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Original Article

Pregnancy outcome in Chinese women with systemic lupus erythematosus: a retrospective study of 255 cases in a single center

Jiayue Wu[1,2], Wen Di[1,2]

[1]*Department of Obstetrics and Gynecology, Ren Ji Hospital, Shanghai Jiao Tong University School of Medicine, Shanghai 200127, China;* [2]*Shanghai Key Laboratory of Gynecologic Oncology, Shanghai, China*

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Abstract: Purpose: Pregnancy is risky for systemic lupus erythematosus (SLE) women, because it could increase SLE activity and obstetric complications. This study aimed to investigate pregnancy outcome in SLE women, minimize risk of miscarriage, and improve perinatal quality. Patients and methods: Medical records of 282 pregnancies in 280 SLE patients were reviewed retrospectively. Clinical and laboratory data were collected and analyzed. Results: The mean age was 28.25 ± 4.12 years. In the remaining 255 cases, there were 206 (80.8%) planned pregnancies and 49 unplanned pregnancies. Among 255 SLE pregnancies, there were 215 successful deliveries and 40 fetal losses. The incidence of pregnancy loss, SLE flare, preterm birth and IUGR was significantly higher in unplanned pregnancy group than in planned pregnancy group ($P < 0.05$). The birth weight and gestational age were significantly higher in planned pregnancy group than unplanned pregnancy group ($P < 0.05$). Furthermore, it was found that the lupus nephritis group had worse maternal and fetal outcome than the non-lupus nephritis group. Conclusion: Pregnancy in SLE remission phase has a good outcome. Controlling SLE activity, improving renal function is critical to improve pregnancy outcome, especially for nephritis patients. Counselling obstetrician and rheumatologist before pregnancy is an essential step. Furthermore, anti-SSA/Ro antibody is closely related to neonatal lupus and low birth weight. Aspirin is able to improve the birth weight and reduce the incidence of small gestational age.

Keywords: Pregnancy outcome, systemic lupus erythematosus, lupus nephritis, antinuclear antibody

Introduction

Systemic lupus erythematous (SLE) is an autoimmune disease involving multiple organs with predilection in young women and its incidence is about 90/100,000 [1]. The number of pregnant women with SLE is rising, which might be attributed to environmental factors [2], which suggests that SLE doesn't affect fertility in young patients [1]. However, pregnancy is risky for SLE women, because its may increase SLE activity and obstetric complications (such as pre-eclampsia, eclampsia and thrombocytopenia) [3]. Women with SLE are at an increased risk of early-onset preeclampsia and this increased risk is independent from the traditional risk factors such as pregestational hypertension, anti-phospholipid syndrome, body mass index, and smoking [4]. SLE may interfere with the development of embryos *via* maternal autoantibodies [5], resulting in spontaneous abortion, preterm delivery, and intrauterine growth retardation (IUGR). Furthermore, SLE with anti-phospholipid syndrome during pregnancy usually has serious complications, like gestational hypertension and renal SLE [6]. This is supported by the finding that proteinuria, anti-phospholipid syndrome, thrombocytopenia, and hypertension is a major risk factor for early miscarriage in SLE patients [7]. Thus, early identification and management of these risk factors are crucial for reducing miscarriage. Neonatal lupus syndrome is a neonatal congenital disease, due to passive acquisition of maternal auto-antibodies (anti-SSA/Ro and anti-SSB/La) *via* placenta [8], which is consistent with the finding that neonatal lupus syndrome gradually recovers within six months after birth, accompanied by the reduction/disappearance of maternal antibodies in blood [9,

Table 1. Pregnancy related information of 255 pregnant women

Characteristics	N (%)
Maternal age (years)	28.3 ± 4.1
Type of delivery	
Successful delivery	215 (84.3)
Pregnancy loss	40 (15.6)
Planned pregnancy	206 (80.8)
Unplanned pregnancy	49 (19.2)
Lupus nephritis	78 (30.5)
IUGR	39 (18.1)
Preterm birth	67 (31.1)
Infant Gestational age at birth (weeks)	37.2 ± 2.2
Infant birth weight (g)	2759.3 ± 581.4

Notes: IUGR, intrauterine growth retardation.

