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ANTICOAGULATION MANAGEMENT IN PREGNANT WOMEN UNDERGOING VALVULAR HEART SURGERY: A RETROSPECTIVE OBSERVATIONAL STUDY

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ABSTRACT

Background: Pregnant women who require valvular heart surgery represent one of the highest-risk groups in cardio-obstetric practice. Anticoagulation is central to their care, both because many present with prosthetic valve thrombosis driven by inadequate anticoagulation and because cardiopulmonary bypass (CPB) and mechanical valve implantation impose competing maternal thrombotic and fetal haemorrhagic and teratogenic risks. We describe anticoagulation strategies and maternal-fetal outcomes in a single-centre cohort.
Materials and Methods: We retrospectively reviewed 22 pregnant women who underwent valvular heart surgery under CPB. Antenatal, peri-procedural and post-operative anticoagulation regimens, operative variables and maternal and fetal/neonatal outcomes were analysed using descriptive statistics.
Results: Mean maternal age was 28.5 years (range 22–35) and mean gestational age at surgery was 21.3 weeks (range 10–30); 9 women (40.9%) were in NYHA class IV. Twelve women (54.5%) had native rheumatic valve disease and 10 (45.5%) had a pre-existing prosthesis, of whom 9 presented with mechanical prosthetic valve thrombosis. All anticoagulated women were subtherapeutic at presentation, and 7 of the 9 valve-thrombosis cases (77.8%) had been managed with heparin-based regimens. Intravenous unfractionated heparin was used for peri-procedural bridging in all patients. Maternal survival was 90.9% (2 deaths, 9.1%), both following emergency redo surgery for obstructive valve thrombosis. Live birth occurred in 15 pregnancies (68.2%) and total fetal loss in 7 (31.8%).
Conclusion: In this cohort, prosthetic valve thrombosis necessitating surgery clustered among women on heparin-based or subtherapeutic regimens, reinforcing the importance of adequate, monitored anticoagulation and individualised, multidisciplinary planning. Maternal and fetal outcomes were consistent with contemporary literature on cardiac surgery during pregnancy.
Keywords: Pregnancy; valvular heart surgery; anticoagulation; mechanical heart valve; prosthetic valve thrombosis; cardiopulmonary bypass; warfarin; low-molecular-weight heparin.

INTRODUCTION

Cardiac disease complicates roughly 1–4% of pregnancies and is among the leading causes of indirect maternal mortality worldwide. Valvular heart disease forms a large share of this burden, particularly in low- and middle-income regions where rheumatic heart disease remains prevalent and where young women frequently reach reproductive age with significant native valve lesions or with previously implanted prosthetic valves.[1] The physiological adaptations of pregnancy—a 30–50% rise in cardiac output, expanded plasma volume, tachycardia and a pronounced hypercoagulable state—can unmask or decompensate valvular lesions and sharply increase the risk of thromboembolic complications.[1,2]

In settings such as ours, where rheumatic heart disease remains endemic, this problem is encountered disproportionately. Young women may undergo valve replacement in adolescence and subsequently conceive while dependent on lifelong anticoagulation, or may first present in pregnancy with previously undiagnosed, haemodynamically

critical rheumatic mitral or aortic disease. Access to specialised cardio-obstetric services, reliable INR monitoring and structured self-management can be limited, and the warfarin requirement in rheumatic mitral prostheses frequently exceeds the 5 mg/day threshold below which fetal risk is lower. These realities make the choice and supervision of anticoagulation especially consequential, and they shape both the spectrum of disease that reaches the operating theatre and the outcomes that follow. Understanding local patterns is therefore a prerequisite for rational, context-appropriate protocols.[1,2,14]

Anticoagulation sits at the centre of management for these women, yet it is uniquely difficult during pregnancy. Women with mechanical prosthetic valves require uninterrupted therapeutic anticoagulation, but every available agent carries a trade-off. Vitamin K antagonists (VKAs) provide the most reliable protection against valve thrombosis but cross the placenta and are associated with dose-dependent embryopathy, fetal loss and intracranial haemorrhage.[3,5,6] Unfractionated heparin (UFH) and low-molecular-weight heparin (LMWH) do not cross the placenta and avoid these fetal effects, but when used as fixed-dose or inadequately monitored substitutes they are associated with a substantially higher incidence of maternal valve thrombosis and thromboembolism.[2,4,5,7] The result is a clinical dilemma in which the safest regimen for the fetus is the least safe for the mother, and vice versa.

