Effectiveness of the Sellick maneuver for painless gastroscopy in patients with esophageal hiatal hernia: A randomized, self-control trial

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Abstract. The Sellick maneuver is used for endotracheal intubation to prevent the occurrence of gastroesophageal reflux. The aim of the present study was to observe the effect of the Sellick maneuver on safety, esophageal closure status, gastric mucosal fold extension status, and positive detection rate of lesions in patients with esophageal hiatal hernia under painless gastroscopy. A total of 40 patients with esophageal hiatal hernia who underwent painless gastroscopy were screened for the use of the Sellick maneuver, in which the operator applied pressure to the cervical cricoid cartilage during the examination. The status of esophageal closure at the are pressed, examination time, gastric mucosal fold extension score, positive rate of lesion detection, and reflux of gastric juice or gastric contents, amongst other parameters were assessed. After using the Sellick maneuver, the state of esophageal closure during gastroscopy was significantly better than the no-Sellick maneuver group ($P<0.05$), and the extension scores of the greater curvature folds of the gastric body, the lateral folds of the lesser curvature of the gastric body, and the mucosal folds of the fundus were significantly higher than that of the no-Sellick maneuver (all $P<0.05$). The number of gastric polyps and gastric lesions (gastric ulcers and mucosal hyperplasia, amongst others) examined with the Sellick maneuver was significantly higher than the no-Sellick maneuver group ($P<0.01$). The Sellick maneuver effectively improved the extension of gastric mucosal folds during gastroscopy in patients with esophageal hiatal hernia, increased the positive detection rate of gastric lesions, and shortened the endoscopy time.

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Abbreviations: SPO2, peripheral capillary oxygen saturation; CP, cricoid pressure; PACU, postanesthesia Care Unit

Key words: esophageal hernia, gastroscopy, gastroesophageal reflux, intravenous anesthesia, cricoid cartilage

Introduction

The Sellick maneuver is a technique used for endotracheal intubation in which the operator applies pressure to the cervical cricoid cartilage (at the level of the 6th cervical vertebrae) to directly compress and obstruct the posterior esophagus to prevent the occurrence of gastroesophageal reflux (1).

During the painless gastroscopy procedure, CO_2 is pumped into the stomach to fully extend the gastric folds, allowing the endoscopist to detect mucosal lesions in the stomach. The effect of gastric inflation is related to the function of the cardia, if the patient has a disease such as esophageal hiatal hernia (2), the normal contraction and closing function of the cardia sphincter will be affected. As CO_2 can leak into the esophagus through the cardia during gastroscopy inflation, the mucosa of the gastric folds cannot be fully expanded, and this affects the endoscopist's observation of gastric mucosal lesions and may result in a missed diagnosis (3). In addition, gastroesophageal reflux disease, upper gastrointestinal bleeding, intestinal obstruction, and insufficient fasting times may lead to the aspiration of gastric contents during painless gastroscopy, which may cause aspiration pneumonia in severe cases (1,4).

The Sellick maneuver can result in the closure of the upper esophagus; however, whether it is beneficial to promote gastric insufflation during gastroscopy and promote gastric mucosal extension while reducing the occurrence of aspiration pneumonia caused by gastric reflux, has not been determined. Therefore, the aim of the present study was to evaluate the effectiveness of the Sellick maneuver in painless gastroscopy of patients with esophageal hiatal hernia.

Materials and methods

Patients and procedure. The experimental protocol was established, according to the ethical guidelines of the Helsinki Declaration and was approved by the Human Ethics Committee of Wuhan No.1 Hospital (approval no. W202208-1). The study was also registered before patient enrollment at the Chinese Clinical Trials Registry. Gov (registration no. ChiCTR2200063683; principal investigator, Li Zhang; date of

registration, September 14, 2022; registry URL, http://www.chictr.org.cn/edit.aspx?pid=177929&htm=4). After written informed consent was obtained, 40 adult patients [American Society of Anesthesiologists grade 1-3 (5), aged 25-80 years old] scheduled for elective painless gastroscopy under sedation were recruited for the study. Age (median 59; range 29-80), 29 male, 11 female), and other general information are shown in Table I). The exclusion criteria were: Poor gastric emptying with residual food in the stomach; active bleeding in the upper gastrointestinal tract; and severe cardiopulmonary disorders. Patients signed the informed consent forms before undergoing the painless operation. After admission to the gastroscopy suite, routine blood pressure, heart rate, and oxygen saturation monitoring was performed, and peripheral venous access was established. Propofol (1.5-3 mg/kg) was administered slowly intravenously until the patient loses consciousness and eyelash reflex, then the gastrointestinal endoscopist started the gastroscopy procedure. All procedures were performed by the same experienced gastrointestinal endoscopist.

