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Value of ultrasound in diagnosis and treatment of Guillain-Barre syndrome

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Research Article

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Value of ultrasound in diagnosis and treatment of Guillain-Barre syndrome

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Abstract

Objective: This study aimed to evaluate the clinical value of high-frequency ultrasound in the early diagnosis of Guillain-Barré syndrome (GBS) by observing morphological alterations in peripheral nerves. We further summarized the characteristic ultrasonographic changes of peripheral nerves during clinical treatment and explored the feasibility of ultrasound for prognostic evaluation in patients with GBS.

Methods: 35 GBS patients were selected as the experimental group. High-frequency ultrasonic examinations of their peripheral nerves were performed at the time of admission, 7 days (n = 35), 1 month (n = 34), and 6 months (n = 30) after treatment, respectively. The results were compared with those of the control group to summarize the changing patterns, and the patients with poor prognosis were analyzed at the same time.

Result: At admission, the cross-sectional area (CSA) values of the C5 and C6 nerve roots, median nerve (wrist, elbow, and axillary segments), ulnar nerve (wrist, elbow, and axillary segments), sciatic nerve, tibial nerve, peroneal nerve, and sural nerve were significantly increased in GBS patients compared with the control group (all $P<0.05$). At 6 months after treatment, among patients with a Hughes functional score greater than 3, the CSA of the C5 nerve root, axillary median nerve, and axillary ulnar nerve remained remarkably larger than that in the control group, and the differences were statistically significant ($P<0.05$).

Conclusion: Persistent thickening of the C5 nerve root, axillary median nerve, and axillary ulnar nerve at the 6-month follow-up may serve as independent adverse prognostic indicators for patients with GBS.

Keywords: Guillain-barre syndrome, Ultrasound examination, Peripheral nerve, Disease prognosis

Introduction

The Guillain-Barré syndrome(GBS) is a condition in which the body's immune system mistakenly attacks the nerves, causing damage and leading to paralysis. It's actually the most common reason for sudden progressive paralysis. The main symptoms include rapidly worsening weakness on both sides of the body. In severe cases, it can even lead to complete paralysis of all four limbs and potentially life-threatening breathing problems. Researchers have shown that ultrasound can be used within 3 days of onset to see thickening of certain nerves. And ultrasound can continuously and dynamically observe the morphological changes of peripheral nerves[1-2].

The prognosis of Guillain-Barré syndrome (GBS) varies greatly. So it is crucial to predict the prognosis for patients' diagnosis and treatment. This study explores the value of ultrasound in GBS diagnosis by conducting ultrasound examinations at diff erent time points during the treatment process of GBS patients. It summarizes the c -haracteristic changes in peripheral nerve ultrasound imaging of GBS patients during clinical treatment. It examines the value of ultrasound in predicting the prognosis f -or GBS patients.

Material and Methods

We collected 35 GBS patients who sought treatment at the People's Hospital in Liaocheng City, with a time span ranging from October 2020 to June 2023. These patients eventually became our experimental group. Our control group consisted of 35 healthy individuals who were matched with the experimental group in terms of age, gender, and other factors. This study met the diagnostic criteria of the 2019 Chinese Guidelines for Diagnosis and Treatment of Guillain-Barre Syndrome.The ethics number for this study is 2021072

Check equipment and methods

Ultrasound instrument: The color Doppler ultrasound instrument we used was Logiq E9 and Voluson E8 (GE Company). We used a linear array probe with a frequency range of 9-14MHz and selected the musculoskeletal detection mode.

Neuroelectrophysiological examination instrument: The myoelectric induced potentiometer

we used was MEB-9404c (Japan Optoelectronics Company).

The peripheral nerves of patients with GBS were assessed at admission, 7 days post-treatment, 1 month, and 6 months. All assessments were conducted bilaterally using the same machine before and after treatment, ensuring consistent calibration.

(1) Examination sites included the vagus nerve: C5 (at the intervertebral foramen); C6 (at the intervertebral foramen); median nerve (wrist, elbow, axilla); ulnar nerve (wrist, elbow, axilla); radial nerve (midshaft of humerus); sciatic nerve (gluteal fold); femoral nerve (inguinal region); tibial nerve (origin site); peroneal nervesuperficial fibular branch) origin site).

