Manual rotation of occiput posterior or transverse positions: a systematic review and meta-analysis of randomized controlled trials

Charline Bertholdt, MD; Olivier Morel, MD, PhD; Stéphane Zuily, MD, PhD; Gaëlle Ambroise-Grandjean, RM, PhD

OBJECTIVE: The primary objective of this systematic review was to assess the association between spontaneous vaginal delivery and manual rotation during labor for occiput posterior or transverse positions. Our secondary objective was to assess maternal and neonatal outcomes.

DATA SOURCES: An electronic search of PubMed, EMBASE, ClinicalTrials.gov, and the Cochrane Register of Controlled Trials covered the period from January 2000 to September 2021, without language restrictions.

STUDY ELIGIBILITY CRITERIA: The eligibility criteria included all randomized trials with singleton pregnancies at ≥37 weeks of gestation comparing the manual rotation groups with the control groups. The primary outcome was the rate of spontaneous vaginal delivery. Additional secondary outcomes were rate of occiput posterior position at delivery, operative vaginal delivery, cesarean delivery, postpartum hemorrhage, obstetrical anal sphincter injury, prolonged second stage of labor, shoulder dystocia, neonatal acidosis, and phototherapy. Subgroup analyses were performed according to types of position (occiput posterior or occiput transverse), techniques used (whole-hand or digital rotation), and parity (nulliparous or parous).

METHODS: The quality of each study was evaluated with the revised Cochrane risk-of-bias tool for randomized trials, known as RoB 2. The meta-analysis used random-effects models depending on their heterogeneity, and risks ratios were calculated for dichotomous outcomes.

RESULTS: Here, 7 of 384 studies met the inclusion criteria and were selected. They included 1402 women: 704 in the manual rotation groups and 698 in the control groups. Manual rotation was associated with a higher rate of spontaneous vaginal delivery: 64.9% vs 59.5% (risk ratio, 1.09; 95% confidence interval, 1.03—1.16; P=.005; 95% prediction interval, 0.90—1.32). This association was no longer significant after stratification by parity or technique used. Manual rotation was associated with spontaneous vaginal delivery only for the occiput posterior position (risk ratio, 1.08; 95% confidence interval, 1.01—1.15). Furthermore, it was associated with a reduction in occiput posterior or transverse positions at delivery (risk ratio, 0.64; 95% confidence interval, 0.48—0.87) and episiotomies (risk ratio, 0.84; 95% confidence interval, 0.71—0.98). The groups did not differ significantly for cesarean deliveries, operative vaginal deliveries, or neonatal outcomes.

CONCLUSION: Manual rotation increased the rate of spontaneous vaginal delivery.

Key words: cesarean delivery, digital rotation, instrumental rotation, management of labor, manual rotation, obstetrical anal sphincter injury, occiput posterior, occiput transverse, operative delivery, second stage of labor, spontaneous vaginal delivery

Introduction

For the past 2 decades, several cohort studies comparing outcomes between occiput posterior (OP) and occiput anterior deliveries have shown that the OP position is associated with adverse maternal outcomes. These observed outcomes include a second stage of labor that is 45 minutes longer, a cesarean delivery rate 4 to 10 times higher, an operative delivery rate 6 to 11 times higher, and an obstetrical anal sphincter injury rate at least 7 times higher.[1–4]

These findings led to suggestions for interventions to reduce the OP position and its consequences at delivery. Among them, such maternal postures as hand-and-knees and lateral asymmetric decubitus were evaluated. However, we failed to demonstrate their effectiveness in reducing OP rates at delivery.[5,6] Furthermore, instrumental rotation was used to correct OP position before delivery and seemed to be effective regardless of the instrument used (ie,

From the Centre Hospitalier Régional Universitaire de Nancy, Université de Lorraine, Pôle de la Femme, Nancy, France (Drs Bertholdt, Morel, and Ambroise-Grandjean); International Adaptive Diagnosis Imaging, Institut National de la Santé et de la Recherche Médicale U1254, Rue du Morvan, Vandœuvre-lès-Nancy, France (Drs Bertholdt, Morel, and Ambroise-Grandjean); Unité Mixte de Recherche_S 1116, Institut National de la Santé et de la Recherche Médicale, Université de Lorraine, Nancy, France (Dr Zuily); Vascular Medicine Division and Regional Competence Centre for Rare Vascular and Systemic Autoimmune Diseases, Centre Hospitalier Régional Universitaire de Nancy, Nancy, France (Dr Zuily); and Midwifery Department, Université de Lorraine, Nancy, France (Dr Ambroise-Grandjean).

Received Aug. 10, 2021; revised Nov. 1, 2021; accepted Nov. 4, 2021.

The authors report no conflict of interest.

This work received no funding.

This review was registered on July 6, 2021, with the International Prospective Register of Systematic Reviews (registration number CRD42021266223).

Corresponding author: Charline Bertholdt, MD. charline.bertholdt@gmail.com

0002-9378/$36.00
© 2021 Elsevier Inc. All rights reserved.
https://doi.org/10.1016/j.ajog.2021.11.033

Click Supplemental Materials and Video under article title in Contents at ajog.org

AJOG at a Glance

Why was this study conducted?

This review aimed to assess whether manual rotation during the second stage of labor was associated with a higher rate of spontaneous vaginal delivery and a decrease in the adverse effects of occiput posterior delivery.

Key findings

Manual rotation increased the rate of spontaneous vaginal delivery and was associated with a reduction of the rates of occiput posterior position at delivery and of episiotomy. The effect on the rate of cesarean delivery remained unclear. Neonatal outcomes were not affected.

What does this add to what is known?

The association between manual rotation and the rate of spontaneous vaginal delivery has been unclear. Our review demonstrated that manual rotation during labor increases the rate of spontaneous vaginal delivery and is associated with a reduction in episiotomies.

vacuum, Kielland's forceps, or Thierry's spatulas).[7–12] Nonetheless, their use requires a high level of expertise to ensure patient safety.

Manual rotation, first described in 1971, seems more effective than maternal posture and safer than instrumental rotation.[13] Until recently, only a few studies had evaluated its value. The studies have mainly been observational, and the most recent study was published almost 10 years ago.[14–20]

More recently, the first randomized controlled trials (RCTs) comparing expectant management with manual rotation have emerged.[21–26] Most trials report that manual rotation significantly reduces the length of the second stage of labor, by approximately 15 to 30 minutes, depending on parity. Thus, the length of the second stage of labor remains <3 hours, the time point at which increased maternal morbidity requires operative delivery.[21,24,25] However, these recent trials have failed to demonstrate any difference in the rate of operative delivery between the 2 study groups, mainly because of their lack of statistical power. Specifically, despite preliminary pilot studies, the rates of spontaneous vaginal delivery used for the initial sample size calculations have differed from the rates of the final trial and led to underestimations of the sample sizes required for the comparisons.

Thus, the available data do not currently allow a definitive assessment of the value of attempting manual rotation to manage OP positions during labor.[27] Therefore, a meta-analysis of these isolated primary data is necessary.

The primary objective of this systematic review with meta-analysis was to assess the association between spontaneous vaginal delivery and attempted manual rotation (regardless of its success or failure) of fetuses in OP or occiput transverse (OT) positions. Our secondary objectives were to compare maternal and neonatal outcomes in women managed expectantly or by sham rotation and those for whom manual rotation was attempted.