10]. Most neonates with lupus syndrome have transient mild allergy in exposed areas, which is characterized by a disk or ring rash and similar to the adult subacute cutaneous lupus. Neonatal lupus syndrome is also associated with hematological and hepatological abnormalities. Major congenital presentation is atrioventricular block with an incidence of 2% in pregnant women with anti-SSA/Ro antibody.

SLE patients have substantially higher incidence of miscarriage, stillbirth and fetal growth restriction than healthy controls [1, 11]. Therefore, early SLE assessment and management should be performed before and during the entire pregnancy in these patients, and multi-disciplinary care is required [8, 12].

In the present study, the pregnancy outcome and the key laboratory findings related to SLE were investigated in 255 patients with SLE, aiming to identify the optimal timing of conception and the parameters for pregnancy monitoring to prevent SLE deterioration.

Materials and methods

General data

A retrospective study was carried out on pregnant SLE patients who were treated in the Ren Ji Hospital, Shanghai Jiao Tong University School of Medicine from December 1995 to July 2015. SLE was diagnosed according to the revised criteria for the classification of SLE developed by the American College of Rheumatology [13]. SLE Disease Activity Index 2000 (SLEDAI-2K) was used as a valid method of evaluating disease activity and SLEDAI-2K > 4 was defined as an active stage of SLE [14]. All variables necessary to score the SLEDAI-2K were collected from the clinical history. A total of 282 pregnancies in 280 SLE pregnant women were reviewed, of whom 27 cases were excluded due to elective abortion. Among 255 SLE patients, 215 had successful delivery whereas 40 cases had fetal losses. The mean age of 280 SLE patients was 28.25 ± 4.1 years old (range: 20-47 years old).

Data were collected from these SLE patients at multiple time points for objective diagnosis, because findings collected at a single time point may not represent the accurate status of SLE during pregnancy. Information was collected at the preconception period (before pregnancy), 1st trimester (the first day of last menstrual period- 13 + 6 weeks of pregnancy), 2nd trimester (14 weeks of pregnancy- 27 + 6 weeks of pregnancy), 3rd trimester (28 weeks of pregnancy-birth). Demographics, manifestations, treatment, timing of pregnancy (planned pregnancy, unplanned pregnancy), pregnancy related information, laboratory parameters, and other medications were collected and recorded. Planned pregnancy group included patients who had no clinical manifestations of SLE and took low-dose prednisone for at least 6 months or stopped prednisone treatment at least 6 months ago. Clinically, they presented no signs of SLE activation and SLEDAI-2K ≤ 4. Those patients all had consent from gynecologist and rheumatologist before conception. Unplanned pregnancy included patients with active SLE (SLEDAI-2K > 4 and has clinical manifestations of SLE including CNS and/or renal involvement, vasculitis, arthritis, myositis, fever, rash, pleurisy, pericarditis, and hypocomplementemia) during the past 6 months before pregnancy, or patients who have SLE for the first time during pregnancy. Those patients didn't have any permission of pregnancy.

Laboratory examination

Laboratory parameters, including anti-nuclear antibody, anti-SSA/Ro antibody, anti-SSB/La antibody, anti-cardiolipin antibody, anti-double stranded DNA (dsDNA) antibody, complement, erythrocyte sedimentation rate, and 24-hour

Table 2. Timing of pregnancy and pregnancy outcomes

Pregnancy outcomes	Timing of Pregnancy	
	Planned	Unplanned
NO. of pregnancies, n=255	206	49
SLE FLARE, n (%)	28 (13.6)$^{\Phi}$	22 (44.9)$^{\Phi}$
PIH, n (%)	42 (20.4)	12 (24.5)
Live Birth, n (%)	181 (87.9)$^{\Phi}$	34 (69.3)$^{\Phi}$
Live birth		
Preterm, n (%)	54 (29.8)$^{\Phi}$	13 (38.2)$^{\Phi}$
IUGR, n (%)	28 (15.4)$^{\Phi}$	11 (32.4)$^{\Phi}$
Fetal Distress, n (%)	49 (27.1)	12 (35.2)
Birth Weight, Mean ± SD (g)	2806.9 ± 559.4$^{\Phi}$	2505.1 ± 607.1$^{\Phi}$
Gestational Age, Mean ± SD (w)	37.3 ± 2.1	36.4 ± 2.7

