

Full length article

# Vacuum-assisted birth in maternal lateral posture versus lithotomy. A simulation study

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## ABSTRACT

**Objective:** Maternal lateral postures provide advantages during childbirth. This study aims to investigate the feasibility of assisting vacuum births in maternal lateral postures in a simulation model.

**Study design:** In a simulation model, four obstetricians and four medical students were randomly allocated to perform vacuum-assisted births first in maternal lateral posture or lithotomy. A modification of Aldo Vacca's 5-step technique was developed to assist vacuum-assisted births in lateral posture. The lateral distance, vertical distance, and distance from the cup center to the flexion point were measured for every placement of the cup.

**Results and conclusions:** A total of 128 vacuum-assisted births were performed. The mean distance to the flexion point was  $1.15 \pm 0.71$  cm for the lithotomy posture and  $1.31 \pm 0.82$  cm for the lateral posture ( $P = 0.127$ ). There were no statistically significant differences in vacuum extractor cup placement accuracy based on maternal posture.

Performing vacuum-assisted births in maternal lateral posture is feasible in a simulation model. The technique is easy to learn, and the differences in cup placement between the lateral and lithotomy postures are small.

## Introduction

The obstetric suction cup, also known as the vacuum extractor, is a medical instrument that operates by creating negative pressure between the cup and the fetal head. When properly positioned, this device achieves its intended purposes of facilitating flexion, limited traction, and induced rotation [1,2]. Precise placement of the vacuum extractor cup is crucial, particularly at the flexion point, which is located along the sagittal suture, three centimeters in front of the posterior fontanelle [3,4]. The Vacca technique, also known as the Vacca 5-Steps Technique, is the preferred application method [5].

The Vacca 5-Steps technique employs measurement indicators on the suction tubing of maneuverable vacuum extractor cups to ensure the cup is inserted at the appropriate depth within the birth canal and correctly positioned over the flexion point [3,4]. It's important to note that this technique is specifically described in the maternal lithotomy position.

Maternal postures with flexible sacrum, such as the lateral position, have theoretical advantages and are preferred by many women [6–9]. Flexible sacrum postures have been reported to provide increased comfort for mothers, potentially leading to a shorter second stage of labor and a reduced incidence of perineal tears [7–9]. However, despite the potential benefits, there is currently a lack of literature focusing on instrumental birth techniques in flexible sacrum postures. There is only one article that explores this possibility in the all-fours position [10].

Simulation offers a safe and effective method to test and compare the feasibility of vacuum-assisted births in different maternal postures, without exposing women to any potential harm [11]. Hence, simulation is the recommended methodology for conducting studies that evaluate new techniques in obstetrics.

This simulation-based study aims to evaluate the feasibility and accuracy of a modified Vacca 5-Steps Technique used for maternal lateral posture compared to the standard Vacca 5-Steps Technique used in

**Abbreviations:** Cm, centimeters.

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lithotomy.

## Material and methods

This experimental study included four obstetricians and four medical students who conducted 128 vacuum-assisted births on a simulation model. The Ethics Committee of Hospital Universitario La Paz reported the exemption from approval in November 2022 due to the non-participation of human patients. In the absence of human participants, informed consent was not required. The institutional board approved the investigation.

The simulation used a Lucy and Lucy's Mum Instrumental Delivery Birth Simulator (MODEL-med®, Australia), specifically designed to replicate the process of instrumental delivery using vacuum and forceps. The Kiwi Omnicup (Clinical Innovations Inc., USA) was selected as the instrument to conduct the births.

The selection criteria for the obstetricians included having over ten years of experience working in delivery rooms and proficiency in using the Vacca 5-Steps Technique. On the other hand, the medical students were inexperienced with the technique; they were fourth-year volunteers. Before participating in the study, all participants, including the obstetricians and students, completed the online course "The Fundamentals of Safe Vacuum Delivery" provided by the Vacca Academy [12]. Additionally, the participants conducted a vacuum-assisted birth in each maternal posture as a familiarization exercise on the simulator prior to the study.

The Vacca 5-Steps technique is a five-step process that involves: 1) identify the location of the flexion point and determine its distance from the maternal posterior fourchette; 2) insert the cup into the introitus; 3) maneuver the cup posteriorly along the maternal pelvis axis until the measured distance in step one is reached, which can be verified by checking the distance marks on the suction tubing; 4) create the necessary vacuum and ensure the exclusion of maternal tissue; 5) provide traction along the axis of the maternal pelvis (Video 1) [4].