Material and Methods

Eligibility criteria, information sources, and search strategy

This review, conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines, was registered on July 6, 2021, with the International Prospective Register of Systematic Reviews (registration number CRD42021266223). The review protocol has not previously been published. Some deviations from the protocol were found necessary to improve the methodology and use of this study: exclusion of non-RCT studies, addition of another RCT, assessment of risk ratios (RRs) with 95% confidence intervals (CIs) and 95% prediction intervals (PIs), assessment of the risk of bias using the revised Cochrane risk-of-bias tool for randomized trials (RoB 2) because the New-Ottawa Scale is only for observational studies, and assessment of publication bias.

The following search terms were used: "manual rotation," "digital rotation," and "occiput posterior." One author (C.B.) performed a systematic electronic search in PubMed, Embase, ClinicalTrial.gov, the International Clinical Trials Registry Platform, and the Cochrane Central Register of Controlled Trials to identify the relevant articles from January 2000 to September 2021, with no geographic or language restriction. Searching by hand was not performed. Studies were eligible if they involved women with a singleton pregnancy, gestational age of ≥37 weeks, and attempted manual or digital rotation for an OP or OT position during labor. Ultimately, we chose to include only RCTs and excluded observational studies, systematic reviews, letters, and case reports. The full database search query is available on request.

Study selection

Two authors (C.B. and G.A.) independently screened the search results, first by title and abstracts and then after reading the full text. Any discrepancies were resolved at each step by consensus or with a discussion that included other authors (S.Z., O.M., or both). The eligibility criteria, defined before data collection, aimed to identify all the trials comparing manual rotation with either expectant management or sham rotation. The lack of a control group was an exclusion criterion, whereas the addition of complementary interventions (such as changes in maternal posture) in the rotation group was not.

Risk of bias

Two authors (C.B. and G.A.) independently evaluated the risk of bias for each study with RoB 2. The assessment focused on 5 different aspects of each study: (1) the randomization process, (2) deviation from the intended intervention, (3) missing outcome data, (4) outcome measures, and (5) selection of reported results. For each section, algorithms assessed the potential bias (low risk, some concerns, or high risk). Publication bias was assessed using a visual inspection of the funnel plot asymmetry and the Begg and Mazumdar rank correlation and Egger regression test.

Data extraction and outcomes

Two authors (C.B. and G.A.) independently extracted the data, which were validated by a third author (S.Z.). The data collection was designed for an intention-to-treat meta-analysis, that is, all attempted rotations were included in the rotation group, regardless of whether the procedure was completed, failed, or succeeded.

The primary outcome was the rate of spontaneous vaginal delivery. As secondary outcomes, we assessed the rates of operative vaginal delivery, cesarean delivery, OP or OT positions at delivery, a prolonged second stage of labor (defined in other studies as a second stage of labor of more than 2 or 3 hours), maternal morbidity (postpartum hemorrhage, obstetrical anal sphincter injury, episiotomy, or transfusion), and neonatal morbidity (low Apgar score at 5 minutes, defined in other studies as an Apgar score of <7 or 5 or 4; low umbilical artery pH, defined in other studies as an umbilical artery pH of <7.10 or 7.00; shoulder dystocia; phototherapy; and admission to a neonatal intensive care unit).

Prespecified subgroup analyses by parity (nulliparous or parous), technique of rotation (ie, digital vs whole-hand rotation), and type of occiput position (OP or OT) were performed for the primary main outcome.

Whole-hand rotation was defined as the use of the operator's entire hand in the woman's vagina, positioned behind the fetal ear to both flex and rotate the fetal head.[21,25] For digital rotation, the operator placed 1 or 2 fingers, as preferred, on either side of the fetal sagittal suture. The rotation was secondarily applied to correct the head deflexion and guide the occiput to an anterior position during contractions and pushing.[28] Commonly, the right hand is used for left posterior or transverse positions, and the left hand is used in cases of right posterior or transverse positions. These techniques are shown in Video 1.

For each study, we extracted data about sample size, type of intervention (whole-hand or digital), timing of intervention (as mentioned and detailed in the studies), the profession and experience of the operator (physician, midwife, or resident), number of attempts allowed, technical conditions (epidural analgesia, timing with contractions or pushing efforts, cervical dilation, or whether the bladder was emptied). Moreover, other extracted data covered the inclusion criteria for the type of position (OP, OT, or both) and mode of diagnosis (digital examination or ultrasound), the success rate of manual rotation, the rate of operative delivery in the control group, the practice of early or delayed pushing, complications if reported, parity (nulliparous vs parous), maternal age, gestational age, labor induction, body mass index (BMI; in kg/m^2), and birthweight (in grams) were collected. Template data collection forms and data extracted from included studies and used for analysis are available on request.

Statistical analysis

This was a meta-analysis on published data only. The women's characteristics were compared between the groups using the chi-square test for dichotomous data in Stata (version 14.0; StataCorp, College Station, TX). Statistical analysis was performed using the Review Manager software (RevMan; version 5.4; Cochrane Collaboration, 2020) and Comprehensive Meta-Analysis software (CMA; version 2.2.064). We calculated the RR with 95% CIs for dichotomous outcomes using RevMan and 95% PI for primary outcomes using CMA. The data extracted were combined in the meta-analysis, which used a random-effects model. We assessed the heterogeneity of the studies using I^2 statistics (low=25%, moderate=50%, and high=75%). A P value of <.05 was considered significant. All studies with available data for each outcome contributed to the statistical analysis, and missing data were not included in analyses. The Grading of Recommendations Assessment, Development, and Evaluation (GRADE) approach was employed to interpret findings.

Results

Study selection and characteristics

We identified 384 studies in the database, from which we included 7 RCTs in the qualitative and quantitative analyses (Figure 1). These 7 studies included 1402 women: 704 in the manual rotation group and 698 in the control group.

All studies were in English. Table 1 and Table 2 summarize the study details, and Table 3 shows the women's characteristics. The participants' baseline characteristics did not differ between the groups, except for the rate of nulliparous women (90.2% in the manual rotation group vs 84.4% in the control group; P=.001).

Study quality and risk of bias

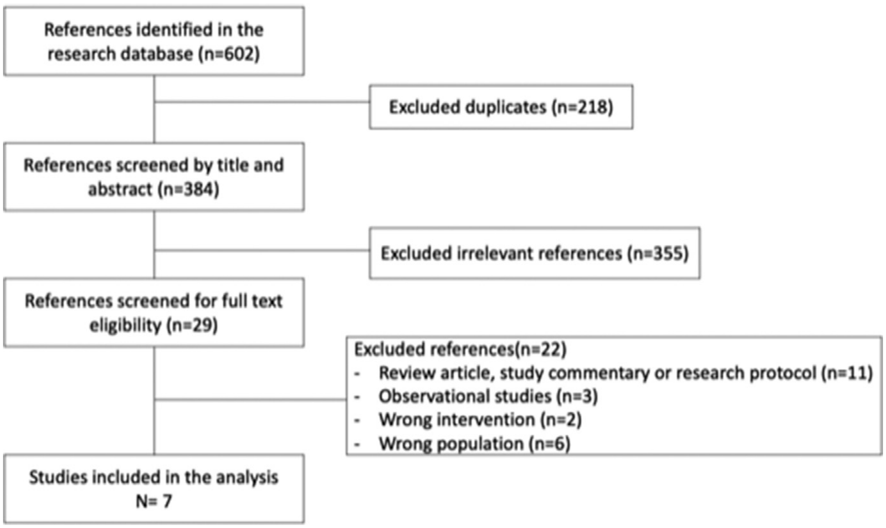
All trials except 1[24] mentioned receiving institutional review board or committee on human research approval. Furthermore, 2[15,24] of 7 RCTs did not mention the need for written consent. Investigators in 4 RCTs provided an additional information sheet to eligible women in the third trimester of pregnancy. Moreover, 5 studies proceeded to clinical trial registration, and 2 studies provided a pilot study or protocol publication.[22,25]

