Retrospective Clinical Research Report

Journal of INTERNATIONAL MEDICAL RESEARCH

Journal of International Medical Research
50(1) 1–11

DOI: 10.1177/03000605211070753
journals.sagepub.com/home/imr
SAGE

Evaluation of the necessity of laparoscopic repair of a uterine scar defect for cesarean scar pregnancy

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Abstract

Objective: This study aimed to determine the risk factors associated with the necessity of laparoscopic scar defect repair for cesarean scar pregnancy (CSP).

Methods: We retrospectively analyzed 237 patients with CSP who were treated by ultrasound-guided suction curettage and/or laparoscopy in our hospital from April 2012 to November 2019. A total of 199 of these patients underwent ultrasound-guided suction curettage without uterine scar defect repair, while 38 of these patients underwent laparoscopic resection and uterine scar defect repair. We analyzed various clinical variables and compared the efficacy of treatment between the two groups.

Results: Gestational age, the maximum transverse diameter (MTD) of the gestational sac, myometrial thickness, the operation time, intraoperative blood loss, and the duration of the hospital stay were significantly different between the two groups. Gestational age, the MTD of the gestational sac, and myometrial thickness were independent risk factors for laparoscopic repair.

Conclusions: Gestational age, the MTD of the gestational sac, and myometrial thickness are important factors associated with the necessity for laparoscopic repair of a uterine scar defect.

Keywords

Cesarean scar pregnancy, laparoscopy, suction curettage, magnetic resonance imaging, operative treatment, myometrial thickness

Date received: 12 September 2021; accepted: 13 December 2021

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Introduction

Cesarean scar pregnancy (CSP) is a special and rare type of ectopic pregnancy involving a gestational sac that has implanted into a previous cesarean scar. The gestational sac is located completely outside the uterus and is surrounded by myometrium and fibrous tissue.[1] CSP is a complex and serious condition, which is associated with severe maternal morbidity and mortality owing to the risk of uterine rupture and life-threatening hemorrhage.[2,3] Therefore, early and accurate diagnosis of CSP with timely management are important. The estimated incidence rate of CSP ranges from 1/1800 to 1/2500, accounting for 6.1% of all ectopic pregnancies in women with a prior cesarean section (CS).[4,5] As the proportion of CSs has markedly increased worldwide, its adverse effects have gradually been revealed.[6,7]

Recently, various treatment strategies for CSP have been published, including expectant, medical, and surgical methods, but none of the management strategies helps predict which therapy is more effective.[8,9] Among these strategies, minimally invasive surgeries, including suction curettage, hysteroscopy, and laparoscopy, are effective and safe therapeutic options. These surgeries have the advantages of a high success rate, few complications, and a rapid return to normal β-human chorionic gonadotropin (hCG) concentrations.[10] However, uterine suction curettage might cause uncontrollable hemorrhage or uterine rupture, which may require emergency laparotomy or hysterectomy.[11] In contrast, the laparoscopic approach with excision and repair of a uterine scar defect represents a feasible and effective method for high-risk patients with CSP.[12] Laparoscopic repair surgery has the advantages of a high success rate, short duration of hospital stay, fast recovery, short time for normalization of the β-hCG concentration and absorption of the local mass, and effective restoration of the patient's fertility. Nevertheless, the choice of the best surgical approach and the related crucial factors are still uncertain. There is no defined standard for estimating which patients are suitable for suction curettage alone, which patients require laparoscopic uterine defect repair, and what indicators should be evaluated. Therefore, clinicians need to accurately assess the risk factors that affect the choice of surgical methods to determine safer and more effective individualized treatment for CSP.

In this study, we aimed to compare the treatment efficacy of suction curettage and laparoscopy, and to evaluate the risk factors associated with the necessity of laparoscopic repair of a uterine scar defect.

Materials and Methods

Patients

This retrospective study included 237 patients who were treated for CSP at the Department of Obstetrics and Gynecology, Shanghai General Hospital, Shanghai Jiaotong University School of Medicine, from April 2012 to November 2019. The study was reviewed and approved by the Institutional Review Board and the Research Ethics Committee of Shanghai General Hospital (approval no. 2021KY012). Informed consent for treatment was obtained from all included patients. All of the patients diagnosed with CSP were informed of the treatment options, risks, and complications. Informed consent for publication was not required because of the retrospective nature of this study.