(2) Examination method: Patients assumed appropriate positions and maintained a relaxed state while adequately exposing examination sites. Pressure on peripheral nerves was avoided to ensure clear imaging display. The probe was aligned parallel to the long axis of the nerves to obtain longitudinal sections of the respective nerves. Echogenicity, morphology, sheath appearance, blood flow signals and other sonographic features of the nerves were observed and recorded. The probe was then rotated by 90° to obtain transverse sections for measuring cross-sectional area (CSA) of each nerve using trajectory mapping provided by the instrument. Measurements were taken along the inner edge of high echogenicity neural sheaths at each measurement point three times and averaged.

Neuroelectrophysiological examination instrument: MEB-9404c type myoelectric induced potentiometer (Japan Optoelectronics Company). Room temperature 25℃or so, the hypothesis that patients with in the quiet, relaxed state. The nerves examined included the median nerve, ulnar nerve, tibial nerve, and common peroneal nerve. Data of complex action potential amplitude (CMAP), motor nerve conduction velocity (MCV), terminal motor latency (DML) and other related data were recorded. All nerve electrophysiological tests were performed by one operator.

Prognosis evaluation

Hughes score (Table 1) was used to evaluate the recovery of GBS patients after six months, and the patients were divided into a good prognosis group (Hughes score ≤3 points) and a

poor prognosis group (Hughes score >3 points).

Table 1

Hughes scoring criteria

Grade：
0 score: completely normal, without any neurological impairment
1 score: only mild signs and symptoms, can perform general physical work
2 points: Can walk more than 5 meters without assistance
3 points: Can walk more than 5 meters with help
4 points: can not walk with help, need to use a wheelchair or bed
5 points: Bed rest and need mechanical ventilation
6 points: Death

Results

Comparison of peripheral nerve ultrasound CSA measurements between experimental group and control group

Compared with the control group, CSA of C5, C6, median nerve (wrist, elbow, axillary), ulnar nerve (wrist, elbow, axillary), femoral nerve, sciatic nerve, tibial nerve and common peroneal nerve increased in experimental group, and the difference was statistically significant (P <0.05). There was no significant difference in vagus nerve and radial nerve CSA compared with healthy control group (P >0.05), as shown in Table 2.

Table 2

Comparison of CSA between experimental group and control group（cm2）

	Control group （n=35）	Treatment Group （n=35）	*P*
Vagus nerve	0.012±0.003	0.012±0.004	0.998
C5	0.053±0.010	0.076±0.026	0.000
C6	0.086±0.014	0.107±0.031	0.000
Median nerve (wrist)	0.067±0.010	0.096±0.018	0.000
Median nerve (elbow)	0.078±0.008	0.103±0.024	0.000
Median nerve (axillary)	0.092±0.012	0.117±0.023	0.000
Ulnar nerve (wrist)	0.045±0.006	0.052±0.012	0.002
Ulnar nerve (elbow)	0.057±0.009	0.065±0.013	0.000
Ulnar nerve (axillary)	0.070±0.008	0.077±0.011	0.000
Musculospiral nerve	0.034±0.006	0.035±0.010	0.587
Femoral nerve	0.311±0.032	0.328±0.044	0.002
Ischiadic nerve	0.521±0.038	0.559±0.062	0.014

Nervus peroneus	0.104±0.011	0.130±0.032	0.000
Tibial nerve	0.280±0.024	0.296±0.035	0.026

Comparison of peripheral nerve ultrasound results before and after treatment

There was no significant difference in CSA between the experimental group after 7 days of treatment and before treatment (P >0.05). After 1 month of treatment, the CSA values of C5, C6, median nerve (wrist), median nerve (elbow), median nerve (axilla), ulnar nerve (wrist), ulnar nerve (elbow), ulnar nerve (axilla), radial nerve, sciatic nerve, tibial nerve, peroneal nerves showed a decrease compared to admission but the differences were not statistically significant (P >0.05). After 6 months of treatment, all measured nerves showed statistically significant differences compared to admission(P <0.05). The CSA values of C5 and C6 nerves were significantly different from the control group(P <0.05) while the remaining nerves did not show any statistical significance in comparison with the control group(P >0.05), as shown in Table 3 and Figure 1.

