; pregnancy; cardiac surgery; cardiopulmonary bypass; treatment sequencing; pregnancy heart team

Background

Intracardiac masses during pregnancy are exceptionally rare, but their consequences may be immediate. Cardiac myxoma is the most common benign primary cardiac tumor, yet it can cause valvular obstruction, embolism, arrhythmia, or sudden hemodynamic deterioration [1-3]. Pregnancy may amplify these risks through increased blood volume, cardiac output and heart rate, as well as a state of hypercoagulability.

The therapeutic dilemma differs from that in nonpregnant patients. Prompt resection is generally considered for a mobile, symptomatic, or obstructive myxoma-like mass because observation carries obstructive and embolic risk. During pregnancy, however, cardiac surgery may expose the fetus to cardiopulmonary bypass (CPB), uteroplacental hypoperfusion, hypoxia, uterine activity, and prematurity. The clinical question is therefore not only whether the mass should be removed, but how maternal cardiac surgery should be sequenced relative to gestational age, fetal maturity, and delivery.

Published experience with intracardiac masses in pregnancy consists largely of case reports, small series, and reviews [4-10]. Yuan's review assembled 51 patients with cardiac myxoma from 44 publications [4], while original series have provided detailed accounts of only a few patients [5,6]. Broader studies of cardiac surgery during pregnancy include heterogeneous lesions and procedures, which complicates their application to localized mass resection [11-17]. An earlier report from our institution described 9 pregnant patients undergoing cardiac surgery, including 3 with atrial myxoma [18]. A focused cohort can clarify how the sequence of delivery and resection determines fetal exposure to CPB and how pregnancy outcomes differ across the observed treatment pathways.

We report a 10-year single-center surgical experience in 21 patients whose pregnancies were complicated by intracardiac masses. We aimed to describe the sequence of cardiac surgery and delivery, the resulting pattern of fetal CPB exposure, and maternal and pregnancy outcomes.

Methods

Study design and participants

This retrospective, single-center cohort study was conducted at Beijing Anzhen Hospital, Capital Medical University. We consecutively included patients with an intracardiac mass during pregnancy who underwent surgical treatment between April 2016 and July 2026. Eligibility required confirmation of the mass by echocardiography, operative findings, and/or histopathology, together with available clinical data on surgical timing and pregnancy status. The cohort was defined by receipt of surgery and did not include a nonsurgical comparison group. The study complied with the Declaration of Helsinki and was approved by the Institutional Review Board of Beijing Anzhen Hospital, Capital Medical University (approval No. 2026202x). The requirement for written informed consent was waived because de-identified retrospective data were used. The manuscript was prepared in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology recommendations [19]. Because pregnancy was an eligibility criterion, all patients were women, and a sex-based subgroup analysis was not applicable.

Management strategies

After diagnosis, patients underwent prompt cardiovascular and obstetric assessment. Cardiac surgery was recommended when the mass carried clinically relevant obstructive, embolic, or short-term deterioration risk. Treatment sequence was individualized by a pregnancy heart team according to maternal risk, gestational age, fetal maturity, expected operative complexity, perfusion requirements, and patient preference. Figure 1 summarizes the management framework derived from this experience.

Four management groups were defined from the actual treatment sequence: antenatal cardiac surgery with intended pregnancy continuation; delivery-prioritized management, comprising delivery

followed by cardiac surgery during the same anesthetic session; cardiac surgery in a separate admission after delivery; and concurrent early-pregnancy termination and cardiac surgery. Group assignment reflected the initial management intention and sequence, so a subsequent termination did not reclassify a patient out of the antenatal continuation group. Postpartum intervals were recorded in days after delivery. First-, second-, and third-trimester surgery was classified as before 14 weeks, from 14 to less than 28 weeks, and at or after 28 weeks, respectively.

Operative management and outcome definitions

All patients were managed by a multidisciplinary pregnancy heart team comprising specialists in cardiac surgery, obstetrics, anesthesiology, perfusion, intensive care, and echocardiography, with neonatology involvement when required. Echocardiography was used to define the location, size, attachment, and mobility of the mass, as well as valvular involvement and ventricular function; these findings informed both urgency and operative planning. Maximum recorded mass diameter was extracted from echocardiographic or operative measurements documented in the clinical dataset.