The diagnostic criteria for CSP included the following: a history of CS; with or without an obvious history of amenorrhea; serum β-human chorionic gonadotropin (β-hCG) concentrations were higher than normal (>5.0 mIU/mL); and ultrasound imaging features were in accordance with

the Green-top Guideline.[1] Features of this guideline are as follows: empty uterine cavity and empty cervical canal; the gestational sac developed in a previous cesarean scar of the lower uterine segment; a thin or absent myometrium between the gestational sac and the bladder; and a rich vascular pattern in the cesarean scar area.

Treatment groups

Patients were categorized into two groups on the basis of their treatment protocols. In one group, patients underwent ultrasound-guided suction curettage (with or without hysteroscopic resection) without repair of the defect (suction curettage group). In the other group, patients underwent laparoscopic resection and scar defect repair (laparoscopic repair group). None of the patients received any other treatments before surgery, such as methotrexate.

The criteria of selecting surgical methods for patients with CSP without life-threatening situations in our department were as follows. (1) When the myometrial thickness was $\geq$3 mm, ultrasound-guided suction curettage only was performed. (2) When myometrial thickness was $\geq$2 and $<$3 mm, ultrasound-guided curettage was performed first and whether laparoscopic defect repair was added was determined according to the intraoperative situation. (3) When myometrial thickness was $\geq$1 mm and $<$2 mm, laparoscopic defect repair was usually chosen, and a few patients chose ultrasound-guided curettage (depending on the physician's preference and expertise). (4) When myometrial thickness was $<$1 mm, laparoscopic defect repair was performed.

Imaging examinations

Transvaginal ultrasound (TVUS) and contrast-enhanced magnetic resonance imaging (MRI) examinations were used to diagnose pregnancies and assess the myometrial thickness of the lower uterine segment between the gestational sac and the bladder. The MRI sequences of all patients who presented with typical findings of the gestational sac embedded in the anterior lower uterine segment on sagittal T2-weighted images were retrospectively identified. Myometrial invasion and bladder involvement were also assessed. Color Doppler flow imaging (CDFI) was used to evaluate possible vascularization and uterine wall infiltration at the implantation site. The maximum transverse diameter (MTD) and maximum longitudinal diameter (MLD) of the gestational sac were measured precisely by MRI on the sagittal plane (Figure 1).

Laparoscopic resection

Laparoscopy was performed under general anesthesia with the patient in the 15° Trendelenburg position. The main surgical procedures were similar to those of Wang et al. and Lee et al.[13,14] First, we opened the peritoneum between the bladder and the uterus, and pushed down the bladder to clearly visualize the prior cesarean scar. A visible convex mass with a thin wall of the myometrium was observed. Temporary bilateral uterine artery occlusion combined with local injection of dilute vasopressin was then performed. A transverse incision was made over the most prominent area of the mass. After bipolar coagulation of the lesion, the scar was completely opened from one side to the other, and the products of conception were removed using grasping forceps. The lesion tissue was excised from the edge of the defect to access normal myometrium and facilitate further healing. Finally, the incision of the isthmus was completely sutured with three layers using absorbable suture.

In some cases of heavy uterine bleeding intraoperatively, a Foley catheter (Bard Sdn. Bhd., Kedah, Malaysia) was

Figure 1. Magnetic resonance imaging measurements for the dimensions of the gestational sac. Diameter "a" is the maximum longitudinal diameter of the gestational sac, which is measured as the distance between the two ends of the longitudinal axis. Diameter "b" is the maximum transverse diameter of the gestational sac, which is measured as the distance from the most anterior of the gestational sac at the incision to the posterior uterine wall of the lower uterine segment. Thinning or absence of the myometrium between the gestational sac and the bladder can be seen (blue arrow). The dotted yellow line on a sagittal section of the uterus indicates the level of a previous lower uterine segment cesarean section scar.

inserted through the cervical canal. The balloon was filled with 15 to 30 mL of water to compress the wound surface for homeostasis after surgery.

Clinical characteristics

We retrospectively analyzed the clinical data between the two groups. These data included the following variables: maternal age, gravity, parity, number of previous CSs, interval since the last CS, gestational age, myometrial thickness (between the gestational sac and the bladder), MTD and MLD of the gestational sac, pre-treatment serum β-hCG concentrations, clinical symptoms (vaginal bleeding or abdominal pain), intraoperative blood loss, and duration of the hospital stay.

