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INVITED REVIEW ARTICLE

Systemic Lupus Erythematosus and Pregnancy: A Brief Review

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Abstract
Systemic lupus erythematosus is a chronic multisystemic autoimmune disease that predominantly affects young women of childbearing age group. There is a complex immunologic interplay during pregnancy in patients with systemic lupus erythematosus. The pregnancy has direct impact on the disease where an increased rate of flares is noted, and lupus leads to increased risk of hypertensive diseases of pregnancy, preterm birth as well as miscarriages, particularly those with antiphospholipid antibodies. Neonates born to patients with lupus are at increased risk of neonatal lupus as well as heart block if born to patients with positive SSA/SSB. Despite the increased risk of morbidity, recent data suggest improved outcomes in pregnant patients with lupus. A multidisciplinary approach with careful monitoring of pregnancy and lupus could reduce adverse outcomes in these patients. This requires careful pregnancy planning, defining the clinical and serologic involvement of lupus, careful monitoring the patient for adverse pregnancy outcome as well as lupus flares and comprehensive understanding of the drugs that can be safely used in pregnancy. Fetuses should be carefully monitored for heart and neonates for neonatal lupus. Hydroxychloroquine, azathioprine and corticosteroids can be used during pregnancy and may reduce the risk of adverse outcomes. Similarly, appropriate therapy needs to be instituted for hypertensive diseases in pregnancy. Anticoagulant therapy may be necessary for patients with antiphospholipid syndrome.

Keywords Systemic lupus erythematosus · Pregnancy · Antiphospholipid syndrome

Introduction

Systemic lupus erythematosus (SLE) is an multisystemic autoimmune disease which causes mucocutaneous manifestations, hematologic manifestations, renal and neurologic diseases aside from being associated with immunologic phenomena like a positive ANA, low complements, positive double stranded DNA, extractable nuclear antigen and antiphospholipid antibodies [1, 2]. These are the core components of Systemic Lupus International Collaborating Clinics (SLICC) classification criteria which are depicted in Table 1 [3]. A large case series of 1366 Indian lupus patients have demonstrated a high occurrence of renal and neurologic involvement. The prevalence of serologic abnormalities including prevalence of antiphospholipid antibodies was similar to that reported by other countries but had low prevalence of clinical antiphospholipid syndrome [4].

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Table 1 Systemic lupus international collaborating clinics classification criteria

Clinical criteria	Immunologic criteria
Acute cutaneous lupus	Antinuclear antibody
Chronic cutaneous lupus	Anti-DNA antibody
Oral or nasal ulcers	Anti-Smith antibody
Non-scarring alopecia	Antiphospholipid antibody
Arthritis	Low complements (C3, C4 or CH50)
Serositis	Direct Coombs' test in the absence of hemolytic anemia
Renal disease	
Neurologic disease	
Hemolytic anemia	
Leucopenia	
Thrombocytopenia	

Requirements: ≥4 criteria (at least 1 clinical and 1 laboratory criteria) or biopsy-proven lupus nephritis with positive ANA or anti-DNA

Epidemiologically, the prevalence of SLE in India is approximately 3.2 per 100,000 of the population [5]. The majority of lupus patients are females with men comprising only 4–18% of all patients. The mean age of disease onset in women is approximately 30, about 10 years earlier than that for men. It should be noted that lupus can affect prepubescent as well as postmenopausal women, latter often termed as "late onset lupus" [6, 7]. Given that the disease frequently affects women in reproductive age group, it is critical for both obstetricians and rheumatologists, to understand the interplay between the disease, the drugs used to treat the disease and the pregnancy state.

Most patients with systemic lupus erythematosus can have a successful pregnancy, but there is an increased maternal and fetal mortality and this high-risk situation imposes increased healthcare and economic burden [8, 9]. Hence, careful pregnancy planning, antenatal, perinatal and postnatal care along with careful monitoring of the newborn are needed to reduce this burden.

What Does Lupus do to the Pregnancy

There has been significant decline in the rates of pregnancy losses in patients with lupus. More than 80–90% of pregnancies result in live birth which has improved over time but continues to remain lower than the general population [8, 10, 11].

(1) Preterm birth The most common complication of lupus is preterm birth which can occur in approximately one-third of the patients [12, 13]. Risk factors for preterm delivery include increased disease activity (both clinical and serologic as reflected by increasing dsDNA titers and low complements), high prednisone use (which can cause premature rupture of membranes), hypertension and thyroid disease. A recent study by Clowse et al. [14] also noted elevated serum uric acid to be associated with preterm births. This in part may be reflective the hypertensive diseases in pregnancy, like preeclampsia and eclampsia, which are associated with elevated uric acid.

