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Utility of Intrapartum Transabdominal Ultrasound for the Correct Placement of Vacuum during Assisted Delivery

José Antonio García Mejido*, Carlota Borrero, Valdivieso Pamela, Adriana Aquise, Rosa Serrano and José Antonio Sainz

Ginecología y Obstetricia, Hospital Universitario Virgen de Valme, Sevilla, Spain

Abstract: *Objectives*: To correlate the identification of fetal head position through digital examination (DE) and transabdominal ultrasound (TAU) prior to vacuum delivery. A secondary objective was to recognize how knowledge of the exact fetal head position affects the placement of the cup.

Method: Women in active labor at term with normal singleton cephalic fetus were included. Transvaginal digital examination was performed and followed immediately by transabdominal ultrasound assessment. After birth, the distance between the center of the chignon and the flexion point was measured on the newborn.

Results: 81 cases were included. TAU identified the fetal head position in 100% of cases and the DE in 96.3%. In 71.5% (58/81) patients DE was consistent with TAU. 100% of these cases were occiput anterior positions and 60% occiput posterior. Placing the cup in a flexing position, the lateral deviation was 0.7+/-0.5cm and the distance between the center of the chignon and the flexion point was 1.6+/-1.0cm, The center of the chignon was accurately placed at less than 2cm posterior to the flexion point in 92.5% (75/81) of the cases.

Conclusions: Using DE only the vacuum cup was placed inaccurately in 1 of every 4 cases. The employment of TAU improved this result to 1 in 10.

Keywords: ??????????????

INTRODUCTION

Assisted vaginal delivery (AVD) is a common procedure in obstetrics. It is associated to an increased maternal and neonatal morbid-mortality [1-8]. The exact knowledge of fetal head position is essential to the correct placement of a vacuum cup or forceps during assisted delivery. A properly performed operative delivery is associated with a decrease in maternal and neonatal morbidity and mortality [9-11] conversely to poorly performed AVD which can lead to fetal injury and perinatal mortality.

It has been proposed that digital transvaginal examination (DE) fail to identify fetal head position in 30-52% of cases. The employment of transabdominal or transvaginal ultrasound has demonstrated more accurate results.

This study proposes the application of TAU as a method to increase the accuracy of vacuum placement by identifying correctly fetal head position during AVD.

METHOD

This prospective observational study conducted in the Labor and Delivery wardatValme Hospital, Seville, Spain included 102 at term pregnant women admitted between October 2011 and March 2012. Recruited patients were in active labor and required an AVD. A comparative assessment between DE and transabdominal ultrasound (TAU) was performed to identify the fetal head position and estimate the adequate placement of the vacuum cup during operative delivery.

Patients included were primiparous women with singleton at term gestation (37-42 weeks) in expulsive phase of the second stage of labor. All patients had ruptured membranes, longitudinal situation and cephalic presentation and spontaneous or induced labor. Patients excluded were all those with maternal diseases such as severe preeclampsia, uncontrolled gestational diabetes, maternal heart disease stage 3-4, endocrine diseases, severe neurologic diseases, maternal infections (HIV, hepatitis, toxoplasmosis), respiratory diseases, severe orthopedic disease or severe fetal diseases (structural malformation, chromosomal abnormalities, fetal infection, isoimmunization, intrauterine growth restriction, hydrops) and an intention for vacuum assisted delivery even if the completion of the delivery was by caesarean section or spontaneous vaginal delivery.

The main indication for vacuum delivery was a prolonged second stage of labor. When AVD was indicated (and prior to the application of the vacuum cup), DE and TAU were performed in order to assess the fetal head position. Three attending obstetricians with more than ten years of experience in AVD and obstetric ultrasound completed the evaluations. Fetal head position assessment by

*Address correspondence to this author at the Ginecología y Obstetricia, Hospital Universitario Virgen de Valme, Sevilla, Spain; Tel: ??????????????; Fax: ??????????????; E-mail: jagmejido@hotmail.com

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transvaginal digital examination was classified as recommended by the ACOG [12] in one of the following eightpositions: direct occiput anterior (DOA), direct occiput posterior (DOP), left occiput anterior (LOA), right occiput anterior (ROA), left occiput transverse (LOT), right occiput transverse (ROT), left occiput posterior (LOP) and right occiput posterior (ROP). Immediately following transvaginal digital examination, suprapubictransabdominal real time ultrasound was performed utilizinga Toshiba Famio 8 (Tokio, Japan) unit with convex 3.75 MHz probe. Ultrasonographic depiction of fetal head position was achieved using the orbital region, the fetal cervical spine, cerebral midline and cerebellum. Initially, the probe was placed longitudinally and tangential to the skin to identify the cervical fetal spine and the occipital bone, next, it was placed transversely at the suprapubic region of the maternal abdomen to confirm fetal head position using the midline brain echo and the cerebellum [13-15] (Fig. **1**).