Follow-up observation

Three days after the operation, TVUS was used to check any pregnancy residue, and serum β-hCG concentrations were also detected. If serum β-hCG concentrations markedly decreased to more than half of the preoperation value, patients were subsequently discharged. After discharge, the patients were followed up every 2 weeks to determine the serum β-hCG concentration until normalization (<5 IU/L). TVUS or MRI was used to monitor the resolution of the retained mass at the cesarean scar until the mass had been completely absorbed.

Statistical analysis

All statistical analyses were performed using IBM SPSS version 22.0 software (IBM Corp., Armonk, NY, USA). Quantitative variables are expressed as mean $\pm$ standard deviation, and qualitative variables are shown as number (n) and percentage (%). The data of the two independent groups were analyzed using the t test and one-way analysis of variance. A multivariate logistic regression analysis included significantly different variables between the two groups to identify the risk factors associated with predicting the severity of CSP and the choice of the surgical approach procedure. Receiver operating characteristic (ROC) curve analysis was used to identify the optimal cutoff values of the risk factors. $P < 0.05$ was considered to be statistically significant.

Results

Effectiveness of MRI for diagnosing CSP

The MRI findings of early CSP were similar to those seen on TVUS (Figure 2).

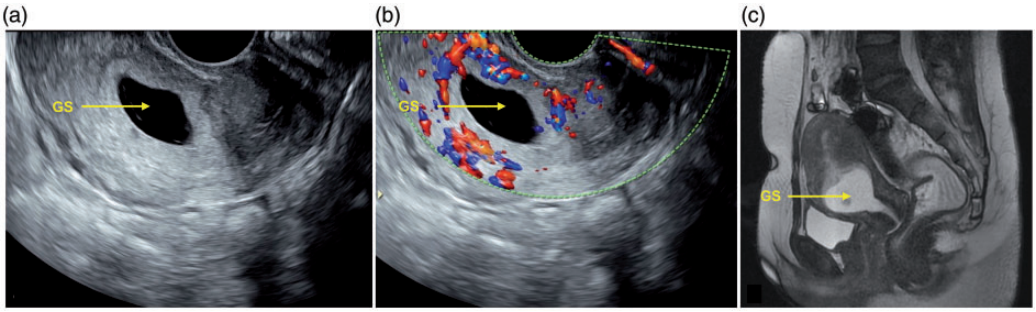

Figure 2. Transvaginal ultrasound imaging and magnetic resonance imaging of a cesarean scar pregnancy. (a) Transvaginal ultrasound image shows a gestational sac (yellow arrow) embedded at the scar site of a previous CS with an empty uterine cavity and cervical canal. (b) Color Doppler shows a rich blood supply surrounding the GS. (c) Sagittal magnetic resonance image shows a GS (yellow arrow) embedded at the site of a previous CS scar.
GS, gestational sac; CS, cesarean section.

The accuracy of MRI in the diagnosis of CPS was 97.9%, while that of TVUS was 88.6% ($P < 0.01$). Four cases with a heterogeneous signal intensity on MRI were initially misdiagnosed in the written MRI reports as a uterine leiomyoma and a trophoblastic tumor. Of the 27 cases misdiagnosed by the initial TVUS, 22 were considered to be a missed spontaneous abortion and 5 were thought to be an intrauterine blood clot. No contrast agent-related complications were recorded in the medical records.

Clinical characteristics of patients with CSP

A total of 199 patients were in the suction curettage group and 38 patients were in the laparoscopic repair group. Among the 237 patients, 134 had had one low-segment cesarean delivery, 99 patients had had two low-segment cesarean deliveries, and 4 patients had had three low-segment cesarean deliveries. Most patients had symptoms of vaginal bleeding (113/237, 47.7%), 7 (3.0%) patients presented with abdominal pain or cramping, and 41 patients had both of these symptoms (17.3%). The rest (76/237, 32.1%) of the patients did not report any complaints. The gestational age was significantly higher ($P = 0.01$) and myometrial thickness was thinner ($P < 0.01$) in the laparoscopic repair group than in the suction curettage group. The MTD of the gestational sac was significantly greater in the laparoscopic repair group than in the suction curettage group ($P < 0.001$), but the MLD of the gestational sac was not different between the groups. There was no significant difference in serum β-hCG concentrations between the groups (Table 1).