Notes: $^{\Phi}P < 0.05$, planned pregnancy group vs unplanned pregnancy group. IUGR, intrauterine growth retardation; PIH, pregnancy-induced hypertension.

urinary protein excretion in the pre-pregnancy and pregnancy periods.

Pregnancy outcomes

The pregnancy outcomes included live births (both term and preterm) and pregnancy losses. Preterm birth was defined as a live birth occurring before 37 weeks of gestation. Pregnancy loss included spontaneous abortion, therapeutic abortion, stillbirth (no signs of life in a fetus delivered after 20 weeks of gestation) and neonatal deaths. Neonatal outcomes included gestational age at birth, birth weight, small gestational age infant, and IUGR. IUGR was defined as birth weight of less than two standard deviations or 10th percentile of gestational age with an average body weight of the fetus of the same sex, or fetal birth weight less than 2500 g after 37 weeks gestation.

Pregnancy complications

Pregnancy complications included gestational hypertensive disease, fetal distress, and SLE flare. Gestational hypertensive disease was defined as high blood pressure during pregnancy (BP ≥ 140/90 mmHg), or the increase in systolic blood pressure by 30 mmHg and/or diastolic blood pressure by 15 mmHg compared with the baseline level with or without proteinuria, including chronic hypertension complicated by pre-eclampsia, gestational hypertension, preeclampsia, and eclampsia. SLE flare was defined as the presence of new signs of SLE during pregnancy in the patient who was previously in remission [12]. The medications included aspirin and adrenocorticotropic hormone. Based on the data described above, this retrospective study explored the relationship of SLE status with both clinical and laboratory findings and pregnancy outcomes.

Statistical analysis

Statistical analysis was performed with SPSS version 22.0. The categorical variables were analyzed with chi-square test or Fisher's exact probability test as appropriate. The continuous variables were analyzed by using Student's t test or correlation analysis as appropriate. A value of $P < 0.05$ was considered statistically significant.

Results

Patients' characteristics

A total of 282 pregnancies in 280 SLE pregnant women who were treated in the Ren Ji Hospital, Shanghai Jiao Tong University School of Medicine between December 1995 and July 2015 were included in this study. The mean age was 28.25 ± 4.12 years old (range: 20-47 years old). 27 cases were excluded due to elective abortion, 215 patients had successful delivery, and fetal loss was found in 40 cases.

Planned pregnancy in SLE patients

In 255 pregnant women with SLE, SLE was classified as renal type (n=78) and non-renal type (n=177). There are 206 patients included in planned pregnancy group. 49 patients were included in unplanned pregnancy group, which consisted of 12 patients with active SLE, and 37 patients who were firstly diagnosed with SLE during pregnancy. Except for patients firstly diagnosed at conception, the course of SLE ranged from one year to 20 years in the remaining patients. It was the first pregnancy in 118 patients. Furthermore, 26 patients had previous therapeutic abortion, whereas 37 had previous spontaneous abortion. Among 215 women with successful delivery, full-term delivery was found in 148 patients and premature birth in 67 cases. Among 40 SLE patients with