When medical therapy fails—most commonly because of obstructive prosthetic valve thrombosis, critical native stenosis with pulmonary oedema, or severe regurgitation with refractory heart failure—valvular heart surgery becomes necessary during pregnancy. Cardiac surgery on CPB carries acceptable contemporary maternal mortality but persistently high fetal loss, attributed largely to utero-placental hypoperfusion, non-pulsatile flow, hypothermia and embolic phenomena.[8-11] In this setting anticoagulation must be managed across three distinct phases: the antenatal regimen that the woman arrives on (and which often explains why she needs surgery), the intraoperative anticoagulation required for CPB, and the post-operative regimen following valve repair or replacement.[1,12,13]

Despite clear guideline frameworks from the European Society of Cardiology and the American College of Cardiology/American Heart Association, the evidence base rests on registries, systematic reviews and single-centre series rather than randomised trials, and practice varies widely.[1,4,15] We therefore reviewed our experience with pregnant women undergoing valvular heart surgery, with the specific aim of describing the anticoagulation regimens used before, during and after surgery and relating them to maternal and fetal-neonatal outcomes.

MATERIAL AND METHODS

Study design and setting. This was a retrospective, single-centre observational study conducted at a tertiary-care teaching hospital with a combined cardio-obstetric and cardiac surgical service. Consecutive pregnant women who underwent valvular heart surgery under CPB were identified from operative and obstetric records. The study was conducted after approval by the Institutional Ethics Committee, and the requirement for individual informed consent was waived for this retrospective analysis of de-identified records; this approval should be confirmed and referenced by the authors.

Participants. Women were eligible if they were pregnant at the time of valvular heart surgery requiring CPB, whether for native valve disease or for dysfunction of a previously implanted prosthesis. Procedures included mitral, aortic and double valve replacement, valve repair and redo valve replacement for prosthetic valve thrombosis or structural degeneration. Twenty-two women met the criteria and constituted the study cohort.

Anticoagulation protocol. Antenatal regimens were recorded as documented at presentation and classified as: no anticoagulant (native valve, no independent indication); warfarin at ≤5 mg/day; LMWH used as first-trimester substitution followed by a VKA; LMWH throughout; or UFH throughout. Therapeutic targets followed prevailing guidance—an international normalised ratio (INR) of 2.5–3.5 for VKA in mechanical mitral prostheses and anti-factor-Xa–guided dosing for LMWH where used.[1,15] Peri-procedurally, women were converted to intravenous UFH, which was discontinued before bypass and reversed with protamine after weaning from CPB. Intraoperative anticoagulation for CPB used heparin to a target activated clotting time per institutional protocol. Post-operatively, anticoagulation was reintroduced with a UFH bridge transitioning to warfarin for mechanical prostheses, while antiplatelet therapy alone was used after valve repair or bioprosthetic replacement.

Surgical and CPB technique. Operations were performed through median sternotomy with aorto-bicaval or aorto-right atrial cannulation. Where the fetus was considered viable, a multidisciplinary decision was taken to perform caesarean delivery immediately before bypass. CPB was conducted preferentially under normothermia or mild hypothermia, with the highest feasible pump flow and perfusion pressure and, when available, continuous fetal heart-rate monitoring, in keeping with measures reported to improve fetal tolerance of bypass.[8,9,13]

Data collection and outcomes. Extracted variables included maternal age, gravidity and parity, gestational age at surgery, NYHA functional class, valvular lesion and aetiology, prosthesis status, antenatal/ peri-operative/post-operative anticoagulation, pre-operative INR, CPB and aortic

cross-clamp times, temperature strategy and whether concomitant caesarean was performed. The principal maternal outcomes were in-hospital/30-day mortality, prosthetic valve thrombosis, systemic thromboembolism, major bleeding requiring intervention and low cardiac output syndrome. Fetal-neonatal outcomes were classified as live birth (term or preterm), spontaneous abortion or intrauterine fetal death.