Efficacy of suction curettage and laparoscopy for treating CSP

Eighteen patients in the suction curettage group required retreatment because of massive intraoperative bleeding. Two of the 18 patients were switched to laparotomic resection and defect repair, and 16 underwent conversion to laparoscopic resection and defect repair. The remaining 181 patients completed the operation successfully. Patients in the laparoscopic repair group were successfully treated, and none of them required retreatment. The mean operation time in the laparoscopic repair group was significantly longer than that in

Table 1. Comparison of clinical characteristics of patients with cesarean scar pregnancy in the two groups.

Characteristic	Suction curettage group, n = 199	Laparoscopic repair group, n = 38	P value
Maternal age (years)	31.61 ± 4.85	32.13 ± 5.37	0.553
Gravidity (n)	3.09 ± 1.47	3.42 ± 1.27	0.197
Parity (n)	1.47 ± 0.56	1.50 ± 0.56	0.780
Number of prior CSs	1.45 ± 0.54	1.47 ± 0.51	0.779
Interval since the last CS (months)	68.79 ± 51.39	71.21 ± 46.98	0.788
Symptoms at diagnosis, n (%)			0.128
Abdominal pain	6 (3.01)	1 (2.63)	
Vaginal bleeding	90 (45.23)	23 (60.53)	
Both	33 (16.58)	8 (21.05)	
None	70 (35.18)	6 (15.79)	
Gestational age (days)	51.75 ± 13.72	61.58 ± 21.70	0.010
MTD of the gestational sac (mm)	17.27 ± 6.82	22.63 ± 8.40	<0.001
MLD of the gestational sac (mm)	45.31 ± 18.77	50.75 ± 18.88	0.104
Myometrial thickness (mm)	3.07 ± 1.84	1.63 ± 0.70	<0.001
Serum β-hCG concentrations at the time of diagnosis (mIU/mL), n (%)			
≤5000	26 (13.06)	7 (18.42)	0.424
>5000 and ≤10,000	22 (11.06)	2 (5.26)	
>10,000	151 (75.88)	29 (76.32)	
Hemoglobin (g/L)	124.12 ± 12.52	120.64 ± 13.88	0.136

Data are n, n (%), or mean ± standard deviation.
CS, cesarean scar; MTD, maximum transverse diameter; MLD, maximum longitudinal diameter; hCG, human chorionic gonadotropin.

the suction curettage group ($P < 0.001$). The mean intraoperative blood loss was significantly higher in the laparoscopic repair group than in the suction curettage group ($P < 0.001$). The hospitalization duration in the laparoscopic repair group was significantly longer than that in the suction curettage group ($P < 0.001$, Table 2).

The postoperative vaginal bleeding time was similar between the two groups (Table 2). The length of time for serum β-hCG concentrations to normalize and the time required for the local mass to be completely absorbed were significantly shorter in the laparoscopic repair group than in the suction curettage group (both $P < 0.001$, Table 2). Color Doppler ultrasonography showed that the uterine scar defect was significantly improved in the laparoscopy repair group.

Logistic regression analysis of risk factors

Multivariate logistic regression analysis showed that gestational age, the MTD of the gestational sac, and myometrial thickness were independent factors that predicted the necessity for laparoscopic repair of the uterine scar defect (Table 3). Gestational age and the MTD of the gestational sac were positively associated with the severity of CSP, and myometrial thickness was negatively associated with the severity of CSP.

ROC curve analysis of optimal cutoff values

The optimal cutoff values of gestational age, the MTD of the gestational sac, and myometrial thickness were 50.5 days, 20.52 mm, and 1.95 mm, respectively

Table 2. Comparison of treatment outcomes between the two groups.

	Suction curettage group, n = 199	Laparoscopic repair group, n = 38	P value
Operation time (minutes)	28.84 ± 18.45	85.34 ± 47.15	<0.001
Intraoperative blood loss (mL)	52.81 ± 107.43	303.03 ± 326.89	<0.001
Duration of hospitalization (days)	6.09 ± 3.34	9.39 ± 3.82	<0.001
Vaginal bleeding time (days)	9.17 ± 4.34	7.74 ± 4.04	0.060
Time to resolution of serum β-hCG (days)	29.30 ± 9.28	20.68 ± 6.51	<0.001
Time to resolution of the local mass (days)	91.58 ± 18.90	7.63 ± 1.91	<0.001

Data are mean ± standard deviation.

Table 3. Results of multivariate logistic regression analysis.