Inclusion criteria: The present study formally included a patient if the endoscopist proposed to diagnose an esophageal hiatal hernia during a sedative gastroscopy. The evaluation tools and measurement indicators of esophageal hiatal hernia were: Under endoscopy, the dentate line of the lower esophageal segment moved up by ≥2 cm; when the endoscope body was inverted, the gastric cavity exhibited enlargement, relaxation, or cystic changes at the cardia, and the mouth of the gastric body moved towards the longitudinal axis of the esophagus; and there was inflammation in the lower esophageal segment.

First, the gastroscopy was performed from the upper esophagus without the Sellick maneuver, after which the anesthesiologist performed the Sellick maneuver, which involved the application of 30 Newton pressure to the cricoid cartilage (6,7), after which the gastroscopist performed the gastroscopy again. Patients were monitored until the end of the gastroscopy operation and the patient woke up in the post-anesthesia care unit (PACU).

Observed indicators. The closure of the esophagus at the location of compression was scored as follows: 2 points, complete closure of the esophagus without air leakage; 1 point, partial closure of the esophagus with small air bubbles seen; and 0 point, poor closure of the esophagus (Fig. 1).

The stomach mucosal fold extension score was scored as follows: 1 point, stomach body major curvature fold extension; 1 point, stomach body minor curvature lateral fold extension; 1 point, gastric fundic mucosal fold extension; and 0 point, corresponding parts not extended. The positive detection rate of the lesions in the gastric lumen (number of polyps or number of lesions) was counted. The operating time of gastroscopy with and without the Sellick maneuver in the same patient in seconds was recorded. The number of times the patient coughed during the examination was scored as follows: No cough, 0 point; 1-2 times, 1 point; 3-4 times, 2 points; and ≥5 times, 3 points. Reflux of gastric juice or stomach contents during a gastroscopy was recorded as yes/no. The blood oxygen saturation SPO_2 (%) variability, heart rate (beats/min) variability; and wake time (in mins) were also recorded.

Table I. Clinicopathological characteristics of the recruited cohort.

Patient characteristic	Measurement
Sex, n, male/female	29/11
Age, years	59 (29-80)
Height, cm[a]	167.10±9.73
Weight, kg[a]	69.98±7.51
Systolic blood pressure, mmHg[a]	132.9±12.09
Diastolic blood pressure, mmHg[a]	70.53±12.09
Heart rate, beats/min[a]	75.05±9.55
SPO_2, %[a]	99.28±1.01
Propofol dosage, mg[a]	137.75±15.77
Wake-up time, min[a]	5.71±0.8

[a]Mean ± SD. SPO_2, peripheral capillary oxygen saturation.

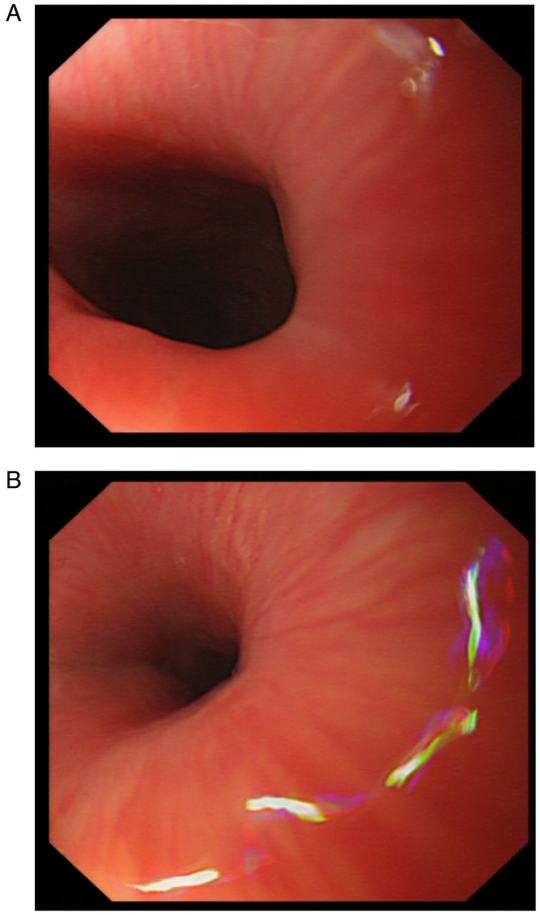

Figure 1. Closed status of the esophagus. Upper esophageal mucosa under endoscopy (A) without and (B) with the Sellick maneuver.