Statistical analysis. Continuous variables are summarised as means with ranges and categorical variables as counts and percentages. Given the descriptive, hypothesis-generating nature of the study and the small sample, no formal inferential testing was undertaken; subgroup patterns are reported descriptively.

RESULTS

Baseline characteristics. Twenty-two pregnant women underwent valvular heart surgery under CPB during the study period [Table 1]. Mean maternal age was 28.5 years (range 22–35) and mean gestational age at surgery was 21.3 weeks (range 10–30); 8 women (36.4%) were primigravid. Thirteen women (59.1%) were in NYHA class III and 9 (40.9%) in class IV at presentation. Twelve women (54.5%) had native rheumatic valve disease—predominantly mitral stenosis with or without regurgitation—and 10 (45.5%) had a pre-existing prosthesis (9 mechanical, 1 bioprosthetic). Among the 9 women with a mechanical prosthesis, all presented with prosthetic valve thrombosis.

Anticoagulation patterns. Anticoagulation use is summarised in [Table 2]. Twelve women (54.5%) with native valve disease had no antenatal anticoagulant indication. Of the 10 women receiving antenatal anticoagulation, 3 (13.6% of the cohort) were on warfarin ≤5 mg/day, 3 on first-trimester LMWH substitution, 3 on LMWH throughout and 1 on UFH throughout. Notably, every anticoagulated woman was subtherapeutic at presentation, with pre-operative INR values ranging from 1.3 to 1.9 in those on VKA and documented subtherapeutic or unmonitored dosing in those on heparin. Intravenous UFH was used for peri-procedural bridging in all 22 women (100%). Post-operatively, 20 women (90.9%) received a UFH bridge transitioning to warfarin, while 2 (9.1%)—one after mitral repair and one after bioprosthetic replacement—received antiplatelet therapy alone.

Operative details. Surgical and CPB characteristics are shown in [Table 3]. The commonest operations were redo valve replacement for prosthetic dysfunction or thrombosis (10 women, 45.5%) and native mitral valve replacement (8 women, 36.4%); 2 women underwent aortic valve replacement, 1 mitral valve repair and 1 double valve replacement. Three operations (13.6%) were performed as emergencies for obstructive valve thrombosis. Mean CPB time was 91.2 minutes (range 68–120) and mean aortic cross-clamp time was 61.5 minutes (range 41–88). Bypass was conducted under normothermia in 10 women (45.5%) and mild hypothermia in 12 (54.5%). Concomitant caesarean delivery immediately before CPB was performed in 4 women (18.2%) with viable pregnancies.

Maternal outcomes. Maternal and fetal-neonatal outcomes are presented in [Table 4]. Twenty women (90.9%) survived to discharge and 2 (9.1%) died; both deaths followed emergency redo surgery for obstructive mechanical valve thrombosis, complicated by low cardiac output and multiorgan failure. A valve-thrombosis–related complication was recorded in 6 women (27.3%), systemic thromboembolism in 1 (4.5%), major bleeding requiring intervention in 3 (13.6%) and low cardiac output syndrome in 2 (9.1%); 12 women (54.5%) had no maternal complication. Of the 9 women presenting with mechanical valve thrombosis, 7 (77.8%) had been managed with heparin-based regimens and the remaining 2 with low-dose VKA at subtherapeutic INR or with poor compliance.

Fetal-neonatal outcomes. A live birth occurred in 15 pregnancies (68.2%), comprising 5 term (22.7%) and 10 preterm (45.5%) deliveries; preterm birth therefore accounted for 10 of 15 live births (66.7%). Total fetal loss occurred in 7 pregnancies (31.8%)—5 spontaneous abortions (22.7%) and 2 intrauterine fetal deaths (9.1%). Fetal loss was concentrated among women operated at earlier gestational ages and among emergency operations for valve thrombosis. None of the 4 fetuses delivered by caesarean immediately before bypass were lost. Among the 15 live births, delivery was by caesarean section in 13 (86.7%) and vaginal in 2 (13.3%).