Vacuum extraction was performed using aMalmströmcup. Optimal placement was established as the center of the chignon been on the sagittal suture 6 cm posterior from the anteriorfontanel. We assessed two deviations from the optimal cup position: the midline anterior-posterior and the midline lateral, both measured in centimeters (cm) [15, 16]. Immediately, after delivery of the newborn, the distance between the center of the chignon and the flexion point was determined using a transparent plastic sheet by a registered midwife [15]. We considered an adequate cup placement when the center of the chignon was two or less cm. posterior from the flexion point.

The correlation between quantitative parameters was evaluated using Student t test. The association between two qualitative parameters was tested with X^2 and Mann-Whitney test. $P< 0.05$ was considered statistically significant.

RESULTS

We have analyzed a total of 102 women prior to vacuum cup placement. Twenty one cases were missed: in nine of these cases, a caesarean section was decided after digital and ultrasound examination; seven of the cases required an instrument different than vacuum and in five cases the data was incomplete.

Table **1** shows general obstetric and intrapartum parameters of the studied population (81 patients). The mean maternal age was 29.6+/-5.9 years. Mean gestational age at delivery was 39.4+/-1.4 weeks.

Table 1. General and intrapartum obstetric features of the total studied population (N=81).

	N 81	Percentage %
Mean maternal age	29.60	SD 5.901
History of cesarean section	9	11.1 %
Gestational disease	15	18.5%
Gestational Diabetes	2	2.5%
Hypertensive state of pregnancy	2	2.5%
Intrauterine growth restriction	5	6.1%
Others	6	7.4%
Gestational weeks at delivery	39.47	SD 1.452
Induced deliveries	23	28.4%
Chronological prolonged pregnancy	5	6.2%
Ruptured membranes	7	8.6%
Intrauterine growth restriction	5	6.2%
Hypertensive state of pregnancy	2	2.5%
Others	4	4.9%
Epidural analgesia	81	100%
Number of operative deliveries (vacuum)	81	100%
Indication of operative delivery		
Prolonged expulsive phase	56	69.1%
Others	25	30.1%
Maternal morbidity	2	2.5%
Tear of Cesarean section scar	2	2.5%
Others	0	0%

The results are show in media and standard deviation (SD).

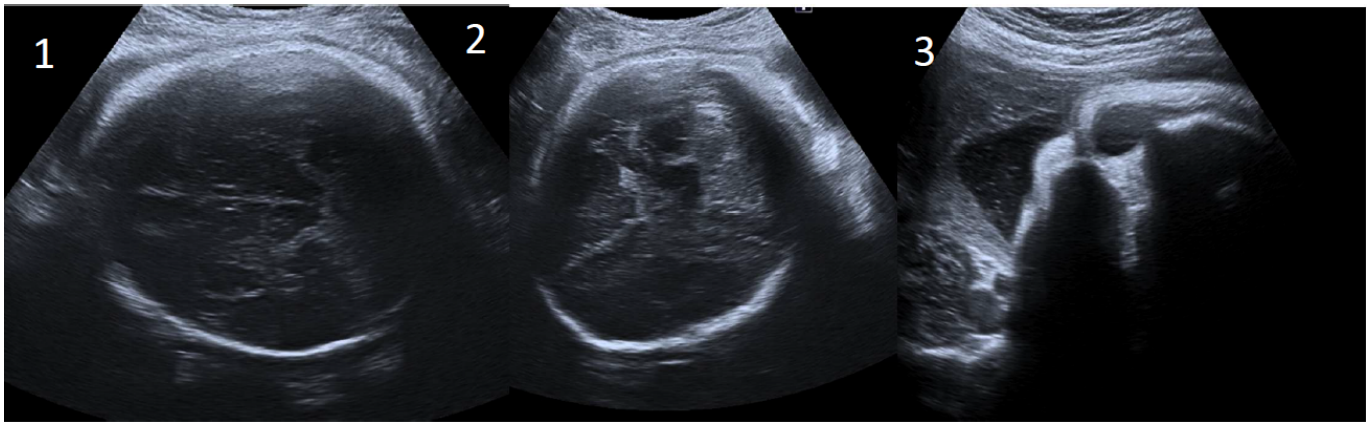

Fig. (1). To determine the position of the head use: 1 cerebral midline. 2 cerebellum. 3 orbital region.