The risk of bias assessment is presented in Figure 2. The risk of bias was low for all sections evaluated in 3 studies.[22,26,28] Their absence of blinding resulted in an unclear risk of bias in the "allocation concealment" section only for 3 others.[21,24,25] No study had a high risk of bias. The funnel plot generated for this meta-analysis to assess publication bias revealed a slight asymmetry but with an equal number of positive and negative studies (Figure 3). Neither the Begg and Mazumdar rank correlation test (P=.88) nor Egger test (P=.83) identified a statistically significant publication bias.

Synthesis of results

All 7 studies contributed to the primary outcome. Manual rotation was

FIGURE 1
Flow diagram of the study selection



Bertholdt. Manual rotation of occiput and spontaneous deliveries. Am J Obstet Gynecol 2022.

significantly associated with an increase of spontaneous vaginal delivery (64.9% vs 59.5%; RR, 1.09; 95% CI, 1.03–1.16; *P*=.005) (Figure 4). The heterogeneity was low for the primary outcome and low to moderate for other maternal and neonatal outcomes. The overall quality of evidence for this outcome that included pooled data from RCTs only was assessed using the GRADE approach and graded at "moderate certainty" for the limited magnitude of effect.

Table 4 presents the maternal outcomes. Manual rotation was significantly associated with a reduction in both OP and OT positions at delivery (RR, 0.64; 95% CI, 0.48–0.87) and episiotomies (RR, 0.84; 95% CI, 0.71–0.98). Manual rotation was not significantly associated with operative vaginal delivery (RR, 0.87; 95% CI, 0.75–1.01), obstetrical sphincter anal injury (RR, 0.91; 95% CI, 0.41–2.02), or postpartum hemorrhage (RR, 0.94; 95% CI, 0.59–1.52).

Data for the subgroup analysis are presented in Table 5. The rate of spontaneous vaginal delivery did not differ significantly after stratification by parity. In contrast, the technique used for the rotation affected the results: the association between manual rotation and spontaneous vaginal delivery was not observed in the digital rotation subgroup (RR, 1.17; 95% CI, 0.85–1.60), whereas it remained at the borderline of significance in the whole-hand rotation subgroup (RR, 1.08; 95% CI, 1.00–1.18). Finally, the association between manual rotation and spontaneous vaginal delivery was observed for OP positions (RR, 1.08; 95% CI, 1.01–1.15) but not for OT positions. None of the neonatal outcomes differed significantly between the groups (Table 6).

Comment

Main findings

This systematic review and meta-analysis of 7 RCTs from France, the United States, Australia, and China demonstrated that the manual rotation of OP positions, compared with expectant management, increases the rate of spontaneous vaginal delivery. Simultaneously, manual rotation was associated with lower rates of both OP positions at delivery and episiotomy. These effects of manual rotation seemed to reduce maternal morbidity; however, we probably lacked the power to show the association between manual rotation and reductions in these consequences of OP, such as postpartum hemorrhage or obstetrical anal sphincter injury. Neonatal outcomes did not differ between the groups.

Comparison with existing literature

Our findings of higher rates of spontaneous vaginal delivery after manual rotation were consistent with the recent scientific literature. Nonetheless, the effect of manual rotation on the rates of cesarean or operative vaginal delivery remains unclear. Manual rotation reduced the rate of cesarean delivery[16,20,21] in some studies and increased it in others.[24,25] This counterintuitive finding is probably attributable to significant differences in obstetrical practices about the indications for both cesarean and operative vaginal deliveries. For example, the rates of intervention in these studies ranged from 3.1% to 20% for cesarean deliveries and 9.5% to 60% for operative vaginal deliveries. These discrepancies reflect different attitudes toward indications for intervention and intrapartum fetal evaluation among obstetrics professionals and contributed to heterogeneity.

These 7 RCTs differed in their strategy for reporting outcomes and focused on different clinical endpoints. For example, the earlier findings that manual rotation reduces the duration of the second stage of labor were mainly based on observational studies[16,20] but have been confirmed in part by these RCTs.[21,24,25] Certainly, the rate of a prolonged second stage (ie, >2 or 3 hours) is a more relevant endpoint than the mean duration for assessing the clinical impact of arrest of labor during its second stage and predicting operative deliveries or maternal morbidity. The discontinuity of the monitoring of fetal head progression and cervical dilation makes it difficult to measure accurately the time spent in the second stage of labor. Thus, our meta-analysis focused on the rate of prolonged second stage labor rather than the duration of the second stage of labor but did not demonstrate a significant decrease associated with manual rotation.

Another usual endpoint was the occiput position at delivery associated with failure or success of the manual rotation procedure. Although a persistent OP position was associated with higher morbidity, this endpoint was not

TABLE 1

Study details

First author, y	Country	Study design	Trial intervention: experimental group vs control group (intervention rate % per group)	Inclusion criteria: fetal positions recorded (mode of diagnosis)	Exclusion criteria	Main outcome	Sample size: total number (experimental group vs control group)
Blanc et al,[21] 2021	France	RCT multicenter (4) not blinded	Whole-hand rotation (93.6%) vs expectant management (21.4%)	OP or OT position (ultrasound)	Previous cesarean delivery, nonreassuring fetal heart rate	Operative delivery	257 (126 vs 131)
Broberg and Caughey,[24] 2021	United States of America	RCT single center not blinded	Whole-hand or digital rotation (100.0%) vs expectant management (34.3%)	OP (transabdominal ultrasound)	Parous, nonreassuring fetal heart rate, OT position	Length of the second stage of labor (length of the pushing time)	65 (33 vs 32)
Graham et al,[28] 2014	Australia	Pilot RCT single center double blinded	Digital rotation (100.0%) vs sham rotation (0.0%)	OP (transabdominal ultrasound)	Previous cesarean delivery, nonreassuring fetal heart rate	Operative delivery	30 (15 vs 15)
Phipps et al,[22] 2021	Australia	RCT multicenter (4) double blinded	Whole-hand or digital rotation (96.8%) vs sham rotation (12.0%)	OP (transabdominal ultrasound)	Previous cesarean delivery, nonreassuring fetal heart rate	Operative delivery	254 (127 vs 127)
Yang et al,[23] 2020	China	Pilot RCT single center not blinded	Manual rotation + birth stool and position management (NR) vs expectant management (NR)	OP (ultrasound)	Parous, nonreassuring fetal heart rate, low birthweight or large for gestational age	Spontaneous vaginal delivery	400 (200 vs 200)
Verhaeghe et al,[25] 2021	France	RCT single center not blinded	Whole-hand rotation (90.5%) vs expectant management (18.5%)	OP (transabdominal ultrasound)	Nonreassuring fetal heart rate, previous cesarean delivery, preexisting diabetes mellitus	Spontaneous vaginal delivery	236 (117 vs 119)
Vries et al,[26] 2021	Australia	RCT multicenter (3) double blinded	Whole-hand or digital rotation (98.5%) vs sham rotation (5.7%)	OT (transabdominal ultrasound)	Previous cesarean delivery, nonreassuring fetal heart rate, preexisting diabetes mellitus	Operative delivery	160 (80 vs 80)

NR, not recorded; *OP*, occiput posterior; *OT*, occiput transverse; *RCT*, randomized controlled trial.