Statistical analysis. Data are presented as the mean ± standard deviation or median (range). Data were compared using a paired-samples t-test (Cohen's d post hoc test) and the count data is presented as the frequency and percentage, the χ^2 test was employed to compare count data, and repeated measures ANOVA (LSD and Tamhane's T2 post hoc tests) was employed

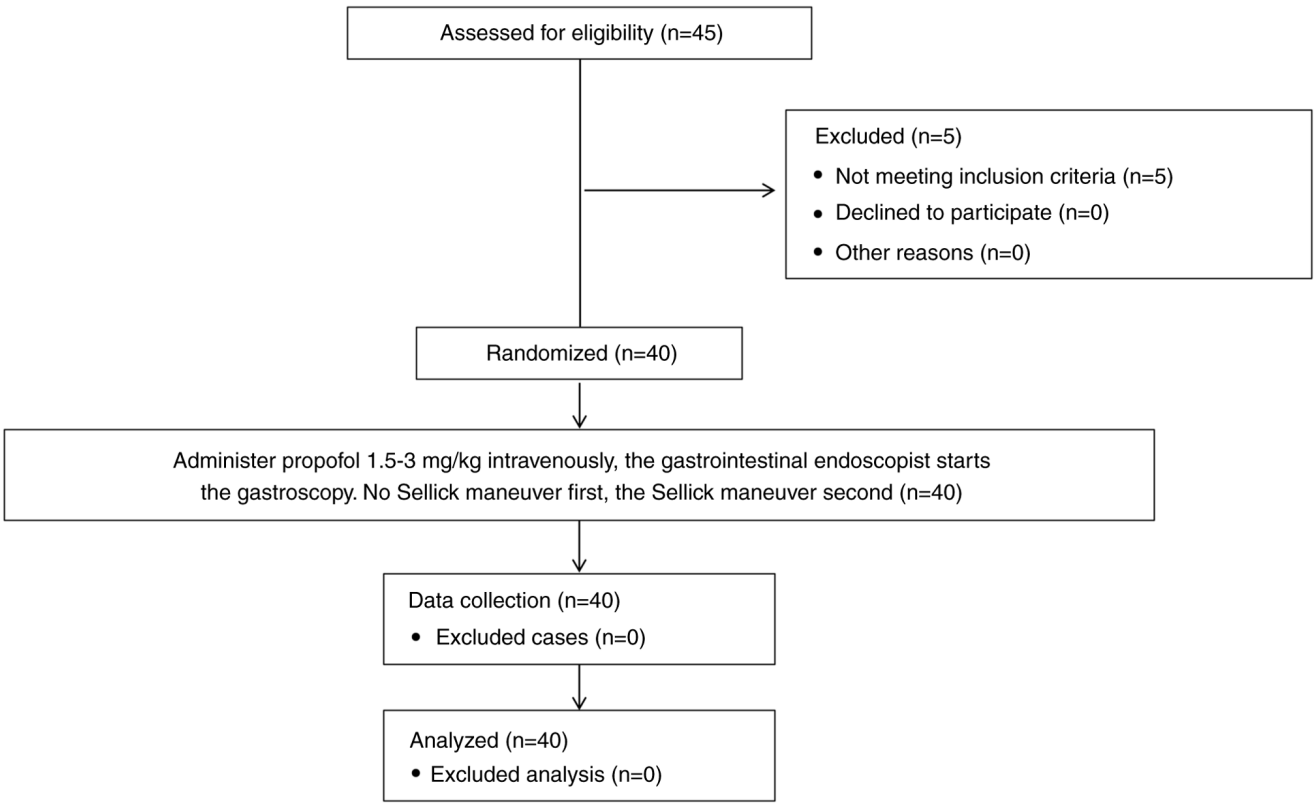

Figure 2. CONSORT flow diagram of the recruitment of participants.

to make comparisons within groups. SPSS version 26.0 (IBM Corp.) was used for statistical analysis. P<0.05 was considered to indicate a statistically significant difference.