Our modification of the Vacca 5-Steps technique for use in maternal lateral posture involves a revision to step 3: 3) maneuver the cup posteriorly along the maternal pelvic axis using one hand, while the other hand keeps the tubing on the posterior fourchette until the distance measured in step one is reached. The distance can be confirmed by examining the distance marks on the suction tubing (Video 2).

The obstetricians and medical students were randomly allocated to perform the first vacuum-assisted birth in maternal lateral posture or lithotomy in a one-to-one ratio. Each participant was required to complete eight vacuum-assisted births in maternal lateral posture and eight in lithotomy. They conducted eight vacuum-assisted births in each posture to investigate every possible fetal head position (occiput anterior, right occiput anterior, left occiput anterior, left occiput transverse, right occiput transverse, occiput posterior, right occiput posterior, and left occiput posterior). The fetal head station was + 2 in all vacuum-assisted births. MJ Cuerva or M Cortes supervised the obstetricians and medical students to ensure that the correct steps were performed in the proper order.

The data collected for each vacuum extractor cup placement included three variables: the lateral distance, vertical distance, and the distance from the cup center to the flexion point. The measurements were performed after the birth with an accuracy of up to 1 mm. The measurement of the lateral distance was conducted from the sagittal suture, where displacement towards the right parietal bone was regarded as positive, while displacement towards the left parietal bone was considered negative solely for graphical representation purposes. Similarly, for graphical representation purposes, the vertical distance was measured as positive when measured between the flexion point and the anterior fontanel, and as negative when measured between the flexion point and the posterior fontanel.

Two different definitions were used to determine the proper placement of the cup. According to the first definition, a placement was

considered correct if it had a vertical and lateral displacement of less than 10 mm [13]. The second definition stated that any placement within 20 mm of the center of the cup to the flexion point was deemed appropriate [14].

Sample size (number of vacuum-assisted births) was calculated using the data from a previous study conducted by MJ Cuerva et al. [5]. Sample size was calculated to demonstrate a difference of at least 5 mm in the distance from the center of the cup to the flexion point. With a variance of 36, an alpha value of 0.05, and a power (1 – beta) of 90%, the required sample size was 30 vacuum extractor cup placements in each group. To study all possible different head positions, it was decided that 32 vacuum-assisted births would be performed in maternal lateral posture and 32 in lithotomy by both the obstetricians and the students, resulting in a total of 128 vacuum-assisted births.

The distribution of the variables was verified by the Shapiro-Wilk test and by visual assessment of histograms. Numerical variables were expressed as mean (standard deviation) or median (interquartile range, IQR) as appropriate and qualitative variables were expressed as proportions (absolute and relative frequencies). Comparisons between groups were performed by the Student's t-test, Mann-Whitney U test, two-tailed  $\chi^2$ -test, or two-tailed Fisher's exact test as appropriate. The level of significance was set at 0.05. All analyses were performed using SPSS version 22.0 (SPSS Inc., Chicago, IL, USA).

## Results

A total of 128 vacuum-assisted births were performed. The mean distance from the flexion point was  $1.23 \pm 0.77$  cm. The lateral displacement (measured as the absolute value of the lateral distance) was 0.6 (0.2; 1.2), while the vertical displacement (measured as the absolute value of the anterior or posterior distance) was 0.5 (0.3; 1.2) (Fig. 1).

The mean distance to the flexion point was  $1.15 \pm 0.71$  cm for the lithotomy posture and  $1.31 \pm 0.82$  cm for the lateral posture ( $P = 0.127$ ). No statistically significant differences were found in the distance to the flexion point, lateral displacement, or vertical displacement based on maternal posture or the operator performing the procedure (Table 1).

Regarding the fetal head positions, there were no statistically significant differences in the distance to the flexion point, lateral displacement, or vertical displacement in the anterior or posterior positions (occiput anterior, right occiput anterior, left occiput anterior, occiput posterior, right occiput posterior, and left occiput posterior) based on maternal posture. In the transverse fetal head positions, the lateral displacement showed statistically significant differences (Table 2).