Table 2. Neonatal outcome of the total studied population (N= 81).

	N 81	Percentage %
Newborn gender (Females)	38	46.9%
Newborn weight in grams	3,364	SD 423.34
APGAR at 1 minute	8.80	SD 1.051
APGAR at 5 minutes	9.96	SD 0.268
Newborn umbilical artery pH	7.24	SD 9.782
Perinatal mortality	0	0%
Perinatal morbidity	3	3.7%
Head laceration	2	66%
Head trauma	1	33%
Others	0	0%

The results are show in media and standard deviation (SD).

Nine women had history of previous caesarean section. 71.6% of labors initiated spontaneously. Average duration of the first stage of labor was 7.82 hours. Epidural anesthesia was used in all the cases. AVD with vacuum extraction was achieved in 100% of cases; the main indication was a prolonged second stage of labor (69.1%).

The neonatal results of the studied population are demonstrated in Table **2**. 46.9% of newborns were females with a mean weight of 3364 gr. Average Apgar at the first minute was 8.8, 9.96 at five minutes. Mean fetal pH, which was obtained from umbilical artery cord blood, was 7.24. No cases of neonatal serious morbidity or mortality were found. Two cases required admittance to the neonatal care unit.

Fetal head position assessment through digital examination, transabdominal ultrasound and its correlation are presented in Table **3**. The most common fetal head position identified by DE was left occiput anterior (27.1%) followed by right occiput transverse (23.4%). DE was not able to discern fetal head position in 3.7% of the cases.

Transabdominal ultrasound identified the fetal head position in 100% of the cases. The most frequent position recognized by TAU was left occiput anterior (29.6%) followed by right occiput transverse (22.2%) (Table **3**).

Assuming that transabdominal suprapubic ultrasound was the gold standard for determining the position of the fetal head, digital examination determined the correct positionin 71.5% (58/81) of the cases. Occiput anterior presentation had the best correlation (100%), followed by right occiput transverse (83.3%) and left occiput anterior (79.1%). Occiput posterior positions showed 60% correlation.

The concordance in the fetal head position identification ranged from 75%, when the presenting fetal part in birth

Table 3. Fetal head position assessment through digital examination (DE), transabdominal ultrasound (TAU) and its correlation.

Position	DE	TAU	DE/TAU Correlation
DOA	13 (16%)	7 (8.6%)	**7/7 (100%)**
ROA	8 (9.8%)	12 (14.8%)	**6/11 (54.5%)**
LOA	22 (27.1%)	24 (29.6%)	**19/24 (79.1%)**
ROT	19 (23.4%)	18 (22.2%)	**15/18 (83.3%)**
LOT	9 (11.1%)	9 (11.1%)	**5/8 (62.5%)**
OP	7 (8.6%)	11 (13.5%)	**6/10 (60%)**
Not possible	3 (3.7%)	0 (0%)	**3 (3.7%)**
Total			**58/81 (71.5%)**

Occiput anterior (DOA), right occiput anterior (ROA), left occiput anterior (LOA), right occiput transverse (ROT), left occiput transverse (LOT), occiput posterior (ROP).

Table 4. Evaluation of the association between digital examination (DE) and transabdominal ultrasound (TAU) in the identification of the fetal head position according to the level of descent of the presenting part. Total number of studied cases: 81.

Level of Descent of the Presenting Part(Hodge's Planes)	Total Cases of DE	DE/TAU Association
High (I / II)	4 (4.9%)	2/4 (50%)
Medium (III)	17 (20.9%)	11/17 (64.7%)
Low (IV)	60 (74.0%)	45/60 (75%)
Total	81 (100%)	58/81 (71.5%)

canal was at a lower level (Hodge's plane 4), to only 50% at higher levels (Hodge's planes I and II) as shown in Table **4**.

The placement of the vacuum cup in a flexing position resulted inlateral displacement from the flexion point of 0.7+/-0.5 cm. The mean distance between the center of the chignon and the flexion point resulted in 1.6+/-1.0cm. In92.5% (75/81) of the cases the distance from the flexion point resulted in less than 2cm. The occiput posterior presentation was found at 4 of the 6 cases in which the chignon was located at more than 2 cm. Although 7.5% of the cases were considered as cup misplacement because the distance from the flexion point exceeded 2cm, none of them were found to be placed anterior from the flexion point.

