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Safety Analysis of Umbilical Vein Puncture Guided by B-Ultrasound in Prenatal Diagnosis

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Abstract: *Objective:* To explore the safety of umbilical vein puncture guided by B-ultrasound in prenatal diagnosis. *Methods:* Patients undergoing prenatal examinations in the Department of Obstetrics and Gynecology from February 2023 to February 2024 were selected as the observational subjects. A total of 90 cases were included. Umbilical vein puncture was performed under B-ultrasound guidance to observe puncture safety. *Results:* The one-time puncture success rate of umbilical vein puncture under B-ultrasound guidance in 90 patients was 97.78%, with an average puncture time of 8.43 ± 1.04 minutes. Fetal heart rate slowed down in 2 cases during umbilical vein puncture guided by B-ultrasound and in 3 patients after surgery, resulting in an incidence rate of 5.56%. Logistic nonlinear multifactor analysis indicated that puncture time and the number of successful punctures were correlated. Additionally, fetal cardiovascular system abnormalities emerged as an independent risk factor for fetal heart rate slowdown, with a statistical value of $P < 0.05$. *Conclusion:* The one-time success rate of umbilical vein puncture guided by B-ultrasound for prenatal diagnosis is high. Early identification of high-risk groups and the implementation of targeted measures can reduce puncture adverse events and ensure the safety of prenatal diagnosis.

Keywords: B-ultrasound guidance; Umbilical vein puncture; Prenatal diagnosis; Safety

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1. Introduction

Prenatal diagnosis serves as a crucial method for screening fetuses for congenital diseases and malformations. With recent attention drawn to population issues, there has been a notable increase in the number of individuals voluntarily opting for prenatal diagnosis to enhance the quality of newborn delivery [1,2]. The advent of ultrasound technology has revolutionized prenatal diagnosis assisted by B-ultrasound to effectively mitigate the risks associated with traditional blind punctures, thereby enhancing clinical diagnosis safety. Umbilical venipuncture, guided by B-ultrasound, represents an invasive examination technique employed to gather fetal blood samples for screening blood diseases, chromosomal abnormalities, and genetic metabolic diseases [3-5]. In this context, this study focuses specifically on the utilization of umbilical venipuncture guided by B-ultrasound during delivery. This discussion centers on the safety of its pre-diagnosis application, with a selection of 90

patients as observation subjects.

2. Materials and methods

2.1. General information

Patients undergoing prenatal examinations in the Department of Obstetrics and Gynecology between February 2023 and February 2024 were selected as the observation subjects. A total of 90 cases were included. The age range varied from 21 to 46 years old, with a mean of 28.77 ± 2.50 years. Gestational age ranged from 18 to 34 weeks, with a mean of 25.18 ± 0.92 weeks, and gestation occurred 1–3 times, with a mean of 1.33 ± 0.21 times.

Inclusion criteria: (1) All 90 patients met the indications for umbilical venipuncture and voluntarily underwent the procedure under B-ultrasound guidance; (2) Patients and their families were informed of the research content; (3) The research received approval from the ethics committee.

Exclusion criteria: (1) Patients with complicated pregnancy complications, such as gestational hypertension; (2) Patients with potential allergies to inducers; (3) Patients with abnormal liver and kidney function or coagulation dysfunction; (4) Patients who were uninformed about or refused to participate in the research project.

2.2. Method

All selected patients underwent umbilical vein puncture under B-ultrasound guidance, performed by the same medical team. Before the procedure, patients were briefed on the purpose, operation method, precautions, and common complications of umbilical vein puncture guided by B-ultrasound. The location of the placenta, umbilical cord distribution, and puncture site were clarified. Patients were required to empty their bladder and lie down before the examination. The puncture site and surrounding skin were routinely disinfected. The operator inserted the puncture needle into the amniotic cavity while ensuring proper depth and angle using B-ultrasound. Once successful puncture was confirmed, the needle core was withdrawn, a syringe was attached to collect venous blood (1–2.5 mL), and the blood was stored in a heparin-containing test tube. The needle was then removed, and pressure was applied to the puncture site to reduce bleeding. Patients were observed post-operation to monitor umbilical blood vessels and fetal heart rate conditions, and discharge from the hospital was permitted only if no abnormalities were detected.

2.3. Evaluation criteria

The one-time puncture success rate of 90 patients was observed, along with monitoring fetal heart rate during the puncture. Fetal heart rate slowing was defined as < 100 beats/min lasting more than 1 minute. Fetal heart rate was also monitored during and after the procedure to assess the occurrence probability and risk factors associated with rate slowdown.

