Five-year retrospective review of ultrasound-guided manual vacuum aspiration for first-trimester miscarriage

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ABSTRACT

Introduction: Manual vacuum aspiration is increasingly accepted as an alternative to medical or surgical evacuation of the uterus after first-trimester miscarriage. This study aimed to assess the efficacy of ultrasound-guided manual vacuum aspiration (USG-MVA) in the management of first-trimester miscarriage.

Methods: This retrospective analysis included adult women with first-trimester miscarriage who underwent USG-MVA in Hong Kong between July 2015 and February 2021. The primary outcome was the efficacy of USG-MVA in terms of complete evacuation of the uterus, without the need for further medical or surgical intervention. Secondary outcomes included tolerance of the entire procedure, the success rate of karyotyping using chorionic villi, and procedural safety (ie, any clinically significant complications).

Results: In total, 331 patients were scheduled to undergo USG-MVA for first-trimester miscarriage or incomplete miscarriage. The procedure was completed in 314 patients and well-tolerated in all of those patients. The complete evacuation rate was 94.6% (297/314), which is similar to the rate (98.1%) achieved by conventional surgical evacuation in a previous randomised controlled trial in our unit. There were no major complications. Samples from 95.2% of patients were suitable for karyotyping, which is considerably higher than the rate of suitable samples (82.9%) obtained via conventional surgical evacuation in our previous randomised controlled trial.

Conclusion: Ultrasound-guided manual vacuum aspiration is a safe and effective method to manage first-trimester miscarriage. Although it currently is not extensively used in Hong Kong, its broader clinical application could avoid general anaesthesia and shorten hospital stay.

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New knowledge added by this study

- Ultrasound-guided manual vacuum aspiration (USG-MVA) is a safe and effective method for the management of miscarriage, but its use is limited in Hong Kong.
- USG-MVA is similar in safety and efficacy to conventional surgical evacuation of the uterus (dilatation and curettage) under general anaesthesia for the management of miscarriage; it is well-tolerated by patients and causes minimal complications.
- USG-MVA is a good surgical option for women with miscarriage who wish to obtain products of conception for karyotyping.

Implications for clinical practice or policy

- USG-MVA can be more widely implemented as an alternative to conventional dilatation and curettage/electrical vacuum aspiration of the uterus for the management of first-trimester miscarriage in Hong Kong.
- For women with recurrent miscarriage, USG-MVA should be considered because it has a higher rate of karyotyping success, compared with conventional suction evacuation of the uterus.

Introduction

Miscarriage occurs in 10% to 20% of pregnancies, and approximately one in four women will experience a miscarriage in their lifetime.[1] It is managed using one of three approaches: expectant, medical, or surgical.

In 1972, manual vacuum aspiration (MVA) was introduced[2] as an alternative method for the surgical management of miscarriage. It is performed using a handheld 60-mL syringe, which creates a suction force to aspirate the contents of the uterus through a cannula. This technique has various applications, including the management of first-trimester

超聲波引導式手動真空抽吸術治療早孕期流產：五年回顧性研究

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引言：手動式真空抽吸術漸漸被接受替代藥物流產或手術刮宮來治療早孕期流產。本研究評估超聲波引導式手動真空抽吸術在治療早孕期流產的成效。

方法：本研究回顧性分析了2015年7月至2021年2月期間在香港接受超聲波引導式手動真空抽吸術的早孕期流產成年女性病例。主要成效判定指標是該手術在清宮方面的成效，而無需進一步的藥物流產或手術刮宮。另一成效判定指標包括患者對整個程序的耐受、使用絨毛膜絨毛進行核型分析的成功率和整個程序的安全性（即沒有出現任何具有臨床意義的併發症）。

結果：總共有331名患者因早孕期流產或不完全流產而獲安排進行超聲波引導式手動真空抽吸術，當中的314名患者中完成了該手術，這些患者對整個程序的耐受都很高。該手術的成功率為94.6%（297/314），與我們先前隨機對照研究中常規刮宮手術的成功率（98.1%）相似，而且沒有重大併發症。當中95.2%患者的流產組織樣本適合進行核型分析，這大大高於我們之前的隨機對照研究中通過常規刮宮手術獲得的合適樣本率（82.9%）。