When CPB was required during an ongoing pregnancy, fetal-protective principles were applied whenever feasible: avoidance of deep hypothermia, maintenance of adequate flow and perfusion pressure, stable maternal oxygenation and acid-base status, minimization of CPB and aortic cross-clamp times, and fetal or uterine monitoring appropriate for gestational age [11-15].

Predefined major maternal perioperative complications included maternal death, stroke, myocardial infarction, low cardiac output syndrome requiring mechanical circulatory support, reoperation for bleeding, renal failure requiring renal replacement therapy, respiratory failure requiring prolonged mechanical ventilation or tracheostomy, severe infection or sepsis, and unplanned reoperation. Pregnancy outcomes were classified as live birth, ongoing pregnancy, or termination. Spontaneous intrauterine fetal death and neonatal complications were recorded separately. Terminations were described according to the documented reason.

Follow-up

Follow-up was obtained from clinic visits, hospital records, and telephone contact through 31 August 2026. Maternal follow-up focused on survival, tumor recurrence, major cardiovascular events, and reintervention, and its duration was calculated from cardiac surgery to the census date. Perioperative outcomes covered the index admission. Pregnancy outcomes and available child health information were obtained from clinical records and caregiver reports.

Statistical analysis

Continuous variables are reported as mean ± standard deviation and as median with range. Categorical variables are reported as counts and percentages. Follow-up duration in months was calculated as elapsed days divided by 30.4375. The study included all eligible surgically treated patients during the study period. An exact two-sided 95% confidence interval for in-hospital maternal mortality was calculated using the Clopper–Pearson method. Group summaries were descriptive; no formal hypothesis testing or multivariable modeling was performed because of the small sample size and nonrandom selection of treatment strategies.

Use of generative AI

ChatGPT assisted with language editing. All analyses, data interpretation, references, and final manuscript content were verified and approved by the authors, who take full responsibility for the work.

Results

Baseline characteristics

The cohort included 21 patients (Table 1). Mean age was 31.5 ± 4.6 years (median, 30; range, 23-42), and 7 patients (33.3%) were aged ≥35 years. All 21 pregnancies were singleton pregnancies. Mean

gestational age at diagnosis was 16.2 ± 6.9 weeks (median, 14.0; range, 8.0-37.0). Ten patients were diagnosed in the first trimester, 9 in the second trimester, and 2 in the third trimester.

The mass was located in the left atrium in 17 patients (81.0%), the right atrium in 3 (14.3%), and the right ventricle in 1 (4.8%). Maximum recorded mass diameter was available for all 21 patients and averaged 34.5 ± 14.0 mm (median, 32.0; range, 14–60). Histopathology identified 19 myxomas (90.5%), 1 hemangioma (4.8%), and 1 lipoma (4.8%).

Management strategies

All 21 patients underwent cardiac surgery (Table 2 and Figure 2). Fourteen (66.7%) underwent antenatal surgery with intended pregnancy continuation at a mean gestational age of 15.8 ± 3.4 weeks (median, 15.0; range, 12–24). Four procedures occurred in the first trimester and 10 in the second trimester. Pregnancy outcomes by management strategy are shown in Table 2.

Four patients (19.0%) underwent delivery-prioritized management at 35, 36, 37, and 39 gestational weeks, and all had live births. In each case, cesarean delivery was completed before sternotomy and CPB during the same anesthetic session; thus, none of the 4 fetuses was exposed to CPB. Two patients (9.5%) were diagnosed in the first trimester, completed term cesarean delivery, and underwent cardiac surgery 49 and 57 days postpartum; both had live births. One patient (4.8%) requested early pregnancy termination, which was performed concurrently with cardiac surgery at 9.0 gestational weeks.

By actual timing of cardiac surgery, 5 patients underwent surgery in the first trimester, 10 in the second trimester, 4 in the third trimester, and 2 postpartum. Pregnancy outcomes according to treatment sequence are summarized in Figure 2.

The 3 pregnancy terminations comprised 2 procedures undertaken at the patients' request and 1 performed after detection of fetal hydrocephalus. One patient requested elective early-pregnancy

termination concurrent with cardiac surgery, and another requested elective termination after antenatal cardiac surgery. In the third patient, fetal hydrocephalus was detected 4 weeks after antenatal cardiac surgery and the pregnancy was subsequently terminated. The clinical record did not establish the cause of the fetal anomaly.