Table 3

Comparison of ultrasound CSA before and after treatment (cm²)

	control group （n=35）	at admission （n=35）	7 days after surgery （n=35）	1month after surgery （n=34）	6 month after surgery （n=30）
Vagus nerve	0.012±0.003	0.012±0.004	0.013±0.005	0.012±0.004	0.011±0.005*
C5	0.053±0.010	0.076±0.026	0.076±0.023	0.072±0.020	0.048±0.011*#
C6	0.086±0.014	0.107±0.031	0.099±0.031	0.096±0.023	0.078±0.016*
Median nerv -e (wrist)	0.067±0.010	0.096±0.018	0.093±0.019	0.084±0.013	0.070±0.013*
Median nerv -e (elbow)	0.078±0.008	0.103±0.024	0.102±0.020	0.096±0.017	0.081±0.014*
Median nerv -e (axillary)	0.092±0.012	0.117±0.023	0.117±0.020	0.109±0.018	0.102±0.035*
Ulnar nerve (wrist)	0.045±0.006	0.052±0.012	0.050±0.009	0.046±0.009	0.047±0.009*
Ulnar nerve (elbow)	0.057±0.009	0.065±0.013	0.062±0.011	0.059±0.011	0.060±0.012*

Ulnar nerve (axillary)	0.070±0.008	0.077±0.011	0.079±0.015	0.073±0.009	0.069±0.013*
Musculospira	0.034±0.006	0.035±0.010	0.037±0.013	0.029±0.005	0.033±0.008*
Femoral ner-ve	0.311±0.032	0.328±0.044	0.327±0.042	0.322±0.075	0.306±0.038*
Ischiadic ne-rve	0.521±0.038	0.559±0.062	0.555±0.059	0.515±0.056	0.504±0.045*
Nervus pero-neus	0.104±0.011	0.130±0.032	0.131±0.030	0.123±0.024	0.100±0.021*
Tibial nerve	0.277±0.025	0.296±0.035	0.294±0.037	0.274±0.028	0.262±0.043*

Note: After 6 months of treatment, * P <0.05 compared with admission, and # P <0.05 compared with control group.

Comparison of nerve electrophysiological measurements before and after treatment

There were significant differences in DML, CMAP and MCV of median nerve, ulnar nerve, tibial nerve and common peroneal nerve in experimental group compared with control group at admission (P <0.05). Median nerve DML, tibial nerve MCV and common peroneal nerve DML after 1 month of treatment were significantly different from those at admission (P <0.05). After 6 months of treatment, there were statistically significant differences in ulnar nerve CMAP, MCV and tibial nerve MCV compared with the control group (P <0.05), while there were no statistically significant differences in residual nerves (P >0.05), as shown in Table 4 and Figure 2.

Table 4

Comparison of neuroelectrophysiological results before and after treatment

		control group（n=35）	at admission（n=35）	1month after surgery（n=34）	6 month after surgery（n=30）
Median nerve	DML(ms)	2.871±0.383	3.079±0.640*	3.571±0.440#	3.023±0.395
	CMAP(mv)	8.113±0.730	6.890±1.558*	6.682±0.519	7.938±0.757
	MCV(m/s)	55.427±2.856	44.220±7.168*	47.126±4.757	52.755±6.768
Ulnar nerve	DML(ms)	3.130±0.310	3.519±0.569*	3.532±0.396	3.148±0.411
	CMAP(mv)	7.676±0.547	7.269±1.140*	7.122±0.468	7.312±0.828+
	MCV(m/s)	56.473±3.281	42.251±7.122*	48.368±2.912	52.737±3.667+
Nervus tibialis	DML(ms)	3.161±0.228	3.554±0.783*	3.341±0.504	3.153±0.337
	CMAP(mv)	10.149±1.494	7.183±2.329*	6.884±0.940	9.922±1.287
	MCV(m/s)	40.934±0.763	35.480±7.895*	39.672±4.584#	39.512±2.638+

Nervus	DML(ms)	3.271±0.140	4.417±1.171*	3.934±0.532#	3.112±0.488
peroneus	CMAP(mv)	7.250±0.194	6.747±1.087*	6.629±0.767	7.300±0.406
communis	MCV(m/s)	41.154±1.004	39.443±3.223*	39.941±3.808	41.537±1.306

Note: DML: terminal latency; CMAP: Compound muscle action potential; MCV: motion conduction velocity. * indicates GBS at admission compared with control group, P <0.05; # indicates that after 1 month of GBS treatment, compared with admission, P <0.05. + indicates that after 6 months of GBS treatment, compared with the control group, P <0.05.

