OBSTETRICS

Intrapartum ultrasound during rotational forceps delivery: a novel tool for safety, quality control, and teaching

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BACKGROUND: Operative vaginal delivery and, in particular, rotational forceps delivery require extensive training, specific skills, and dexterity. Performed correctly, it can reduce the need for difficult late second-stage cesarean delivery and its associated complications. When rotation to occiput anterior position is achieved, pelvic trauma and anal sphincter injury commonly associated with direct delivery from occiput posterior positions may be avoided.

OBJECTIVE: We report the original and novel use of real-time intrapartum ultrasound simultaneously during Kielland's rotational forceps delivery to monitor correct execution and increase maternal safety.

STUDY DESIGN: This is a prospective observational study performed at the Charité University Hospital in Berlin between 2013 and 2018. Simultaneous, real-time, intrapartum suprapubic ultrasound during Kielland's rotational forceps deliveries were performed in a series of laboring women with normal fetuses and arrest of labor in the late second stage and with a fetal head malposition, requiring operative vaginal delivery. In addition to vaginal palpation for head station, rotation, and asynclitism, intrapartum ultrasound was also used to objectively determine head station, head direction, and midline angle. The operator was not blinded to the ultrasound findings.

The delivering obstetrician examined the woman and performed the delivery. An assistant, trained in intrapartum ultrasound, placed a curved-array transducer transversely in the midline just above the pubic bone to display the forceps blades being applied and the rotation of the fetal head in occiput anterior position.

RESULTS: In all 32 laboring women included in the study, the blades were applied correctly and the fetal heads successfully rotated to an occiput anterior position with direct ultrasound confirmation, and vaginal delivery was achieved. There were no cases of difficult application, repeat application, slippage of the blades, or rotation of the fetal head in the wrong direction. Maternal outcomes showed no vaginal tears, cervical tears, or postpartum hemorrhage >500 mL. There was 1 case of third-degree perineal tear (3a). Neonatal outcomes included mild hyperbilirubinemia (n=1), small cephalohematoma conservatively managed (n=1), and early-onset group B streptococcus sepsis secondary to maternal colonization (n=1). There were no neonatal deaths.

CONCLUSIONS: Ultrasound guidance during Kielland's rotational forceps delivery is an original and novel approach. We describe the use of intrapartum ultrasound in assessing fetal head station and position and also to simultaneously and objectively monitor performance of rotational forceps delivery. Intrapartum ultrasound enhances operator confidence and, possibly, patient safety. It is a valuable adjunct to obstetrical training and can improve learning efficiency. Real-time ultrasound guidance of fetal head rotation to occiput anterior position with Kielland's forceps may also protect the perineum and reduce anal sphincter injury. This novel approach can lead to a renaissance in the safe use of Kielland's forceps.

Key words: head malposition, Kielland, Kiellands, Kielland's forceps, occiput posterior, operative vaginal delivery, second-stage arrest of labor

Introduction

The number of forceps deliveries in the United States has declined significantly (1.4% to 0.9% from 2005 to 2013; proportion of rotational forceps not reported). However, in 2015, there were still 25,000 women delivered by forceps.[1] In the United Kingdom, 10% to 15% of all births are operative vaginal deliveries (OVDs), of which approximately 50% are forceps.[2] There are limited data on the incidence of OVDs worldwide, but reports show a range from 0.1% to 3% for the use of forceps.[3] There are no data, however, on the proportion of rotational deliveries.

OVD, and rotational forceps delivery in particular, requires extensive training, specific skills, and dexterity. Rotation using Kielland's forceps enables delivery when the fetal head is in the midpelvis and in positions other than occiput anterior where manual rotation or vacuum application cannot be performed. Kielland's forceps is a valuable instrument for rotational delivery at midpelvis malposition. Its application varies widely regionally and nationally.