Operative data

Across all 21 patients, mean CPB time was 55.9 ± 17.9 min (median, 55.0; range, 27–94) (Table 3). Among the 20 patients who underwent aortic cross-clamping, mean cross-clamp time was 34.2 ± 16.1 min (median, 32.0; range, 11–69); 1 right-sided mass was excised without aortic cross-clamping. Mean ICU stay was 22.0 ± 13.4 h (median, 21.2; range, 1.8–60.4). In 19 patients managed with intraoperative cooling, the mean temperature was 34 °C; 2 patients underwent CPB without cooling. Perfusion pressure was maintained at ≥70 mmHg in all 21 patients. No predefined major perioperative maternal complication occurred. One patient required thoracic drainage for postoperative pleural effusion. Operative data by management strategy are presented descriptively in Table 3.

Maternal and pregnancy outcomes

All 21 patients survived the index hospitalization. In-hospital maternal mortality was 0/21 (exact 95% confidence interval, 0–16.1%). Maternal follow-up through 31 August 2026 had a median duration of 23.9 months (range, 1.3–124.1). No maternal death or recurrence of the intracardiac mass was documented during follow-up. Follow-up duration by management strategy is shown in Table 3.

Of the 21 pregnancies, 17 resulted in live births (81.0%), 3 were terminated (14.3%), and 1 was ongoing at the census date (4.8%). Among the 17 live births, 13 were delivered by cesarean section and 4 vaginally. No spontaneous intrauterine fetal death was documented. Two infants were preterm

and underwent brief pediatric observation, and 1 born before maternal postpartum cardiac surgery had transient hypoglycemia and situs inversus with mirror-image dextrocardia.

Discussion

This 10-year cohort describes how cardiac surgeons and pregnancy heart teams coordinated mass resection with pregnancy continuation or delivery in 21 patients. All mothers survived the index hospitalization, and 17 pregnancies resulted in live birth. The clinical contribution lies in distinguishing sequences that expose an ongoing pregnancy to CPB from those in which delivery precedes bypass. These observations suggest that timely maternal treatment and pregnancy preservation can be compatible in selected patients, while emphasizing that gestational age must be considered together with mass-related maternal risk.

The literature against which these results should be interpreted remains small. Yuan reviewed 44 publications and 51 pregnant patients with cardiac myxoma, reporting no maternal deaths, voluntary pregnancy termination in approximately 14% of cases, and event-free survival in 20 of 26 neonates in the delivery group [4]. John et al. reported 2 successful resections during pregnancy and emphasized individualized multidisciplinary management [5]. A recent case series described 3 pregnant women with left atrial myxoma, and other reports have described second-trimester resection, resection at 30 gestational weeks followed by term cesarean delivery, and delivery-prioritized resection [6-10]. Compared with these reports, the present cohort provides a larger single-center surgical experience focused on treatment sequence, although it remains observational.

In our practice, when a clinically significant mass was diagnosed before fetal maturity and maternal risk argued against prolonged observation, cardiac surgery was generally prioritized and pregnancy continuation was intended whenever feasible. This approach was used in 14 patients at a mean of 15.8 ± 3.4 gestational weeks, and 11 subsequently had live births. The experience supports

consideration of antenatal resection when waiting would leave the mother exposed to clinically significant obstruction or embolism.

When intervention was undertaken near fetal maturity, delivery-prioritized management provided a different pathway. All 4 patients in this group underwent cesarean delivery before sternotomy and CPB during the same anesthetic session at 35–39 gestational weeks, and all had live births. This sequence avoided direct fetal CPB exposure while allowing definitive maternal treatment. The 2 postpartum cardiac surgery cases illustrate a third pathway. Both were diagnosed in the first trimester and completed term delivery before cardiac surgery after declining antenatal resection. Deferral requires careful selection and close surveillance because the untreated mass remains a potential maternal hazard.

Based on this experience, a mobile, symptomatic, or obstructive myxoma-like mass diagnosed before fetal maturity should prompt early surgical discussion. When maternal risk precludes waiting, antenatal resection can be considered with a plan for maintaining uteroplacental perfusion. Near fetal maturity, delivery before cardiac surgery may be appropriate when obstetric and maternal conditions permit. Postpartum resection after antenatal diagnosis should be reserved for selected patients following discussion of the risks of continued observation. Pregnancy termination should be reported separately from spontaneous fetal death because the reasons and clinical implications differ. Figure 1 presents this practical framework for multidisciplinary assessment.