Results

A total of 45 patients were recruited in September 2022. Among them, 5 who did not meet the inclusion criteria were excluded, and 40 were included in the final analysis (Fig. 2). The patient characteristics are described in Table I.

The esophageal closure status and gastric mucosal spreading score are shown in Table II. When the gastroscope passed behind the cricoid cartilage of the esophagus, the esophageal closure status score was 0.025±0.16 without the Sellick maneuver and 1.95±0.22 with the Sellick maneuver (P<0.01). The extension scores of the greater curvature folds, the lateral folds of the lesser curvature of the gastric body, and the mucosal folds of the fundus were significantly higher with the Sellick method than without it (1.0+0.0 vs. 0.375±0.49, P<0.01; 1.0±0.0 vs. 0.475±0.51, P<0.01; and 1.0±0.0 vs. 0.375±0.49, P<0.01; respectively; Fig. 3). The total gastric mucosal fold extension score was also significantly higher after the Sellick maneuver than without the Sellick maneuver (3.0±0.0 vs. 1.23±0.70; P<0.01; Fig. 3).

The number of gastric polyps observed with the Sellick maneuver was 0.725±1.13, significantly greater than the 0.325±0.57 observed without the Sellick maneuver (P<0.01), the number of gastric lesions (gastric ulcer and mucosal metaplasia, amongst others) detected using the Sellick maneuver was also significantly higher than that by the no-Sellick method (2.475±1.80 vs. 1.4±1.13, P<0.01; Table II). Painless gastroscopy

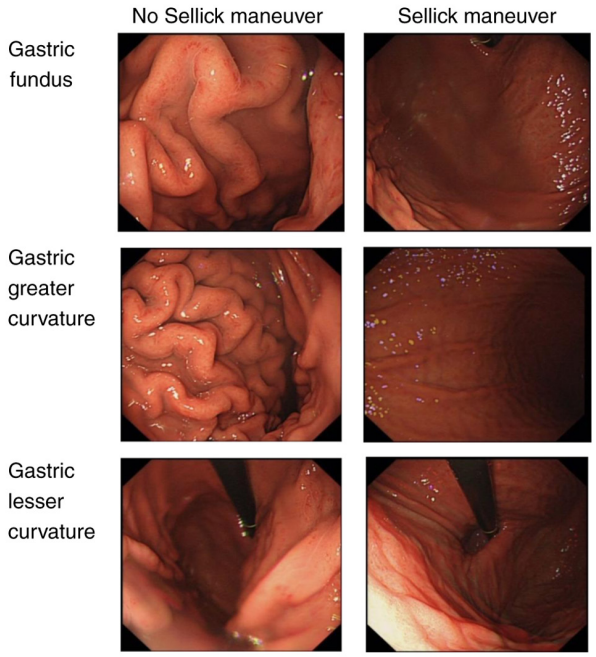

Figure 3. Comparison of gastroscopic extension of the gastric mucosa with and without the Sellick maneuver.

time was shorter with the Sellick maneuver than without (97.93± 15.74 seconds vs. 117.48±18.84 seconds, P<0.01; Table II). Reflux of gastric juice or gastric contents was better with the Sellick maneuver than without (13/40 vs. 0/40, P<0.01; Table II). Choking scores were also significantly lower with the Sellick maneuver than without (0.125±0.33 vs. 0.55±0.60; P<0.01; Table III).

Table II. Comparison of esophageal closure status, gastric mucosal spreading score, and the number of polyps/lesions detected[b].

Scoring criteria	No Sellick maneuver	Sellick maneuver	T-value	P-value
Esophageal closure status	0.025±0.16	1.95±0.22	-45.64	<0.001[a]
Gastric greater curvature fold spreading score	0.375±0.49	1.00±0.00	-8.06	<0.001[a]
Gastric lesser curvature fold spreading score	0.475±0.51	1.00±0.00	-6.57	<0.001[a]
Gastric fundic mucosal fold spreading score	0.375±0.49	1.00±0.00	-8.06	<0.001[a]
The total score of gastric mucosal fold spreading	1.23±0.70	3.00±0.00	-16.09	<0.001[a]
Number of polyps detected	0.325±0.57	0.725±1.13	-3.57	0.001
Number of lesions	1.40±1.13	2.475±1.80	-7.65	<0.001[a]
Operating time, sec	117.48±18.84	97.93±15.74	10.66	<0.001[a]

[a]P≤0.001. [b]Mean ± SD.

