BMJ Open

Evaluation of the risk of umbilical cord prolapse in the second twin during vaginal delivery: a retrospective cohort study

Rokuhiro Asahina, Hiroyuki Tsuda, Yuki Nishiko, Kazuya Fuma, Momoko Kuribayashi, Atsuko Tezuka, Tomoko Ando, Kimio Mizuno

To cite: Asahina R, Tsuda H, Nishiko Y, *et al*. Evaluation of the risk of umbilical cord prolapse in the second twin during vaginal delivery: a retrospective cohort study. *BMJ Open* 2021;**11**:e046616. doi:10.1136/bmjopen-2020-046616

► Prepublication history for this paper is available online. To view these files, please visit the journal online (http://dx.doi.org/10.1136/bmjopen-2020-046616).

Received 04 November 2020
Accepted 14 May 2021

Obstetrics and Gynecology, Japanese Red Cross Nagoya Daiichi Hospital, Nagoya, Japan

Correspondence to
Dr Hiroyuki Tsuda;
hiro-t@nagoya-1st.jrc.or.jp

ABSTRACT

Objective This study aimed to evaluate the success rate of vaginal delivery, the reasons for unplanned caesarean delivery, the rate of umbilical cord prolapse and the risk of umbilical cord prolapse in twin deliveries.

Design Retrospective cohort study.

Setting Single institution.

Participants This study included 455 women pregnant with twins (307 dichorionic and 148 monochorionic) who attempted vaginal delivery from January 2009 to August 2018. The following criteria were considered for vaginal delivery: diamniotic twins, cephalic presentation of the first twin, no history of uterine scar, no other indications for caesarean delivery, no major structural abnormality in either twin and no fetal aneuploidy.

Results The rate of vaginal delivery of both twins was 89.5% (407 of 455), caesarean delivery of both twins was 7.7% (35 of 455) and caesarean delivery of only the second twin was 2.9% (13 of 455). The major reasons for unplanned caesarean delivery were arrest of labour and non-reassuring fetal heart rate pattern. The rate of umbilical cord prolapse in the second twin was 1.8% (8 of 455). Multivariate analysis revealed that abnormal umbilical cord insertion in the second twin (velamentous or marginal) was the only significant factor for umbilical cord prolapse in the second twin (OR, 5.05, 95% CI 1.139 to 22.472, p=0.033).

Conclusions Abnormal umbilical cord insertion in the second twin (velamentous or marginal) was a significant factor for umbilical cord prolapse during delivery. Antenatal assessment of the second twin's umbilical cord insertion using ultrasonography would be beneficial.

Strengths and limitations of this study

- This study addresses the success rate of vaginal delivery, the reasons for unplanned caesarean delivery and the rate of umbilical cord prolapse in twin deliveries.
- The merit of this study is that it was conducted at a single centre and with a relatively high number of target cases (455).
- This study also reveals abnormal umbilical cord insertion (marginal or velamentous insertion) in the second twin is linked to umbilical cord prolapse during delivery, which is an urgent situation requiring rapid caesarean section.
- The limitations of this study are its retrospective nature and that the diagnosis of marginal or velamentous insertion was made post partum by macroscopic placental examination, not by antenatal ultrasonography.
- Antenatal ultrasonography can provide information regarding marginal or velamentous insertion of the umbilical cord, and therefore antenatal assessment of the second twin's umbilical cord insertion using ultrasonography is important in future clinical practice.

INTRODUCTION

Twin pregnancy is associated with higher rates of almost every potential pregnancy complication, including preterm delivery, hypertensive disorders of pregnancy, placenta previa and fetal growth restriction.[1–3] Moreover, twin pregnancies are at an increased risk of late stillbirth and intrapartum complications; therefore, careful management of labour and delivery is necessary.

However, the route of delivery of twin pregnancies remains debatable. In Japan, the Japan Society of Obstetrics and Gynecology Guideline 2020 states that vaginal delivery is preferred for diamniotic twins where the presenting twin is cephalic at the onset of labour, and appropriate expertise in internal and external version and/or breech delivery is available.[4] With appropriate intrapartum monitoring and management, the second twin is not at an increased risk of neonatal mortality or morbidity with a planned trial of labour compared with planned caesarean delivery, even when remote from term and in a non-cephalic presentation.[5–8] Nonetheless, caesarean delivery is preferred for monoamniotic twins, diamniotic twins with a

non-cephalic-presenting twin and pregnancies with standard obstetric indications for caesarean delivery, such as placenta previa.