The favorable outcomes in this series may partly reflect the operative characteristics of localized intracardiac mass resection. Mean CPB time was 55.9 min, mean aortic cross-clamp time among clamped cases was 34.2 min, and no circulatory arrest was required. Perfusion management sought to maintain adequate flow and pressure, stable oxygenation and acid-base balance, and the shortest feasible bypass and cross-clamp exposure [11-15]. The reported mean temperature was 34 °C among patients managed with cooling, and perfusion pressure was maintained at ≥70 mmHg. These

observations describe the operative conditions in this cohort; they do not establish an optimal perfusion target.

Nevertheless, CPB during pregnancy remains a potential source of fetal risk. Reviews and broader surgical cohorts report adverse fetal and neonatal outcomes despite successful maternal treatment [11,16,17]. A 2025 meta-analysis including heterogeneous cardiac surgical conditions reported pooled estimates of 4.9% for maternal mortality and 26.5% for fetal loss/neonatal mortality [16]. An urgent cardiac surgery series also associated longer CPB and cross-clamp exposure with fetal or neonatal loss [20]. These studies include heterogeneous lesions and operations, so their event rates are not directly comparable with localized mass resection. The present experience supports a narrower clinical principle: when maternal surgery cannot be deferred, focused resection with careful perfusion management may permit pregnancy continuation in selected patients treated at experienced centers.

Our previous work on pregnancy-associated aortic dissection showed that maternal and fetal outcomes are strongly influenced by the type of cardiovascular emergency, gestational age, and the sequence of delivery and surgery [21-23]. The same clinical framework applies to pregnancy-associated intracardiac masses, but the operative requirements differ. In aortic dissection, complex repair and hypothermic circulatory arrest may be unavoidable; in intracardiac mass excision, the operation is often anatomically focused, and the main decision is whether maternal risk justifies fetal CPB exposure before maturity. This distinction offers a plausible explanation for the feasibility of pregnancy continuation after antenatal resection in the present cohort, although the study cannot establish which operative factors determined the outcomes.

Limitations

This study is limited by its retrospective, single-center design and the small sample size inherent to a rare disease in pregnancy. The cohort included only surgically treated patients and had no

conservatively managed comparison group. Treatment selection reflected maternal risk, gestational age, fetal maturity, and patient preference; relationships among timing strategy, operative exposure, and outcome are therefore descriptive rather than causal. The small cohort also limits precision for rare adverse outcomes. The findings mainly reflect management of benign intracardiac masses, predominantly myxomas, and may not apply to malignant tumors or more complex cardiovascular operations. Multicenter collaboration would help assess the reproducibility of these management approaches.

Conclusions

Pregnancy-associated intracardiac masses that are clinically significant should prompt early evaluation by a multidisciplinary pregnancy heart team. In this 10-year single-center cohort, individualized sequencing of cardiac surgery and delivery was associated with favorable observed maternal and pregnancy outcomes. For masses with relevant obstructive or embolic risk before fetal maturity, antenatal resection with careful CPB management may be considered in experienced centers. Near fetal maturity, delivery before cardiac surgery can avoid direct fetal CPB exposure while allowing definitive maternal treatment. These conclusions remain bounded by the observational design and small sample size.

List of abbreviations

CPB, cardiopulmonary bypass; GA, gestational age; ICU, intensive care unit; STROBE, Strengthening the Reporting of Observational Studies in Epidemiology.

Declarations

Ethics approval and consent to participate

This retrospective study was approved by the Institutional Review Board of Beijing Anzhen Hospital, Capital Medical University (approval No. 2026202x). The requirement for written informed consent

was waived because de-identified retrospective data were used. The study complied with the Declaration of Helsinki.

Consent for publication

Not applicable. This study used de-identified retrospective data and does not contain individual patient details, images, or videos that could identify any person.