In the literature, neonatal injuries following rotational forceps, including cranial fracture, intracranial bleeding, subdural hematoma, and cranial nerve injury, range from 0% to 10%.[4−7] Postpartum hemorrhage is reported in 12.3% to 17%. Third- and fourth-degree perineal tears range from 1% to 4.3%.[6,8] Deliveries from occiput posterior position, without rotation, using traditional forceps and vacuum extraction, have a 51.5% and 41.7% rate for third- and fourth-degree tears, respectively.[9,10]

Intrapartum translabial ultrasound (US) to assess progress of labor and before vaginal delivery has been used for more than 15 years.[11] Recently, international guidelines (including a literature review) for intrapartum US have been published.[12]

We studied if intrapartum US in addition to clinical examination can be

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AJOG at a Glance

Why was this study conducted?

We investigated the use of real-time intrapartum ultrasound surveillance to ensure correct application of the Kielland's forceps and correct rotation of the fetal head and its impact on maternal and fetal outcomes.

Key findings

We found no cases of incorrect forceps blade placement and, importantly, no incorrect rotation of the fetal head in the wrong direction in relation to the fetal spine. The incidence of postpartum hemorrhage, third-degree tears, and neonatal morbidity was low.

What does this add to what is known?

Kielland's rotational deliveries for fetal head malposition can be complex. Improving maternal and fetal safety and trainee understanding with ultrasound can allow this instrument to be considered an option for mothers in reducing the rising rate of difficult late second-stage cesarean delivery.

performed during rotational forceps delivery in women requiring OVD for malposition.

Materials and Methods

A prospective observational study was conducted using US-guided Kielland's rotational forceps deliveries in a series of spontaneously laboring women with normal fetuses, arrest of labor in the late second stage, and a fetal head malposition, requiring OVD where manual rotation or vacuum application could not be performed. All consecutive women fulfilling the inclusion criteria, delivering between 2013 and 2018 and when one of the authors (L.H.) was in charge of labor ward, were consented verbally and included. One woman was asked and consented in writing to a video recording of the procedure.

The decision to deliver operatively was based on standard clinical examination and parameters. Patients were excluded with an estimated fetal weight above 4.5 kg, presence of HIV infection, antepartum hemorrhage, fetal head above the ischial spines, and where consent was declined. In addition to vaginal palpation for head station, rotation, asynclitism, and relationship to the bony structures of the pelvis, US measurements of fetal head station (angle of progression, converted to head station) and of head position were made transabdominally and translabially according to international guidelines (International Society of Ultrasound in Obstetrics and Gynecology Practice Guideline Intrapartum Ultrasound).[12] Fetal head positions were classified into 8 categories: occiput anterior, left occiput anterior, left occiput transverse, left occiput posterior, occiput posterior, right occiput posterior, right occiput transverse, and right occiput anterior. Arrest of labor is defined as more than 2 hours in primigravidas without an epidural or more than 3 hours with an epidural. In multigravidas, it is defined as more than 1 hour without epidural or more than 2 hours with an epidural.

An assistant, trained in intrapartum US with a minimum of 1 year of experience, placed a curved-array transducer (4C-RS/OB, GE Voluson E portable ultrasound) transversely above the pubic bone to display the fetal head position, the application of the blades, and the success of operative rotation in real time via the monitor to the obstetrician performing the delivery. Assessment and execution of rotational forceps were made according to established guidelines.[13]

Descriptive statistics for percentages, means and standard deviations (SDs) for normally distributed data, or medians with 25th percentile and 75th percentile for nonnormal distribution data were done. Data were analyzed using SPSS software version 25.0 (SPSS Inc, Chicago, IL).

The Declaration of Helsinki was followed. The study had been approved by the local ethics committee (Charité Ethics Committee, EA4/028/08) and was conducted according to the STROBE guidance (strobe-statement.org).

Results

A total of 32 laboring women fulfilling the inclusion criteria were approached, consented, and agreed to participate.

