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Research article

Safety and efficacy of ultrasound-guided superior hypogastric plexus block combined with conscious sedation in ambulatory patients undergoing percutaneous microwave ablation of uterine myomas: Study protocol for a single-center, double-blinded, randomized controlled trial

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ABSTRACT

Background: Pain is a major challenge in performing ultrasound-guided percutaneous microwave ablation (PMWA) of uterine myomas. Inadequate analgesia by local anesthetics hinders the possibility of conducting PMWA of uterine myomas in the Ambulatory Surgery Center (ASC) of the Department of Ultrasound.
Objective: The superior hypogastric plexus (SHP) forms a suitable target for pain relief through the blockade, as it contains nociceptive afferent fibers from pelvic organs such as the uterus, rectum, and bladder. Superior hypogastric plexus block (SHPB) has demonstrated promise as an alternative treatment option for alleviating pelvic pain, reducing opioid consumption, and improving quality of life. This study aims to evaluate the efficacy of ultrasound-guided SHPB combined with conscious sedation as an alternative anesthesia option for ambulatory patients receiving ultrasound-guided PMWA of uterine myomas.
Methods and analysis: This randomized controlled trial (RCT) will be carried out at the Department of Ultrasound, The First Affiliated Hospital of Xiamen University. Women scheduled for ultrasound-guided PMWA of uterine myomas will be eligible. 86 patients will be recruited and randomly assigned to either the intervention or control groups in a 1:1 ratio. The intervention group will undergo ultrasound-guided superior hypogastric plexus block (SHPB) combined with conscious sedation, while the control group will receive local anesthesia combined with conscious

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sedation. The primary outcome is the success rate of anesthesia, secondary outcomes include vasoactive drug consumption, acetaminophen consumption, sleep quality, sonographer satisfaction score, patient satisfaction score, the detained time in hospital, and adverse events.
Discussions: This RCT represents the inaugural effort to specifically evaluate the safety and efficacy of ultrasound-guided SHPB combined with conscious sedation in patients undergoing ultrasound-guided PMWA of uterine myomas and will provide valuable evidence and insight into the analgesic management of this ambulatory surgery.
Ethics and dissemination: This study has been approved by the Ethics Committee of the First Affiliated Hospital of Xiamen University (Scientific Research Ethics Review 2023, No. 139). The results will be submitted for publication in peer-reviewed journals.

1. Introduction

Uterine myoma is a common benign uterine lesion in women of reproductive age, with a prevalence of up to 70% [1,2]. Due to advances in medical technology and the leading role of minimally invasive concepts, ultrasound-guided percutaneous microwave ablation (PMWA) of uterine myomas has garnered increasing attention from patients seeking to preserve their uterus [1,2]. In ultrasound-guided PMWA of uterine myomas surgery, the majority of the patients are women of reproductive age in good physical condition who prefer safe, painless, and comfortable surgery. At the same time, they also aspire to experience a rapid recovery from anesthesia and prompt discharge from the hospital. Due to its small invasiveness, minimal nociceptive stimuli, and quick recovery period, ultrasound-guided PMWA of uterine myomas can often be performed in the Ambulatory Surgery Center (ASC) of the Department of Ultrasound.

Pain management is crucial in ambulatory surgery [3–5]. Failure to provide adequate pain relief may result in anxiety and treatment failure, leading to increased dependence on general anesthesia and worsening the preexisting shortage of anesthesiologists in many countries [6–10]. Hence, it is imperative to explore an alternative anesthesia strategy that relies as little as possible on the anesthesiologist, allowing for ultrasound-guided PMWA of uterine myomas to be safely conducted in the ASC of the Department of Ultrasound.