2.4. Statistical analysis

Statistical analysis was performed using SPSS 26.0 software, employing logistic nonlinear factors for adverse events. A statistical threshold of $P < 0.05$ indicated a difference, while $P < 0.01$ denoted a significant difference.

3. Result

3.1. Analysis of puncture success rate in 90 patients

Out of 90 patients, umbilical vein puncture guided by B-ultrasound was successful in 88 cases, with 2 cases

requiring a second puncture for success. The one-time puncture success rate stood at 97.78%. Among these, 85 cases were punctured within 10 minutes, while 4 cases were successfully punctured within 10–15 minutes. A single case required more than 15 minutes for a successful puncture, with an average puncture time of 8.43 ± 1.04 minutes.

3.2. Statistics on adverse events of umbilical vein puncture under B-ultrasound guidance

Fetal heart rate deceleration occurred in 2 cases during umbilical vein puncture guided by B-ultrasound, with an additional 3 cases experiencing deceleration after the procedure, resulting in an incidence rate of 5.56%.

3.3. Analysis of risk factors for fetal heart rate deceleration caused by umbilical vein puncture guided by B-ultrasound

Logistic nonlinear single-factor analysis revealed a correlation between fetal heart rate deceleration and puncture time, number of successful punctures, amniotic fluid volume, and fetal cardiovascular system abnormalities. Multiple factor analysis demonstrated that puncture time, number of successful punctures, and fetal cardiovascular system abnormalities can serve as independent risk factors for fetal heart rate deceleration (**Table 1**).

Table 1. Analysis of risk factors for fetal heart rate deceleration caused by umbilical vein puncture guided by B-ultrasound

Variable	OR	95% confidence interval	P value
Puncture time	2.175	1.030–3.455	$P < 0.01$
Number of successful punctures	1.903	0.602–2.381	$P < 0.05$
Amniotic fluid volume	0.522	0.291–0.481	$P > 0.05$
Abnormalities of the fetal cardiovascular system	1.302	0.774–2.018	$P < 0.05$

4. Discussion

With an increasing focus on reducing congenital birth defects in fetuses, the number of pregnant women opting for prenatal diagnoses has risen. Traditional umbilical vein puncture, due to its complexity and reliance on operator experience, often results in low one-time puncture success rates and a higher probability of adverse events such as premature birth, miscarriage, umbilical cord bleeding, and fetal heart rate deceleration [6-9]. However, recent advancements in ultrasound technology have introduced percutaneous umbilical vein puncture guided by B-ultrasound. This method simplifies puncture difficulty and clarifies puncture sites, enhancing success rates and minimizing risks associated with the procedure [10-12]. This study, involving 90 patients, demonstrated a high success rate of 97.79% for umbilical vein puncture guided by B-ultrasound, with most procedures completed within 10 minutes, underscoring its efficiency in prenatal diagnosis.

Despite its advantages, B-ultrasound-guided umbilical vein puncture still carries risks, particularly fetal heart rate deceleration [13-15]. This risk is attributed to the invasive nature of the procedure, its technical challenges, and prolonged puncture duration, which may stimulate the umbilical artery excessively, leading to vasovagal reflexes and subsequent fetal heart rate deceleration. In this study, fetal heart rate deceleration occurred in 2 cases during puncture and 3 cases post-surgery, with a 5.56% incidence rate. Logistic nonlinear analysis identified puncture time, number of successful punctures, amniotic fluid volume, and fetal cardiovascular system abnormalities as correlated factors. Multiple factor analysis confirmed puncture

time, number of successful punctures, and fetal cardiovascular system abnormalities as independent risk factors for fetal heart rate deceleration ($P < 0.05$). Research data confirms that if the fetus is accompanied by cardiovascular abnormalities, the body's blood circulation is impaired and the puncture tolerance is low; When stimulated by puncture, vasoactive substances are released in large quantities, leading to autonomic nerve reflexes and subsequent fetal heart rate deceleration.

Effective identification of puncture sites and avoidance of the umbilical artery are crucial in enhancing puncture success rates and minimizing adverse events. Precautions and common risk factors are thoroughly explained to the patients before the procedure, with experienced operators selected to improve success rates and reduce long-term umbilical artery stimulation. Close monitoring of fetal heart rate during the procedure enables timely detection of fetal heart rate deceleration, allowing for targeted interventions to prevent adverse outcomes.

In conclusion, B-ultrasound-guided umbilical vein puncture for prenatal diagnosis demonstrates a high one-time success rate, facilitating early identification of high-risk groups and implementation of targeted measures to mitigate adverse events and ensure safety.

Disclosure statement

The authors declare no conflict of interest.

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