Velamentous cord insertion at the University of Gondar Comprehensive Specialized Hospital, Northwest Ethiopia

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1. Introduction

More than 98% of the time, the umbilical cord inserts directly into the placenta tissue, i.e., at the center (central cord insertion), around the center (eccentric cord insertion), or near the periphery (marginal cord insertion) of the placenta disk. 1 But in a rare case, the umbilical cord and its vessels may not reach the placenta tissue and remain attached at the membrane of the placenta (velamentous cord insertion). 2

Velamentous cord insertion (VCI) is an anomalous cord insertion (CI) in which the umbilical vessels diverge as they traverse between the chorioamniotic membranes before reaching the placenta tissue. 3 Velamentous cord insertion (VCI) occurs in approximately 1% of singleton pregnancies. 4 Twin pregnancies are at higher risk of developing VCI than singleton pregnancies, with double the risk with monochorionic twins. 5 Smoking, advanced maternal age, primiparity, and chronic hypertension are other potential risk factors for this anomaly. 6

Velamentous cord insertion is associated with low birth weight, pre-eclampsia, preterm birth, delivery with acute caesarean section, low APGAR scores, abnormal fetal heart patterns (AFHR) and congenital anomalies like esophageal atresia, obstructive uropathies, congenital hip dislocations, asymmetrical head shape, spina bifida, ventricular septal defect (VSD), bilobed placenta, and trisomy 21. 7-9

Velamentous cord insertion is highly associated with vasa praeavicia, where the vessels cross the internal os of the cervix in front of the leading fetal part, a condition that is highly associated with perinatal mortality if not diagnosed prenatally. 10 It is believed that the abnormal heart rate and some adverse pregnancy outcomes due to VCI are caused by Lake of Wharton’s jelly, which may result in compression of vessels during uterine contraction or fetal movement. Seventy-one percent of the cases in VCI showed a variable deceleration, whereas a non-reassuring FHR was observed in 46%, and of all, 30% went to emergency caesarean section. 7,8

Although prenatal and perinatal care delivery is gradually increasing, adverse pregnancy outcomes (such as perinatal mortality rate, low birth weight, preterm birth, low Apgar scores), abruptio placentae, placenta praevia, Vasa Praevia, and other conditions that lead to the mother having an emergency caesarean section after the onset of labor and the neonate being admitted to the intensive care unit (ICU) are significantly higher in Ethiopia. 11,12 At the same time, there is a clear gap in measuring the magnitude and identifying the factors associated with VCI in this setting. Therefore, the aim of the present study is to assess the prevalence and associated factors of VCI among singleton births in the University of Gondar Comprehensive Specialized Hospital. The result of this study may have some importance for the hospital as well as for the country in drawing the attention of policymakers, healthcare managers, and healthcare professionals to strengthen preventive strategies for effective VCI management. Furthermore, the result of the study can be used as baseline data for further related studies.

2. Methods

2.1. Study settings and period

This study was conducted at the Maternity and Neonatal Ward, UoGCSH, Gondar, Ethiopia. The University of Gondar Specialized Hospital is a more than 600-bed university hospital that acts as the referral center for more than twelve district hospitals in the area. This hospital serves more than seven million people across the region. As a university hospital, it plays an important role in teaching medical and paramedical students. Gynecology and Obstetrics is one of the major departments in the School of Medicine, UoGCSH. This department has 1 High-Risk Ward, 1 Gynecology Ward, 1 Uro-Gynecologic Ward, 1 Neonatal Ward, 1 Labor and Delivery Ward, 2 Postpartum Maternity Wards, 1 Safe Abortion and Postpartum Follow-up Clinic (it is called Michu-Clinic), 4
2.2. Study design

An institution-based cross-sectional study design was used.

2.3. Population

All singleton births at the UoGCSH were the source population. All singleton births available during the study period at the UoGCSH were the study population.

2.4. Inclusion and exclusion criteria

All singleton births were included in the study. Conversely, marginal cord insertion, placenta specimens without intact umbilical cord, placenta with externally identifiable pathology, and bifurcated umbilical cord before its insertion were excluded in the study.

2.5. Sample size and sampling technique

The sample size was calculated using a single population proportion formula \( P = 0.5, d = 0.05, confidence interval = 95\%, \) and non-response rate = 10\%. Accordingly, the final sample size was 422 participants.

The study participants were chosen using a systematic random sampling technique. We estimated the sampling interval of participants to be \( = 4 \) (sampling interval) = \( N \) (number of study population)/\( n \) (sample size) = 1690/422 by taking into account the predicted total number of delivery services during two consecutive months on average (1,690). The participants were selected day and night at the time of delivery.

2.6. Study variables

Velamentous cord insertion is an outcome variable. Independent variables include sociodemographic characteristics such as advanced maternal age, residence, income, educational level, and marital status. Obstetrical and pregnancy-related factors include previous cesarean delivery, parity, prior termination, fertility problems, and previous miscarriage; abruptio placenta; bleeding during pregnancy, placenta praevia, and sex of the fetus; current preeclampsia, low birth weight (LBW), and gestational diabetes mellitus (GDM). Drugs and medicine variables include the use of the intrauterine contraceptive device (IUCD), smoking cigarettes, folic acid supplementation, and the consumption of alcohol. Maternal health-related factors are maternal diabetes, epilepsy, chronic hypertension, rheumatoid arthritis, and asthma.