The origin of the pain associated with the surgery can be ascribed to visceral and somatic pain origins [11]. Somatic pain is initiated by pain receptors located in the skin and deep tissues of the abdominal wall [12] and can be targeted by local infiltration anesthesia of the incision, abdominal wall blocks, or other nerve block techniques such as transversus abdominis plane block [11]. Pelvic visceral pain is associated with the superior hypogastric plexus (SHP). The SHP is a retroperitoneal sympathetic plexus containing nociceptive afferent tracts from pelvic structures, such as the bladder and uterus, located bilaterally in the area between the lower third of the L5 vertebra and the upper third of the S1 vertebra [13–16] which is easy to identify by imaging examination. Transmission of pelvic pain signals can be prevented by superior hypogastric plexus block (SHPB) to the central nervous system [17]. Pieces of evidence have demonstrated that SHPB or superior hypogastric plexus neurolysis (SHPN) has significant advantages in alleviating pelvic pain that occurs acutely and chronically after invasive procedures [18,19], reducing opioid consumption [20], and improving quality of life in women undergoing hysterectomy [21,22], myomectomy, gynecologic cancer [23,24], endometriosis [25], uterine fibroid embolization [26], or uterine artery embolization [17], with fewer side effects. Compared with fluoroscopy-guided and computed tomography-guided, ultrasound-guided is a bedside technique with many advantages such as safety, lack of ionizing radiation, less time-consuming, and facility [23,27,28]. Furthermore, the site of SHP is easily accessible, so ultrasound-guided SHPB can be easily performed before the surgery. However, to date, no study has evaluated the analgesic effect of ultrasound-guided SHPB in patients undergoing PMWA of uterine myomas in a randomized fashion.

To the best of our knowledge, this randomized controlled trial (RCT) will be the first attempt to specifically address the safety and clinical efficacy of ultrasound-guided SHPB combined with sedation in patients undergoing PMWA of uterine myomas compared to the traditional anesthesia strategy. We hypothesize that ultrasound-guided SHPB in combination with conscious sedation may serve as an alternative anesthesia option to provide optimal analgesic and sedative effects and may be an adequate feasibility and safety anesthetic strategy to be performed in the absence of an anesthesiologist.

2. Methods and analysis

2.1. Study design

This is a single-center, double-blinded RCT scheduled to be carried out in the ASC of the Department of Ultrasound, the First Affiliated Hospital of Xiamen University. All participants will be randomly divided into two groups: the intervention group and the control group. This protocol follows the Standard Protocol Items: Recommendations for Interventional Trials guidelines [29] and will be conducted according to the study flow chart (Fig. 1). The intervention group will receive ultrasound-guided anterior-approach SHPB combined with conscious sedation, while the control group will receive local anesthesia combined with conscious sedation. In this study, conscious sedation will be maintained with dexmedetomidine and midazolam. All participants will then undergo ultrasound-guided PMWA of uterine myomas under a certain depth of sedation. After the procedure, they will be transferred to the post-anesthesia care unit (PACU) and allowed to be discharged to the ward if their vital signs stabilize without any observed complications.

2.2. Timeline

All data will be collected according to the participant's specific timeline shown in Table 1 and this timeline includes the following time points: T1: pre-procedure, T2: during the intervention and procedure, T3: in PACU, T4: during the first 24 h after surgery, T5: the 1st week after the procedure, T6: the 4th week after the procedure, T7: the 12th week after the procedure, T8: the 24th week after the procedure.

2.3. Study sample

2.3.1. Participant enrollment

From December 2023 to July 2025, potential subjects for ultrasound-guided PMWA of uterine myomas will be screened and recruited at the outpatient clinic of the Department of Ultrasound, which handles a monthly volume of over 600 uterine myomas patients with the proportion of ultrasound-guided PMWA more than 1 percent. Before the procedure, they will be evaluated and informed of the benefits and the common complications. Before enrollment, written informed consent will be obtained from the patient. All participants have the right to withdraw from the study at any time without incurring any liability, and withdrawal will not affect subsequent treatment.

2.3.2. Participants' inclusion, exclusion and shedding criteria

All potential subjects will be screened according to the inclusion and exclusion criteria below. Participants who meet the following shedding criteria will be removed from this study.

2.3.2.1. Inclusion criteria.

- Patients diagnosed with uterine myomas who are scheduled for ultrasound-guided PMWA of uterine myomas.
- Patients with a body mass index (BMI) of less than 30.0 kg m^{-2}.
- Patients with American Society of Anesthesiologists (ASA) physical status classes I and II.
- Patients aged 18–45 years.
- Patients with a single uterine myoma measuring 2–10 cm in diameter.

2.3.2.2. Exclusion criteria.

- Postmenopausal patients.
- Patients with uterine myomas not excluded as malignant tumors.
- Patients with known allergies to lidocaine, ropivacaine, or other drugs used.
- Patients with a known difficult airway.
- Patients with chronic pain syndromes.
- Patients with coagulopathy.
- Patients with distorted local anatomy.
- Patients with severe cardiopulmonary or hepatorenal disease.
- Patients with mental disorders.