結論：超聲波引導式手動真空抽吸術是一種安全有效治療早孕期流產的方法。雖然該手術目前在香港並未廣泛使用，但臨床上廣泛應用該手術可避免全身麻醉並縮短住院時間。

miscarriage, incomplete or missed miscarriage, endometrial biopsy, and first-trimester termination of pregnancy; it can also be used after failed medical evacuation of pregnancy. Because it only requires simple oral analgesics or conscious sedation, this procedure can be performed on an out-patient basis in a treatment (or procedure) room; thus, it avoids the use of a surgical theatre and the risks of general anaesthesia, resulting in a shorter hospital stay.[3]

Conventional MVA is performed without ultrasound guidance. However, because MVA is performed on an out-patient basis without general anaesthesia, ultrasound guidance may help to minimise discomfort and procedure duration by limiting the number of suction catheter passes and achieving a higher rate of complete evacuation. Studies by Elsedeek[4] and Ali et al[5] have shown that ultrasound guidance allows clinicians to avoid contact with the uterine fundus, leading to higher rates of procedure completion, significantly lower pain scores, and shorter procedure times. We previously demonstrated that ultrasound-guided manual vacuum aspiration (USG-MVA) is a feasible and effective alternative surgical approach for first-trimester miscarriage.[6]

Additionally, women with recurrent miscarriage may prefer surgical evacuation (rather than medical evacuation) because this approach facilitates the acquisition of products of conception for cytogenetic analysis. The use of USG-MVA causes less disruption of products of conception; it also can aid in the identification of chorionic villi for karyotyping. Therefore, USG-MVA may be particularly useful for women with recurrent miscarriage.

Ultrasound-guided manual vacuum aspiration is gaining acceptability, awareness, and recognition in Hong Kong, although it is not commonly used in clinical practice. To demonstrate the value of the procedure, this study aimed to assess the effectiveness of USG-MVA in the management of first-trimester miscarriage.

Methods

Patient selection

This retrospective observational study included all women who underwent USG-MVA in Hong Kong during the period from July 2015 to February 2021. Eligible patients were identified by hospital records in Prince of Wales Hospital and Union Hospital. The indications for USG-MVA included missed or incomplete miscarriage at <12 weeks of gestation, as well as the desire for cytogenetic examination of the products of conception to determine the underlying cause of miscarriage. For naturally conceived pregnancies, the date of the last menstrual period was used to determine gestational age. For artificially conceived pregnancies, gestational age was determined according to the date of ovulation, oocyte retrieval, or embryo transfer. All women were counselled about the management options: expectant, medical, conventional surgical (electrical vacuum aspiration with or without dilatation and curettage, under general anaesthesia), and USG-MVA.

Miscarriage was diagnosed by ultrasound examination. A diagnosis of missed miscarriage was made if a discrete embryo ≥7 mm without fetal heart pulsation, or an intrauterine gestational sac with a mean sac diameter of 25 mm excluding the fetal pole, was detected on transvaginal ultrasound. If only transabdominal ultrasound was performed, the crown-rump length was recorded; a second scan was performed 14 days later. A diagnosis of missed miscarriage also was made if the mean sac diameter was ≤25 mm without evidence of growth, or if there was a sustained absence of fetal heart pulsation, during a follow-up examination 7 to 14 days later.[7,8]

A diagnosis of incomplete miscarriage was made if the ultrasound examination showed residual products of conception after the initial passage, defined as consistent intra-uterine thickness of ≥11 cm in the sagittal and transverse planes, and/or if the patient experienced persistent symptoms such as pain or bleeding.[9]

Patients were excluded if they had a known

history of uterine anomalies, cervical stenosis, and/or multiple fibroids with uterine distortion. Patients were also excluded if they had suspected infection, an abnormal coagulation profile, haemodynamic instability, and/or extreme anxiety that hindered their ability to tolerate a pelvic examination.

Outcome measures

The primary outcome measure was the efficacy of USG-MVA in terms of complete evacuation of the uterus, without the need for further medical or surgical intervention. We also compared the complete evacuation rate with optimal outcomes in our unit from a previous randomised controlled trial (RCT) that involved other methods of miscarriage management.[10] Secondary outcomes included whether patients could tolerate the entire procedure without discontinuation prior to completion; the success rate of karyotyping using chorionic villi obtained from USG-MVA–collected samples, compared with samples collected by conventional surgical evacuation in our unit during the same period; and procedural safety, defined as the occurrence of any clinically significant complications (eg, bleeding requiring blood transfusion, uterine perforation, infection, and vasovagal shock).