Their mean age was 32 years, 71.9% (23/32) were primigravida, and the mean body mass index was 22.2 (Table 1). The median gestational age was 40 completed weeks. In 34.4% (11/32), labor had been induced and augmented with intravenous oxytocin in 87.5% (28/32). The mean duration of the second stage of labor was 190 minutes (range, 32–313). The indications for OVD were arrest of labor in 87.5% (28/32) and fetal distress in 12.5% (4/32) of patients. Epidural anesthesia was used in 90.6% (29/32) and a pudendal block in 18.8% (6/32; in 3, in addition to incomplete epidural block). All fetal head stations (deepest bony part of the skull) as determined by intrapartum US were between +−0 cm and +3 cm, corresponding to angles of progression of 116° and 138°, respectively.[12,14] Fetal head positions were occiput posterior in 37.5% (12/32), left occiput transverse in 31.3% (10/32), right occiput transverse in 28.1% (9/32), and left occiput posterior in 3.1% (1/32) (Table 2).

Using rotational forceps, all fetal heads were successfully rotated to an occiput anterior position, and vaginal delivery was achieved in all. In all women, intrapartum US confirmed the correct rotation of the fetal head, guided by the forceps blades, in real time, confirming the clinical impression owing to the change of position of the forceps handles.

There were no cases of incorrect or difficult application, repeat application, slippage of the blades, or rotation of the fetal head in the wrong direction.

An episiotomy was performed in 75% of deliveries. Third-degree tears occurred in 3.1% (1/32; one 3A third-degree tear).[15] There were no vaginal or cervical tears. The average maternal blood loss was 300 mL (200—500 mL) (Table 3).

The median neonatal head circumference was 35 cm (range, 33—37.5 cm), and the median weight was 3493 g (range, 2460—4130 g); the mean umbilical arterial pH was 7.21 (SD=0.07). Mean APGAR scores at 5 and 10 minutes were 9 (range, 7—10) and 10 (range, 8—10), respectively. The average neonatal stay in hospital was 3 days (range, 1—14 days). There were no fetal lacerations or deaths (Table 3).

There were 3 neonatal admissions for elevated bilirubin levels, early-onset group B streptococcus infection (secondary to antepartum maternal colonization), and cephalohematoma (this was recognized 2 weeks after an unremarkable discharge from hospital). In the neonate with cephalohematoma, there was no cranial fracture on magnetic resonance imaging. The cephalohematoma resolved spontaneously over the following 2 weeks without neurologic sequelae.

Figure 1 shows the main characteristics of the Kielland's forceps: There is a straight line between the handles and blades and only a cephalic, but no pelvic, curve and, unique to this instrument, a sliding lock of the handles to allow for correction of asynclitism.

Supplemental Video 1 shows the external aspect of one entire forceps delivery, using the Kielland's forceps, from positioning of the blades to delivery of the neonate.

The composite video (Supplemental Video 2) shows the shorter segment of the external view of the rotation of the fetal head with the synchronous intrapartum US video that directly demonstrates the fetal head rotation.

Figure 2 shows annotated still images taken from Supplemental Video 2 that indicate the plane of the forceps handles and the position of the blades, both before and after the internal rotation of the head.

Supplemental Video 3 shows the US video of the wandering technique of the Kielland's forceps application in another case with a direct occiput posterior malposition.

TABLE 1
Basic demographics

Basic demographics	n=32
Age, mean±SD	32±5
Median (min—max)	32 (18—40)
Parity, n (%)	
0	23 (71.9)
1	5 (15.6)
2	4 (12.5)
Height (cm), mean±SD	167.1±6.8
Weight (kg), mean±SD	61.5±8.2
BMI, mean±SD	22.2±2.8

BMI, body mass index; *max*, maximum; *min*, minimum; *SD*, standard deviation.