(2) Preeclampsia Patients with lupus have a high rate of adverse pregnancy outcomes including preeclampsia, pregnancy losses and intrauterine growth retardation as compared to general population. Preeclampsia has been noted to occur at about 2–3 times the rate in lupus patients as compared to those without lupus [15, 16]. Risk factors for preeclampsia include lupus and lupus nephritis-specific disease markers, presence of antiphosphoslipid antibodies, thrombocytopenia and reduced complement levels in addition to other predisposing factors like advanced maternal age, history of hypertensive disease in previous pregnancy, preexisting hypertension, diabetes and obesity [16, 17]. Preeclampsia poses a unique clinical challenge given the close resemblance between preeclampsia and lupus nephritis, both of which are characterized by deteriorating renal function, increasing proteinuria, hypertension and reduced platelet counts. Serum uric acid, which is elevated in preeclampsia, can help differentiate between the two. Kuc et al. [18] conducted a systematic review which evaluated 7 serum biomarkers (ADAM12, fβ-hCG, Inhibin A, Activin

Table 2 Definition of antiphospholipid syndrome

A. Clinical criteria:
1. Vascular thrombosis: one or more arterial, venous or small vessel thrombosis
2. Pregnancy morbidity
One or more fetal death at or beyond 10 weeks of gestation
One or more premature births before 34th week of gestation because of eclampsia or placental insufficiency
Three or more embryonic losses before 10 weeks of gestation
B. Laboratory criteria (titers should be positive on 2 occasions at least 12 weeks apart)
1. Lupus anticoagulant
2. Anticardiolipin antibody IgG or IgM at a medium or high titer (>40)
3. B2 glycoprotein antibody IgG or IgM in medium or high titer (over 99th percentile)
Diagnosis requires at least one of the two clinical and one of the three laboratory criteria

A, PP13, PIGF, PAPP-A) and Doppler ultrasound of the uterine vasculature in the first trimester to predict preeclampsia. However, delivery of the baby is sometimes the only definitive answer.

(3) Pregnancy loss and antiphospholipid antibodies Antiphospholipid antibodies occur in one-fourth to one-half patients with lupus; these rates are similar in Indian population as compared to the rest of the world [4, 5]. Notably, these antibodies can occur without coexistent lupus (primary antiphospholipid syndrome) and may still pose the same risk to the pregnancy. The presence of antiphospholipid antibodies (aPL) without antiphospholipid syndrome (APS; defined in Table 2) increases the risk of adverse pregnancy outcomes like intrauterine growth retardation and preterm births [19]. Antiphospholipid syndrome itself is associated with pregnancy losses. The pathophysiology is thought to be related to thrombosis in uterine vasculature as well as binding of antibodies to trophoblasts, endothelial and neuronal cells [20]. Some authors have even associated these antibodies to movement disorders.

What Does Pregnancy do to Lupus

Most studies agree that there is an increased risk of flare of lupus associated with pregnancy. Most of the studies show the increased flare rates by 25–65% [15, 21]. A recent study completed by the investigators at Johns Hopkins University using Hopkins Lupus Cohort showed approximately 60% increased rate of flare in pregnant women as compared to non-pregnant patients; flares were defined as change in "Physician Global Assessment" of more than 1 from previous visit. The study also noted a significant effect modification with hydroxychloroquine, adjusted odds ratio for nonusers of hydroxychloroquine being 1.83 versus that of users being 1.26 [21].

It has been demonstrated that disease activity at the time of conception and the presence of lupus nephritis were significant predictors of flare during pregnancy [22–24]. Conversely, patients with 6 months of inactive disease at the time of conception and the absence of active renal disease significantly reduce the odds of flare during the pregnancy [25, 26]. It is also generally accepted that the flares of lupus during pregnancy are mild, generally involving the musculoskeletal, integumentary or hematologic systems [27]. Finally, flares of lupus may appear very similar to the pregnant state itself. For example, arthralgias, fatigue, lethargy and shortness of breath are common to both. Similarly, both are associated with cytopenias, mildly elevated inflammatory markers, etc.

Finally, it should be noted that de novo flares of lupus nephritis are rare during pregnancy, noted to be $<2\%$ as compared to approximately 11% among those with history of renal disease (including those who were in remission). Buyon et al. [28] also noted the low C4 at baseline was also associated with high risk of de novo flares.