2.3.2.3. Shedding criteria.

- Patients or their authorizers request to withdraw at any stage of this study.
- Serious adverse events occur during the procedure, requiring emergency laparoscopic or open surgery.

- Patients lost to follow-up.

2.3.3. Randomization

Participants will be randomly assigned to either the intervention or control groups based on an allocation sequence generated by a random number generator program. Group allocation will be concealed in opaque envelopes by a separate research assistant who is not responsible for enrollment or follow-up.

2.3.4. Blinding

Patients will be unaware of the anesthesia strategy used as they will be sedated and their medical literacy will prevent them from distinguishing between local anesthesia and SHPB. The anesthesiologist administering conscious sedation will be blinded. The sonographer will be blinded to the group allocation during the procedure. Data will be collected by an independent nurse who will be blinded to the study protocol, enrollment, group allocation, project intervention process, and postoperative care. A research assistant who is responsible for reminding patients to complete questionnaires regularly will be blinded.

The sonographer assistant who has been trained will perform the ultrasound-guided SHPB and local anesthesia. As a result, they will not follow the blinding procedure. Moreover, he and the subjects will be instructed that no information related to this study should be disclosed to any researcher.

2.3.5. Sample size

The calculation of the sample size is based on our preliminary experiment, with a successful anesthesia rate of 60% in the control group and 90% in the intervention group. Based on a power of 0.9 and a type I error of 0.05, we estimate that each group will require 39 participants using sample size calculation software available at http://powerandsamplesize.com/Calculators. To accommodate a 10% dropout rate, a total of 86 participants (43 in each group) will be recruited for this study.

2.4. Intervention

This study aims to compare the safety and efficacy of the two anesthetic strategies in ambulatory patients undergoing ultrasound-guided PMWA of uterine myomas. Once the participant is identified, a schedule for the intervention based on group allocation will be established. The schedule of enrollment, interventions, and assessments is shown in Table 1.

All patients will be consciously sedated by an experienced anesthesiologist using the same sedation protocol consisting of midazolam and dexmedetomidine. After an intravenous infusion of midazolam 2 mg, dexmedetomidine will be administered as a bolus of 0.6 μg kg^{-1} in 10 min, infused continuously at a rate of 0.4 μg kg^{-1} h^{-1}. Flurbiprofen axetil 100 mg will be administered as a part of the multimodal analgesic regimen. Moreover, patients will receive tropisetron 5 mg to prevent nausea and vomiting.

Subjects randomized to the intervention group will receive ultrasound-guided anterior-approach SHPB when the Modified Observer's Assessment of Alertness and Sedation (MOAA/S) scale (Table 2) reaches 3. Using a 2–5 MHz curvilinear ultrasound probe placed in the area between the umbilicus and pubic symphysis, the L5 vertebra will be imaged and identified. The anatomic landmark for locating the site of SHP is the lower third of the L5 vertebra, just below the bifurcation of the aorta [14,15,17]. A trained sonographer assistant will push the abdominal wall slowly with the probe, keeping the bowel away from the puncture path [30]. Color Doppler imaging will be useful in confirming the location of iliac vessels [30]. A 5 ml solution of 1% lidocaine will be injected into the skin and subcutaneous tissue at the puncture site. Using the in-plane ultrasound guidance technique, a 20 cm long, 22-gauge needle will be inserted percutaneously, advanced away from organs and blood vessels until hitting the lower third of the L5 vertebra, and withdrawn for 1∼2 mm to avoid periosteum injection [17,27]. After negative aspiration, the midline position of the needle tip will be identified with 1 ml of normal saline [30]. Subsequently, 10 ml of 0.5% ropivacaine will be incrementally injected into this area without resistance and spread equally on either side of the midline (Fig. 2). 10 min later, ultrasound-guided PMWA of uterine myomas will be performed.