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Principal Findings

We present a novel application of intrapartum US, the use of US during OVD and specifically during rotational forceps delivery. We show that suprapubic transverse transabdominal sonographic

TABLE 2
Forceps delivery parameters

Variable	n (%)
Indication for forceps	
Suspicious CTG	4 (12.5)
Labor arrest	28 (87.5)
Duration of the second stage of labor (min), mean±SD	191±56
Median (minimum—maximum)	190 (32—313)
Estimated fetal weight before delivery (g), mean±SD	3411±408
Station of the head (cm) below the spines	
0	1 (3.1)
1	31 (96.9)
Position of the head before rotation	
DOP	12 (37.5)
LOT	10 (31.3)
ROT	9 (28.1)
LOP	1 (3.1)
Duration of forceps delivery, median (minimum—maximum)	5 (2—10)
Number of tractions, median (minimum—maximum)	2 (1—4)
Anesthesia	
Pudendus nerve block	6 (18.8)
Epidural anesthesia	29 (90.6)

CTG, cardiotocogram; *DOP*, direct occiput posterior; *LOP*, left occiput posterior; *LOT*, left occiput transverse; *ROT*, right occiput transverse; *SD*, standard deviation.

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TABLE 3
Maternal and neonatal outcomes

Outcome	
Maternal outcomes	
Maternal blood loss (mL), median (min—max)	300 (200—500)
Episiotomy, n (%)	24 (75.0)
Perineal tear, n (%)	8 (25.0)
Cervical tear, n (%)	0
Third-degree tear, n (%)	1 (3.1)
Fourth-degree tear, n (%)	0
Maternal problems	
Urinary retention, n (%)	2 (6.3)
Neonatal outcomes	
Birthweight (g), mean±SD	3428.9±391.4
Median (min—max)	3493 (2460—4130)
APGAR at 1 min, median (min—max)	9 (6—10)
APGAR at 5 min, median (min—max)	9 (7—10)
APGAR at 10 min, median (min—max)	10 (8—10)
Umbilical artery pH, mean±SD	7.21±0.07
Neonatal stay, median (min—max)	3 (1—14)
Neonatal problems	
Cephalohematoma, n (%)	1 (3.1)
Early-onset GBS infection, n (%)	1 (3.1)
Elevated bilirubin levels, n (%)	1 (3.1)

GBS, group B streptococcus; *max*, maximum; *min*, minimum; *SD*, standard deviation.
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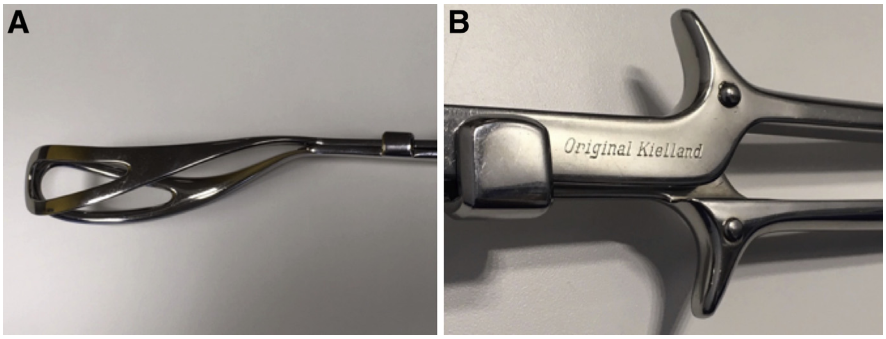
observation is possible during Kielland's forceps rotation, making real-time visualization of forceps application and fetal head rotation possible and enhancing the safety of the procedure. Compared with reported incidences for traditional direct forceps delivery and vacuum delivery without rotation in an occiput posterior head position, in our study, using simultaneous US surveillance, there were fewer third-degree tears.[9,10]

FIGURE 1
Kielland's forceps



A, Cephalic curve of the blades, absence of a pelvic curve (ie, straight line between handles and blades). **B,** Sliding lock that allows for correction of asynclitism.