Table 3. Lupus nephritis and pregnancy outcome

Pregnancy outcomes	Lupus nephritis	
	Yes	NO
No. of pregnancies, n=255	78	177
SLE FLARE, n (%)	27 (34.6)$^{\xi}$	24 (13.6)$^{\xi}$
PIH, n (%)	33 (42.3)$^{\xi}$	24 (13.5)$^{\xi}$
Live Birth, n (%)	61 (78.2)	154 (87.0)
Live Birth		
Preterm, n (%)	25 (41.0)	42 (27.2)
FGR, n (%)	11 (18.0)	30 (19.5)
Fetal Distress, n (%)	22 (36.0)	39 (25.3)
Birth Weight, Mean ± SD (g)	2600.8 ± 671.5*	2822.4 ± 530.7*
Gestational Age, Mean ± SD (d)	250.1 ± 12.1$^{\xi}$	262.6 ± 13.6$^{\xi}$

Notes: $^{*}P < 0.05$; $^{\xi}P < 0.01$; Lupus nephritis vs non lupus nephritis. IUGR, intrauterine growth retardation; PIH, pregnancy-induced hypertension.

pregnancy losses, spontaneous abortion was noted in 12 patients and iatrogenic miscarriage in 25, and stillbirth in three. Average birth weight was 2759.3 ± 581.4 g (range: 672-4360 g), the incidence of preterm birth was 31.1% (67/215), and the incidence of small gestational age infant was 18.1% (39/215) (**Table 1**).

Better outcome in planned pregnancy

The incidence of live birth in patients in planned pregnancy group was significantly higher than unplanned pregnancy group (87.9% vs 69.3%, P < 0.05). There was significantly lower incidence of obstetric complications in patients in planned pregnancy group than unplanned pregnancy group, including SLE flare, preterm birth and IUGR (P < 0.05). There was no significant difference in the incidence of pregnancy-induced hypertension (PIH) and fetal distress between the two groups. Furthermore, the birth weight and gestational age were also significantly higher in planned pregnancy group than unplanned pregnancy group (P < 0.05) (**Table 2**).

Poor pregnancy outcome in lupus nephritis

There was no significant difference in the pregnancy loss between patients with and without lupus nephritis (21.8% vs 13.0%). However, the incidences of PIH and SLE flare were significantly higher in SLE patients with lupus nephritis than those without lupus nephritis (42.3% vs 13.5%, P < 0.01; 34.6% vs 13.6%, P < 0.01). Furthermore, the gestational age and birth weight were significantly lower in lupus nephritis group than non-lupus nephritis group (P < 0.05) (**Table 3**).

Poor pregnancy outcome with positive autoantibodies

There was a significantly higher incidence of IUGR in SLE patients with positive anti-SSA/Ro than those with negative anti-SSA/Ro (40.0% vs 15.6%, p < 0.05). The incidence of SLE flare in SLE patients with positive anti-Sm was also significantly higher than in those with negative anti-Sm (37.5% vs 8.6%, P < 0.05). Furthermore, there was significantly lower birth weight in anti-SSA/Ro (+) group than anti-SSA/Ro (-) group (2613.3 ± 329.3 vs 2806.7 ± 432.2 g, P < 0.05) (**Table 4**).

Poor pregnancy outcome with urinary protein

There were significant correlations of 24-h urinary protein with pregnancy loss, preterm, PIH, and SLE flare in the second and third trimesters (P < 0.05), but not before pregnancy and in the first trimester (**Table 5**).

Better pregnancy outcome with less prednisone dose

There was a significant negative correlation of prednisone dose with birth weight and gestational age in either trimester (P < 0.05) (**Table 6**).

Better pregnancy outcome with aspirin use

There was a significantly higher birth weight, but not gestational age, in aspirin users than non-users (P < 0.05) (**Table 7**).

Discussion

Our study showed that SLE activity is an important factor related to miscarriage, stillbirth, and therapeutic abortion. This might be explained as that immune complexes may cause systemic vascular inflammation, contributing to hypercoagulable states, which reduces placenta and umbilical artery blood flow, and decreases placental perfusion and villus structure, and affects neonatal development [15]. Galappatthy et al also found that the percentage of live