2.7. Data collection tools, techniques, and procedures

The data was collected through the diagnosis of VCI and face-to-face interviews using a structured Amharic version of the questionnaire. Document review was also performed using a well-designed checklist. The questionnaire was first prepared in English, then translated into Amharic, and later, back to English to ensure the accuracy of the meaning. The main variables included in the questionnaire were maternal sociodemographic variables, obstetrical and pregnancy-related variables, maternal health-related factors, and medication/drug-related variables. The questionnaire was adapted from different literature and modified based on our study objectives. The validity of the questionnaire was assessed through a pretest study and expert discussion with different professional experts (obstetricians, pediatricians, and public health professionals) related to the outcome of interest. As a result, revisions and adjustments were made based on expert advice and the findings of the pretest study. Moreover, the questionnaire was assessed for clarity, content, reliability, and flow following the collection of data in the pre-test study. Trained midwifery professionals collected the data under the supervision of an obstetrician resident.

After the placenta was delivered, the mother, neonate, and placenta were transferred into an isolated room in the postpartum maternity ward. Then, the course and insertion site of the umbilical cord were noticed. Following this, the diagnosis of VCI was made if the umbilical cord and its vessels did not reach the placenta tissue and remained attached at the membrane of the placenta. The participants were recruited 24 h a day and the data was collected both day and night in the postpartum maternity ward.

2.8. Data processing and analysis

SPSS Statistical Software, Version 26.0, was used to analyze the collected data. The coding and missing values were considered before the analysis. As a result, findings were presented in the form of text and tables using frequencies and summary statistics. Binary logistic regression and multivariable logistic regression analysis were done to describe the association between VCI and different variables and independent predictors of VCI. The crude odds ratio and adjusted odds ratio were used for testing the associations between VCI and associated variables. The variables that had a P-value of \( \leq 0.2 \) in the bivariable analysis were included in the multivariable logistic regression analysis to control all possible confounding factors simultaneously. The Hosmer–Lemeshow goodness of fit test was used to assess the model fitness. In general, statistical significance is declared if the P-value becomes \( \leq 0.05 \).

2.9. Patient and public involvement

Patients were not involved in this study.

2.10. Data quality control and management

The quality of data was maintained through a well-designed data collection questionnaire. Before the data collection, to assure the quality of data, the data collection questionnaire was checked for clarity, understandability, uniformity, and completeness. The training was given to data collectors for two days about data collection procedures. The trained supervisor undertook close supervision to ensure accuracy. The pretest was performed on 5% of the sample size in a location other than the actual data collection. Necessary amendments were maintained based on the pretest result.

3. Results

3.1. Socio demographic characteristics

A total of 422 mothers participated in the study, with a response rate of 100%. The mean (SD) age of mothers was 244.9 years, and approximately 11.4% of mothers were older than or equal to 39 years. The majority (82.9%) were orthodox Christians and Amhara (91.3%) based on ethnicity. Most (80.0%) of the mothers were from urban areas. Married mothers accounted for 84.4% of the study participants. About half (49.9%) of the study participants were certified with a minimum of a diploma (Table 1).

3.2. Pregnancy and obstetrical related factors

Among all the study participants, 30.6% were primiparous. Approximately 6.9% of mothers have had at least one cesarean delivery. Nearly 13% of the study participants had been using IUCD before the last pregnancy. In this study, abruptio placenta or placenta praevia...
complicated 10% of all births. Vaginal bleeding during pregnancy accounted for 10.0% of the participants, and 6.2% and 7.6% had a history of miscarriage and fertility problems prior to their last pregnancy, respectively. From all participants, 11.1% of mothers had a history of miscarriage and fertility problems prior to their last pregnancy, approximately 19% and 2% of the mothers were found to be alcoholics and smokers, respectively. Asthmatic and epileptic patients were found to be 9% together in the prevalence study (Table 3).

3.4. Prevalence of VCI

Out of 422 births of placenta which were screened for VCI, 12 (2.8%) of them with a 95% CI (1.72–4.13) were found with VCI. The rest, 57.8% and 39.4%, were found with eccentric and central cord insertions, respectively.

3.5. Factors associated with VCI

Preeclampsia, LBW, advanced maternal age, gestational diabetes mellitus, maternal chronic hypertension, and vaginal bleeding during pregnancy were reported as candidate variables for multivariable analysis with a p-value less than 0.2 for VCI in the bivariate analysis (Table 4). In multivariate analysis, only preeclampsia and LBW showed a statistically significant association with VCI. Accordingly, pre-eclamptic mothers were 3.74 times more likely to have VCI compared to their counterparts (AOR = 3.74; 95% CI = 1.02–1.68). The odds of low birth weight among births delivered from mothers’ VCI were 2.25 higher (AOR = 2.25, 95% CI = 1.39–19.74) than those with normal cord insertions (Table 4).