In subjects randomized to the control group, local anesthesia will be performed when the MOAA/S reaches 3. Image uterine myoma using a 2–5 MHz curvilinear ultrasound probe placed in the area between the umbilicus and pubic symphysis and gently push the abdominal wall to remove the bowel from the puncture path. Color Doppler imaging will be useful in confirming the location of iliac vessels. Similarly, 5 ml of 1% lidocaine will be injected into the skin and subcutaneous tissue at the puncture site. Using the in-plane ultrasound guidance technique, a 20 cm long, 22-gauge needle will be inserted percutaneously and advanced away from organs until hitting the uterus. Identify the needle tip located in the subserosa of the uterus with 1 ml of normal saline after negative aspiration and inject 5 ml of 0.5% ropivacaine incrementally into this area (Fig. 3). Continue to push the needle forward until the tip reaches the area under the capsule of the uterine myomas. Identify the needle tip with 1 ml of normal saline after negative aspiration and gradually inject 5 ml of 0.5% ropivacaine into this area (Fig. 4). 10 min later, ultrasound-guided PMWA of uterine myomas will be performed.

2.5. Monitoring and standard practice-based anesthesia protocol

All participants will be instructed to fast for 8 h, refrain from drinking water for 4 h, and empty their bladder prior to anesthesia. Laxatives will be taken the night before the procedure to clean the bowel of air and contents. They will be escorted to the procedure room and placed in the Trendelenburg position. Before the procedure, patients will receive 1000 ml of the lactated Ringer's solution

via a 22-gauge intravenous catheter to prevent hypotension. Vital signs will be monitored continuously and documented in detail, including electrocardiography (ECG), heart rate (HR), peripheral oxygen saturation (SpO_2), non-invasive blood pressure (BP), and respiratory rate. Oxygen will be delivered through a mask at a flow rate of 3 L min^{-1}.

The surgical site will be prepped with iodophor disinfectant and draped with sterile sheets. Artificial ascites will be established by injecting 1500 ml of normal saline into the abdominal cavity through a puncture needle that penetrates the abdominal wall. Ultrasound-guided PMWA of uterine myomas will be performed by an experienced sonographer after anesthesia according to the protocol described previously. At the end of the procedure, stop all sedative infusions and transfer patients to the PACU. They will be discharged to the ward if they are awake with stable vital signs and no complications. At the same time, they will be instructed to alternate oral acetaminophen 1 g every 6 h as needed for pain, and the total acetaminophen consumption during the first 24 h after surgery will be documented.

During the procedure, if the patient complains of pain and requires analgesia or has a visual analog scale (VAS) score $\geq$4 [11,31], 3 ml of 1% lidocaine will be immediately injected locally as remedial analgesia. Need for remedial analgesia more than 3 times within 10 min will be considered as failure of anesthesia. In this case, dexmedetomidine will be immediately discontinued and fentanyl 50 μg will be administered along with single or multiple propofol boluses of 0.5 mg kg^{-1} until the MOAA/S scale reaches 1, followed by continuous infusion at a rate of 0.4–1.0 mg kg^{-1} h^{-1} to maintain sedation. If the patient has any unconscious body movements after the injection of propofol, such as raising the head or moving the limbs, inadequate sedation will be considered. Remedial sedation, a propofol bolus of 0.5 mg kg^{-1}, will be repeated at 1-min intervals until the MOAA/S scale returns to 1.

Atropine 0.5 mg will be injected immediately if the HR is less than 45 beats per minute. Phenylephrine 40 μg will be administered intravenously if the decrease in mean arterial pressure (MAP) exceeds 20% of the baseline.

If airway obstruction or respiratory depression occurs, immediate use of jaw thrust and/or positive-pressure ventilation with bag-mask will be indicated.

In cases of bowel injury, subphrenic free gas may appear at the highest point of the abdominal cavity, such as the front of the left lobe of the liver.

Ultrasound can be used to detect bleeding spots in patients with severe iliac blood vessel injury, where local blood flow velocity is high and the color blood flow signal is visible. In patients with minor injuries, bleeding points can be determined by contrast agent microbubbles in artificial ascites under contrast-enhanced ultrasound.

2.6. Outcomes

2.6.1. Primary outcomes

The primary outcome is the success rate of anesthesia during the procedure.

Anesthesia is deemed successful if remedial analgesia is required no more than three times within 10 min. The success rate of anesthesia is calculated by dividing the number of successful anesthesia cases by the total number of patients in the intervention/control group.