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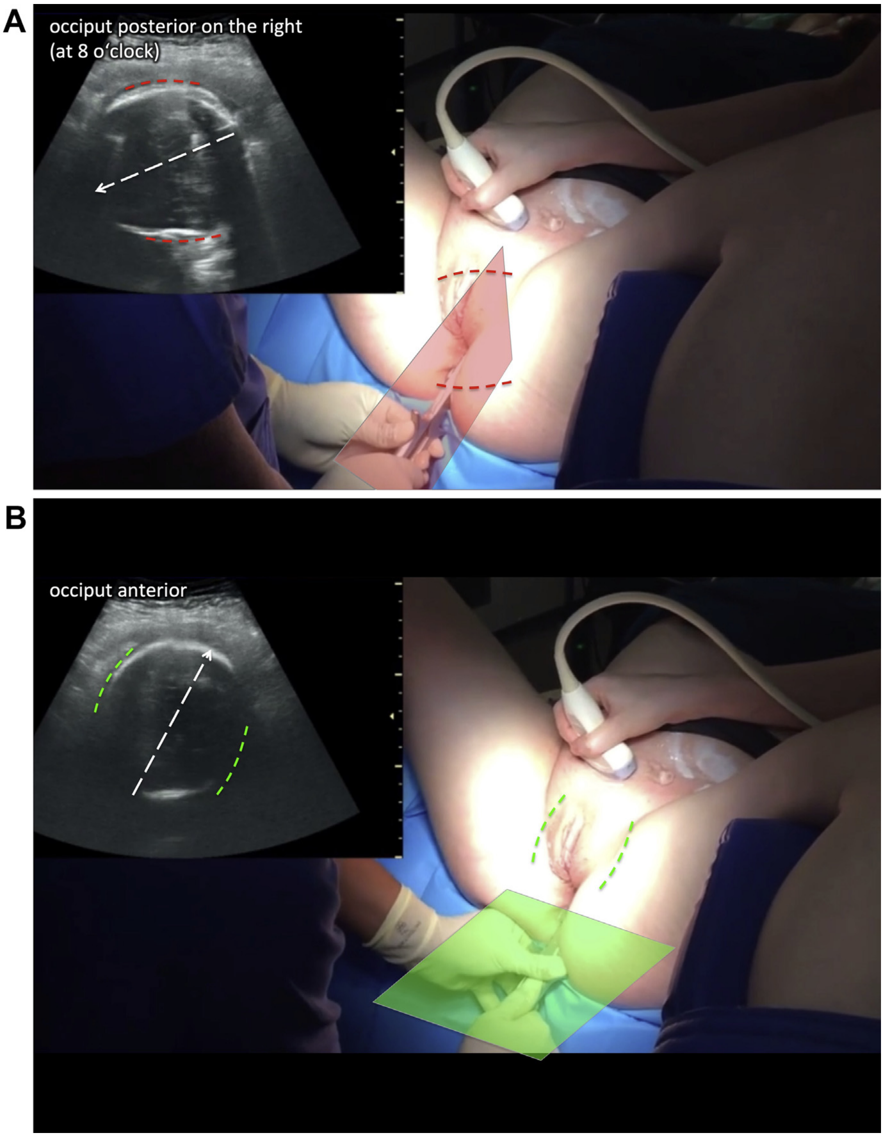
Results in context

When confronted with a fetal head malposition such as occiput posterior in the late second stage of labor, the decision is between OVD and a late second-stage cesarean delivery. There is now a rising trend toward performing more cesarean deliveries in the second stage, and this is associated with increased maternal morbidity and has an effect on future pregnancies and delivery choices. The decision for or against OVD is based on the clinical findings on examination, and the choice of instrument on the experience of the operator.[16,17]

