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Percutaneous umbilical blood sampling: current trends and outcomes

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ABSTRACT

Objectives: To report our contemporary experience with PUBS, including indications and complications, stratified by the presence of hydrops fetalis.
Study design: All PUBS performed from 1988 to 2013 at a single tertiary care center were identified using a comprehensive ultrasound database. We recorded patient demographics, relevant obstetric, fetal and neonatal data, indication for and success of PUBS and any complications. Data were analyzed using SAS, version 9.3 (SAS Institute Inc., Cary, NC).
Results: 455 PUBS were performed on 208 pregnant women, 97.8% of which were successful. The average gestational age at the time of PUBS was 26.7 weeks (SD 5.1 weeks, range 17.5–41.3 weeks). Indications were available for 441: 245 (55.6%) isoimmunization, 77 (17.5%) non-immune hydrops fetalis (NIHF), 98 (22.2%) chromosomal diagnosis, and 21 (4.8%) other indications. Isoimmunization was a less common indication for PUBS in 2008–2013 as compared to 1988–1992 (51.7% vs 66.2%, $p = 0.07$). Amongst PUBS performed in the setting of hydrops, isoimmunization was much less common in the later time period (61.1% vs 0%, respectively; $p < 0.01$). The procedure complication rate (bradycardia or fetal demise at procedure) of 2.5% was stable over the study period and was most common with NIHF (2.0% without hydrops, 0% with immune hydrops and 6.3% with NIHF; $p = 0.04$). Of the 208 women with a PUBS performed, 74 had more than one PUBS procedure (mean 2.2, max 18). Transfusions were performed in 233 of the 455 (51.2%). Overall, 10.2% of the pregnancies had an intrauterine fetal demise (IUFD) within 2 weeks of the procedure, which was most common in pregnancies with NIHF (3.2% without hydrops, 9.1% with immune hydrops and 31.7% with NIHF; $p < 0.01$). The IUFD rate was 60% (3/5) in fetuses with parvovirus-mediated NIHF.
Conclusions: PUBS has a high likelihood of success with a relatively low complication rate. The complication rate is highest in pregnancies with NIHF, and these pregnancies are also at a significantly higher risk of IUFD, particularly those patients with parvovirus-mediated NIHF. Our findings can be used when counseling patients who are considering PUBS for diagnostic or therapeutic purposes.

Introduction

Percutaneous umbilical blood sampling (PUBS) is an ultrasound-guided antenatal technique used for both diagnostic and therapeutic purposes. The procedure entails inserting a needle under ultrasound guidance directly into the fetal umbilical vein in order to withdraw a sample of fetal blood or inject blood or medication directly into the fetal bloodstream. The technique has been described in the literature since the 1980s [1]. PUBS are used clinically to obtain laboratory values from fetal blood, such as hematocrit, platelets, thyroid studies or rapid chromosomal diagnosis. Additionally, the same technique can be used for fetal transfusion in the setting of fetal anemia, which may be mediated by isoimmunization or viral infection such as parvovirus [2].

While multiple case series have confirmed the safety of the PUBS procedure, much of this literature was published in the 1980s and 1990s [3–7]. A recent large case series of >2000 procedures reported that cordocentesis in China is safe and effective [8]. However, updated data from the United States is lacking. We

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sought to review indications, success rates, efficacy and outcomes of PUBS procedures at a single tertiary center to provide contemporary information for providers for use in antenatal counseling.

Materials and methods

All PUBS performed at a single tertiary care center from 1998 to 2013 were identified using a comprehensive ultrasound database. Informed consent for the procedure was obtained from all patients prior to performing PUBS. PUBS procedures are performed by Maternal-Fetal Medicine attending physicians and fellows with Radiology staff ultrasound guidance. All procedures are performed in the ultrasound suite at our hospital; rarely are these procedures performed on Labor and Delivery or in an operating room. At our center, PUBS are all performed under real-time ultrasound guidance by two providers. Prior to the procedure, the patient is prepped with betadine, similar to preparation for amniocentesis. We do not give antibiotic prophylaxis. PUBS is performed free hand without a needle guide using a 22-gauge styleted needle and pre-heparinized 1 cc syringes. The needle is guided into the placental cord insertion site (Fig. 1). If the cord insertion is not easily accessible, PUBS is performed in a free cord loop, though this is rarely done at our center, regardless of placental location. Samples are confirmed as fetal origin with determination of mean corpuscular volume (MCV). The amount of blood removed is determined by the studies needed, with upper limits based on gestational age. With the addition of middle cerebral artery (MCA) Doppler data to screen for fetal anemia, we have changed our protocol over time to decrease the number of PUBS per patient. If there is evidence of fetal anemia, transfusion will begin while awaiting the fetal hematocrit. Otherwise, the needle is removed and a second procedure is performed for transfusion. This procedure is similar for fetuses with neonatal alloimmune thrombocytopenia with platelet transfusion, though there were only 4 such cases in this series. Our center does not impose a maximum number of PUBS attempts, nor do we have a required post-procedural observation protocol. Observation is provider-dependent. All patients have documentation of the fetal heart rate after completion of the procedure.