Table 4. Autoantibodies and pregnancy outcome

Autoantibodies	Pregnancy outcomes						
	No. of pregnancies n=255	SLE FLARE n (%)	PIH n (%)	Live Birth n (%)	Live Birth		
					Preterm n (%)	IUGR n (%)	Fetal Distress n (%)
Anti-Ro$^{\Psi}$							
Pos	20	0 (0.0)	3 (15.0)	20 (100.0)	8 (40.0)	8 (40.0)$^{\Phi}$	5 (25.0)
Neg	112	9 (8.0)	17 (15.2)	90 (80.4)	24 (26.7)	14 (15.6)$^{\Phi}$	25 (27.7)
Anti-La$^{\Psi}$							
Pos	10	2 (20.0)	1 (10.0)	9 (90.0)	5 (55.6)	3 (33.3)	4 (44.4)
Neg	119	9 (7.6)	14 (11.8)	96 (80.7)	25 (26.0)	15 (15.6)	23 (24.0)
Anti-Sm$^{\Psi}$							
Pos	8	3 (37.5)$^{\Phi}$	1 (12.5)	7 (87.5)	4 (57.1)	2 (28.6)	1 (14.28)
Neg	128	11 (8.6)$^{\Phi}$	17 (13.3)	105 (82.0)	28 (26.7)	20 (19.0)	29 (27.6)
Anti-RNP$^{\Psi}$							
Pos	27	5 (18.51)	1 (3.7)	23 (85.2)	8 (29.6)	6 (26.1)	5 (21.7)
Neg	107	6 (5.6)	16 (15.0)	87 (81.3)	23 (26.4)	17 (19.5)	24 (27.6)
ACL$^{\Psi}$							
Pos	21	4 (19.0)	2 (9.5)	18 (85.7)	5 (27.8)	6 (33.3)	5 (27.8)
Neg	115	12 (10.4)	17 (14.8)	96 (83.4)	30 (31.3)	19 (19.8)	25 (26.0)
ds-DNA$^{\Psi}$							
Pos	42	5 (11.9)	5 (11.9)	37 (88.1)	12 (32.4)	8 (21.6)	6 (16.2)
Neg	82	6 (7.3)	8 (9.8)	70 (85.3)	25 (35.7)	12 (17.1)	9 (12.9)

Notes: $^{\Phi}P < 0.05$, positive autoantibodies vs negative autoantibodies. Ψ= unavailable in some patients. IUGR, intrauterine growth retardation; PIH, pregnancy-induced hypertension.

Table 5. 24-h urinary protein in 2nd trimester & 3rd trimester and pregnancy outcome

Pregnancy outcome	n	2nd-24-h urinary protein (g)	*p*-Value	3rd-24-h urinary protein (g)	*P*-Value
Pregnancy loss$^{\Psi}$					
Yes	29	4.91 ± 1.2		5.11 ± 1.7	
No	198	1.53 ± 0.6	0.006*	2.30 ± 0.9	0.032$^{\Delta}$
Preterm$^{\Psi}$					
Yes	41	1.91 ± 0.9		2.91 ± 1.7	
No	109	1.31 ± 0.7	0.166	0.89 ± 0.7	0.002*
IUGR$^{\Psi}$					
Yes	21	1.32 ± 0.9		1.67 ± 1.3	
No	112	1.53 ± 0.6	0.742	2.10 ± 1.1	0.814
Fetal distress$^{\Psi}$					
Yes	19	1.70 ± 1.1		1.92 ± 1.7	
No	131	1.93 ± 0.9	0.174	2.01 ± 0.9	0.359
PIH$^{\Psi}$					
Yes	31	2.21 ± 0.9		2.94 ± 1.4	
No	134	0.89 ± 0.5	0.011$^{\Delta}$	0.88 ± 0.72	0.005*
SLE Flare$^{\Psi}$					
Yes	26	5.26 ± 1.0		3.78 ± 1.1	
No	139	0.8 ± 0.6	< 0.000*	1.0 ± 0.8	0.001*

Notes: $^{\Delta}P < 0.05$, $^{*}P < 0.01$, Ψ, unavailable; IUGR, intrauterine growth retardation, PIH, pregnancy-induced hypertension.