Table 1: Baseline demographic and clinical characteristics (N = 22)

Characteristic	Value
Maternal age, years, mean (range)	28.5 (22–35)
Gestational age at surgery, weeks, mean (range)	21.3 (10–30)
Primigravida, n (%)	8 (36.4)
NYHA class III, n (%)	13 (59.1)
NYHA class IV, n (%)	9 (40.9)
Native rheumatic valve disease, n (%)	12 (54.5)
Pre-existing prosthesis (9 mechanical, 1 bioprosthetic), n (%)	10 (45.5)
Predominant lesion – native mitral stenosis ± MR, n (%)	7 (31.8)
Predominant lesion – mechanical prosthetic valve thrombosis, n (%)	9 (40.9)
Predominant lesion – other native / bioprosthetic, n (%)	6 (27.3)

MR, mitral regurgitation; NYHA, New York Heart Association. Values are simulated/illustrative.

Table 2: Anticoagulation management before, during and after surgery (N = 22)

Anticoagulation variable	n (%)
Antenatal: no anticoagulant (native valve, no indication)	12 (54.5)
Antenatal: warfarin ≤5 mg/day	3 (13.6)
Antenatal: LMWH, first-trimester substitution then VKA	3 (13.6)
Antenatal: LMWH throughout	3 (13.6)
Antenatal: UFH throughout	1 (4.5)
Subtherapeutic anticoagulation at presentation (of 10 treated)	10 (100)
Peri-procedural bridge with intravenous UFH	22 (100)
Post-operative UFH bridge then warfarin	20 (90.9)
Post-operative antiplatelet therapy only	2 (9.1)

LMWH, low-molecular-weight heparin; UFH, unfractionated heparin; VKA, vitamin K antagonist. Values are simulated/illustrative.

Table 3: Operative and cardiopulmonary bypass characteristics (N = 22)

Operative variable	Value
Redo valve replacement (prosthetic dysfunction/thrombosis), n (%)	10 (45.5)
Native mitral valve replacement, n (%)	8 (36.4)
Aortic valve replacement, n (%)	2 (9.1)
Mitral valve repair, n (%)	1 (4.5)
Double valve replacement, n (%)	1 (4.5)
Emergency operation, n (%)	3 (13.6)
CPB time, minutes, mean (range)	91.2 (68–120)
Aortic cross-clamp time, minutes, mean (range)	61.5 (41–88)
Normothermic bypass, n (%)	10 (45.5)
Mild hypothermic bypass, n (%)	12 (54.5)
Concomitant caesarean before CPB, n (%)	4 (18.2)

CPB, cardiopulmonary bypass. Values are simulated/illustrative.

Table 4: Maternal and fetal–neonatal outcomes (N = 22)

Outcome	n (%)
Maternal survival	20 (90.9)
Maternal death	2 (9.1)
Valve-thrombosis–related complication	6 (27.3)
Systemic thromboembolism	1 (4.5)
Major bleeding requiring intervention	3 (13.6)
Low cardiac output syndrome	2 (9.1)
No maternal complication	12 (54.5)
Live birth (term 5, preterm 10)	15 (68.2)
Spontaneous abortion	5 (22.7)
Intrauterine fetal death	2 (9.1)
Total fetal loss	7 (31.8)

Some women had more than one maternal complication, so categories are not mutually exclusive. Values are simulated/illustrative.

DISCUSSION

In this cohort of 22 pregnant women undergoing valvular heart surgery on CPB, three findings stand out. First, prosthetic valve thrombosis was the single commonest indication for operation and clustered overwhelmingly among women managed with heparin-based or subtherapeutic anticoagulation: 7 of the 9 thrombosis cases (77.8%) occurred on LMWH or UFH regimens, and every anticoagulated woman in the cohort was subtherapeutic at presentation. Second, maternal survival was high (90.9%), with both deaths occurring after emergency redo surgery for obstructive valve thrombosis. Third, fetal loss remained substantial (31.8%) despite acceptable maternal outcomes, mirroring the well-recognised dissociation between maternal and fetal risk in cardiac surgery during pregnancy.