Bertholdt. Manual rotation of occiput and spontaneous deliveries. Am J Obstet Gynecol 2022.

TABLE 2
Technical conditions and obstetrical practices in each study

First author, y	Obstetrical practices	Indication (number of attempts)	Operator (experience)	Technical conditions	Complications after manual rotation	Operative delivery rate in the control group All deliveries (cesarean delivery vs operative vaginal delivery) (%)	Success rate of manual rotation (%)[a]
Blanc et al,[21] 2021	Delayed pushing	Prophylactic (at diagnosis of full dilation) (multiple attempts)	Physician on duty	Full dilation, ruptured membranes, epidural analgesia, bladder emptied, during uterine contraction and with pushing	Fetal heart rate abnormalities (17.5%)	41.3 (6.9 vs 34.4)	89.7
Broberg and Caughey,[24] 2021	Early pushing	Early (at the beginning of pushing) (maximum of 3 attempts)	1 single physician trained and comfortable using manual rotation	Full dilation, epidural analgesia, during pushing	None	28.1 (3.1 vs 25.0)	69.7
Graham et al,[28] 2014	Delayed pushing	At the first urge to push or 1 h at full dilation (NR)	Experienced physician	Full dilation, during contraction and pushing	None	80.0 (20.0 vs 60.0)	60.0
Phipps et al,[22] 2021	Delayed pushing	At the first urge to push or 1 h at full dilation (NR)	Experienced physician (≥20 procedures) or inexperienced physician	Full dilation, epidural analgesia, during contraction and pushing	Umbilical cord prolapses (0.8%)	71.0 (17.0 vs 54.0)	61.0
Yang et al,[23] 2020	NR	Prophylactic (NR)	Midwife on duty	From 6 cm to full dilation, during contraction and pushing	NR	15.5 (6.0 vs 9.5)	NR
Verhaeghe et al,[25] 2021	Delayed pushing	At diagnosis of full dilation (NR)	Experienced physician, midwife, or resident on duty	Epidural analgesia, full dilation, during pushing	None	40.3 (6.7 vs 33.6)	68.0
Vries et al,[26] 2021	Delayed pushing	At the first urge to push or 1 h at full dilation (NR)	Experienced physician (≥20 procedures) or inexperienced physician	Full dilation, epidural analgesia, during contraction and pushing	None	50.0 (8.7 vs 41.3)	88.0

NR, not recorded.

[a] Immediately after the maneuver.

Bertholdt. Manual rotation of occiput and spontaneous deliveries. Am J Obstet Gynecol 2022.

TABLE 3
Comparison of women's characteristics, obstetrical conditions, and birthweight for the manual rotation and control groups

First author, y	Maternal age (y)	Body mass index	Nulliparous n/N (%)	Gestational age (wk)	Spontaneous labor n/N (%)	Birthweight (g)
Blanc et al,[21] 2021	30.2±5.6 vs 30.5±5.6	28.5±5.7 vs 28.7±5.4	90/126 (71.4) vs 94/131 (71.8)	40.0±1.1 vs 40.0±1.0	101/126 (80.2) vs 100/131 (76.3)	3433.5±409.0 vs 3424.6±466.0
Broberg and Caughey,[24] 2021	23.9 vs 23.2	29.6±29.8	33/33 (100.0) vs 32/32 (100.0)	39.6 vs 39.6	21/33 (63.6) vs 22/32 (68.7)	3503.0 vs 3446.0
Graham et al,[28] 2014	33.0±6.0 vs 32.0±5.0	22 (21–25) vs 25 (22–28)	13/15(87.0) vs 13/15 (87.0)	40.6 (39.6–41.3) vs 40.4 (39.5–41.2)	10/15 (66.7) vs 9/15 (60)	3515.0±573.0 vs 3564.0±266.0
Phipps et al,[22] 2021	31 (28–34) vs 29 (26–32)	24 (22–28) vs 25 (22–29)	107/127 (82.7) vs 105/127 (82.7)	40.0 (39.0–40.6) vs 40.1 (39.1–40.6)	68/127 (53.5) vs 70/127 (55.1)	3500.0 (3190.0–3770.0) vs 3560.0 (3170.0–3840.0)
Yang et al,[23] 2020	27.9±0.2 vs 28.0±0.2	26.1±3.2 vs 26.8±3.2	196/196 (100) vs 188/188 (100)	39.2±1.0 vs 39.3±1.1	NR	3300.0±300.0 vs 3200.0±300.0
Verhaeghe et al,[25] 2021	28.74 (4.93) vs 27.85 (4.76)	26.99±5.76 vs 26.89±5.52	83/117 (70.9) vs 85/119 (71.4)	39.58±1.17 vs 39.39±1.12	90/117 (76.9) vs 80/119 (67.2)	3350.0±390.0 vs 3368.0±395.0
Vries et al,[26] 2021	31 (29–34) vs 30 (27–34)	24 (21–27) vs 24 (22–28)	68/80 (85) vs 67/80 (84)	40.0 (39.0–41.0) vs 40.0 (39.0–40.5)	45/80 (56.0) vs 39/80 (48.0)	3500.0 (3170.0–3810.0) vs 3430.0 (3130.0–3830.0)

Data are presented as mean±standard deviation, median (Q1–Q3), median (interquartile range), or unknown for continuous variables, unless otherwise indicated. A *P* value of $<.05$ is statistically significant.

NR, not recorded.

Bertholdt. Manual rotation of occiput and spontaneous deliveries. Am J Obstet Gynecol 2022.

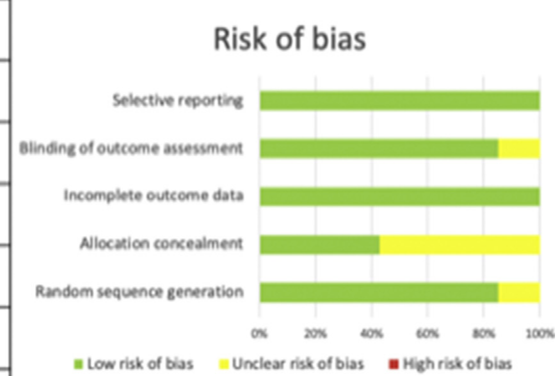
per se a clinical indicator sufficient to warrant a change in obstetrical management.[2] Accordingly, a research strategy based on an intention-to-treat analysis (ie, focusing on attempted rotations regardless of the procedure's completion, failure, or success) was more likely to provide more clinically relevant findings.