Remedial analgesia will be administered if requested by the patient or if the VAS score is greater than 3 during the procedure. The VAS is a validated 100-mm scale ranging from 0 to 10, with 0 indicating “no pain” and 10 indicating “the worst pain imaginable” [10,20].

2.6.2. Secondary outcomes

Secondary outcomes include vasoactive drug consumption, acetaminophen consumption, sleep quality, sonographer satisfaction score, patient satisfaction score, the detained time in hospital, and adverse events.

Vasoactive drug consumption will be defined as the aggregate consumption of atropine and phenylephrine during the procedure and in PACU.

Acetaminophen consumption will be the total consumption documented during the first 24 h post-operation.

Sleep quality will be assessed at pre-procedure and the 1st, 4th, 12th, and 24th weeks after the procedure using the Pittsburgh Sleep Quality Index (PSQI) (Table 3), a 19-item questionnaire, with a PSQI score greater than 5 defined as poor sleepers [32].

Sonographer satisfaction score (0 = dissatisfied, 10 = very satisfied) [14] will be collected following the operation, whereas the patient’s satisfaction will be assessed on the 1st after the procedure.

Time from admission to discharge from the hospital will be defined as the detained time in the hospital.

Bowel injury, vascular injury, nausea, vomiting, and hypoxemia needed to treat will be included in adverse events.

2.7. Data collection, handling, and monitoring

We will collect additional patient and procedure-related characteristics from the medical record as follows:

- Demographic data including age and ASA physical status classifications.
- Data about the primary and secondary outcomes.
- Physical examination data and clinical monitoring data including HR, MAP, SpO_2, MOAA/S, and VAS.

To avoid a loss to follow-up, patients will be periodically contacted by a research assistant who is blinded to the group assignment to remind them to complete the questionnaires above. All adverse events will be thoroughly followed up and recorded in detail. Under

the supervision of an independent research data administrator, all raw data will be inputted into Excel spreadsheets, which are stored in a password-protected database. Ultrasound images will also be stored on the research center's computer with login passwords. Nobody can be accessible to this database or this computer without the permission of the administrator.

2.8. Statistical analysis

All data will be analyzed using the Statistical Product and Service Solutions (IBM SPSS, V.20.0) statistical software. The last observation carried forward method will be used to impute missing data and the interim analyses will not be performed in this study. Continuous variables will be analyzed using the *t*-test or Wilcoxon rank test. Counting data will be compared using the chi-squared test or Fisher's exact test. A p-value less than 0.05 will be considered statistically significant.

3. Discussion

Ultrasound-guided SHPB is currently an underutilized option for anesthesia. This study is the first RCT to confirm its safety and efficacy in patients undergoing ultrasound-guided PMWA of uterine myomas, providing valuable evidence and insight into the analgesic management of this surgery. The strengths of this study ought to be emphasized as follows.

3.1. Strengths of the study

Firstly, SHPB is conducted by utilizing ultrasound-guided anatomical landmarks to identify the injection site. On the other hand, sonographers are adept at determining the abdominal and pelvic anatomical structures, allowing for ultrasound-guided SHPB with an anterior-approach to be performed safely, easily, and directly. Therefore, ultrasound-guided anterior-approach SHPB will be easily reproducible and popularized in clinical practice.

Secondly, compared to fluoroscopic guidance [33,34] or computed tomography (CT) [15], ultrasound guidance is a user-friendly approach. For women of reproductive age, harmful radiation is a big concern and is not acceptable. Conversely, ultrasound guidance can offer several unique advantages, including bedside utilization, safety, lack of ionizing radiation, less time-consuming, and facility.

Thirdly, ultrasound SHPB has exhibited analgesic and opioid-sparing properties, and it will be expected to reduce the need for other commonly utilized anesthesia strategies, such as intravenous anesthesia, spinal anesthesia, epidural anesthesia, or general anesthesia [35–37]. In future clinical practice, we anticipate that a trained nurse will administer conscious sedation and an on-call anesthesiologist will be arranged for the occasional propofol and fentanyl cases. Thus, this may lessen dependence on anesthesiologists and potentially ameliorate the common issue of a shortage of anesthesiologists in many countries [6–9], allowing for optimal allocation of medical resources. Additionally, the anesthesia strategy in the intervention group can reduce the use of anesthetics and sedatives and anesthesia-related adverse events, thereby promoting the development of enhanced recovery after surgery (ERAS)-focused and comfort-focused medical practices.