Comparison of good prognosis group and poor prognosis group

Compared with ultrasound CSA in the good prognosis group and the poor prognosis group, there were statistically significant differences in C5, median nerve (axillary) and ulnar nerve (axillary) (P <0.05), as shown in Table 6. Comparison of electrophysiological measurements between the two groups showed statistically significant differences in CAMP and MCV of the median nerve (wrist) and ulnar nerve (wrist) (P <0.05), as shown in Table 5.

Table 5

Comparison of peripheral nerve CSA between good prognosis group and poor prognosis group（cm²）

	Good prognosis group（n=17）	Poor prognosis group（n=13）	*P*
Vagus nerve	0.013±0.002	0.014±0.005	0.319
C5	0.052±0.013	0.067±0.010	0.008
C6	0.079±0.045	0.061±0.019	0.857
Median nerve (wrist)	0.067±0.013	0.012±0.015	0.207
Median nerve (elbow)	0.079±0.013	0.076±0.017	0.270
Median nerve (axillary)	0.095±0.012	0.129±0.052	0.044
Ulnar nerve (wrist)	0.048±0.009	0.042±0.012	0.839
Ulnar nerve (elbow)	0.011±0.013	0.045±0.010	0.687
Ulnar nerve (axillary)	0.054±0.012	0.087±0.009	0.038
Musculospiral nerve	0.026±0.009	0.027±0.004	0.919
Femoral nerve	0.030±0.026	0.312±0.029	0.078
Ischiadic nerve	0.050±0.056	0.465±0.040	0.084
Nervus peroneus	0.097±0.021	0.104±0.021	0.359
Tibial nerve	0.024±0.024	0.229±0.029	0.120

Discussion

GBS is an autoimmune disease. The main clinical manifestations of GBS are symmetrical weakness in the limbs and diminished or absent tendon reflexes. It often starts acutely and peaks within 2 weeks. GBS is the most common cause of acute paralysis in China and

most countries. The disease is self-limiting with a monophasic course and a mortality rate of about 3%-10%[3]. Immunotherapy has shown good efficacy in treating this disease. Most patients recover with timely treatment. If treatment is not timely, patients can be left with permanent disability due to persistent axon loss. Therefore, early diagnosis and identification of GBS patients with poor prognosis are essential for their treatment and prognosis. Studies have shown that increased peripheral nerve CSA can be observed by neurosonography in patients with GBS at an early stage of the disease (within 3 days)[4-7]. The researchers described the characteristics of nerve changes in sonogram. They provide ultrasound morphological basis for the clinical diagnosis of GBS and assessment of the degree of neural involvement.

In this study, CSA of peripheral nerves of 35 GBS patients at admission was compared with that of the control group. Except for vagus nerve and radial nerve, CSA values of other nerves in the GBS group were all higher than those in the control group, which was similar to the results of the domestic research conducted by Zhang Jie and Liu Li et al. [8,9]. Foreign Grimm A et al. [10] found that in the early stage of onset, all nerves except sural nerve are thickened. Their research provides ultrasound morphological evidence for the clinical diagnosis of GBS and assessment of the degree of neural involvement..

In our longitudinal study of GBS patients, we found that there was no significant change in the CSA values of peripheral nerves compared to admission after about one week of treatment. Our research findings are consistent with previous studies[11]. Most nerves became smaller than at admission one month after onset, and most patients' clinical symptoms improved compared to admission. Compared with admission, the DMLs of the median nerve and tibial nerve were shortened, while the MCVs of the median nerve and peroneal nerve were accelerated (Figure 2 a-d). The possible reason for this phenomenon is that peripheral nerves in GBS patients are reversible injuries. After glial and axonal repair at damaged sites in a short period of time, normal neural conduction function can be restored. However, inflammation around nerves still exists. Therefore, peripheral nerves remain thickened.