Moreover, these RCTs directly illustrated the impact of the difference in the behavior of healthcare providers, specifically in the practice of manual rotation. As explained above, this meta-analysis applied an intention-to-treat analysis. Nonetheless, late manual rotation attempts in the control group seemed frequent in some datasets (eg, 20% in Blanc et al[21] and Verhaeghe et al[25]). This result was probably more common among caregivers who habitually use a therapeutic manual rotation. Indeed, both prophylactic or early rotation (to address a nonanterior occiput position early in the second stage of labor at the diagnosis of full dilation) and therapeutic rotation (treating stagnation in labor related to a nonanterior occiput position or before operative vaginal delivery) were common.[29] This meta-analysis highlighted that the differences between these 2 indications remain unclear in both clinical practice and research, which has important clinical and research implications, as discussed below.

The best benefit-risk balance between prophylactic and therapeutic rotations must be identified. The implementation of prophylactic rotation implies a systematic ultrasound assessment of fetal occiput position at full dilation, which, in turn, may lead to inappropriate management because of obstetrical uncertainty after the procedure and unnecessary procedures when spontaneous rotation is likely to occur. In contrast, restricting manual rotation to therapeutic indications (ie, persistent nonanterior positions) might lead to a higher rate of failure and reduce the procedure's benefits for maternal and neonatal outcomes. Only a further comparative assessment of both procedures through an RCT comparing prophylactic and therapeutic approaches

FIGURE 2
Assessment of the risk of bias

First author reference	Random sequence generation	Allocation concealment	Incomplete outcome data	Blinding of outcome assessment	Selective reporting
Blanc et al [21]	+	?	+	+	+
Broberg et al [24]	+	?	+	+	+
Graham et al [28]	+	+	+	+	+
Phipps et al [22]	+	+	+	+	+
Yang et al [23]	?	?	+	?	+
Verhaeghe et al [25]	+	?	+	+	+
De Vries et al [26]	+	+	+	+	+

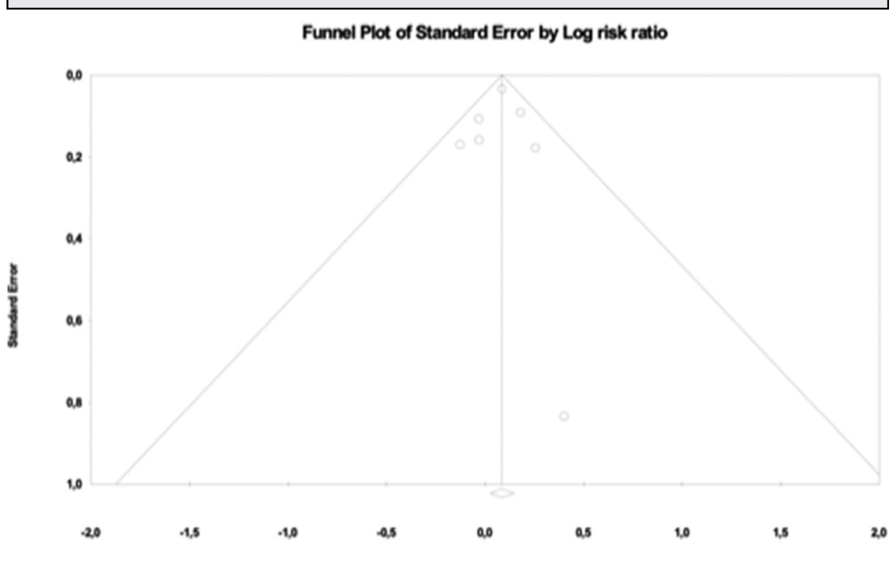


Bertholdt. Manual rotation of occiput and spontaneous deliveries. Am J Obstet Gynecol 2022.

could strike a balance between the rotation's global acceptability and its positive impact.

Two of these RCTs reported the impact of the operator's experience with manual rotation.[22,26] They defined more experienced operators as physicians who had performed at least 20 manual rotation procedures before the trial started. No data about the learning curve of manual rotation currently justifies the choice of 20 procedures, which seems arbitrary. Certainly, if all 20 attempts were unsuccessful, we cannot consider that the operator has reached competency. Nonetheless, regardless of the definition of experience, the data reported do not provide a clear answer about its impact on the success rate of manual rotation. In particular, they only report the rates of operative delivery between the groups according to the operator's experience. Given the different success rates in several studies, experience probably has an effect that has been insufficiently documented until now. Furthermore, it may explain part of the heterogeneity among studies.

FIGURE 3
Assessment of the publication bias for the primary outcome (funnel plot)



Bertholdt. Manual rotation of occiput and spontaneous deliveries. Am J Obstet Gynecol 2022.

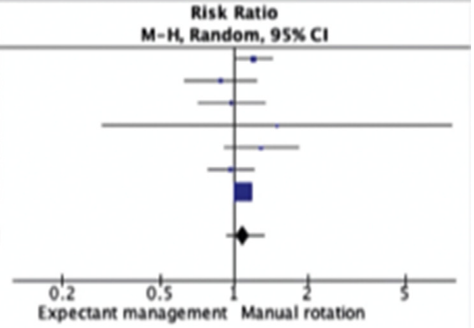
Strengths and limitations

The most important strength of this study was the meta-analysis of the value of manual rotation vs expectant management or sham rotation in OP or OT positions, which adds to the existing knowledge pool. A Cochrane systematic review published in 2014 included only 1 randomized pilot study and produced no conclusion.[30] This meta-analysis included the 5 RCTs published in 2021. It highlights the value of manual rotation when these RCTs could not do so separately, mainly because of inadequate sample sizes, because of the substantial differences between their anticipated

FIGURE 4

Effect of manual rotation vs expectant management on spontaneous vaginal delivery

Study	Manual rotation Events	Manual rotation Total	Expectant management Events	Expectant management Total	Weight	Risk Ratio M-H, Random, 95% CI
Blanc 2021	89	126	77	131	10.9%	1.20 [1.00, 1.44]
Broberg 2021	21	33	23	32	3.2%	0.89 [0.63, 1.24]
De Vries 2021	39	80	40	80	3.7%	0.97 [0.71, 1.33]
Graham 2014	3	15	2	15	0.1%	1.50 [0.29, 7.73]
Phipps 2021	48	127	37	127	2.9%	1.30 [0.91, 1.84]
Verhaeghe 2021	68	117	71	119	8.0%	0.97 [0.79, 1.21]
Yang 2020	185	200	169	200	71.2%	1.09 [1.02, 1.18]
Total (95% CI)		**698**		**704**	**100.0%**	**1.09 [1.03, 1.16]**
Total events	453		419			



CI, confidence interval.

Bertholdt. Manual rotation of occiput and spontaneous deliveries. Am J Obstet Gynecol 2022.

primary outcome rates and the rate in their control groups, which left them underpowered. However, another strength of this meta-analysis was its subgroup analyses for parity (nulliparous or parous), technique (whole-hand or digital), and fetal occiput position (posterior or transverse). The lack of conclusive findings of parity underlined the limitations in our comprehension of the mechanisms of fetal head rotation. The conditions in which spontaneous rotation occurs and the likelihood of success for the manual rotation procedure remained unclear among both nulliparous and parous women. Although the number of patients in the subgroups remained insufficient to provide a clear response, especially about parity, it did not warrant to date a clinical attitude based on maternal characteristics. The 1 exception was transverse position, which did not seem to benefit from manual rotation.