Fourthly, nervousness and anxiety may decrease patient's tolerance during the procedure and may produce a bad surgical experience, even surgery failure. Surgical stress response, sedative, postoperative pain, and opioid use are the main factors that may influence postoperative sleep [38]. Propofol is a common sedative used for procedural sedation and general anesthesia [39,40]. However, it can pose a high risk of cardiopulmonary depression events [41,42] and sleep disorders [38]. Dexmedetomidine and midazolam have shown promising results for conscious sedation in the absence of an anesthesiologist [43]. It is worth noting that dexmedetomidine can induce a state similar to natural sleep without respiratory depression [44], allowing for more reliable sedation when combined with midazolam [45,46]. Additionally, SHPB also has the potential to improve mental state and insomnia [14]. Therefore, we anticipate that combining both drugs may enhance the practicality and potential of SHPB in clinical practice.

3.2. Limitations

There are likewise several limitations that should not be disregarded.

Firstly, ultrasound-guided anterior-approach SHPB may carry the risks of injuries to the viscera and the iliac vessels. However, preprocedure bowel and bladder preparation, the Trendelenburg position, and a smaller size needle can avoid visceral injury, because collapsed viscera will tend to fall away from the needle path [30]. The risk of vessel injuries is readily reduced using color Doppler imaging guidance and after negative aspiration of blood [30]. Additionally, artificial ascites will increase the bowel's range of motion and push it from the needle path by compressing the abdominal wall with the probe. Simultaneously, it also enhances the ultrasonic imaging of the needle and blood vessels, avoiding iatrogenic injuries to the viscera and the vessels during the process. Therefore, an experienced sonographer can avoid these injuries.

Secondly, although more frequent and longer follow-ups may better assess sleep quality continuously, it may lead to reduced adherence and higher rates of patient dropout. Therefore, balancing the potential benefit with patient compliance is critical and requires careful consideration.

Lastly, we recognize that the strength of the findings may be limited due to its single-center nature with a small sample size. To enhance the robustness and generalizability of the results, conducting multi-center randomized controlled trials (RCTs) with larger participant groups may be beneficial.

4. Conclusion

We anticipate that ultrasound-guided PMWA of uterine myomas surgery can be performed and completed under ultrasound-guided anterior-approach SHPB combined with conscious sedation. Meanwhile, we will also evaluate the safety and feasibility of this anesthesia strategy in the absence of an anesthesiologist, thereby enhancing its potential value in ambulatory surgery.

Ethics and Dissemination

This RCT was designed following the principles of the Declaration of Helsinki. This study was reviewed and approved by the Ethics Committee of the First Affiliated Hospital of Xiamen University on November 20, 2023 (Scientific Research Ethics Review 2023, No.139), and it was registered at the China Clinical Trial Center on December 13, 2023 (ChiCTR2300078599). All participants will receive a comprehensive explanation of the procedures and potential risks of the study and will be required to sign an informed consent form before participating. The project will be subject to periodic scrutiny by the Ethics Committee to determine whether it should continue. The research findings will be published in peer-reviewed journals as papers, and the research data will be made publicly available at that time.

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Data availability statement

No data was used for the research described in the article.

Summary

Inadequate analgesia by local anesthetics hinders the possibility of performing ultrasound-guided PMWA of uterine myomas in the ASC of the Department of Ultrasound. SHPB has demonstrated promise as an alternative treatment option for alleviating pelvic pain, reducing opioid consumption, and improving quality of life. This RCT represents the inaugural effort to specifically evaluate the safety and efficacy of ultrasound-guided anterior-approach SHPB combined with conscious sedation in these individuals.

CRediT authorship contribution statement

Lijuan Yan: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Xiao Wang:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Zuobing Zhang:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Resources, Methodology, Investigation, Conceptualization. **Zhibin Li:** Writing – review & editing, Writing – original draft, Visualization, Software, Project administration, Methodology, Formal analysis, Data curation, Conceptualization. **Laiting Chi:** Writing – review & editing, Writing – original draft, Visualization, Validation, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Lijuan Wang:** Writing – review & editing, Writing – original draft, Visualization, Validation, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

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