Ultrasound-guided manual vacuum aspiration procedure

Ultrasound-guided manual vacuum aspiration was performed on an out-patient basis in a treatment room with a handheld syringe and flexible curette, as well as an ultrasound machine. Each patient was instructed to take misoprostol 400 μg orally 2 to 3 hours before the procedure for cervical priming; they were also instructed to take naproxen 500 mg 1 hour before the procedure for pre-emptive pain relief. Patients were instructed to take paracetamol or codeine, rather than naproxen, if they were allergic to non-steroidal anti-inflammatory drugs. Upon admission, patients were asked not to void because a full bladder enables better visualisation of the uterus on transabdominal ultrasound. Prophylactic antibiotics were not routinely administered prior to the procedure.

Ultrasound-guided manual vacuum aspiration was performed by an experienced clinician using a 60-mL handheld syringe with a self-locking plunge (MedGyn Aspiration Kit; MedGyn Products, Addison [IL], US) attached to a flexible curette (size 4-7 mm, according to clinician preference); a nurse assisted with ultrasound guidance. During USG-MVA, a speculum examination and swabbing were performed with aseptic technique. A paracervical block with 2% lidocaine was administered using a Terumo Dental Needle (Terumo, Tokyo, Japan). If necessary, the clinician performing the procedure could immobilise the cervix using a tenaculum. Local topical anaesthetic gel (xylocaine 2%) was applied to the cervix and suction catheter. To guide curette insertion into the uterine cavity, transabdominal ultrasound was performed using a Voluson E730 Expert USG system (GE Medical Systems, Kretztechnik, Zipf, Austria). Suction was applied with the handheld syringe to remove products of conception, which were then immersed in normal saline along with detached chorionic villi.

The USG-MVA procedure was completed when the ultrasound examination showed a thin endometrial lining, confirming that the uterine cavity was empty. Products of conception were sent to the laboratory for histological examination and cytogenetic analysis, in accordance with each patient's preferences. All Rhesus-negative women were administered anti-D prophylaxis.

Patients were discharged 2 to 3 hours after the procedure if they were clinically healthy and haemodynamically stable. A postoperative telephone hotline was established; patients were advised to contact the ward at any time if they encountered excessive bleeding, abdominal pain, or fever. A follow-up appointment was scheduled 2 to 3 weeks after the procedure to ensure complete evacuation had been achieved.

Statistical analysis

Analyses were performed using SPSS (Windows version 23.0; IBM Corp, Armonk [NY], United States). Data were expressed as counts and percentages. Comparisons were conducted using the Chi squared test for categorical variables and Student's *t* test for continuous variables. Two-tailed P values <0.05 were considered statistically significant.

Results

In total, 331 patients were scheduled to undergo USG-MVA during the study period. Seventeen of these 331 patients did not undergo USG-MVA: 15 patients experienced passage of a tissue mass before the procedure, and two patients could not tolerate swabbing before the procedure. Thus, 314 patients successfully underwent USG-MVA (Fig).

The baseline characteristics of the 314 included patients are summarised in Table 1. All patients received oral misoprostol for cervical priming; all patients were able to tolerate and complete the procedure. There were no major complications such as uterine perforation or significant bleeding (ie, requiring blood transfusion or uterotonics). All patients were discharged within 3 hours after the procedure. The complete evacuation rate was 94.6% (297/314) [Table 2] and there were no unscheduled readmissions.

With respect to the results of other miscarriage management methods analysed in our previous RCT,[10] we found that USG-MVA had a significantly