DISCUSSION

Rates of instrumental vaginal delivery range from 5% to 20% of all births in industrialized countries [2]. When fetal extraction with vacuum fails, maternal and neonatal morbid-mortality increases significantly [17, 18]. Failure has been recorded to occur in 4-23% of vacuum extractions: the most common reason associated with this is non-flexing application of the vacuum cup [19, 20]. Bhide [18] concluded that failed vacuum assisted delivery was associated with malposition of the cup and this causes an increased risk of maternal postpartum hemorrhag e (OR 3.5). Vacca [10] found suboptimal placement of the cup to be a common factor in 50% of failed deliveries and that neonatal injury rate increased from 5% for flexing median to 45% for deflexingparamedian application. Mola [11] demonstrated that when a vacuum delivery fails there is a 4.5 times increased association of deflexing application, and can result in low Apgar score, serious scalp trauma and admission to the neonatal unit of 3.2 times, 5.2 times and 12 times more likely, respectively. Teng [21] established that among the principal facts that cause fetal scalp traumas after vacuum extraction were: duration of vacuum application, duration of second stage of labor and paramedian application of the cup. Chadwick [7] showed how incorrect vacuum cup application is associated with an increased risk of subgaleal hematomas.

In multiple studies it has been recognized thatdigital examination fails to accurately identify correct fetal head position during labor. Sherer [13, 22] described a 46% failure, Kreiser [23] a 30% and Souka [24] a 61% during the first stage and 31% in second stage of labor. Akmal [25] found that digital examination failed to determine fetal head position in 26.6% to 34% of the cases. According to Sherer [13, 22] epidural anesthesia improves the results on improving the fetal head position identification; however this study does not observe differences of DE accuracy among parity, maternal age, body mass index, gestational age, dilation and cervical effacement, ruptured membranes, level of the descent of the presenting part, and fetal head position.

Dupuis [26] making use of a newly designed birth simulator observed that digital examination failed between 36-80% of the cases; 34% failure in classifying the level of fetal descent and a 67% error in identifying high and mid-pelvic stations. Sherer [13, 22] showed similar results on failure rate (50%) with ACOG's station 0 and refers to the difficulty of an operative delivery in this situation.

Intrapartum ultrasound has demonstrated its efficacy to identify the proper fetal head position. Results show a low interobserver variability with a difference less than 15º in 90% of the case. Requirements include a moderate level of ultrasound diagnostic proficiency since the reference points (orbits, cerebral middle line and cerebellum) are easy to recognize [27]. Mean time to perform the ultrasound examination was 2 minutes, no differences in accuracy between transabdominal or transvaginal ultrasound modalities have been found [15, 28].

Our study collected 81 primiparous women in the expulsive phase of the second stage of labor that required an operative delivery. In such cases accurate knowledge of the exact fetal head position is essential. Prior to operative maneuvers, exact determination of the fetal head position by digital examination was not possiblein 3.7% of cases. In OP positions the digital examination was inaccurate in 30% of cases. In addition, we observed that a higher level (Hodge's planes I/II) of head descent was associated with a higher level of inaccuracy of fetal head position determination. This data agrees with several recent publications. Furthermore, our results shows how the vacuum cup will be misplaced in 1 of every 4 operative deliveries if the flexion point is identified only using digital examination.

Wong [29], during the first study assessing the intrapartum TAU for the correct vacuum cup application found no statistical differences in DE, but it did observed a shorter distance between the center of the chignon and flexion point (2.1+/- 1.3 versus 2.8+/- 1.0). Haikin [16] observed that the vacuum cup application is not influenced by the experience of the obstetricianin contrast to the correct identification of cranial fetal sutures. Accurate application of the vacuum cup was defined as 3 or less cm of deviation from the anterior-posterior midline and 2 or less cm of lateral deviation from the flexion point. In 28.5% of the cases the vacuum cup site was modified after confirming the misplacement with TAU. Accurate placement of the cupat less than 2cm posterior from the flexion point proved to be successful in 92.5% of the cases. We found more difficulty in placing the vacuum cup in OP presentations. Our results show that TAU improves the assessment of the correct presentation in 40% of cases. Four of every ten cases resulted in cup misplacement defined as more than 2cm from the flexion point.

A potential limitation of our study is the short number of cases and paucity of maternal and neonatal complications. More studies should assess the deviation distance between vacuum cup and the flexion point and compare DE with TAU before the vacuum cup placement.

In summary, our data demonstrate that suprapubic transabdominal real time ultrasound assessment enhances the correct identification of fetal head position during assisted vaginal delivery. Failure to identify the fetal head position results in one of every four with digital examination to 1 of every 10 cases with transabdominal suprapubic ultrasound.

CONFLICT OF INTEREST

The author(s) confirm that this article content has no conflict of interest.

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