Availability of data and materials

The de-identified datasets used and/or analyzed during the current study are not publicly available because they contain sensitive individual-level clinical information and are subject to institutional data-sharing restrictions. They may be available from the corresponding author on reasonable request and with institutional approval.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

YY: Conceptualization, Data curation, Investigation, Methodology, Formal analysis, Writing – original draft, Writing – review and editing. QW: Data curation, Investigation, Validation, Writing –

review and editing. ZQ: Investigation, Resources, Validation, Writing – review and editing. YG: Investigation, Resources, Validation, Writing – review and editing. CL: Investigation, Resources, Validation, Writing – review and editing. HH: Investigation, Resources, Validation, Writing – review and editing. JZ: Conceptualization, Methodology, Supervision, Project administration, Writing – review and editing. All authors read and approved the final manuscript.

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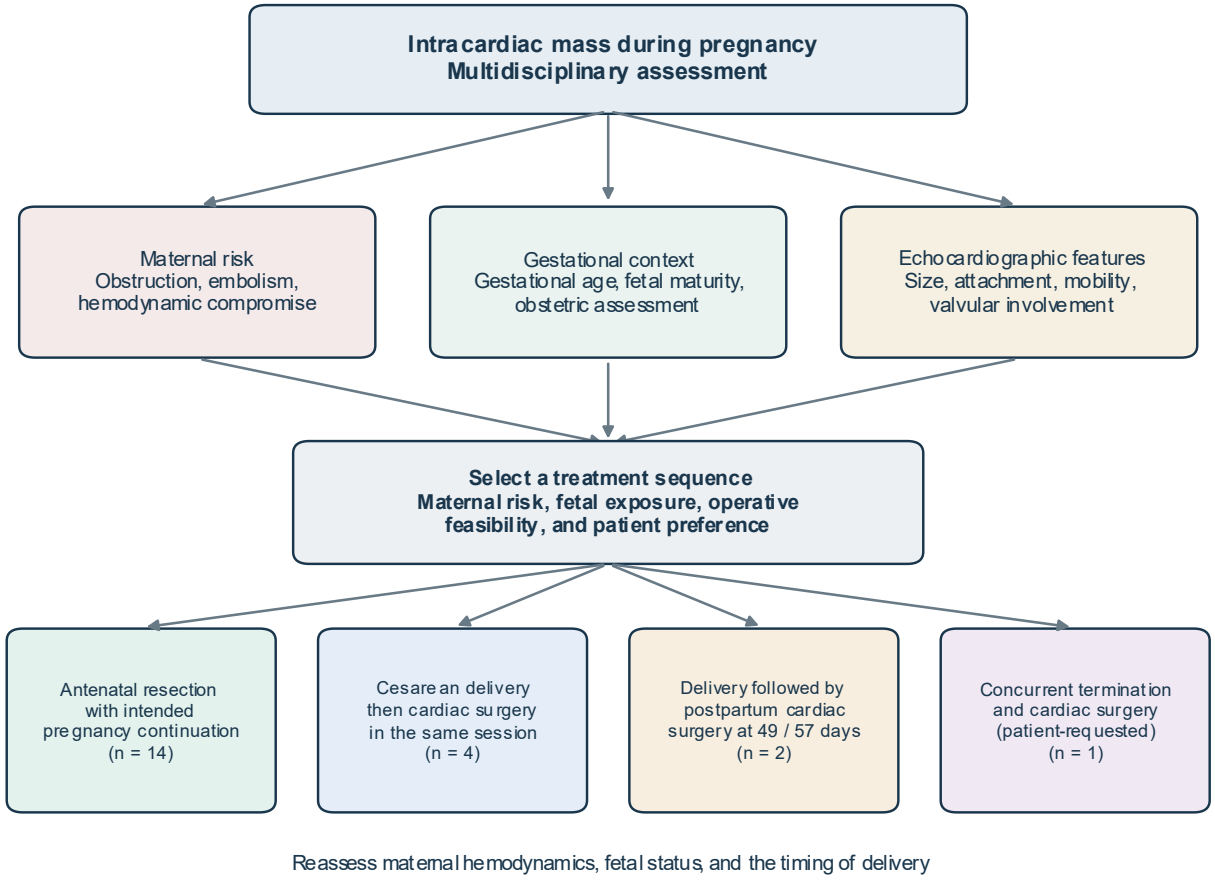
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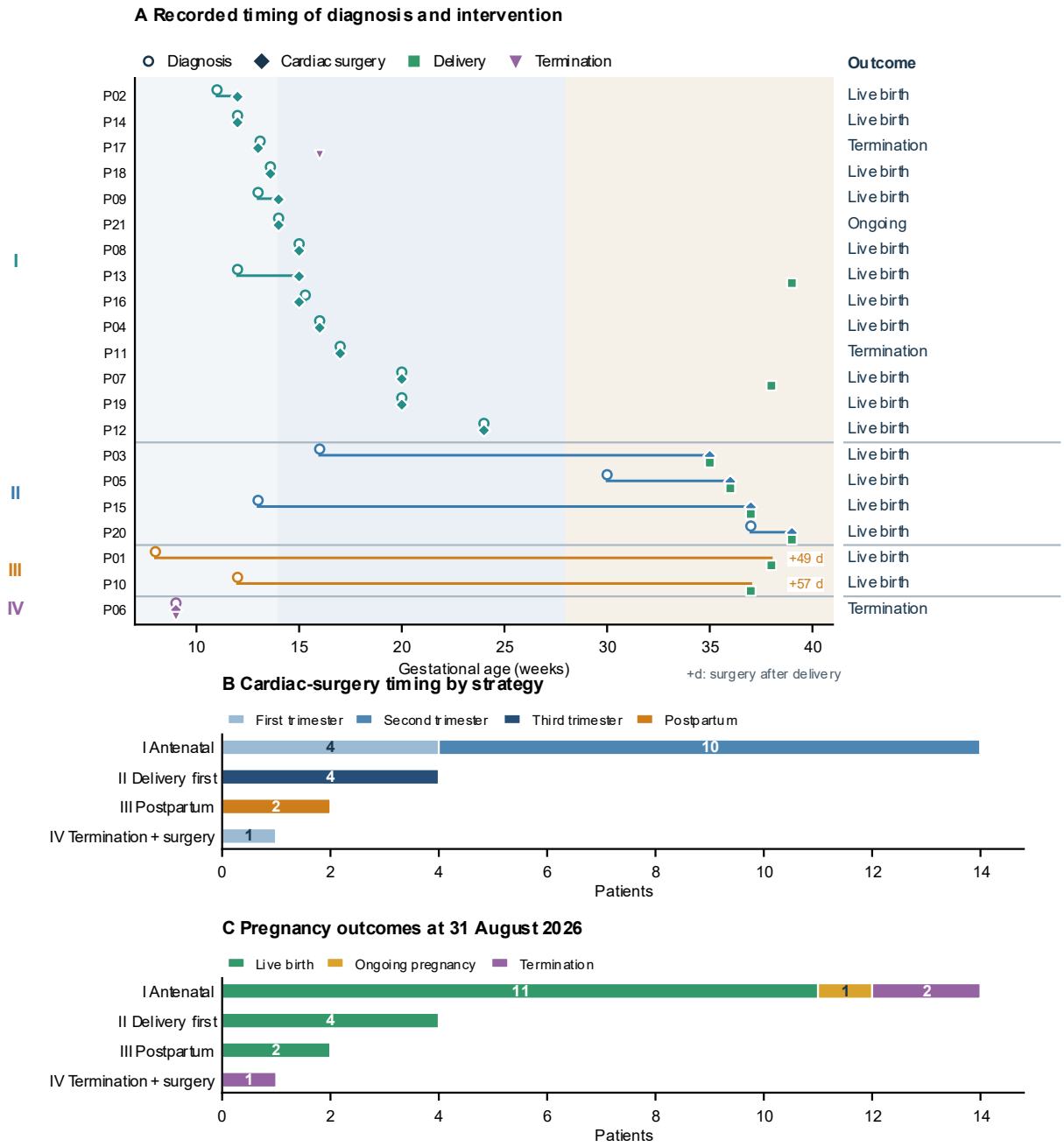
Figures