No statistically significant differences were observed in the accuracy of vacuum extractor cup placement based on maternal posture. Specifically, for lateral and vertical displacements below 1 cm, there were 36 (56.3%) correct placements in the lithotomy posture, compared to 31 (48.4%) in the lateral posture ( $P = 0.376$ ). In terms of the distance to the flexion point below 2 cm, there were 52 (81.3%) correct placements in the lithotomy posture, compared to 50 (78.1%) in the lateral posture ( $P = 0.660$ ). Furthermore, there were no notable differences based on the expertise level of the operator (student or obstetrician) or the randomization allocation (Table 3).

## Discussion

The feasibility of assisting births in maternal lateral posture using a vacuum extractor has been observed in our study. No significant differences were found in cup placement, indicating that this technique can be successfully applied. Moreover, both experienced obstetricians and medical students were able to learn the technique effectively. Considering the potential benefits associated with flexible sacrum maternal postures, we believe that facilitating instrumental births in these positions could provide advantages for both the mother and the neonate.

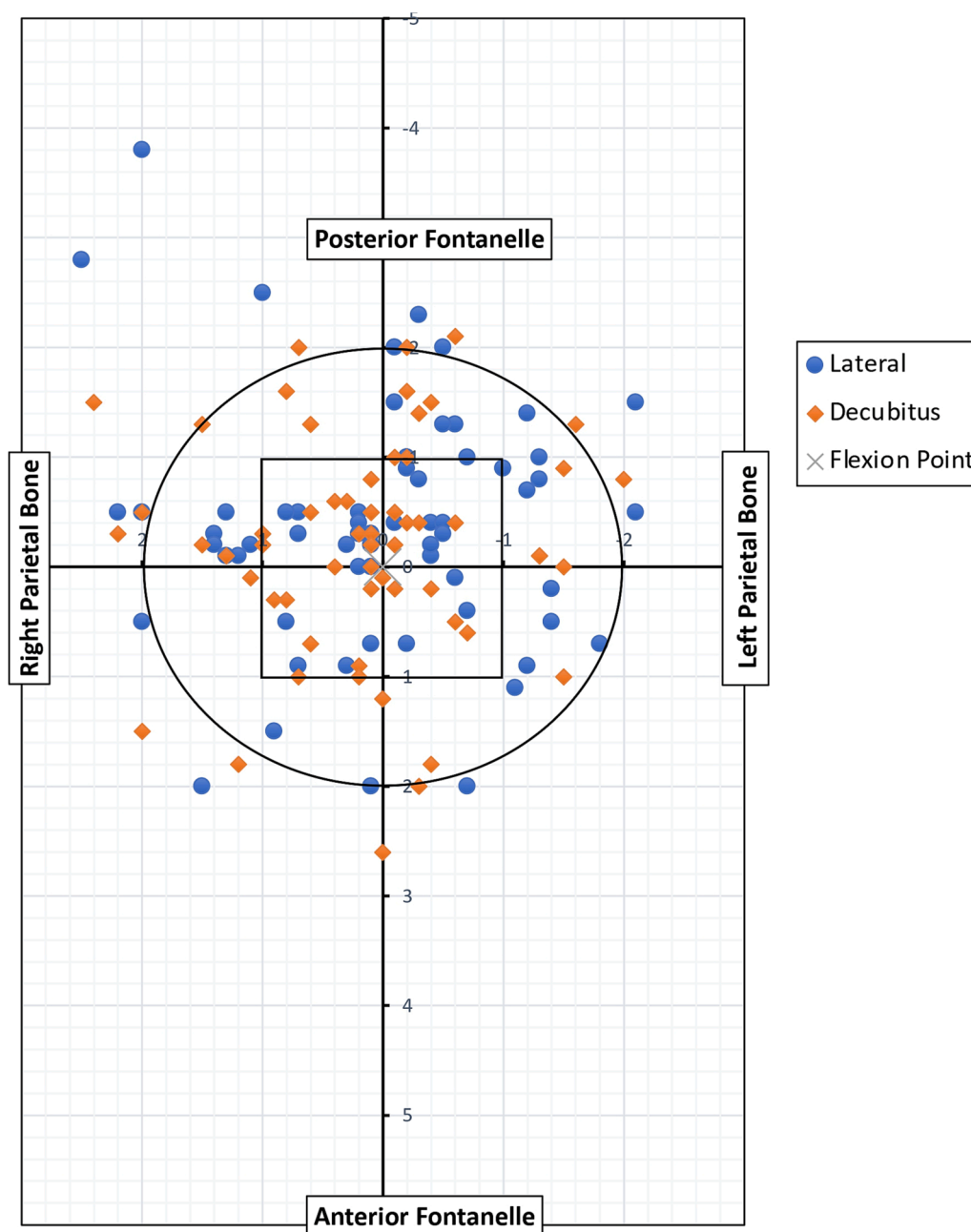


Fig. 1. Placement of the vacuum extractor cups in the 128 vacuum-assisted births. The square shows a vertical or lateral displacement of 10 mm. The circle shows a 20 mm distance from the flexion point.

The Vacca 5-Steps technique is currently widely used for assisting births with vacuum extractor cups [15]. Other techniques, such as the one described by Bird, may be less accurate, although they can be used with maneuverable cups without measurements on the suction tubing [5]. The success in learning the technique can be explained by the system used in our study, with a theoretical course first and later the practical application on a simulator [12]. Both the medical students and the obstetricians demonstrated proficiency on the simulator, indicating that the technique was easily learned. The ease with which students learned the technique in both maternal postures shows that prior experience in the lithotomy position may not be a prerequisite for learning the technique in maternal lateral posture.