Another strength of this study was the population choice—all studies minimized bias because of the certainty of the diagnoses before attempted rotation. A sonographic identification of the fetal occiput was performed before the procedure in all RCTs reviewed. Currently, no evidence shows that knowledge of the correct position necessarily translates into a measurable outcome benefit in delivery management, even for operative vaginal delivery.[31] Nonetheless, the inaccuracy of digital examination in determining head position has been amply documented in the scientific literature.[32] Palpation seems even less accurate in cases of abnormal head position, such as OP or OT.[33] Ultrasound provides assurance that an unnecessary procedure will be avoided in false-positive cases (anterior positions) and ensures the correct positioning of the operator's hand during the procedure. This approach seemed to have been adopted in each of these RCTs.

One limitation of our study was paradoxically related to one of its strengths—its review of RCTs only. This type of study usually reduces the risk of bias compared with observational studies. However, in obstetrics, a selection bias may emerge in RCTs and impair the reliability of their data, because issues related to consent, organization of care, duration of labor, or subjective opinions of the obstetrician on duty can prevent the consecutive inclusion of all eligible women. This is mainly seen in studies where few women are included vs long study periods and the condition (ie, OP position) remains frequent.[21,25] Therefore, data are not always fully representative of the target population. Moreover, standard exclusions from clinical trials, such as women with a previous cesarean delivery (or other uterine scars), impair data reliability and generalizability. Nonetheless, the principal limitation of this study remained the heterogeneity of the studies, especially when comparing data from several continents. For example, the studies do not use homogeneous criteria to define the secondary outcomes, which must be compiled into generic items, such as low Apgar score, low pH, or prolonged second stage of labor. This compilation provided interesting but less precise information and was thus a limitation. However, the heterogeneity, assessed by the I^2 statistic, remained low for most maternal and neonatal outcomes. If we consider PI for the primary outcome, which reflects the dispersion between studies, manual rotation might have no effect on spontaneous vaginal delivery in further studies. The 95% PI ranged between 0.90 and 1.36, which means that the true effect observed in further studies should be in this range in 95% of cases, that is, close to or <1, thus without any effect.

Another related limitation was the large number of confounding factors involved, including obstetrical management of maternal posture during the second stage of labor and the midwives' various interventions used during deliveries. It is very difficult, if not impossible, to disentangle the respective impact of each intervention on perinatal outcomes. These differences in the behavior of mothers and healthcare providers contributed to the heterogeneity within and between studies and were often poorly described in the scientific literature. Because it is impossible to control such factors, in the study selection stage, we did not exclude any study because it used maternal positions or midwifery interventions. In addition, we preferred a random-effects analysis

TABLE 4

Comparison of maternal outcomes for women with manual rotation and expectant management

Variable	Blanc et al,[21] 2021	Broberg and Caughey,[24] 2021	Graham et al,[28] 2014	Phipps et al,[22] 2021	Verhaeghe et al,[25] 2021	Yang et al,[23] 2020	Vries et al,[26] 2021	Total n/N (%) Risk ratio (95% CI) *P* value, I^2
Spontaneous vaginal delivery, n/N (%)	89/126 (70.6) vs 77/131 (58.8)	21/33 (63.6) vs 23/32 (71.8)	3/15 (20.0) vs 2/15 (13.3)	48/127 (37.8) vs 37/127 (29.1)	68/117 (58.1) vs 71/119 (59.6)	185/200 (92.5) vs 169/200 (84.5)	39/80 (45.0) vs 40/80 (50.0)	453/698 (64.9) vs 419/704 (59.5) 1.09 (1.03—1.16) *P*=.005; 0% 95% prediction interval: 0.90—1.32
Cesarean delivery, n/N (%)	6/126 (4.8) vs 9/131 (6.9)	2/33 (6.1) vs 1/32 (3.1)	4/15 (26.7) vs 3/15 (20.0)	22/127 (17.3) vs 22/127 (17.3)	14/117 (11.9) vs 8/119 (6.7)	4/200 (2.0) vs 12/200 (6.0)	6/80 (7.5) vs 7/80 (8.7)	58/698 (8.3) vs 62/704 (8.8) 0.96 (0.66—1.40) *P*=.84; 10%
Operative vaginal delivery, n/N (%)	31/126 (24.6) vs 45/131 (34.3)	10/33 (30.3) vs 8/32 (25.0)	9/15 (60.0) vs 9/15 (60.0)	57/127 (44.8) vs 68/127 (53.5)	35/117 (29.9) vs 40/119 (33.6)	11/200 (5.5) vs 19/200 (9.5)	35/80 (43.7) vs 33/80 (41.2)	188/698 (26.9) vs 222/704 (31.5) 0.87 (0.75—1.01) *P*=.07; 0%
Occiput posterior or occiput transverse at delivery, n/N (%)	4/126 (3.2) vs 16/131 (12.2)	4/33 (12.1) vs 3/32 (9.4)	NR	41/123 (33.3) vs 79/125 (63.2)	45/117 (38.5) vs 59/119 (49.5)	NR	23/80 (28.7) vs 30/80 (37.5)	117/479 (24.4) vs 157/406 (38.7) 0.64 (0.48—0.87) *P*=.004; 50%
Prolonged second stage of labor, n/N (%)	NR	9/33 (27.3) vs 9/32 (28.1)	NR	61/127 (48.0) vs 63/127 (49.6)	NR	NR	27/80 (33.7) vs 20/80 (25.0)	97/240 (40.4) vs 92/239 (38.5) 1.03 (0.83—1.28) *P*=.77; 0%
Obstetrical anal sphincter injury, n/N (%)	4/126 (3.2) vs 4/131 (3.0)	4/33 (12.1) vs 4/32 (12.5)	0/15 (0) vs 2/15 (13.3)	7/127 (5.5) vs 13/127 (10.2)	1/117 (0.8) vs 5/119 (4.2)	NR	11/80 (13.7) vs 4/80 (5.0)	27/498 (5.4) vs 30/504 (5.9) 0.91 (0.41—2.02) *P*=.82; 44%
Episiotomy, n/N (%)	24/126 (19.0) vs 27/131 (20.6)	NR	NR	51/127 (40.1) vs 68/127 (53.5)	23/117 (19.6) vs 28/119 (23.5)	76/200 (38.0) vs 101/200 (50.5)	38/80 (47.5) vs 33/80 (41.2)	212/650 (32.6) vs 257/657 (39.2) 0.84 (0.71—0.98) *P*=.03; 18%
Postpartum hemorrhage, n/N (%)	9/126 (7.1) vs 7/131 (5.3)	3/33 (9.1) vs 3/32 (9.4)	3/15 (20.0) vs 3/15 (20.0)	NR	1/117 (0.8) vs 5/119 (4.2)	NR	NR	29/291 (9.9) vs 31/297 (10.4) 0.94 (0.59—1.52) *P*=.84; 0%
Transfusion, n/N (%)	NR	NR	0/15 (0) vs 0/15 (0)	3/127 (2.3) vs 3/127 (2.3)	0/117 (0) vs 2/119 (1.7)	NR	2/80 (2.5) vs 4/80 (5.0)	5/339 (1.5) vs 9/354 (2.5) 0.61 (0.21—1.80) *P*=.37; 0%

CI, confidence interval; *NR*, not recorded.

Bertholdt. Manual rotation of occiput and spontaneous deliveries. Am J Obstet Gynecol 2022.