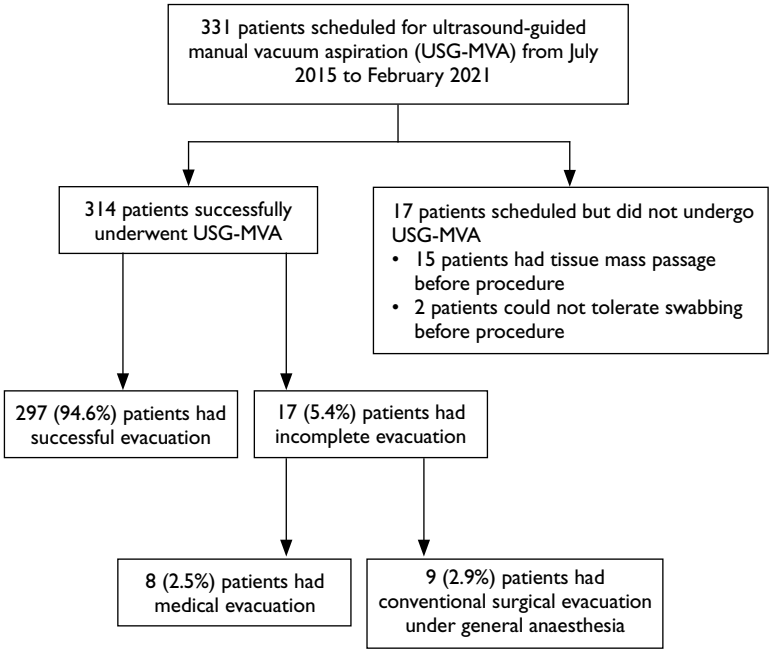

FIG. Flowchart of patient inclusion and outcomes

TABLE 1. Baseline characteristics of patients undergoing ultrasound-guided manual vacuum aspiration (n=314)*

Mean age, y (SD)	36.07 (4.1)
Nulliparous	215 (68.5%)
Multiparous	99 (31.5%)
Previous miscarriage	
0	125 (39.8%)
1	75 (23.9%)
2	55 (17.5%)
≥3	59 (18.8%)
Mean gestational age at miscarriage, d (SD)	62.6 (10.4)
History of vaginal birth	68 (21.7%)
History of caesarean section	28 (8.9%)
History of MTOP	28 (8.9%)
History of STOP	68 (21.7%)

Abbreviations: MTOP = medical termination of pregnancy; SD = standard deviation; STOP = surgical termination of pregnancy
* Data are shown as No. (%), unless otherwise specified

higher complete evacuation rate compared with medical evacuation (94.6% vs 70%; P<0.001) or expectant management (94.6% vs 79.3%; P<0.001). Ultrasound-guided manual vacuum aspiration also had a complete evacuation rate that was comparable with the rate achieved by conventional surgical evacuation (94.6% vs 98.1%[10]; P=0.024). Furthermore, the rate of complete evacuation did not significantly differ between women with missed miscarriage and women with incomplete miscarriage (P=0.621).

TABLE 2. Surgical characteristics and outcomes among patients undergoing ultrasound-guided manual vacuum aspiration (n=314)*

Miscarriage	285 (90.8%)
Incomplete miscarriage	29 (9.2%)
Duration of procedure, mean, min	17.6 (SD=9.5)
Blood loss, median, mL	9 (IQR=5-10)
Complete evacuation	297 (94.6%)
Incomplete evacuation with subsequent medical evacuation	8 (2.5%)
Incomplete evacuation with subsequent surgical evacuation under general anaesthesia	9 (2.9%)

Abbreviations: IQR = interquartile range; SD = standard deviation
* Data are shown as No. (%), unless otherwise specified

Of the 17 patients (5.4%) who had incomplete evacuation during USG-MVA, eight (2.5%) subsequently underwent medical evacuation, whereas nine (2.9%) selected conventional surgical evacuation under general anaesthesia (Table 2).

In terms of histological examination, 66.2% of patients (208/314) requested karyotyping. Among samples from those patients, 95.2% (198/208) were suitable for karyotyping; the culture failure rate was 4.8% (10/208). During the same period, 82.9% (295/356) of samples obtained via conventional surgical evacuation[10] were suitable for karyotyping, which is significantly lower than the 95.2% of samples obtained via USG-MVA (P<0.001).

Among the samples that were suitable for karyotyping, 65.7% (130/198) had an abnormal karyotype and 34.3% (68/198) had a normal karyotype. Of the 10 samples that were unsuitable for karyotyping, eight contained no chorionic villi, whereas two had a limited number of villi; these characteristics contributed to culture failure.

Discussion

Since our unit introduced MVA as an alternative to conventional surgical evacuation of the uterus for first-trimester miscarriage, it has generally been well-received by eligible patients.[11] Manual vacuum aspiration constitutes a safe and effective uterine evacuation procedure; it is widely used in other countries, including the United States and United Kingdom.[11-14] Thus far, MVA is not commonly used in Hong Kong, possibly because there is a lack of familiarity with the procedure. This study was conducted to explore the utilisation and outcomes of USG-MVA, particularly with respect to the complete

evacuation rate, safety, tolerability, and successful acquisition of chorionic villi for karyotyping.