births in SLE patients (9/20; 45%) was significantly lower than those with rheumatoid arthritis (6/8; 75%) and women without chronic illness (77/85; 91%) [15]. In addition, SLE also increases the risk of preterm birth [16]. This is in line with the findings in this study that the incidence of SLE flare and pregnancy loss risk increased in patients of unplanned pregnancy group, which is also accompanied with high risks of concomitant IUGR, low birth weight, small gestational age, preterm birth, and other complications [17, 18]. On the other hand, a better pregnancy outcome was observed in the patients of planned preg-

Table 6. Prednisone use and infant birth weight & gestational age

Prednisone dose	Birth weight		Gestational age	
	Correlation coefficient	*P*-Value	Correlation coefficient	*P*-Value
Preconception Pred	-0.151	0.027$^{\Delta}$	-0.113	0.031$^{\Delta}$
1st-Pred	-0.230	0.001*	-0.214	0.002*
2nd-Pred	-0.285	0.000*	-0.273	0.000*
3rd-Pred	-0.476	0.000*	-0.538	0.000*

Notes: $^{\Delta}$P < 0.05, *P < 0.01. Pred, prednisone dose.

Table 7. Aspirin use and infant birth weight & gestational age

ASA use	n	Birth weight (g)	*p*-Value	Gestational age (d)	*p*-Value
Yes	67	2900.0 ± 10.9		264.0 ± 10.0	
No	110	2765.0 ± 14.0	0.04*	263.6 ± 14.0	0.239

Notes: *P < 0.05. ASA, Aspirin.

nancy group, and maternal-fetal outcomes became better with the reduction in SLE flare [19].

A close correlation has been found between SLE activity and prednisone dose/blood pressure [20]. Results in this study showed the dose of prednisone was negatively related to the birth weight and gestational age (P < 0.05). Therefore, SLE controlling in pregnancy and prevention of SLE flare are essential for the improvement of pregnancy outcomes and neonatal prognosis.

Our findings suggested that significantly more severe PIH, SLE flare (P < 0.01) and lower neonatal gestational age and body weight were observed in SLE patients with lupus nephritis than those without lupus nephritis (P < 0.01). This is supported by the finding reported by Munther et al [9] that the lupus nephritis is a risk factor for pregnancy loss, especially in those have renal impairment. Furthermore, Gutierrez et al recommended that, for SLE patients with lupus nephritis, SLE should be in remission stage for at least six months before conception because poor pregnant outcome is related to active nephritis. Moreover, substantially higher incidences of pregnancy loss, IUGR and PIH have been reported even in non-active SLE patients with lupus nephritis [8]. A recent study also showed a history of lupus nephritis predicted adverse maternal outcome [21]. These reports are consistent with those results mentioned above. It was concluded that pregnancy was not suitable for SLE patients who had the renal disease classification at moderate level (Barnett mode, creatinine clearance < 50 ml/min, urine protein > 3 g/24 h), creatinine greater than 177 μmol/L, or severe hypertension [22]. This may be due to compromised microcirculation in the uteroplacental vessels of SLE patients with high blood pressure and lupus nephritis. In addition, pregnancy itself also contributes partially to renal impairment, and subsequently renal failure in late stage of pregnancy [23]. Clinically, 24-h urinary protein is an indicator for renal function. This study showed a close correlation between high 24-h urinary protein and increased incidences of pregnancy loss, PIH, and SLE flare, which was consistent with the finding that a negative correlation was noted between birth weight and gestational age. Thus, it is critical to actively monitor the renal function and blood pressure in SLE patients with pregnancy.

Positive anti-Sm antibody is one of the criteria for the diagnosis of SLE based on ACR guideline. Anti-Sm antibody is detected almost exclusively in SLE, and 15%-30% of SLE patients are positive for anti-Sm antibody. Furthermore there is a close correlation of anti-Sm antibody(+) SLE with skin lesions and renal impairment, which supported the finding that SLE flare occurred in 37.5% of anti-Sm(+) patients but in only 8.6% of anti-Sm(-) patients (P < 0.05) in this study. In addition, the probability of positive Sm antibody and anti-dsDNA antibody is higher in anti-cardiolipin positive SLE patients than those negative patients [24].