The World Health Organization and the American College and Obstetricians and Gynecologists (ACOG) have recommended efforts including the consideration of OVD to reduce the cesarean delivery rate and its complications.[3,18] Therefore, improving the safety of OVD and the correct execution of rotational forceps is desirable, especially when other interventions such as prolonging the second stage of labor to reduce the incidence of the first cesarean increases the rate of instrumental delivery. Indeed, since the ACOG Obstetric Care Consensus Statement in 2014, which advised prolonging the second stage of labor by 1 hour to reduce the incidence of the first cesarean, there have been conflicting reports on the results and the effects on the rate of instrumental delivery.[18] In a retrospective study, Thuillier et al[19] reported in 2018 a nonsignificant decrease in second-stage cesarean deliveries from 1.3% to 1% and a significant decrease in instrumental deliveries from 19.5% to 17.2% because of this recommendation. However, Zipori et al[20] in 2019 in a larger cohort showed an opposite result, where prolonging the second stage in nulliparous women resulted in a significant increase in instrumental deliveries from 17.7% to 19.2%. A review by Nelson et al[18] in 2020 of publications measuring the effects of prolonging the time definitions of delayed progress in labor suggests that there may be little effect on

FIGURE 2
Ultrasound-guided rotational forceps delivery using Kielland's forceps



Corresponding images show the external view with the plane of the handles (*red* and *green shaded planes*) and the sonographic internal view (*biparietal contour lines*, *dashed red* and *green lines* [also in external view] indicating head rotation; *dashed arrow* indicating occiput position; still images taken from Supplemental Video 2). **A,** Fetal head with occiput at the 8-o'clock position before head disimpaction and correction of asynclitism, the midline indicated by *dashed white arrow* pointing to the fetal occiput, Kielland's forceps handle vertical (indicated by *shaded red plane*), blades position biparietally (indicated by *dashed red lines*) approximately horizontal. **B,** After rotation, the handles are in horizontal position, the blades approximately vertical, and the head rotated into occiput anterior position before the next contraction and forceps traction, ready to be delivered.

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the rate of cesarean delivery while significantly increasing maternal and neonatal morbidity rates generally.

To identify women more likely to require operative intervention, Dall'Asta et al[21] showed the usefulness of using intrapartum US parameters in the second stage to predict the chance of spontaneous vaginal delivery in 109 nulliparous women with a prolonged second stage of labor. Although the study was underpowered to analyze maternal and fetal outcomes, it identified the midline angle and head-symphysis distance as predictive parameters for spontaneous vaginal delivery in nulliparous women with a prolonged second stage of labor.[21]

To safely reduce cesarean deliveries by performing more instrumental deliveries, performing them safely is crucially important to protect mothers and babies. We show that in selected cases of prolonged labor when the indication for a rotational operative delivery with Kielland's forceps arises, there are several benefits to performing the rotational delivery under real-time direct US observation.

Kielland's forceps has been shown to be more effective than rotation by vacuum extraction.[22,23] A recent systematic review and metaanalysis confirmed this and concluded that for the management of malposition, rotational forceps was also less traumatic for the fetus.[24] Kielland's rotational forceps from occiput posterior to anterior also resulted in fewer third- and fourth-degree tears than direct forceps delivery from occipitoposterior position.[25,26] There have been no prospective studies comparing the use of manual rotation with vacuum and Kielland's rotational deliveries.

The cesarean delivery rates in the second stage of labor have also risen and in some studies even doubled, possibly because of failed OVD using vacuum extraction or earlier recourse to cesarean delivery.[16,27] The causes for this are likely to be multifactorial and may include lack of training in potentially complex vaginal operative deliveries and the fear of litigation.[28,29]

Favorable results for Kielland's rotational forceps may, however, be biased by studies performed by experienced operators with a selection of more suitable cases.[8] Nevertheless, this highlights even more the need for training and improving methods of enhancing safety.