In this study, the complete evacuation rate of USG-MVA was 94.6%, which is within the range of 89% to 98% reported in previous studies.[12,15] The complication rate was low, tolerability was good, and the proportion of samples that were suitable for karyotyping was high.

The complete evacuation rate achieved using conventional dilatation and curettage reportedly ranges from 88% to 98%,[16,17] which is consistent with previous data from our unit (98.1%).[10] These rates are comparable with the rate achieved using USG-MVA in the present study. Moreover, complete evacuation rates achieved via medical management were 84% in an RCT by Zhang et al[18] and 70% in our unit[10]; complete evacuation rates after expectant management reportedly ranged from 16% to 76%,[19,20] similar to the rate of 79.3% observed in our unit.[10] Overall, the complete evacuation rate achieved via medical or expectant management is substantially lower than the rate achieved using USG-MVA.

Clinical implications

The rate of complications associated with conventional dilatation and curettage is reportedly similar[21] to the rate of complications associated with MVA; neither approach has been linked to major complications. These low complication rates may be related to the use of ultrasound guidance, which lowers the risk of uterine perforation or false tract creation. There is evidence that ultrasound guidance for dilatation and curettage reduces the complication rate.[22,23] In an RCT that investigated the use of ultrasound guidance during surgical termination of pregnancy, Acharya et al[24] found significant reductions in infection rates, retained products of conception requiring repeat evacuation, and volume and duration of bleeding in patients who underwent the procedure with ultrasound guidance. Therefore, it is reasonable to expect that USG-MVA also has a lower complication rate, compared with conventional MVA lacking ultrasound guidance. However, ultrasound guidance requires additional equipment and staff with appropriate ultrasound probe training. Further research is needed to clearly determine whether the use of ultrasound during MVA provides a clinical benefit.

Because USG-MVA is an out-patient procedure performed with local anaesthesia in a procedure room, it does not require a surgical theatre or surgical staff. These modified requirements could reduce costs and allow the surgical theatre to be used for other procedures. Patients also would also not be required to fast for a prolonged period prior to general anaesthesia, which would reduce discomfort related to the miscarriage experience. Since a general anaesthesia is not required, it would facilitate a shorter hospital stay, allowing patients to return more rapidly to the comfort of their home after the procedure. Other benefits include the potential for reduced clinical costs and the availability of beds for other patients who require hospitalisation.

This study also demonstrated that a large proportion of samples obtained by USG-MVA are suitable for karyotyping, which is particularly important for women with recurrent miscarriage. The culture failure rates with products of conception obtained via conventional suction evacuation reportedly range from 10% to 40%[25]; these rates are higher than the culture failure rate using samples obtained by USG-MVA in the present study. Karyotyping requires relatively intact and fresh samples, which are often difficult to obtain by medical evacuation. The products of conception may be passed hours before a sample is sent to the laboratory; they may also be accidentally discarded by the patient.[26] During conventional suction evacuation, the products of conception may be extensively damaged by the curette, leading to a higher rate of culture failure.

Strengths and limitations

To our knowledge, this is the first large study in Hong Kong to assess USG-MVA over an extended period. It provides a clear picture of the utilisation of USG-MVA in Hong Kong, with important information regarding the complete evacuation rate, safety, and tolerability of the procedure.

A notable limitation in this study was its retrospective design. Although MVA is generally well-tolerated by patients, as demonstrated in previous studies,[3,11,12,15] it causes greater discomfort than conventional dilatation and curettage under general anaesthesia.[11] In the present study, tolerability was determined by review of patient medical records; it was solely based on whether a patient had been able to tolerate the entire procedure, and no measurement of pain was conducted. The use of a visual analogue scale score during the procedure may provide a better indication of the actual tolerability of the procedure. A previous trial of USG-MVA, conducted by our unit to investigate the efficacy of hyoscine butylbromide in reducing uterine contraction pain during the procedure, showed a slight reduction in pain score compared with placebo.[6] Additional methods could be investigated to improve pain control during USG-MVA.

Furthermore, some patients may have experienced pain because misoprostol was administered for cervical priming prior to the procedure; this was intended to facilitate insertion of the suction catheter. The MedGyn Aspiration Kit provides suction catheters in sizes 4 to 7; if necessary, dilatation could thus be performed under ultrasound guidance using the suction catheters,

thereby eliminating the need for misoprostol before the procedure and reducing the amount of pain involved in USG-MVA.