Unplanned caesarean delivery of the second twin occurs in approximately 4%–10% of planned vaginal births.[9 10] A population-based cohort study of twin deliveries in the USA reported that, overall, 9.5% of second twins were delivered by caesarean section after vaginal delivery of the first twin.[11] This rate decreased to 6.3% when the second twin was cephalic,[12] but increased to 24.8% if only cephalic/non-cephalic live births were considered.[13]

When vaginal delivery is attempted in twin pregnancies, the capacity for immediate caesarean delivery is important because situations necessitating urgent delivery may arise, such as a prolapsed umbilical cord. The rate of umbilical cord prolapse is approximately 1.3% in the second twin after the delivery of the first twin[14]; however, there are no reports regarding the risk factors for umbilical cord prolapse in the second twin during delivery. The purpose of this study was to examine the success rate of vaginal delivery, the reasons for unplanned caesarean delivery, the rate of umbilical cord prolapse and the risk for umbilical cord prolapse in twin deliveries.

METHODS

Subjects

This was a retrospective study of 752 twin pregnancies registered at our institution from January 2009 to August 2018. Vaginal delivery was attempted based on the following criteria: diamniotic twins, cephalic presentation of the first twin, no history of uterine scar, no other indications for caesarean delivery (such as placenta previa), no major structural abnormality in either twin and no fetal aneuploidy (either suspected or confirmed). After excluding 297 patients, we finally enrolled 455 patients pregnant with twins: 307 patients with dichorionic twins and 148 patients with monochorionic twins (figure 1). All registered mothers were Japanese and lived in a similar environment. All patients provided written informed consent for participating in the study.

Management

After confirming twin pregnancy, we performed an ultrasound in the first trimester to determine chorionicity and amnionicity. That is, an intertwin membrane with the 'twin peak' or 'lambda' sign indicates dichorionic twins, and an intertwin membrane with the 'T' sign indicates monochorionic/diamniotic twins. We followed up with the pregnant women every 2 weeks after 16 weeks of gestation in the monochorionic pregnancies and after 22 weeks of gestation in the dichorionic pregnancies. We assessed fetal position, fetal growth and amniotic fluid volume at every examination; we then screened for congenital anomalies and placental position and performed umbilical artery Doppler in cases of all monochorionic twins and fetal growth restriction and/or oligohydramnios in dichorionic twins. All prenatal and ultrasound data were stored in medical records. We recommended planned vaginal delivery after 36 weeks of gestation in monochorionic and at 37 weeks of gestation in dichorionic pregnancies and aimed to deliver by 38+6