4. Discussion

The present study aimed to assess the prevalence and associated factors of VCI presents the report of 422 women with their newly delivered placenta in the UoGCSH, northwest Ethiopia. Accordingly, the prevalence of VCI was 2.8%. Preeclampsia, and LBW are factors that showed a statistically significant association with VCI. The prevalence of VCI in the present study (2.8%) is in line with the studies done in Ireland and Finland. However, this prevalence was found to be lower than in studies done in Japan and the USA. Even though multiple gestation and use of artificial reproductive technology (ART) to conceive showed a high association with VCI, subjects with these variables were not included. And this may be the reason for the lower prevalence compared to the Japan study. VCI can be diagnosed either by placental inspection after delivery or by using a sonogram during pregnancy, which sonographic diagnosis may result in a high prevalence due to a false-negative sonogram, placental remodeling, or technical error. This methodological variation may explain the different

<table>
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3.3. Medical, drug and related factors

About 10% of the respondents were diabetic, while chronic hypertensive patients accounted for nearly a tenth (10.2%). Prior to or during the last pregnancy, approximately 19% and 2% of the mothers were found to be alcoholics and smokers, respectively. Asthmatic and epileptic patients were found to be 9% together in the prevalence study (Table 3).
prevalence between the present and American studies. On the other hand, the current prevalence of VCI was found to be higher than in a study conducted in Guyana.\textsuperscript{16}

An abnormal cord insertion, especially VCI has been linked to a higher risk of complications during pregnancy.\textsuperscript{17} In addition, the present study confirms the previous finding\textsuperscript{18} of an increased risk of pre-eclampsia in pregnancies with velamentous cord insertion. Preeclampsia (PE) is a significant pregnancy complication that affects 5–7% of pregnancies worldwide. It is characterized by high blood pressure and damage to several maternal organs.\textsuperscript{19} There is a strong correlation between VCI and preeclampsia,\textsuperscript{20,21} with hypoxia being a key stage in the pathophysiological presentation of the cases. The shared pathophysiological pathways between these disorders are supported by biochemical research. Because pre-eclampsia and velamentous cord insertion were both shown to exhibit a trend of raised serum human chorionic gonadotrophin and decreased fetoprotein during mid-trimester investigations.\textsuperscript{22}

Our results tried to confirm the association between adverse pregnancy outcomes and VCI that has been found in previous studies.\textsuperscript{23,24} Consequently, our results confirmed that VCI increased the risk of LBW. But there are some exceptions, like SGA and IUFD, which were not statistically significant in the multivariate analyses in our study. In VCI, umbilical vessels are too far to reach placental tissue.\textsuperscript{25} This can affect fetal circulation, which can potentially lead to decreased weight gain in the fetus. In the research area and region, this study is the first of its kind. Due to a lack of recorded data and the fact that preconception medical consultation is uncommon in Ethiopia, some possible risk variables such as preconception BMI and previous pregnancy cord insertion type were not considered in this study. The results of this study may not be generalizable to the general community because it was conducted at health institutions. In addition, the cross-sectional nature of the study can be taken as the limitation of the research as VCI is a rare case. Most importantly, comparing results between the current study and studies conducted in western countries is the limitation of the study.

5. Conclusions

The current hospital-based cross-sectional study’s prevalence is consistent with prior studies. Despite the fact that the majority of the factors failed to meet the chi-square assumptions (due to the small number of cases), this study gives some hint to factors associated with VCI. Preeclampsia and LBW have a direct association with VCI. Prenatal detection of VCI should be done on a regular basis and hospitals should give emphasis to this condition. Relevant Trainings should be given to health professionals specially; Midwives, Nurses, and others to enhance knowledge on the danger pregnancy due to VCI. Researchers should conduct large scale study using the current study as a base line data.

Data sharing statements

All data and materials of this study are available and can be accessed with a reasonable request from the corresponding author with the email address of “hailuaragie995@gmail.com”.

Authors’ contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis, and interpretation, or in all these areas; took part in drafting, revising, or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

Consent for publication

“As applicable”.

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Ethical issues

Ethical clearance (Reference No. 1858/02/2020) was obtained from the ethical review committee of the School of Medicine, College of Medicine and Health Sciences, the University of Gondar. A permission letter was obtained from the Gynecology and Obstetrics Department. The purpose of the study was described to all mothers, and written informed consent was obtained. Moreover, they were reassured as their confidentiality was secured and kept. Study participants’ privacy was maintained and the examination was performed in the isolated room in the Postpartum Maternity Ward. Following the data collection, health education was provided to each participant, and mothers with adverse birth outcomes were reassured and helped to have an appropriate management plan. We can confirm that all methods were performed in accordance with the relevant guidelines and regulations.

Declaration of competing interest

The authors declare that they have no conflict of interest in any aspect of the article.

Acknowledgments

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Abbreviations

ACD: acute caesarian delivery, CI: Cord Insertion, IUCD: GDM: Gestational Diabetes Miletus, Intrauterine Contraceptive Device, LBW: Low birth weight, ORD: Odds ratio, NICU: neonatal intensive care unit,
UoGCSH: University of Gondar comprehensive specialized hospital, VCI: Velamentous cord insertion.

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