The clinicians who performed USG-MVA in this study ranged from supervised junior trainees to attending physicians with many years of experience. Although the procedures were performed by experienced clinicians who had completed at least 30 MVA procedures before independent practice, or by trainees who were directly supervised by an experienced clinician, differences in clinician experience have the potential to influence the rate of complete evacuation and the amount of pain involved. A standardised approach involving a few dedicated clinicians may reduce this variation.

In this study, data were available concerning the complete evacuation rate achieved by dilatation and curettage in our unit and also from the Union Hospital; however, no data were available from Union Hospital, where USG-MVA is also performed. Additionally, the present study was not designed to allow a comprehensive comparison of miscarriage management methods. In the future, a well-designed RCT should be conducted to compare outcomes among USG-MVA, surgical evacuation, and medical evacuation.

Importantly, no long-term follow-up was performed in this study; thus, we could not examine the long-term effects of USG-MVA.

Future research

Ultrasound-guided manual vacuum aspiration is regarded as a safe, simple, efficient, and cost-effective procedure. It allows patients to maintain greater autonomy, avoids the risks of general anaesthesia, and has a higher success rate in terms of collecting the products of conception for karyotyping. However, USG-MVA remains an invasive procedure, and some patients may not be able to endure the physical or (possible) emotional pain involved.[27] The addition of ultrasound guidance to MVA may reduce the number of suctions required for complete evacuation and help clinicians avoid contacting the uterine fundus, thereby minimising the duration and severity of pain during the procedure. Further research is needed regarding approaches to minimise the physical and emotional pain that patients may experience during the procedure, such as the use of other pain-relieving agents to minimise discomfort during the procedure. Research is also needed to identify other potential advantages of USG-MVA with respect to other methods of miscarriage management. Moreover, prospective studies comparing pain scores with visual analogue scale scores and patient satisfaction are needed to determine whether the addition of ultrasound guidance to MVA has a meaningful effect on pain outcomes.

Because USG-MVA is an out-patient procedure that does not require a surgical theatre, an anaesthetist, and an overnight stay, it may be significantly less expensive than conventional surgical evacuation of the uterus. The cost of a USG-MVA procedure includes the MedGyn Aspiration Kit, which costs approximately US$18. A cost-effectiveness study is needed to fully explore the potential for reduced clinical costs.

Future research should also focus on the potential effects of USG-MVA on fertility. Asherman's syndrome, caused by trauma to the basal layer of the uterus, is most commonly associated with dilatation and curettage[28]; it is detected in approximately 20% of patients after dilatation and curettage.[29] We hypothesise that the use of USG-MVA without curettage may reduce endometrial trauma and the number of intrauterine adhesions, thereby lowering effects on future fertility. Currently, our unit is investigating this hypothesis via second-look out-patient hysteroscopy.

Conclusion

Ultrasound-guided manual vacuum aspiration is a safe and effective alternative to medical and conventional suction evacuation, with minimal complications (eg, uterine perforation, bleeding, and retained products of conception). Patients can avoid the risks of general anaesthesia and have a shorter hospital stay. Ultrasound-guided manual vacuum aspiration may be appropriate for patients with first-trimester miscarriage, particularly women who have experienced recurrent miscarriage and express a desire for karyotyping.

Author contributions

Concept or design: OSY Chau, TC Li, JPW Chung.
Acquisition of data: OSY Chau, TC Li, JPW Chung.
Analysis or interpretation of data: OSY Chau, JPW Chung.
Drafting of the manuscript: OSY Chau, JPW Chung.
Critical revision of the manuscript for important intellectual content: All authors.

All authors had full access to the data, contributed to the study, approved the final version for publication, and take responsibility for its accuracy and integrity.

Conflicts of interest

As an editor of the journal, JPW Chung was not involved in the peer review process. Other authors have disclosed no conflicts of interest.

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Ethics approval

This study was performed in accordance with the Declaration of Helsinki. The human study protocol was approved by the Joint Chinese University of Hong Kong—New Territories East Cluster Clinical Research Ethics Committee (Ref No.: CREC-2021-206) and the Union Hospital Ethics Committee (Ref No.: EC025), Hong Kong. All adult participants provided written informed consent for inclusion in this study. The STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) guidelines were followed when reporting this study.

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