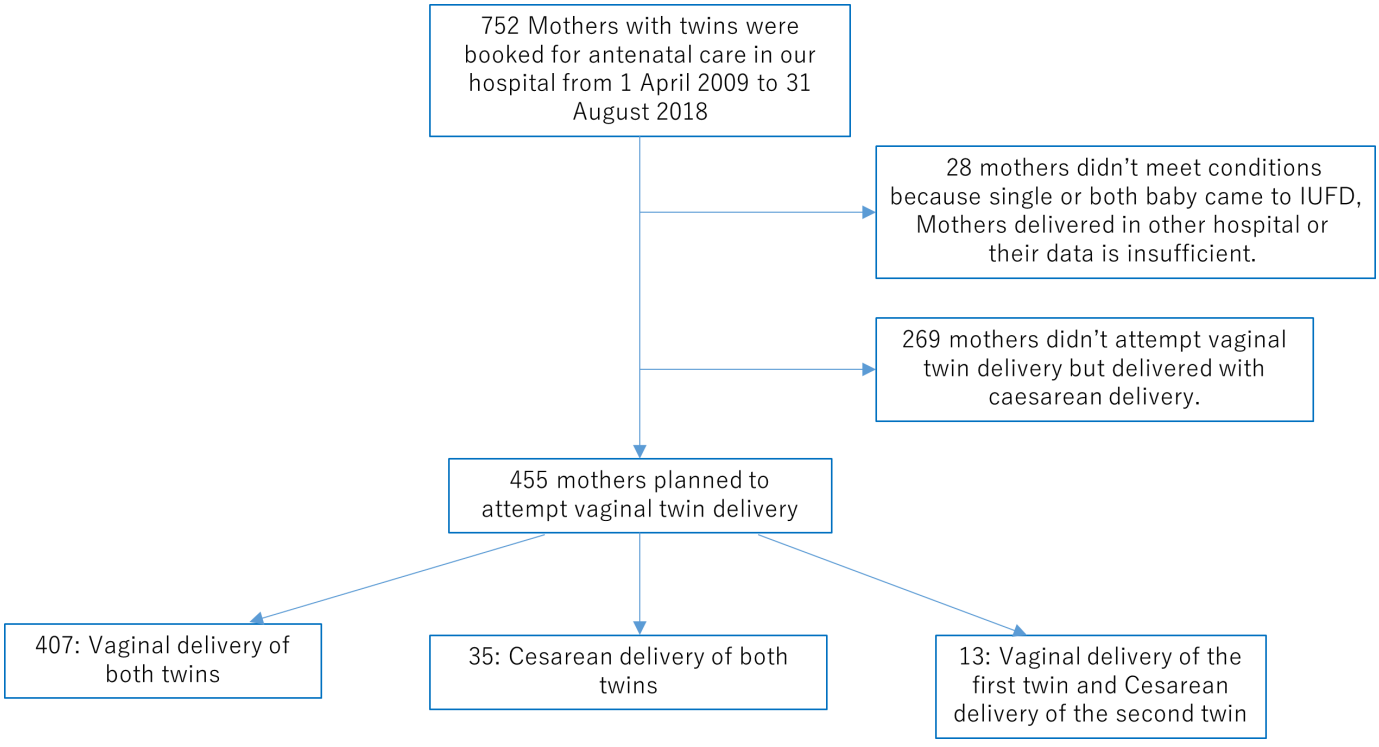

Figure 1 Flow chart showing the number of mothers pregnant with twins who were booked and finally delivered in our unit. IUFD, intrauterine fetal death.

weeks of gestation at the latest. When inducing labour, if the cervix was unfavourable, prostaglandin was generally selected for cervical ripening. Dinoprostone (prostaglandin E2) tablets (0.5 mg) were administered orally every hour, up to six tablets daily. In women with favourable cervix, oxytocin was generally selected as the labour induction method and artificial amniotomy was added, as appropriate. Oxytocin was administered intravenously by an infusion pump to allow for continuous and precise control of the dose administered. Our regimen included a solution of 5 units of oxytocin in 500 mL crystalloid (10 milliunits in 1 mL) to allow the infusion pump setting (mL/hour) to match the dose administered (milliunits/hour). After an initial dose of 100 milliunits/hour, we increased the dose 100 milliunits/hour every 30 min and 20 milliunits/min to the maximum dose specified in the guideline for obstetrical practice in Japan. Clinicians adhere strictly to this dose. After delivery of the first twin, we immediately performed ultrasonography and confirmed the fetal presentation and umbilical cord position of the second twin. We did not perform external and internal version and did not perform artificial amniotomy if the presenting part was unengaged. In our hospital, the delivery of twins is managed by two or more obstetricians, including a senior specialist. During labour, we continuously monitored maternal vital signs (blood pressure, ECG and SpO_2) and performed intrapartum fetal heart rate tracing. After delivery, we performed gross examination of the placenta and umbilical cord and identified the number of vessels, length, insertion site and gross abnormalities (eg, knots).

Statistical analyses

Clinical data were extracted from the medical records and entered into a computerised spreadsheet (Excel, Microsoft Japan, Tokyo, Japan). EZR software (V.1.38, Saitama, Japan) was used to perform all data analyses. After performing the Shapiro-Wilk test to assess normality of data, the Mann-Whitney U test was conducted to compare the continuous variables between the two groups and the Student's t-test was used as appropriate. The χ^2 test was performed for comparison of categorical variables. The categorical variables were as follows: chorionicity, nulliparity, presentation of the second twin and abnormal umbilical cord insertion (velamentous or marginal) of the second twin. The continuous variables were as follows: maternal age, body mass index, birth weight, gestational age at delivery and umbilical cord length. A logistic regression model was used that included body mass index, birth weight of the second twin, gestational age at delivery, umbilical cord length of the second twin, dichorionic twin, cephalic position of the second twin and abnormal umbilical cord insertion (velamentous or marginal) in the second twin to develop the prediction model for umbilical cord prolapse in the second twin. For each variable, the OR and 95% CI were estimated. Bonferroni correction was used for multiple comparisons. P values <0.05 were considered statistically significant.