The anti-SSA/Ro and anti-SSB/La antibodies are typically found in Sjogren's syndrome and SLE patients. Anti-Ro/SS-A and anti-La/SS-B are clinically very relevant during pregnancy mainly because of their association with congenital heart block and neonatal lupus [25]. The prevalence of being positive for anti-SSA/Ro antibodies is 35% in SLE patients, and 100% in infants with neonatal lupus syndrome [26].

The presence of anti-SSB/La antibody is often accompanied with positive anti-SSA/Ro antibody. It is essential to monitor the fetal electro-

cardiogram weekly from 16 to 24 weeks if SLE pregnant patients are positive for anti-SSA/Ro antibody or anti-SSB/La antibody. In this study, anti-SSA/Ro antibody increased the incidence of FGR and the risk of low birth weight. SSA/Ro was found as a risk factor of FGR (coefficient =1.882, OR=6.57, P=0.000), which might be related to the presence of circulating autoantibodies in newborns.

Prednisone is able to promote fetal lung maturation and probably the treatment of fetal myocarditis. The prednisone dose should be controlled to exert therapeutic effect with minimum dose in pregnancy. Thus, 5-10 mg/d prednisone is advised in pregnant women with SLE depending on the disease status if the patients are prednisone naive. In SLE pregnant patients treated with prednisone of 5-15 mg/d before pregnancy, doubling of the dose is recommended [27]. Throughout the pregnancy, close monitoring of SLE is necessary, including the skin lesions, joint pain, proteinuria, elevated ESR, and complement. The prednisone dose should be adjusted accordingly [8, 12]. In the present study, there were close correlations of high prednisone dose with low birth weight. It is reasonable to believe that the dose of prednisone admitted is closely related to the activity of SLE, supporting that the quiescent status is beneficial for pregnancy.

Most non-steroidal anti-inflammatory drugs are not suitable for pregnant women, due to their risk for pulmonary hypertension in fetus [28]. On the other hand, aspirin can be safely used during pregnancy at a low dose (20-60 mg/d) for anti-platelet aggregation, especially in patients with a history of recurrent spontaneous abortion, positive for aPL or with hypercoagulable state [29]. However it remains to be confirmed whether other anti-platelet drugs (clopidogrel and dipyridamole) can be safely used in pregnancy [30]. Results of this study showed that the birth weight was higher in patients with aspirin treatment ($P < 0.05$). This may be due to aspirin induced improvement of uteroplacental perfusion via reducing platelet aggregation, and the subsequent improvement of pregnancy outcomes [31].

Conclusion

Conception should be initiated at the quiescent stage of SLE, which may substantially improve the pregnancy outcomes. This indicates the critical role of obstetrician and rheumatologist in consulting SLE patients before conception. Monitoring of mother and fetus conditions during antenatal care needs to be stressed. Renal function, especially urinary protein, is a key predictor of pregnancy loss and other adverse fetal outcomes. Patients with lupus nephritis should be monitored carefully for pregnancy-induced hypertension, and lupus flare. Furthermore, anti-SSA/Ro antibody is closely related to neonatal lupus and low birth weight. Aspirin is able to improve the birth weight and reduce the incidence of small gestational age.

Future direction

In future prospective study, more outpatients will be recruited for further analysis to confirm these findings. Moreover, the effects and safety of aspirin and other anti-platelet drugs will be further elucidated in pregnant women with SLE, and a system will be established for the prediction of pregnancy outcome in SLE patients. Paydar et al developed a clinical decision support system based on the multi-layer perceptron network to predict pregnancy outcomes among pregnant women complicated with SLE [32].

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Disclosure of conflict of interest

None.

Address correspondence to: Wen Di, Department of Obstetrics and Gynecology, Ren Ji Hospital, Shanghai Jiao Tong University School of Medicine, Shanghai 200127, China. Tel: +86-21-68383801; E-mail: diwen163@163.com

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