These observations align closely with the existing literature. The seminal systematic review by Chan and colleagues established that VKA use throughout pregnancy minimises valve thrombosis but carries embryopathy in approximately 6% of live births, whereas substituting heparin reduces fetal risk at the cost of higher maternal thromboembolism.[3] The ROPAC registry subsequently reported mechanical valve thrombosis in 4.7% of pregnancies with a mechanical valve, with first-trimester events concentrated among women who had been switched to heparin—precisely the pattern reproduced in our series.[2] Meta-analyses by D'Souza and by Steinberg confirmed that VKAs yield the highest live-birth rates relative to other maternal endpoints only when balanced against their fetal toxicity, and that fixed-dose LMWH in particular is associated with catastrophic valve failure.[4,5,7] Our finding that thrombosis clustered among heparin-treated and subtherapeutic women is therefore not novel but is clinically instructive: it underscores that the mode of anticoagulation matters less than whether therapeutic intensity is actually achieved and monitored.

The dose-dependence of warfarin's fetal effects, demonstrated by Vitale and colleagues, has reshaped contemporary practice: women requiring ≤5 mg/day may reasonably continue a VKA across pregnancy, whereas higher requirements prompt consideration of first-trimester heparin.[6] Both the 2018 ESC and 2014 AHA/ACC guidelines endorse this individualised, dose-stratified approach, recommend anti-factor-Xa monitoring when LMWH is used, and emphasise management by a multidisciplinary pregnancy heart team.[1,15] The experience reported here reinforces the practical corollary that suboptimal monitoring—labile INR, unmonitored anti-Xa levels, or fixed-dose heparin—converts a theoretically fetus-sparing strategy into a maternal catastrophe requiring high-risk surgery.

It bears emphasis that no anticoagulation strategy in this population is free of risk; the decision balances competing harms rather than eliminating them. Pooled analyses indicate that VKAs throughout pregnancy carry the lowest maternal thromboembolic risk but the highest rate of fetal loss and embryopathy, whereas sequential or heparin-based regimens invert that balance.[4,5] In our series the predominance of heparin exposure among the thrombosis cases illustrates the maternal cost of prioritising fetal safety without securing therapeutic intensity. Contemporary opinion increasingly favours continuation of a low-dose VKA where the daily requirement is modest, reserving first-trimester heparin for women needing higher doses, and counselling every woman explicitly about the residual fetal risk that accompanies even optimal warfarin management.[5,6] These trade-offs are best made transparent during shared decision-making, ideally before conception, so that the woman's own valuation of maternal versus fetal risk guides the regimen selected.

With respect to surgery itself, our maternal mortality of 9.1% sits within the range described across decades of reports. John and colleagues, reviewing the Mayo Clinic experience, found cardiac surgery could be performed with relative safety in pregnancy but that emergency operations conferred substantially higher maternal mortality—consistent with both of our deaths occurring during emergency redo surgery.[8] Earlier reviews by Pomini and by Weiss reported maternal mortality around 3–6% and embryofetal mortality of roughly 20–30%, while the more recent meta-analysis by Jha and colleagues found an 11% maternal mortality and a 33% fetal loss rate.[9-11] Our fetal loss of 31.8% closely matches the latter figure. The persistent fetal toll of CPB reflects utero-placental hypoperfusion, non-pulsatile flow and the systemic inflammatory response, and is worsened by earlier gestational age and emergency surgery.[8,9,12]

Several technical measures are reported to mitigate fetal risk: normothermic or only mildly hypothermic bypass, high pump flow and perfusion pressure, the shortest feasible bypass time, continuous fetal monitoring, and—where the fetus is viable—caesarean delivery immediately before bypass.[8,9,12,13] In our cohort these principles were applied: bypass was normothermic or mildly hypothermic in all cases, and all 4 fetuses delivered by caesarean before CPB survived, supporting the strategy of delivering a viable fetus before exposing it to bypass. The predominance of rheumatic native valve disease in our series reflects the epidemiology of valvular disease among young women in our region and is consistent with registry data showing higher rheumatic representation and a heavier prosthesis-related burden in emerging compared with developed countries.[2,14]

The peri-operative and post-operative phases of anticoagulation deserve particular attention, because they are where iatrogenic risk is most readily introduced. In our cohort all women were converted to intravenous UFH before surgery, exploiting its short half-life and reversibility with protamine to permit controlled cessation before bypass and prompt restoration of haemostasis afterwards. The timing of post-operative resumption is a recognised tension: reintroducing heparin too early after cardiac surgery risks tamponade and surgical-site bleeding, whereas delay exposes a fresh mechanical prosthesis to thrombosis. The three episodes of major bleeding observed here (13.6%) all arose in the early post-operative window during heparin bridging, underscoring the narrow therapeutic margin. A pragmatic approach—delaying therapeutic heparin until surgical haemostasis is secure, overlapping with warfarin until the INR is therapeutic, and monitoring closely—balances these hazards, but the optimal protocol remains undefined and was not standardised across our patients.[1,8,15]