Table 1 Maternal characteristics and delivery outcomes in this study

Variable	Frequency (%)
Maternal age, years	
<30	137 (30.1)
30–39	284 (62.4)
≥40	34 (7.5)
Body mass index, kg/m^2	
<18.5	132 (29.0)
18.5–24.9	298 (65.5)
25.0–29.9	22 (4.8)
≥30	3 (0.7)
Gestational age at delivery	
<30 weeks	13 (2.9)
30 weeks to 31 weeks, 6 days	11 (2.4)
32 weeks to 33 weeks, 6 days	22 (4.8)
34 weeks to 35 weeks, 6 days	83 (18.2)
≥36 weeks	326 (71.6)
Chorionicity	
Dichorionic and diamniotic	307 (67.5)
Monochorionic and diamniotic	148 (32.5)
Nulliparity	270 (59.3)
Presentation of the second twin	
Cephalic	282 (62.0)
Pelvic	155 (34.1)
Transverse	18 (4.0)
Birth weight, mean (range), g	
First twin	2261 (657–3320)
Second twin	2231 (722–3340)
Mode of delivery	
Vaginal, vaginal	407 (89.5)
Caesarean, caesarean	35 (7.7)
Vaginal, caesarean	13 (2.9)

Patient and public involvement

No patients were involved in setting the research question or in determining the outcome measures, nor were any patients involved in developing plans for the design or implementation of the study. No patients were asked to advise on interpretation or writing up of the study results.

RESULTS

Maternal characteristics and delivery outcomes

The maternal characteristics and delivery outcomes are shown in table 1. In this study, the proportion of nulliparous woman was 59.3% (270 of 455) and of cephalic position of the second twin was 62.0% (282 of 455). The rate of vaginal delivery of both twins was 89.5% (407 of 455), the rate of caesarean delivery of both twins was

Table 2 Indications for caesarean delivery of the twins (n=35)

Variable	Frequency (%)
Arrest of labour	23 (65.7)
Non-reassuring fetal heart rate pattern	6 (17.1)
Malrotation	2 (5.7)
Umbilical cord prolapse in the first twin	2 (5.7)
Umbilical cord prolapse in the second twin	1 (2.9)
Transverse presentation	1 (2.9)

7.7% (35 of 455), and the rate of caesarean delivery of only the second twin was 2.9% (13 of 455). The reasons for caesarean delivery of both twins are shown in table 2, of which arrest of labour and non-reassuring fetal heart rate pattern were the major indications. The reasons for caesarean delivery of only the second twin are shown in table 3, of which umbilical cord prolapse and non-reassuring fetal heart rate pattern were the major indications. Among 13 twin pairs of caesarean delivery of only the second twin, the rate of neonatal intensive care unit (NICU) admission was 61.5% (8) in the first twin and 76.9% (10) in the second twin. The reasons for NICU admission are as follows: low birth weight in all eight neonates of the first twin and four neonates of the second twin, and birth asphyxia in nine neonates of the second twin. The mean period of hospitalisation was 17.6 days in the first twin and 16.8 days in the second twin. No long-term respiratory or neurological adverse events were observed in any of the neonates.

Risk factors for umbilical cord prolapse in the second twin during delivery

Among the indications for unplanned caesarean delivery in twin pregnancies, umbilical cord prolapse is an emergent complication that requires urgent caesarean delivery. Therefore, we examined the risk factors for umbilical cord prolapse in the second twin. Comparing the cases of vaginal delivery of both twins and of umbilical cord prolapse in the second twin, abnormal umbilical cord insertion in the second twin (velamentous or marginal) was the significant risk factor for umbilical cord prolapse during delivery identified in univariate analysis (p=0.042; table 4). We also performed multivariate analysis to calculate the OR for umbilical cord prolapse; abnormal umbilical cord insertion in the second twin (velamentous or marginal) was the only significant factor (OR, 5.05, 95% CI 1.139 to 22.472, p=0.033; table 5).