Table III. Comparison of the occurrence of choking, regurgitation, oxygen saturation, and heart rate variability.

Variable	No Sellick maneuver	Sellick maneuver	T-value/χ^2	P-value
Choking and coughing score[b]	0.55±0.60	0.125±0.33	5.37	<0.001[a]
Reflux of gastric juice or stomach contents, n	13/40	0/40	15.52	<0.001[a]
SPO_2 variability[b]	2.72±2.01	0.85±1.23	-7.544	<0.001[a]
Heart rate variability[b]	5.0±2.29	3.63±2.16	4.474	<0.001[a]

[a]P≤0.001. [b]Mean ± SD.

Table IV. Comparison of the SPO_2 and HR without and with the Sellick maneuver.

Measurement	Baseline	No Sellick maneuver	Sellick maneuver	P-value
SPO_2	99.28±1.01	96.55±2.25[a]	98.38±1.93[a,b]	0/0.028/0
HR	75.05±9.55	80.05±9.42[a]	78.68±9.32	0.019/0.088/0.516

[a]P<0.05 vs. baseline; [b]P<0.05 vs. no Sellick maneuver; mean ± SD. SPO_2, peripheral capillary oxygen saturation. P-values: No Sellick maneuver vs. baseline/Sellick maneuver vs. baseline/Sellick maneuver vs. no Sellick maneuver.

SPO_2 variability and heart rate variability were significantly different between the Sellick maneuver and non-Sellick maneuver (0.85±1.23 vs. 2.72±2.01 and 3.63±2.16 vs. 5.0±2.29, respectively; both P<0.01; Table III).

During the operation without the Sellick maneuver and with the Sellick maneuver, the SPO_2 of the patients decreased slightly compared with baseline, but both were >95%, and no patient's required an oxygen mask (Table IV). The heart rate measured without the Sellick maneuver was slightly higher than the baseline heart rate, but there was no difference in the heart rate between the without Sellick maneuver group and with the Sellick maneuver (Table IV).

Discussion

Cricoid pressure (CP) is commonly used during the induction of general anesthesia to prevent passive reflux of gastric contents, also known as the Sellick maneuver. Dr. Sellick demonstrated in 1961 that occlusion of the esophagus by cricoid cartilage compression on a cadaver could prevent the flow of barium from the stomach to the pharynx, and he reported the successful use of this technique in 26 'satiated' cases (8-10). The Sellick maneuver prevents gas from entering the stomach during mask ventilation and prevents gastric contents from flowing back into the trachea. Although its efficacy remains controversial (1,11,12), the Sellick maneuver has become more commonly used to prevent gastric reflux in the induction of anesthesia in patients with a full stomach in the emergency setting (13). The results of Rice *et al* (14). also strongly support the efficacy of the Sellick maneuver in occluding the digestive tract after compression of the cricoid cartilage (14).

In the 40 cases of patients diagnosed with hiatal hernia, ordinary gastroscopy was first performed, and this was followed by gastroscopy again under the Sellick maneuver. This was the self-controlled trial, and the relevant data were compared before and after. The observation began when the patient entered the gastroscope operation room, followed by

the normal operational procedure, and then the procedure under the Sellick maneuver.

In the before-and-after comparison of the 40 patients diagnosed with esophageal hiatus hernia during painless gastroscopy, it was found that the state of esophageal closure was significantly better with the Sellick maneuver than without the Sellick maneuver. The extension scores of the greater curvature of the gastric body fold, the lateral folds of the lesser curvature of the gastric body, and the mucosal folds of the fundus were significantly higher than those without the Sellick maneuver. The number of gastric polyps and gastric lesions detected with the Sellick maneuver was significantly higher than without the Sellick maneuver. Inspection time using the Sellick maneuver was shorter than the no-Sellick maneuver. The reflux of gastric juice or gastric contents was also better with the Sellick maneuver than without it. It has previously been shown that in the absence of cricoid cartilage pressure, the esophagus is lateral to the cricoid cartilage in >50% of people, and that pressure on the cricoid cartilage further moves the esophagus and larynx laterally (15). Another study suggested that cricoid pressure was more effective than paratracheal pressure in occluding the esophagus (7). In the present study, it was observed that the gastroscope usually entered the esophagus from the side of the tracheal opening, and through the cricoid cartilage compression, it was clear to see that the compressed esophageal area was tightly wrapped with the gastroscope, and from the extension state of the gastric mucosa, the gas was sealed in the esophagus and stomach below the cricoid cartilage compression site, thus distending the stomach of the patient with hiatal hernia, making it easy for the endoscopist to operate and observe. Previously, increasing the flow rate and flow of gas to compensate for the gas leakage through the esophageal hiatal hernia has been used by the endoscopist; however, this often did not improve the degree of gastric mucosal extension. After using the Sellick maneuver, the gastric lumen filled sufficiently and the extension of the folds improved the efficiency of the observation and shortened the amount of time needed for examination.