In relation to postures with flexible sacrum, such as the maternal lateral posture, there exists controversy surrounding their potential advantages. While some studies have reported a potential reduction in

the duration of the second stage of labor and a decreased likelihood of perineal tears, these differences have not consistently been observed across various *meta-analyses* [6–9,16]. We believe that flexible sacrum postures have the potential to provide advantages in operative births by enabling the adaptation of obstetric diameters in response to pelvic forces. From a biomechanical perspective, the diverse adaptations of the sacrum may contribute to reducing resistance and facilitating the birthing process [10,17,18]. In addition, flexible sacrum postures may prevent aorto-caval compression and, in some cases, cord compression, resulting in improved fetal oxygenation [7].

Regarding the potential disadvantages of performing a vacuum-assisted birth in maternal lateral postures, an important consideration is the potential difficulty in conducting vaginal exams on women in this position. However, it is feasible to explore the crucial parameters necessary for ensuring a safe instrumental delivery through the use of

**Table 1**

Distances according to operator.

Obstetricians	Distance (cm)	Lithotomy	Lateral	P	Total
Obstetricians (n = 64)	Lateral displacement	0.4 (0.1; 1.3)	0.45 (0.2; 1.3)	0.589	0.4 (0.2; 1.3)
32 lithotomy position	Vertical displacement	0.5 (0.3; 1.0)	0.5 (0.2; 0.9)	0.721	0.5 (0.3; 0.9)
32 lateral position	Distance to flexion point	1.09 ± 0.67	1.15 ± 0.78	0.375	1.12 ± 0.72
Students (n = 64)	Lateral displacement	0.4 (0.1; 1.0)	0.7 (0.4; 1.3)	0.060	0.6 (0.2; 1.2)
32 lithotomy position	Vertical displacement	0.75 (0.2; 1.5)	0.85 (0.4; 1.5)	0.423	0.8 (0.3; 1.5)
32 lateral position	Distance to flexion point	1.22 ± 0.76	1.47 ± 0.85	0.107	1.34 ± 0.81
Total (n = 128)	Lateral displacement	0.4 (0.1; 1.1)	0.7 (0.2; 1.3)	0.079	0.6 (0.2; 1.2)
64 lithotomy position	Vertical displacement	0.5 (0.2; 1.3)	0.5 (0.3; 1.1)	0.646	0.5 (0.3; 1.2)
64 lateral position	Distance to flexion point	1.15 ± 0.71	1.31 ± 0.82	0.127	1.23 ± 0.77

Data are presented as distance in centimeters (cm). Mean ± Standard deviation or Median (IQR) as appropriate.

**Table 2**

Distances according to fetal head position.