Table 3 Indications for caesarean delivery of the second twin (n=13)

Variable	Frequency (%)
Umbilical cord prolapse in the second twin	7 (53.8)
Non-reassuring fetal heart rate pattern	4 (30.8)
Transverse presentation	1 (7.7)
Arrest of labour	1 (7.7)

DISCUSSION

In many institutions, vaginal delivery is attempted in cases of diamniotic twins with the first twin in a cephalic presentation. The Twin Birth Study Collaborative Group revealed that planned caesarean delivery does not significantly improve neonatal or early childhood outcomes, compared with planned vaginal delivery (with caesarean delivery if medically indicated) for diamniotic twins, where the first twin is in a cephalic presentation.[5] However, the rate of emergent caesarean sections in cases of attempted vaginal delivery was higher in twin pregnancies than in singleton pregnancies. In a series of 349 twin pregnancies at >32 weeks' gestation with the first twin in a cephalic presentation, vaginal delivery was achieved in 70% of pregnancies with cephalic second twins and 85% of those with non-cephalic second twins on admission to the labour unit.[15] In this study, the rate of vaginal delivery of both twins was 89.5% and that of caesarean delivery of only the second twin was 2.9%, each of which was higher than the aforementioned rates.

In this study, the main reasons for emergent caesarean section in cases of attempted vaginal delivery were arrest of labour, non-reassuring fetal heart rate pattern and umbilical cord prolapse. Among these, umbilical cord prolapse is an urgent situation requiring rapid caesarean section. Therefore, it is essential for obstetricians to understand the incidence and risk factors for the occurrence of umbilical cord prolapse when attempting vaginal delivery in twin pregnancies. Our results revealed the rate of umbilical cord prolapse in the second twin to be 1.8%, which was compatible with the data reported by Wen *et al*,[14] who reported a rate of approximately 1.3% in the second twin after the delivery of the first twin.

Regarding the risk for umbilical cord prolapse, fetal and maternal factors have been reported, such as malpresentation, low birth weight, low-lying placentation, uterine malformations, multiparity, polyhydramnios, long umbilical cord and obstetric interventions (iatrogenic rupture of membranes, cervical ripening with a balloon catheter and induction of labour).[16–19] However, no data have revealed whether these factors are also considered risk factors for umbilical cord prolapse in the second twin. Therefore, we analysed the risk factors for umbilical cord prolapse in the second twin and revealed that abnormal umbilical cord insertion in the second twin (velamentous or marginal) was the only significant risk factor. Fetal presentation, birth weight and umbilical cord length did not present significant risk for umbilical cord prolapse in the second twin. This is the first report to investigate this issue. Since umbilical cord insertion can be diagnosed by antenatal ultrasonography, especially in the second trimester, our data are valuable. By detecting abnormal umbilical cord insertion using antenatal ultrasonography, the risk for umbilical cord prolapse in the second twin

Table 4 Univariate analysis of risk factors for umbilical cord prolapse in the second twin

Variable	Successful vaginal delivery of both twins (n=407)	Umbilical cord prolapse in the second twin (n=8)	P value
Maternal age, mean (range), years	32.0 (17–46)	33.5 (27–37)	0.488
Nulliparous	236/407 (57.9%)	3/8 (37.5%)	0.292
Body mass index, mean (range), kg/m^2	25.1 (17.7–35.8)	25.1 (18.4–35.6)	0.655
Birth weight of the second twin, mean (range), g	2270 (722–3160)	2110 (884–2864)	0.714
Dichorionic	261/407 (64.7%)	6/8 (75%)	0.717
Gestational age at delivery, mean (range), weeks	36.7 (24.9–39.3)	35.7 (26–37.9)	0.181
Cephalic position of the second twin	267/407 (65.6%)	5/8 (62.5%)	>0.99
Umbilical cord length of the second twin, mean (range), cm	48 (17–80)	54 (36–65)	0.333
Abnormal umbilical cord insertion (velamentous or marginal) in the second twin	73/407 (17.9%)	4/8 (50%)	0.042

could be identified before delivery. Unfortunately, in this study, the umbilical cord insertion site could not be definitively diagnosed before birth and the data were derived from the macroscopic findings of the placenta after birth. Therefore, it should be noted that the umbilical cord insertion site should be correctly identified using antenatal ultrasonography. Additionally, special attention should be given to umbilical cord prolapse in the second twin during delivery, especially in cases of abnormal umbilical cord insertion (marginal, velamentous) in the second twin.