The study found that after 6 months of treatment, the CSA of peripheral nerves in GBS

patients tended to return to normal (Figure 1 a-f). However, compared with the control group, the C5 nerve remained thickened. In contrast, Grimm A et al.'s study showed that after 6 months, all GBS patients had normal CSA of peripheral nerves[12]. The difference in research results may be due to the heterogeneity of enrolled patients. According to Hughes score at 6 months, approximately 57% of GBS patients in this study had a good prognosis without residual disability and were able to walk independently. The peripheral nerves of these patients have shown a tendency towards recovery. Compared with the good prognosis group, the poor prognosis group still showed thickening of C5 nerve and median nerve (axillary) as well as ulnar nerve (axillary) after 6 months of treatment. Therefore, continuous thickening of C5 nerve and median/ulnar nerves may be an adverse prognostic factor for GBS patients.

Conclusion

The structural analysis and quantitative measurement of peripheral nerves in GBS p-atients by ultrasound can not only identify patients with GBS early, but also provid-e important information for the course and prognosis assessment of the disease.

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Figure

Fig.**1** Comparison of peripheral nerve CSA in GBS patients before and after treatment

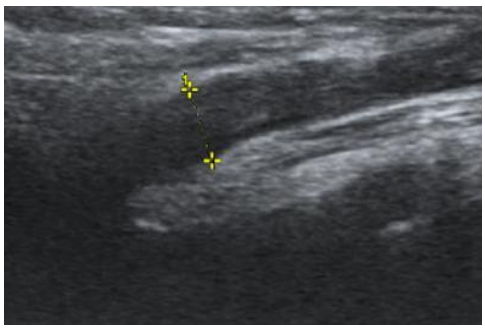


Fig.1.a C5 Before treatment, CSA was about 0.14 cm^2

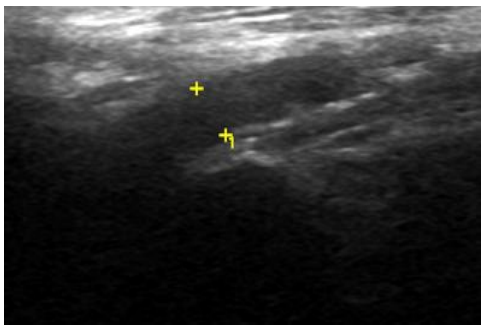
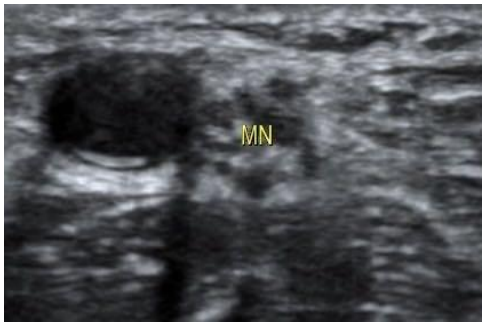