	B	Wald	P value	OR	95% CI
Gestational age (days)	0.033	8.706	0.003	1.034	1.011–1.057
MTD of the gestational sac (mm)	0.067	6.023	0.014	1.069	1.014–1.127
Myometrial thickness (mm)	−0.923	15.658	<0.001	0.397	0.252–0.628

OR, odds ratio; CI, confidence interval; MTD, maximum transverse diameter.

Table 4. Cutoff values of the risk factors for predicting laparoscopic scar defect repair.

	Cutoff	Sensitivity	Specificity	AUC	P value	95% CI
Gestational age (days)	50.50	0.684	0.618	0.671	0.001	0.573–0.769
MTD of the gestational sac (mm)	20.52	0.658	0.749	0.700	<0.001	0.611–0.790
Myometrial thickness (mm)	1.95	0.678	0.763	0.762	<0.001	0.693–0.831

AUC, area under the curve; CI, confidence interval; MTD, maximum transverse diameter.

(Table 4). The areas under the ROC curves for gestational age, the MTD of the gestational sac, and myometrial thickness were 0.671, 0.700, and 0.762, respectively (Figure 3).

According to our results, we used 50.5 days, 20.5 mm, and 2 mm as the optimal cutoff values of gestational age, the MTD of the gestational sac, and myometrial thickness, respectively. We further used the χ^2 test to analyze these categorical variables between the two groups. There was a significant difference in myometrial thickness between the two groups ($\chi^2 = 24.427$, $P < 0.001$). In the laparoscopic repair group, the majority of patients had a myometrial thickness <2 mm, while most patients had a myometrial thickness ≥2 mm in the suction curettage group. Moreover, the MTD of the gestational sac was greater in the laparoscopic repair group than in the suction curettage group ($\chi^2 = 24.391$, $P < 0.001$). Preoperative serum β-hCG concentrations were not significantly different between the two groups (Table 5).

Discussion

CSP is a life-threatening condition, and therefore, a timely and reliable diagnosis is

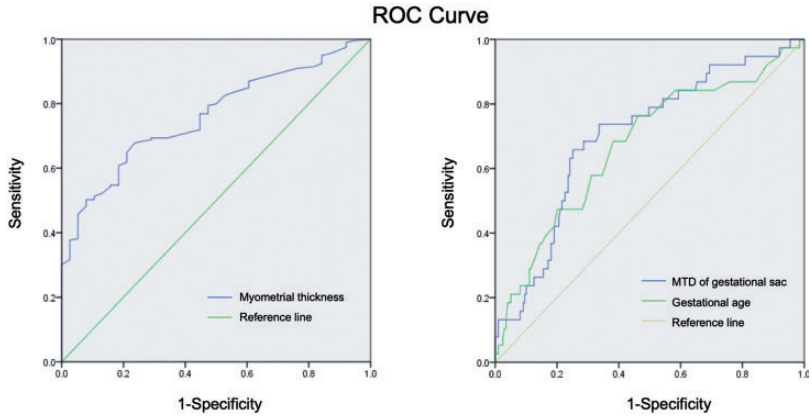

Figure 3. ROC curve analysis was used to assess risk factors for predicting laparoscopic scar repair, including gestational age, the MTD of the gestational sac, and myometrial thickness. The areas under the curve for gestational age, the MTD of the gestational sac, and myometrial thickness were 0.671, 0.700, and 0.762, respectively.
ROC, receiver operating characteristic; MTD, maximum transverse diameter.

Table 5. Chi-square test analysis of factors in the two groups.

Variable	Suction curettage group, n = 199	Laparoscopic repair group, n = 38	χ^2	P value
Gestational age (days)			11.894	0.001
<50.5	123	12		
≥50.5	76	26		
MTD of the gestational sac (mm)			24.391	<0.001
<20.5	149	13		
≥20.5	50	25		
Myometrial thickness (mm)			24.427	<0.001
<2	71	128		
≥2	30	8		
Serum β-hCG concentration at diagnosis (IU/mL)			1.715	0.424
≤5000	26	7		
>5000 and ≤10,000	22	2		
>10,000	151	29		

MTD, maximum transverse diameter; hCG, human chorionic gonadotropin.

particularly important for CSP.[15] Although ultrasonography has long been applied as the first-line diagnostic tool for the diagnosis of CSP, a disadvantage of this imaging modality is its limited sensitivity.[16,17] In our hospital, MRI is applied as a problem-solving modality for suspected CSP when sonograms are inconclusive, and this modality is safe and feasible.[18,19] Our study showed that MRI was a useful and routine imaging modality for determining the features of CSP with a diagnostic accuracy of 97.9% compared with 88.6% using TVUS. Using MRI examinations,

we accurately measured the minimum myometrial thickness of the cesarean section scar defect, and the MTD and MLD of the gestational sac.