The pathogenesis of marginal and velamentous cord insertion is unknown. A marginal cord insertion occurs in approximately 6% of pregnancies,[20] and a velamentous cord insertion occurs in approximately 1% of singleton gestations, but as many as 15% of monochorionic twin gestations.[21] In our study, the rate of abnormal umbilical cord insertion (marginal or velamentous) was 18.4%, which is compatible with reported data. In addition, the rates of abnormal umbilical cord insertion between the first and second twin were similar (19.8% vs 16.9%). However, abnormal umbilical cord insertion in the first twin did not correlate with umbilical cord prolapse in the first twin during delivery. Therefore, abnormal umbilical cord insertion with an unengaged presenting part could pose a risk for umbilical cord prolapse in the second twin.

Table 5 Multivariate analysis of risk factors for umbilical cord prolapse in the second twin

Variable	OR	95% CI	P value
Body mass index	1.00	0.965 to 1.040	0.973
Birth weight of the second twin	1.00	0.998 to 1.000	0.415
Gestational age at delivery	0.94	0.882 to 1.010	0.102
Umbilical cord length of the second twin	1.05	0.970 to 1.130	0.234
Dichorionic	2.06	0.389 to 10.90	0.395
Cephalic position of the second twin	1.13	0.224 to 5.750	0.878
Abnormal umbilical cord insertion (velamentous or marginal) in the second twin	5.05	1.139 to 22.472	0.033

The merit of this study is that it was conducted at a single centre and with a relatively high number of target cases (455). However, there were only eight cases of umbilical cord prolapse in the second twin during vaginal delivery. Abnormal umbilical cord insertion was the only significant risk for umbilical cord prolapse in the second twin that was found using multivariable analysis; however, given the low incidence of umbilical cord prolapse, larger studies are needed to confirm this finding.

The major limitation associated with the present study is its retrospective nature. The diagnosis of marginal or velamentous insertion was made by macroscopic postpartum examination of the placenta, not by antenatal ultrasonography. Additionally, it is assumed that marginal or velamentous insertion on the internal uterine ostium side can be a factor in the umbilical cord prolapse in the second twin; however, antenatal ultrasonography can provide information regarding the side of umbilical cord insertion (internal uterine ostium or fundus) and marginal or velamentous umbilical cord insertion. Therefore, future prospective studies regarding this issue with different medical centres in Japan and Asian countries are necessary.

CONCLUSION

In conclusion, we herein indicated that the rate of umbilical cord prolapse in the second twin was 1.8% when attempting vaginal delivery in twin pregnancies. Abnormal umbilical cord insertion in the second twin (velamentous or marginal) was the only significant risk factor for umbilical cord prolapse during delivery. Umbilical cord prolapse is an urgent situation requiring rapid

caesarean delivery. Therefore, it is essential for obstetricians to understand the incidence and risk factors for the occurrence of umbilical cord prolapse when attempting vaginal delivery in twin pregnancies. We believe that the findings of the present study provide valuable, novel information for the management of twin pregnancies.

Acknowledgements We thank Editage (https://www.editage.com/) for English-language editing. We would like to thank Atsushi Kubo for support in data collection from medical records.

Contributors RA was the principal author who participated in the conceptualisation, design, data collection and management, and data analysis. HT is the corresponding author and contributed to design, data collection and management, data analysis, and drafted the manuscript. YN, KF, MK, AT, TA and KM were coadvisors and contributed to data collection and management. All authors read and approved the final manuscript.

Funding This research was funded by the Japanese Red Cross, Nagoya Daiichi Hospital Research Grant (grant number NFRCH20-0027). The funder played no role in the study design, data collection, analysis or interpretation, and writing of the manuscript.

Competing interests None declared.

Patient and public involvement No patients and/or the public were involved in the design, or conduct, or reporting, or dissemination plans of this research. Refer to the Methods section for further details.

Patient consent for publication Not required.

Ethics approval This study was approved by the Ethics Committee of the Japanese Red Cross Nagoya Daiichi Hospital, Nagoya, Japan (approval number: 2018-116). The investigation conformed to the principles outlined in the Declaration of Helsinki of 1964.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement The data (deidentified participant data) that support the findings of this study are available from the corresponding author (H.T.), upon reasonable request.

ORCID iD

Hiroyuki Tsuda http://orcid.org/0000-0002-4658-2160

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