Fig.1.b After C5 treatment, the CSA was about 0.08cm^2



1

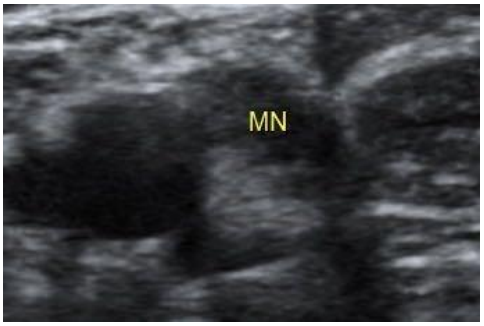


Fig.1.c CSA before median nerve treatment was about 0.27 cm^2

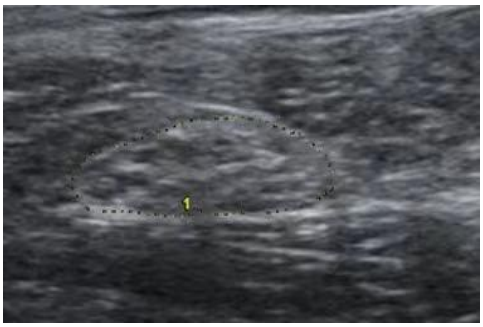


Fig.1.d The CSA after median nerve treatment was about 0.16cm^2

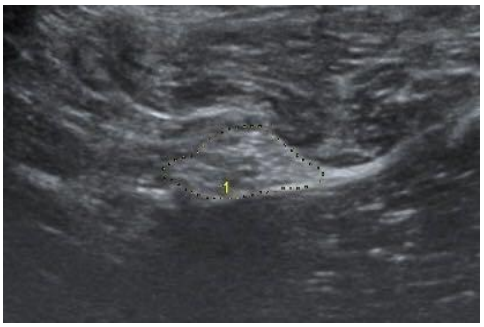


Fig.1.e The CSA before sciatic nerve treatment was about 1.02cm^2

Fig.1.f The CSA after sciatic nerve treatment was about 0.59 cm^2

Fig.**2** Changes of nerve electrophysiological measurements in patients with GBS before and after treatment

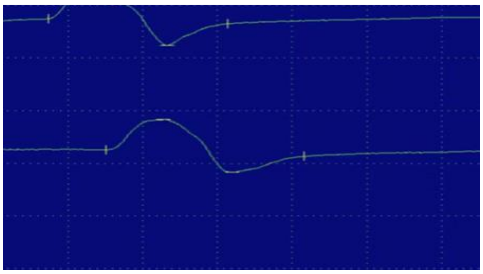


Fig.2.a Median nerve MCV decreased by 36m/s and DML was prolonged by 4.8ms before treatment

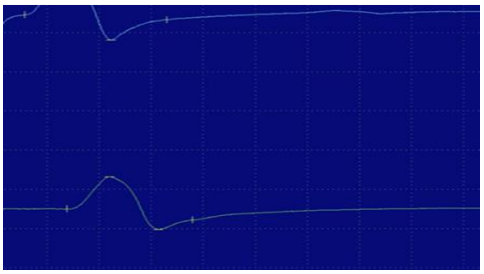


Fig.2. b After treatment, the median nerve MCV was normal(about 54m/s)and DML was normal(about 3.1ms)

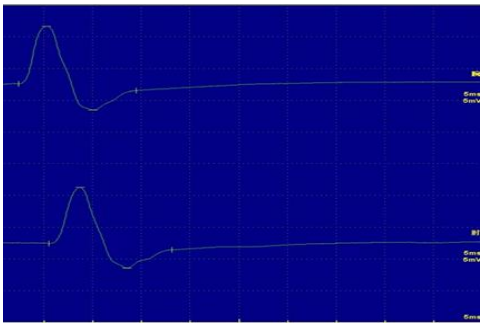


Fig.2.c The anterior tibial nerve was treated with decreased MCV (about 33m/s) and prolonged DML (about 3.7ms)

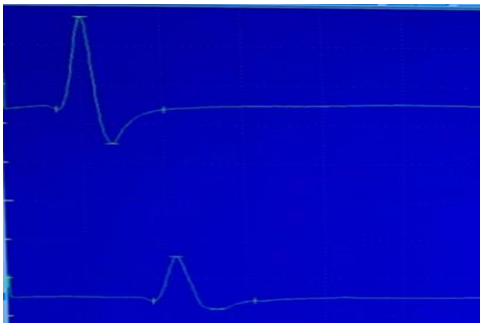


Fig.2.d After treatment, the tibial nerve MCV was normal(about 60m/s)and DML was normal(about 2.1ms)

Declarations

Ethics approval and consent to participate

This study was approved by the Ethics Committee of Liaocheng People's Hospital (Approval No.: 2021072). All procedures performed in this study were in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Due to the retrospective nature of the study, the requirement for informed consent from individual patients was waived by the ethics committee.

Consent for publication

Not applicable. All patient data and imaging information used in this study were fully anonymized without any identifiable personal information.

Availability of data and materials

The datasets used and analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

YG conceived and designed the study, collected clinical and imaging data, performed statistical analysis, and drafted the original manuscript. BZ, FZ, XL and RYL participated in data sorting, literature retrieval and result discussion. MS supervised the whole research process, revised the manuscript critically for important intellectual content, and finalized the version to be published. All authors have read and approved the final manuscript.

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