Medical records were retrospectively reviewed to confirm that PUBS was performed, patient demographics, relevant obstetric, fetal and neonatal data including evidence of parvovirus infection, along with indication for PUBS, success of the procedure and any complications. Success was defined as needle placement within the umbilical cord with blood return along with blood confirmed of fetal origin by MCV. Both immediate (fetal bradycardia or demise) and long-term (preterm, premature rupture of membranes [PPROM] and intrauterine fetal demise [IUFD]) complications were collected. Long-term complications were attributed to PUBS if they occurred within 2 weeks of the procedure. Indications for PUBS were stratified into isoimmunization, non-immune hydrops fetalis (NIHF), suspected chromosomal abnormality, or other. Success of PUBS was defined as laboratory confirmation of fetal blood cells using mean corpuscular volume (MCV). In procedures where transfusion was performed, pre- and post-procedure hematocrit was used to confirm success of the procedure when available.

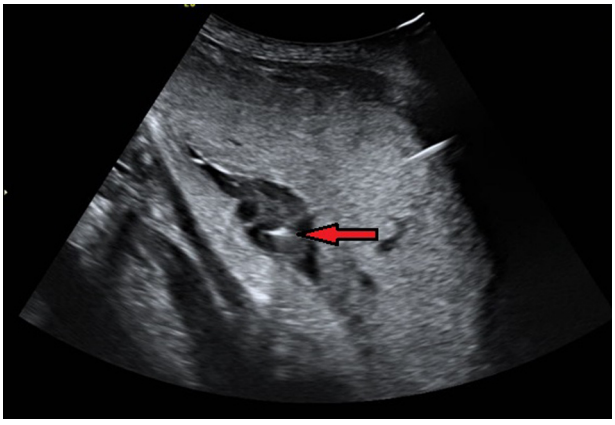

Fig. 1. Percutaneous umbilical blood sampling at the placental cord insertion site. Arrow = needle tip.

Data were collected in a centralized database and deidentified for data analysis. ANOVA was used for continuous variables and Chi-Square or Fisher Exact testing, as appropriate, was used for categorical variables. Data were analyzed using SAS, version 9.3 (SAS Institute Inc., Cary, NC). A p-value of <0.05 was considered significant. Our Institutional Review Board approved this study.

Results

455 PUBS were performed on 208 pregnant women over a 15-year period, 97.8% of which were successful. The average gestational age at the time of PUBS was 26.7 weeks (SD 5.1 weeks, range 17.5–41.3 weeks). 158 of 455 (34.7%) PUBS were performed in fetuses <24 weeks' gestational age. The average gestational age (GA) at delivery was 33.8 weeks (SD 5.1 weeks, range 18.4–41.1 weeks) (Table 1). Pregnancy outcome was available in 176 patients; intrauterine fetal demise occurred in 18 (10.2%). Of the 208 patients, 74 had more than one PUBS (mean 2.2, max 18). Transfusions were performed in 233 of the 455 procedures (51.2%) (Table 2).

Indications were available for 441 of the 455 procedures: isoimmunization in 245 (55.6%), non-immune hydrops in 77 (17.5%), chromosomal diagnosis in 98 (22.2%) and other in 21 (4.8%) (Fig. 2). After stratification by GA at the time of PUBS, significantly more fetuses <24 weeks underwent PUBS for chromosomal diagnosis (65/154, 42.2%) compared to those >24 weeks' GA (33/287, 11/5%), $p < 0.01$, who were more likely to undergo PUBS for isoimmunization (Table 3). Other indications included suspected fetal anemia (in the setting of maternal vaginal bleeding or in twin-twin transfusion syndrome), diagnosis of neonatal alloimmune thrombocytopenia, and maternal thyroid disease. Isoimmunization was a less common indication for PUBS in 2008–2013 as compared to 1988–1992 (51.7% [45/87] vs 66.2% [49/74]; $p = 0.06$) (Fig. 2), likely due to the increased use of MCA Doppler to identify fetuses with anemia. These trends were also seen after stratifying for GA <24 weeks and >24 weeks at the time of PUBS.

The procedure complication rate of 2.5% was stable over the study period, and most common with non-immune hydrops (2.0% without hydrops, 0% with immune hydrops and 6.3% with non-immune hydrops; $p = 0.04$) (Table 2). There was no difference in the complication rate following procedures with a transfusion (2.6%) vs those without a transfusion (2.3%) [$p = 1.00$].

The most common complication was fetal bradycardia, occurring in 8 cases – 3 with non-immune hydrops, while the other 5 had no hydropic physiology. Of 3 fetuses with non-immune hydrops, 2 had an IUFD within 2 weeks of the procedure (one at 22 weeks' GA from severe bradycardia and demise at the end of the procedure, the other at 30 weeks' GA with worsening non-parvo NIHF) and the other underwent emergent cesarean delivery with subsequent neonatal demise at 25 weeks' gestational age. Five (5) additional fetuses experienced prolonged bradycardia in the setting of PUBS; only 2 of these were delivered emergently and there were no fetal or neonatal deaths.