Similarly, since the Sellick maneuver resulted in complete esophageal closure, there were fewer incidents of gastric content release and acid reflux compared with endoscopic procedures without the Sellick maneuver, which is consistent with the results of a previous study (16). However, it has been suggested that the use of Sellick maneuver in clinical guidelines cannot prevent pulmonary aspiration in all patients (1). In addition, in the present study, the Sellick maneuver did not increase the degree of choking, as well as changes in SPO_2 and heart rate. Thus, there is little concern regarding the suppression of the patient's breathing by compressions. The SPO_2 in the operation with Sellick maneuver was higher than that in the operation without the Sellick maneuver, and the variability of SPO_2 was lower than that in the operation without the Sellick maneuver, which may be due to the fact that the operation without Sellick maneuver preceded the operation with the Sellick maneuver, and the anesthetic drug propofol was at peak effect in gastroscopy without Sellick maneuver, and therefore influenced the SPO_2. The HR variability was higher in the operation without Sellick maneuver than in the operation with Sellick maneuver, which may be caused by the enhanced stimulation of the gastroscope entering the esophagus before the operation without the Sellick maneuver.

This was self-controlled trial, which indirectly reflects the expansion of the gastric cavity by comparing the expansion of the gastric mucosa of the same patient before and after the Sellick maneuver. Therefore, the Gastric mucosa expansion score was developed to objectively evaluate the effect of the Sellick maneuver. After CO_2 filling of the stomach is stopped under the Sellick maneuver, the gastric expansion was continuously observed, and the gastric mucosa extended without retraction. Similarly, there were significant differences in gastric cavity expansion and Gastric mucosa extension before and after the Sellick maneuver, which indirectly reflected that the Sellick maneuver could better seal the upper esophagus. There may still have been leakage after esophageal closure, but this likely did not affect the observation of Gastric mucosa extension.

The present study has certain limitations in terms of the intensity of compression, which requires appropriate pressure according to the physiology of the patient's cricoid cartilage and esophagus, and training of those who perform the operation is essential (17). Taylor *et al* (18) developed a cricoid cartilage device that may be more effective and safer for performing the Sellick maneuver. In addition, during the operation, the anesthesiologist needs to cooperate with the endoscopist to prevent the occurrence of cardia laceration due to overinflation of the stomach. It is undeniable that this method does have subjectivity, and there was no scoring criteria for gastric mucosal extension after reviewing the literature. Therefore, the scoring criteria were developed for the detection of gastric polyps and gastric lesions under gastroscopy, with the aim to improve and standardize the evaluation of the number of gastric polyps and gastric lesions observed by endoscopy.

In summary, the use of the Sellick maneuver in painless gastroscopy of patients with esophageal hiatal hernia can improve the extension of the gastric mucosa, providing a clearer view, and increasing the detection rate of gastric polyps and lesions. It also did not increase the incidence of cardiac lacerations and did not affect the patient's voluntary breathing, making it a simple maneuver worthy of clinical use.

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Availability of data and material

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

Authors' contributions

LZ conceived and designed the study. LZ and LS collected the data and wrote the manuscript. LS designed the study. ZS and ZC analyzed and interpreted data. LZ, LS, ZS and ZC confirm the authenticity of all the raw data. All authors read and approved the final manuscript.

Ethics approval and consent to participate

The experimental protocol was established according to the ethical guidelines of the Declaration of Helsinki and was approved by the Human Ethics Committee of Wuhan No. 1 Hospital (approval no. W202208-1). Written informed consent was obtained from all individuals or their parents/guardians.

Patient consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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