What Does Lupus do to the Newborn

Neonatal lupus Neonatal lupus is a temporary condition which lasts approximately 6 to 8 months after birth. Pathologically, it is due to passively acquire autoimmunity from maternal autoantibodies that cross the placenta and hence last until the maternal autoantibodies last in fetal circulation [29, 30]. It is usually characterized by a red-raised rash along with hematologic and hepatic abnormalities. It is seen in about 10% of patients who usually have positive SSA (anti-Ro) and SSB (anti-La) antibodies. In its most severe form, it can be associated with congenital heart block and hydrops fetalis but is also associated with cardiac conduction defects, structural abnormalities, cardiomyopathy and congestive heart failure [31].

Complete Heart Block This is the most feared complication of neonatal lupus. It occurs in about 2% of newborns whose mothers have SSA or SSB antibodies. However, the recurrence rates are between 16 and 20% among those with a prior pregnancy resulting in a neonate with complete heart block. Complete heart block results in fetal mortality in 20% of the cases. Among the survivors, 70% require pacemaker insertion [32].

Conduction abnormalities can be detected as early as the second trimester of pregnancy starting at 16 weeks of gestation. However, there have reports of complete heart block even in the postpartum phase. Often lower degrees of conduction delays precede the development of complete heart block, although rapid development of complete heart block has been described [33].

Treatment Considerations (Fig. 1)

Before pregnancy and pregnancy planning Women should discuss their desire to become pregnant with the caring medical team early and, ideally, should be planned. Women should be advised to avoid pregnancy if they have one of the high-risk comorbidities associated with lupus. This includes severe pulmonary hypertension, severe restrictive lung disease, advanced renal failure, advanced congestive heart failure, prior pregnancy with severe preeclampsia, eclampsia or HELLP syndrome (hemolysis, elevated liver enzymes, low platelets) and recent stroke [34–37]. Women should plan pregnancy during a period of minimal disease activity or quiescence. As discussed previously, disease activity at the time of conception is the strongest predictor of adverse outcomes. Appropriate contraception should be used to ensure pregnancy planning. This would generally require extensive discussion with the caring gynecologist. While