Recently, minimally invasive surgery has gradually become the main treatment for CSP.[20,21] Suction curettage and laparoscopic defect repair are recommended treatments for CSP because of their safety and efficacy, practicality, lower potential for side effects, and minimal effect on future fertility.[22–24] Consistent with these studies, in our study, no patients underwent hysterectomy, and there was no uncontrolled intraoperative bleeding or serious complications among the 237 patients. Laparoscopic repair resulted in a significantly longer operation time and hospitalization duration, and greater intraoperative blood loss than ultrasound-guided suction curettage, but no patients required retreatment. Eighteen patients who underwent suction curettage required retreatment because of massive intraoperative bleeding. A report showed that one patient had massive hemorrhage after suction curettage, and another report showed a high complication rate, including myometrial interruption and heavy bleeding.[5,11] Consistent with other reports, our study showed less time for the serum β-hCG concentration to normalize and for the local mass to be completely absorbed in the laparoscopic repair group.[13]

Because there are still no efficient and simple factors to determine which surgical approach should be selected for CSP, we further compared the clinical characteristics between the two groups. We found that gestational age was higher, the MTD of the gestational sac was greater, and the myometrial thickness was thinner in the laparoscopic repair group than in the suction curettage group, which are consistent with other reports.[25] We used multivariate logistic regression analysis and ROC curve analysis to further confirm that these three factors are independent risk factors associated with the necessity of laparoscopic repair of a uterine scar defect. Some gynecologists believe that the β-hCG concentration and the number of prior CSs are also influential factors in the treatment of CSP.[26] However, in our study, there were no significant differences in these two clinical variables between the two groups. Interestingly, there was a significant difference in the MTD but not the MLD, of the gestational sac as measured by MRI between the two groups. This finding may be related to excessive expansion of the lower uterine segment, which affects uterine contraction and causes hemorrhage. Therefore, severity cannot be assessed only in terms of the implantation depth, but should also be assessed according to the growth pattern.

The optimal cutoff values for gestational age, the MTD of the gestational sac, and myometrial thickness were 50.5 days, 20.52 mm, and 1.95 mm, respectively. Therefore, when gestational age is greater than 50.5 days, the MTD of the gestational sac is >20.5 mm, or the myometrial thickness is <2 mm, uterine suction curettage alone may increase the risk of bleeding or uterine incision rupture. Our result is in line with previous reports that concluded that suction curettage was safe only when the myometrial thickness was ≥ 2 mm.[23,27,28] When myometrial thickness is <2 mm, laparoscopic repair should be recommended.[29]

This study is primarily limited by its retrospective nature of data collection and the limited sample size. In the future, multicenter, prospective, randomized, controlled trials should be conducted in a large population for a more comprehensive and objective evaluation of our study findings.

Conclusion

This study suggests that contrast-enhanced MRI is a safe and useful diagnostic tool for diagnosing CSP. Gestational age, the MTD

of the gestational sac, and myometrial thickness are crucial indicators of severe CSP. Laparoscopic repair of a uterine scar defect is safer and more effective in patients with a myometrial thickness <2 mm or in patients with a long MTD.

Availability of data and materials

The datasets generated and/or analyzed during the current study are not publicly available because of patient privacy and hospital policy, but are available from the corresponding author on reasonable request.

Authors' contributions

LL and JX were responsible for the conception and design of the study. JX, LZ, and SW were responsible for drafting the manuscript and revising it critically for important intellectual content. HY and SW were responsible for data collection. LL, JX, and YC were responsible for the acquisition of data, analysis, and interpretation of data. All authors have reviewed and approved the final manuscript.

Declaration of conflicting interest

The authors declare that there is no conflict of interest.

Funding

The authors disclosed receipt of the following financial support for the research, authorship, and publication of this article: This study was supported by the National Natural Science Foundation of China (no. 81802590 to Jiangdong Xiang) and the Scientific Research Project of Shanghai Municipal Health Commission (no. 202140279 to Linxia Li).

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