TABLE 5
Effect of manual rotation vs expectant management or sham rotation on the rate of spontaneous delivery: subgroups analysis

Subgroup population	Studies included	n/N (%) (manual rotation vs expectant management or sham rotation)	I^2	Risk ratio	95% confidence interval *P* value
By parity					
- Nulliparous	Blanc et al,[21] 2021; Broberg and Caughey,[24] 2021; Yang et al,[23] 2020; Verhaeghe et al,[25] 2021	302/406 (74.4) vs 277/411 (67.4)	50%	1.08	0.92–1.27 *P*=.32
- Parous	Blanc et al,[21] 2021; Verhaeghe et al,[25] 2021	64/70 (70.7) vs 60/71 (53.2)	84%	1.09	0.79–1.50 *P*=.62
By technique					
- Digital rotation	Phipps et al,[22] 2021; Vries et al,[26] 2021; Graham et al,[28] 2014	52/137 (37.9) vs 46/142 (32.4)	0%	1.17	0.85–1.60 *P*=.33
- Whole-hand rotation	Phipps et al,[22] 2021; Verhaeghe et al,[25] 2021; Vries et al,[26] 2021; Yang et al,[23] 2021; Blanc et al,[21] 2021	373/513 (72.7) vs 346/513 (67.4)	13%	1.08	1.00–1.18 *P*=.06
By type of position					
- OP only	Broberg and Caughey,[24] 2021; Graham et al,[28] 2014; Yang et al,[23] 2021; Phipps et al,[22] 2021; Verhaeghe et al,[25] 2021	325/492 (66.0) vs 302/493 (61.2)	0%	1.08	1.01–1.15 *P*=.002
- OP or occiput transverse	Blanc et al,[21] 2021; Vries et al,[26] 2021	128/206 (62.1) vs 117/211 (55.4)	24%	1.13	0.93–1.36 *P*=.23

OP, occiput posterior.

Bertholdt. Manual rotation of occiput and spontaneous deliveries. Am J Obstet Gynecol 2022.

approach to address the heterogeneity within the studies.

Research implications

In addition, characteristics, such as estimated fetal weight or maternal BMI, might influence the outcomes of manual rotation. Thus, this meta-analysis pointed out the major limitations imposed by confounders in assessing the benefits of rotation. Further analysis of individual data might address some of these limitations but would require extensive collaboration within the scientific community on this point. Furthermore, these elements argued for additional prospective explorations of specific subgroups based on maternal or fetal characteristics.

A meta-analysis at the individual patient level should clarify and standardize definitions and classes and refine the analysis. Similarly, the impact of other confounding factors, such as estimated fetal weight or BMI, should be examined. However, only a further study should address the impact of parity because the parous women included in the studies were different from the target population, especially because women with previous cesarean deliveries or other uterine scars were excluded, and the sample size of parous women remained very low. Moreover, this confounding factor has an independent impact on both the success of manual rotation and the risk of operative delivery.

Conclusions and implications

Manual rotation was associated with an increased rate of spontaneous vaginal deliveries, especially for fetuses in OP position. Furthermore, it reduced the rates of OP position and episiotomy at delivery. To date, there is probably confounding decreasing the magnitude of effect and limiting evidence gradation at moderate certainty. Therefore, further studies are needed to confirm and better understand the role of confounding factors before any review of guidelines about managing OP positions during labor. The benefit-risk balance seemed to favor manual rotation, given its very low rate of complications compared with the benefits of avoiding operative delivery, known not only to be frequently associated with complications but also to affect the woman's birth experience negatively. We believe that the results of this meta-analysis provided GRADE 2 evidence regarding the impact of manual rotation on spontaneous vaginal delivery.

Nonetheless, relevant clinical questions remained unanswered and will require further studies. Among them, the indication for rotation, that is, prophylactic or therapeutic, is a central point. The other being, the best way to deal with the large number of

TABLE 6
Comparison of neonatal outcomes between manual rotation and expectant management

Variable	Number of studies	Blanc et al,[21] 2021	Broberg and Caughey[24] 2021	Graham et al,[28] 2014	Phipps et al,[22] 2021	Verhaeghe et al,[25] 2021	Vries et al,[26] 2021	Total n/N (%); Risk ratio (95% CI); *P* value; I^2
Shoulder dystocia, n/N (%)	4	NR	2/33 (6.0) vs 2/32 (6.2)	NR	4/127 (3.1) vs 1/127 (0.8)	4/117 (3.4) vs 5/119 (4.2)	2/80 (2.5) vs 1/80 (1.2)	12/357 (3.4) vs 9/358 (2.5) 1.25 (0.51−3.04) *P*=.76; 0%
Photo therapy, n/N (%)	4	NR	NR	1/15 (6.7) vs 2/15 (13.3)	10/127 (7.8) vs 10/127 (7.8)	6/117 (5.1) vs 8/119 (6.7)	6/80 (7.5) vs 11/80 (13.7)	23/339 (6.8) vs 31/341 (9.1) 0.75 (0.44−1.26) *P*=.27; 0%
Admission to the neonatal intensive care unit, n/N (%)	5	1/126 (0.8) vs 4/131 (3.0)	NR	6/15 (0.4) vs 3/15 (0.2)	0/127 (0) vs 0/127 (0)	0/117 (0) vs 0/119 (0)	0/80 (0) vs 0/80 (0)	7/465 (1.5) vs 7/472 (1.5) 0.88 (0.12−6.64) *P*=.90; 64%
Low Apgar score, n/N (%)	6	0/126 (0) vs 1/131 (0.7)	0/33 (0) vs 0/32 (0)	2/15 (13.3) vs 2/15 (13.3)	1/127 (0.8) vs 0/127 (0)	4/117 (3.4) vs 5/119 (4.2)	0/80 (0) vs 0/80 (0)	7/498 (1.4) vs 8/504 (1.6) 0.90 (0.36−2.28) *P*=.83; 0%
Low pH, n/N (%)	5	5/126 (3.9) vs 4/131 (3.0)	NR	2/15 (13.3) vs 2/15 (13.3)	1/127 (0.8) vs 2/127 (1.6)	1/117 (0.8) vs 3/119 (2.5)	0/80 (0) vs 1/80 (1.2)	9/465 (1.9) vs 11/472 (2.3) 0.81 (0.35−1.91) *P*=.63; 0%

CI, confidence interval; *NR*, not recorded.

Bertholdt. Manual rotation of occiput and spontaneous deliveries. Am J Obstet Gynecol 2022.

confounding factors that contribute to heterogeneity. The conflicting and counterintuitive results for parity demonstrated the limitations that remain, notably about our comprehension of the spontaneous rotation process. For these reasons, meta-analysis of individual data and further analyses are needed.

Finally, the place of instrumental rotation, mainly in manual rotation failure, must be defined. ■

ACKNOWLEDGMENTS

We would like to thank Emilien Micard, MSc (Centre Hospitalier Régional Universitaire de Nancy [CHRU-Nancy], Institut National de la Santé et de la Recherche Médicale, Université de Lorraine, Centre d'Investigation Clinique, Innovation Technologique, Nancy, France) and Jocelyn Germain, MD (CHRU-Nancy, Pôle de Gynécologie-Obstétrique, Nancy, France).