Clinical implications

US to determine progress of labor, and in particular before OVD, was first reported over a decade ago.[11] Numerous studies have since assessed potential uses of intrapartum US. International guidelines have recently summarized existing studies and presented guidance.[12] Palpation of fetal head position is inaccurate, but intrapartum US to determine fetal head position, station, and head direction is objective, reproducible, well tolerated by laboring women, easily learned, and less painful.[14,30,31]

Incorrect blade placement is not uncommon in rotational forceps deliveries and increases failure rates and maternal and neonatal morbidity.[32] There is a need for specific training and objective real-time supervision of instrument placement and correct execution of instrumental delivery.[33] Our novel use of US in labor and US guidance of OVDs has the potential to satisfy both these needs. We also provide annotated videos, showing the external view of the entire procedure (Supplemental Video 1) and a compound video with the concurrent intrapartum US equivalent (Supplemental Video 2). We also show (Supplemental Video 3) an US video of Kielland's forceps blade placement in direct occiput posterior malposition.

We have used intrapartum US transabdominally, in addition to translabial US for confirmation of head station, to confirm the position of the fetal head and to ensure and directly observe correct operative rotation of the fetal head. During blade application, the wandering movements of blade (Supplemental Video 3) and the rotation of the head into an occiput anterior position were visually confirmed in real time. In all 32 laboring women delivered this way, there were no cases of incorrect application; wrong rotation direction; or vaginal spiral tears, which are associated with more serious complications.

Research implications

In addition to the potential clinical benefits, sonographic imaging and video documentation of the induced rotation provide objective documentation of instrumental delivery.

Having provided this novel method, now other operators can study it. Eventually, as part of a coordinated study with a management protocol, the questions of efficacy of intrapartum US during rotational forceps delivery with regard to neonatal and maternal morbidity can also be addressed.

There is potential also for further research into the impact and efficacy of this method on training in Kielland's rotational delivery. Traditionally, rotational forceps has been taught with structured training and mentorship from senior consultants, hands-on training, practice on mannequins in a simulation environment, and the use of internet resources and teaching videos.[22,34] Still, obtaining and maintaining competence for complex OVD can be difficult.[35–37] Learning efficiency is greatest when additional visual methods are used.[38] This has been utilized by international societies to teach practical obstetrics, for example, by the Royal College of Obstetricians and Gynaecologists through an internet platform (https://stratog.rcog.org.uk) that provides a video library of operative procedures.[39] We provide 3 videos: one with the entire rotational forceps procedure; one with the unique combination of the external aspect and the intrapartum US video; and one with the US video of the wandering technique of the Kielland's forceps in a case with direct occiput posterior malposition, along with a detailed explanation of the procedure (included in the Supplemental Material).

Strengths and weaknesses

All deliveries were performed by a single expert operator. We cannot comment on possible effects of US-guided deliveries done by other, possibly less experienced, obstetricians. This may be perceived as a limitation of our study, but testing the efficacy of intrapartum US during rotational forceps deliveries was not an aim of this study. Rather, we studied if intrapartum US can document the indirect signs of successful operative rotation noninvasively and directly. Given the relative rarity of rotational forceps deliveries, our study has a relatively large number of cases, and our maternal and fetal outcomes compare favorably with other studies.[24]

Conclusions

In conclusion, we report a novel way to use intrapartum US, that is, to assess correct execution and to confirm success of rotational forceps. This reassurance of correct execution of Kielland's rotational forceps delivery through accurate placement of the forceps blades, avoidance of slippage, and rotation in the correct direction can have a positive impact on the reduction of difficult cesarean delivery in the late second stage of labor, protecting the maternal perineum and reducing fetal morbidity. With real-time sonographic surveillance, we can promote safer rotational deliveries with Kielland's forceps and support a renaissance in this obstetrical skill.

Highlights

1. Real-time ultrasound during the Kiellands rotational delivery improves outcomes.
2. Intrapartum real-time ultrasound allows visualization of Kiellands forceps delivery.
3. Intrapartum real-time ultrasound ensures correct Kiellands forceps placement.
4. Ultrasound ensures correct Kiellands forceps head rotation in relation to fetal spine.
5. Intrapartum ultrasound video (Supplemental Video 1) provides objective surveillance of the second stage. ■

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