Taken together, these findings argue for conceptualising anticoagulation in the surgical pregnant patient as a continuum spanning three phases rather than as a single antenatal choice. The antenatal regimen frequently determines whether surgery becomes necessary at all; the intraoperative phase must reconcile the heparinisation demanded by CPB with the bleeding risk of a gravid, vascularly engorged patient; and the post-operative phase must protect a new prosthesis while a fresh surgical bed heals.[1,8] Decisions at each phase are interdependent and are best made by a multidisciplinary pregnancy heart team comprising cardiology, cardiac surgery, obstetrics, anaesthesia and neonatology, working to a documented plan agreed in advance.[1,9] Where rheumatic disease is endemic, embedding such teams within referral pathways and improving access to reliable INR and anti-factor-Xa monitoring may do more to prevent valve thrombosis than any change in agent selection, since our data implicate inadequate monitoring rather than the choice of drug per se.[2,14]

The fetal and neonatal implications extend beyond the binary of survival and loss. Two-thirds of the live births in our series were preterm, reflecting both the severity of maternal disease and the frequent need for expedited or operative delivery around the time of surgery. Preterm birth carries its own burden of

respiratory, neurological and developmental morbidity, so that a surviving neonate is not necessarily an unaffected one, and longer-term follow-up is essential to characterise true outcomes.[9,14] The observation that all four fetuses delivered by caesarean immediately before bypass survived supports a deliberate, gestational-age-stratified delivery strategy: below viability the focus is on optimising bypass conduct to protect the fetus in utero, whereas at or beyond viability planned delivery before CPB may convert an otherwise unsalvageable fetal situation into a survivable neonatal one.[8,12,13] Such decisions presuppose neonatal intensive-care availability and antenatal corticosteroid administration whenever time permits. The timing of surgery within pregnancy is itself a determinant of outcome that interacts with anticoagulation. Where the clinical situation permits, elective valve surgery is best deferred to the second trimester, after organogenesis is complete but before the uterus is large enough to impede venous return and bypass flow.[10,12] In practice, however, the commonest indication in our series—obstructive prosthetic valve thrombosis—rarely allows such deferral, and the emergency operations clustered the worst maternal and fetal outcomes. This reinforces the principle that the most effective way to improve surgical results is to prevent the haemodynamic crisis that mandates urgent surgery, which returns the emphasis to adequate antenatal anticoagulation and surveillance.[8,10] When emergency surgery is unavoidable, rapid assembly of the multidisciplinary team and pre-emptive planning for fetal delivery offer the best prospect of salvaging both lives.[9,13]

Limitations: This analysis is retrospective, single-centre and small, and—as flagged at the outset—the dataset presented here is simulated and intended as a structural template; the figures must be replaced with verified institutional data before any conclusions are drawn. Selection and referral bias are inevitable, follow-up was limited to the peripartum period, and confounding by indication is substantial, since the sickest women and the most subtherapeutic anticoagulation regimens are precisely those that precipitate surgery. The descriptive design and small sample preclude formal inference, and INR and anti-Xa data were not available continuously. Prospective, multicentre, registry-based study with standardised anticoagulation protocols and longer-term neurodevelopmental follow-up of offspring is needed to refine practice.

CONCLUSION

Among pregnant women undergoing valvular heart surgery, the need for operation—particularly for prosthetic valve thrombosis—was strongly associated with heparin-based or subtherapeutic anticoagulation, and the highest maternal mortality occurred in emergency operations for obstructive thrombosis. Maternal survival was favourable but fetal loss remained high, consistent with the wider literature on cardiac surgery in pregnancy. These patterns support adequate, closely monitored anticoagulation tailored to warfarin dose, intravenous UFH bridging around surgery, fetus-protective bypass conduct, delivery of the viable fetus before CPB, and management throughout by a multidisciplinary pregnancy heart team.

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