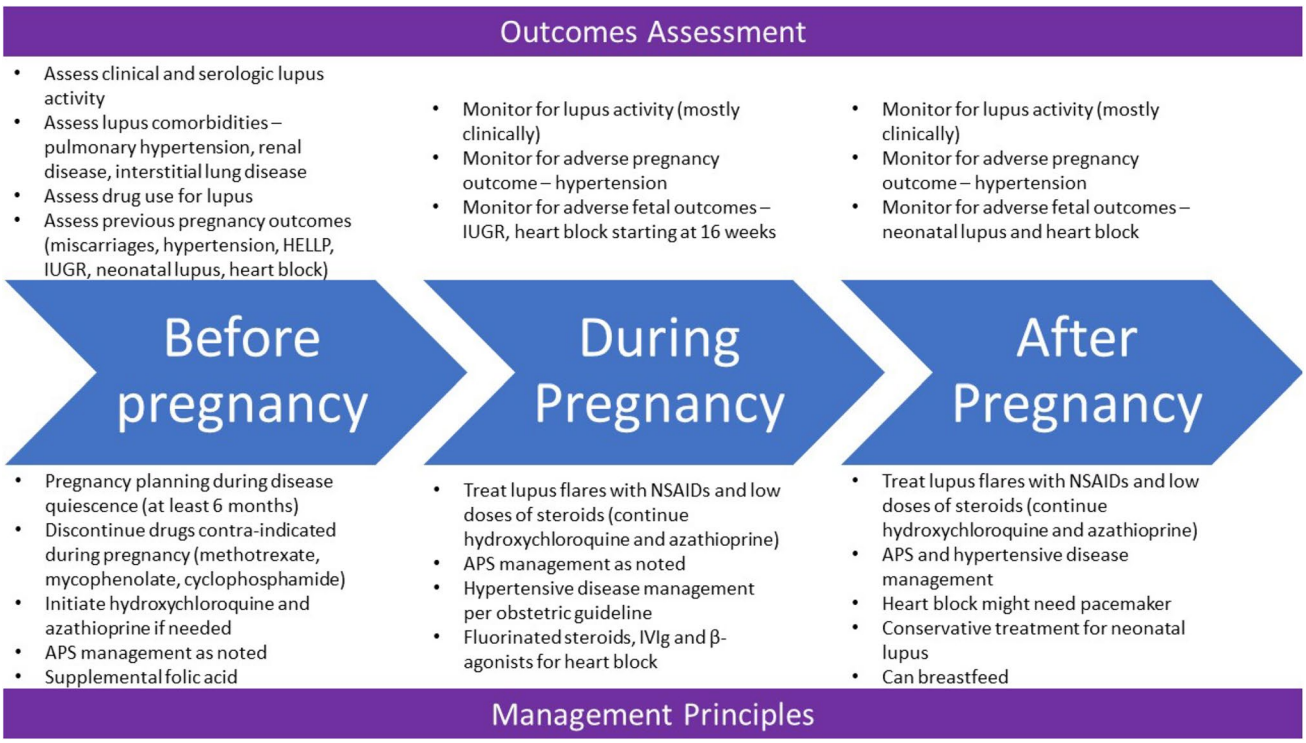

Fig. 1 Summary of assessment and management of patients with lupus before, during and after pregnancy

barrier contraceptives have a higher failure rates, hormonal preparations may be unsuitable for those with high risk of thrombosis.

In addition to routine investigations that are needed for pregnancy planning, additional laboratory investigation should be carried out to serologically define lupus. This should include evaluation of lupus serologies as well as urinalysis, complements, Sjogren's antibodies and antiphospholipid antibodies. Nutritional supplementation with folic acid is recommended to reduce neural tube defects. Improved preconceptional cardiovascular health (total cholesterol, body mass index and blood pressure) has been associated with better pregnancy outcomes [38].

Hydroxychloroquine has been shown to reduce the rates of lupus flares in pregnant women. It is also associated with lower disease activity. Its role in reducing growth retardation has not been concretely established, but it may reduce occurrence of complete heart block in patients with SSA and SSB antibodies [39–42]. Azathiophine and steroids (at the lowest possible dose) can be continued during pregnancy. Drugs like methotrexate, mycophenolate and cyclophosphamide are teratogenic and need to be stopped prior to conception. There are very limited data about belimumab and rituximab use during pregnancy

During pregnancy It is important to recognize features of lupus flare or active lupus versus features of complications of pregnancy, especially because the two may overlap. If the patient is on hydroxychloroquine or antimalarials, these should be continued. Flares of lupus, particularly arthritis, can be treated with nonsteroidal analgesics. Beyond 32 weeks of gestation, NSAIDs are associated with premature closure of ductus arteriosus and should be stopped. If needed, short course with the lowest possible dose of steroids can be used for flare of lupus; fluorinated steroids like betamethasone or dexamethasone should be used no more than once [43]. Vitamin D deficiency has been associated with high disease activity and worse pregnancy outcomes. Hence, calcium and vitamin D supplementation should be considered

Antiphospholipid antibodies: Management of patients with antiphospholipid antibodies requires risk stratification and use of antiplatelet agents/heparin. Patients are stratified into one of the three categories [15]

a. Asymptomatic carriers (positive antibodies without previous obstetric complications or thrombosis) usually do not require any therapy; however, the use of aspirin is common
b. Obstetric antiphospholipid syndrome (positive antibodies with previous obstetric complications but without thrombosis): These patients should be treated with a combination of aspirin along with prophylactic doses of heparin

c. Patients with established antiphospholipid syndrome with prior thrombosis require therapeutic doses of heparin throughout the pregnancy until approximately 6 weeks postpartum

* Low molecular weight heparin (like enoxaparin) can be used in place of unfractionated heparin. Coumadin is contraindicated in pregnancy

Patients with positive Sjogren's serologies are at increased risk of heart block. Neonatal lupus is usually self-resolving [43]. Monitoring for this complication should start as early as 16 weeks of gestation and should be done weekly until 26 weeks and every 2 weeks thereafter. Fetal echocardiography is at the core of such evaluations. Even milder conduction delays like PR prolongations should prompt discussion. Fluorinated steroids and β-agonists can be tried to improve fetal survival. IVIg has also been tried in such situation, but the merit is often debated.

Hypertensive disease in pregnancy is more common in lupus patients than those without. The treatment of this disease should follow routine obstetric guidelines

After the pregnancy Breastfeeding is considered safe in lupus patients. As such, medications like hydroxychloroquine, azathioprine, methotrexate and prednisone have very limited transfer into breast milk and can be continued while breastfeeding [44]. Neonatal lupus is self-resolving and does not need any therapy.

Conclusion

Pregnancy outcomes in patients with lupus have improved considerably over time. Yet, lupus continues to present increased risk of adverse pregnancy outcomes and pregnancy increases the risk of lupus flares. A thorough understanding of the pathophysiologic processes involved and a multidisciplinary team are needed from careful planning of pregnancy to delivery of the fetus.

Compliance with Ethical Standards

Conflict of interest The authors declare that they have no conflict of interest.

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