REFERENCES

1. Barth WH Jr. Persistent occiput posterior. Obstet Gynecol 2015;125:695–709.
2. Fitzpatrick M, McQuillan K, O'Herlihy C. Influence of persistent occiput posterior position on delivery outcome. Obstet Gynecol 2001;98:1027–31.
3. Ponkey SE, Cohen AP, Heffner LJ, Lieberman E. Persistent fetal occiput posterior position: obstetric outcomes. Obstet Gynecol 2003;101:915–20.
4. Cheng YW, Shaffer BL, Caughey AB. Associated factors and outcomes of persistent occiput posterior position: a retrospective cohort study from 1976 to 2001. J Matern Fetal Neonatal Med 2006;19:563–8.
5. Le Ray C, Lepleux F, De La Calle A, et al. Lateral asymmetric decubitus position for the rotation of occipito-posterior positions: multicenter randomized controlled trial EVADELA. Am J Obstet Gynecol 2016;215:511.e1–7.
6. Levy AT, Weingarten S, Ali A, Quist-Nelson J, Berghella V. Hands-and-knees posturing and fetal occiput anterior position: a systematic review and meta-analysis. Am J Obstet Gynecol MFM 2021;3:100346.
7. Al Wattar BH, Al Wattar B, Gallos I, Pirie AM. Rotational vaginal delivery with Kielland's forceps: a systematic review and meta-analysis of effectiveness and safety outcomes. Curr Opin Obstet Gynecol 2015;27:438–44.
8. Giacchino T, Karkia R, Zhang W, Beta J, Ahmed H, Akolekar R. Kielland's rotational forceps delivery: a comparison of maternal and neonatal outcomes with rotational ventouse or second stage caesarean section deliveries. Eur J Obstet Gynecol Reprod Biol 2020;254:175–80.
9. Guerby P, Allouche M, Simon-Toulza C, Vayssiere C, Parant O, Vidal F. Management of

persistent occiput posterior position: a substantial role of instrumental rotation in the setting of failed manual rotation. J Matern Fetal Neonatal Med 2018;31:80–6.

10. Hinkson L, Henrich W, Tutschek B. Intrapartum ultrasound during rotational forceps delivery: a novel tool for safety, quality control, and teaching. Am J Obstet Gynecol 2021;224: 93.e1–7.

11. Tempest N, Hart A, Walkinshaw S, Hapangama DK. A re-evaluation of the role of rotational forceps: retrospective comparison of maternal and perinatal outcomes following different methods of birth for malposition in the second stage of labour. BJOG 2013;120: 1277–84.

12. Tempest N, Lane S, Hapangama D. UK Audit Ressearch Trainee Collaborative in Obstetrics, Gynecology (UK-ARCOG). Babies in occiput posterior position are significantly more likely to require an emergency cesarean birth compared with babies in occiput transverse position in the second stage of labor: a prospective observational study. Acta Obstet Gynecol Scand 2020;99:537–45.

13. Walkowiak RG. Manual rotation of the transverse posterior occiput. Obstet Gynecol 1971;37:464–7.

14. Le Ray C, Serres P, Schmitz T, Cabrol D, Goffinet F. Manual rotation in occiput posterior or transverse positions: risk factors and consequences on the cesarean delivery rate. Obstet Gynecol 2007;110:873–9.

15. Reichman O, Gdansky E, Latinsky B, Labi S, Samueloff A. Digital rotation from occipito-posterior to occipito-anterior decreases the need for cesarean section. Eur J Obstet Gynecol Reprod Biol 2008;136:25–8.

16. Shaffer BL, Cheng YW, Vargas JE, Caughey AB. Manual rotation to reduce caesarean delivery in persistent occiput posterior or transverse position. J Matern Fetal Neonatal Med 2011;24:65–72.

17. Shaffer BL, Cheng YW, Vargas JE, Laros RK Jr, Caughey AB. Manual rotation of the fetal occiput: predictors of success and delivery. Am J Obstet Gynecol 2006;194:e7–9.

18. Yagel O, Cohen SM, Lipschuetz M, et al. Higher rates of operative delivery and maternal and neonatal complications in persistent occiput posterior position with a large head circumference: a retrospective cohort study. Fetal Diagn Ther 2018;44:51–8.

19. Bertholdt C, Gauchotte E, Dap M, Perdriolle-Galet E, Morel O. Predictors of successful manual rotation for occiput posterior positions. Int J Gynaecol Obstet 2019;144:210–5.

20. Le Ray C, Deneux-Tharaux C, Khireddine I, Dreyfus M, Vardon D, Goffinet F. Manual rotation to decrease operative delivery in posterior or transverse positions. Obstet Gynecol 2013;122: 634–40.

21. Blanc J, Castel P, Mauviel F, et al. Prophylactic manual rotation of occiput posterior and transverse positions to decrease operative delivery: the PROPOP randomized clinical trial. Am J Obstet Gynecol 2021;225:444.e1–8.

22. Phipps H, Hyett JA, Kuah S, et al. Persistent occiput posterior position outcomes following manual rotation: a randomized controlled trial. Am J Obstet Gynecol MFM 2021;3:100306.

23. Yang L, Yi T, Zhou M, et al. Clinical effectiveness of position management and manual rotation of the fetal position with a U-shaped birth stool for vaginal delivery of a fetus in a persistent occiput posterior position. J Int Med Res 2020;48:300060520924275.

24. Broberg JC, Caughey AB. A randomized controlled trial of prophylactic early manual rotation of the occiput posterior fetus at the beginning of the second stage vs expectant management. Am J Obstet Gynecol MFM 2021;3:100327.

25. Verhaeghe C, Corroenne R, Spiers A, et al. Delivery mode after manual rotation of occiput posterior fetal positions: a randomized controlled trial. Obstet Gynecol 2021;137: 999–1006.

26. de Vries B, Phipps H, Kuah S, et al. Transverse position. Using rotation to aid normal birth-OUTcomes following manual rotation (The TURN-OUT Trial): a randomized controlled trial. Am J Obstet Gynecol MFM 2021;4:100488.

27. Dall'Asta A, Ghi T. Manual rotation of persistent occiput posterior position: more research is warranted. Am J Obstet Gynecol MFM 2021;3:100387.

28. Graham K, Phipps H, Hyett JA, et al. Persistent occiput posterior: OUTcomes following digital rotation: a pilot randomised controlled trial. Aust N Z J Obstet Gynaecol 2014;54:268–74.

29. Bertholdt C, Piffer A, Pol H, Morel O, Guerby P. Management of persistent occiput posterior position: the added value of manual rotation. Int J Gynaecol Obstet 2021 [Epub ahead of print].

30. Phipps H, de Vries B, Hyett J, Osborn DA. Prophylactic manual rotation for fetal malposition to reduce operative delivery. Cochrane Database Syst Rev 2014;12:CD009298.

31. Bellussi F, Di Mascio D, Salsi G, et al. Sonographic knowledge of occiput position to decrease failed operative vaginal delivery: a systematic review and meta-analysis of randomized controlled trials. Am J Obstet Gynecol 2021 [Epub ahead of print].

32. Dupuis O, Ruimark S, Corinne D, Simone T, André D, René-Charles R. Fetal head position during the second stage of labor: comparison of digital vaginal examination and transabdominal ultrasonographic examination. Eur J Obstet Gynecol Reprod Biol 2005;123: 193–7.

33. Ghi T, Eggebø T, Lees C, et al. ISUOG Practice Guidelines: intrapartum ultrasound. Ultrasound Obstet Gynecol 2018;52:128–39.