Figure 1. Management framework for intracardiac masses in pregnancy.



Multidisciplinary assessment combines maternal risk, gestational age and fetal maturity, echocardiographic findings, and patient preference to select a treatment sequence. The four pathways describe the sequences observed in this cohort. Antenatal continuation denotes the intention at surgery. This experience-derived framework has not been prospectively validated. CPB, cardiopulmonary bypass.

Figure 2. Surgical timing and pregnancy outcomes.



(A) Recorded gestational ages at diagnosis, cardiac surgery, and delivery or termination, grouped by treatment strategy. Marker shapes distinguish events; small vertical offsets separate events recorded in the same week and do not indicate elapsed time. Records have differing gestational-age precision, so order within a rounded week should not be inferred. The shaded regions denote trimesters. Postpartum cardiac surgery is annotated in days after delivery. Pregnancy outcome is shown in a separate column; delivery or termination markers are plotted only when gestational age was recorded. (B) Cardiac-surgery timing by strategy. (C) Pregnancy outcomes through 31 August 2026. Counts represent patients; each patient contributes once to each bar-chart panel. CPB, cardiopulmonary bypass.

Table 1. Baseline clinical, imaging, and pathological characteristics.

Variable	Value
Patients, n	21
Age, years	31.5 ± 4.6; median 30, range 23-42
Age ≥35 years	7 (33.3%)
Gestational age at diagnosis, weeks	16.2 ± 6.9; median 14.0, range 8.0-37.0
Diagnosis trimester	First, 10; second, 9; third, 2
Singleton pregnancy	21 (100%)
Tumor location	Left atrium, 17; right atrium, 3; right ventricle, 1
Maximum recorded mass diameter, mm	34.5 ± 14.0; median 32.0, range 14-60
Histopathology	Myxoma, 19; hemangioma, 1; lipoma, 1

Values are presented as mean ± standard deviation, median (range), or n (%), as appropriate. Recorded mass diameter was taken from echocardiography or the operative record. All variables were available for 21 patients.

Table 2. Actual treatment sequence and pregnancy outcome.

Management strategy	Patients, n (%)	Actual treatment sequence	Pregnancy outcome
Antenatal surgery with intended continuation	14 (66.7%)	Cardiac surgery at 15.8 ± 3.4 weeks; first trimester, 4; second trimester, 10	Live birth, 11; ongoing, 1; termination, 2
Delivery-prioritized management	4 (19.0%)	Cesarean delivery, then cardiac surgery in the same anesthetic session at 35, 36, 37, and 39 weeks	Live birth, 4
Postpartum cardiac surgery	2 (9.5%)	Cesarean delivery at 38/37 weeks; cardiac surgery 49/57 days postpartum	Live birth, 2
Concurrent termination and cardiac surgery	1 (4.8%)	Patient-requested termination and cardiac surgery at 9 weeks	Termination, 1
Total	21 (100%)	First-trimester surgery, 5; second trimester, 10; third trimester, 4; postpartum, 2	Live birth, 17; ongoing, 1; termination, 3

Pregnancy outcomes were assessed on 31 August 2026. Antenatal continuation describes the intention at cardiac surgery, regardless of the eventual pregnancy outcome.

Table 3. Operative exposure, perfusion management, and maternal outcomes by treatment strategy.

Variable	Entire cohort	Antenatal continuation	Delivery-prioritized	Postpartum surgery	Termination + surgery
Patients, n	21	14	4	2	1
CPB time, min	55.9 ± 17.9	51.1 ± 15.0	63.8 ± 23.0	78.0 ± 15.6	47.0
Aortic cross-clamp time, min	34.2 ± 16.1 (n=20)	31.1 ± 13.7 (n=13)	37.8 ± 21.7	52.5 ± 17.7	23.0
No aortic cross-clamping	1	1	0	0	0
ICU stay, h	22.0 ± 13.4; median 21.2 (1.8–60.4)	17.9 ± 7.3	35.0 ± 22.4	31.6 ± 12.9	9.7
Reported mean temperature, °C (19 cooled patients)	34	—	—	—	—
No cooling, n	2	2	0	0	0
Perfusion pressure ≥70 mmHg, n	21	14	4	2	1
In-hospital maternal death	0	0	0	0	0
Predefined major perioperative complication	0	0	0	0	0
Maternal follow-up, months, median (range)	23.9 (1.3–124.1)	17.7 (1.3–73.0)	41.1 (1.5–124.1)	58.0 (30.1–85.9)	31.6

Values are presented as mean ± standard deviation unless otherwise indicated. Follow-up is reported as median (range) in months from cardiac surgery to 31 August 2026. Data by management strategy are descriptive; no formal between-group hypothesis testing was performed. The reported mean intraoperative temperature refers to 19 patients managed with cooling; 2 patients underwent CPB without cooling. Subgroup-specific intraoperative temperature data were not available; these entries are indicated by em dashes (—). CPB, cardiopulmonary bypass; ICU, intensive care unit.