Head position	Distances (cm)	Lithotomy	Lateral	p
Anterior (n = 48)	Lateral displacement	0.40 (0.10; 0.90)	0.50 (0.20; 0.95)	0.406
24 lithotomy, 24 lateral	Vertical displacement	0.50 (0.20; 0.85)	0.50 (0.30; 1.00)	0.276
	Distance to flexion point	0.90 ± 0.59	1.08 ± 0.65	0.167
Transverse (n = 32)	Lateral displacement	0.50 (0.10; 1.27)	1.30 (0.72; 1.95)	0.025
16 lithotomy, 16 lateral	Vertical displacement	0.55 (0.22; 1.15)	0.50 (0.32; 0.77)	0.820
	Distance to flexion point	1.27 ± 0.71	1.54 ± 0.85	0.169
Posterior (n = 48)	Lateral displacement	0.50 (0.40; 1.20)	0.60 (0.20; 1.20)	0.950
24 lithotomy, 24 lateral	Vertical displacement	1.00 (0.30; 1.50)	0.80 (0.32; 1.87)	0.852
	Distance to flexion point	1.32 ± 0.78	1.38 ± 0.94	0.402

Data are presented as mean distance in centimeters ± Standard deviation or median (IQR). Anterior includes OA, LOA and ROA. Transverse includes RT and LT. Posterior includes OP, LOP and ROP. cm = centimeters.

intrapartum ultrasound [19]. Another aspect to take into account is the potential challenges associated with accurately performing an episiotomy when it is required, which can be addressed through prior training on simulators. In situations where difficulties arise during tear or episiotomy repair, modifying the woman's position may present a viable solution. It may also appear that the traction technique could be more challenging in maternal lateral posture. For traction, it is necessary to follow the pelvic axis, which is altered in the lateral posture to a horizontal plane. On the simulator, the horizontal plane is easy to follow; whereas in an actual birth, the direction of traction may undergo slight changes depending on the movements of the woman. These changes should be easy to appreciate through direct visualization of the woman's posture.

Studies carried out with obstetric simulators provide advantages such as being conducted in a safe environment, without potential harm to the mother or the neonate [11]. Furthermore, these studies are

**Table 3**

Correct placement of the cup according to operator and randomization (first in lateral or lithotomy posture).

Placement of the cup	Students (32)	Obstetricians (32)	P	Total (64)
Within 1 cm <sup>2</sup> Lithotomy	17 (53.1%)	19 (59.4%)	0.614	36
Within 1 cm <sup>2</sup> Lateral	14 (43.8%)	17 (53.1%)	0.453	31
Distance from the FP < 2 cm Lithotomy	25 (78.1%)	27 (84.4%)	0.522	52
Distance from the FP < 2 cm Lateral	23 (71.9%)	27 (84.4%)	0.226	50
Placement of the cup	First lateral (32)	First lithotomy (32)	P	Total (64)
Within 1 cm <sup>2</sup> Lithotomy	18 (56.3%)	18 (56.3%)	1.0	36
Within 1 cm <sup>2</sup> Lateral	16 (50.0%)	15 (46.9%)	0.802	31
Distance from the FP < 2 cm Lithotomy	27 (84.4%)	25 (78.1%)	0.522	52
Distance from the FP < 2 cm Lateral	23 (71.9%)	27 (84.4%)	0.226	50

Data are presented as absolute and relative frequencies.

essential for describing and analyzing new techniques, as they allow for a high number of repetitions and analyses to be performed [20,21]. In our study, 128 births were assisted by four obstetricians and four students. The inclusion of students in actual birth studies would not have been ethically permissible. Regarding realism, improvements in materials and technology have allowed the simulators to faithfully adapt to the sensations of birth assistance in a real woman.

The main strength of our study lies in its design, which enabled us to investigate 64 operative births in maternal lateral posture using a simulation model, eliminating any potential risks. Another strength is that we assessed the technique from the viewpoints of both experienced obstetricians and students, enabling us to address the learning challenge.

Regarding weaknesses, the main limitation is that the simulators are limited in their sacroiliac and sacrococcygeal joints mobility, which made it impossible to determine if dynamic changes in obstetric diameters during a lateral operative birth would alter the required forces and potential damages.

## Conclusions

Vacuum-assisted birth technique for maternal lateral posture is easy to learn. Vacuum extractor cup placement in maternal lateral posture can be performed with similar accuracy to the placement in lithotomy position. The potential benefits of using flexible sacrum maternal postures make it worth further investigation. More studies are necessary, and the translation of simulation models into real-life scenarios will be essential to evaluate the technique's potential progress.

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## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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### Author contributions

All authors have accepted responsibility for the entire content of this manuscript and approved its submission. MJC: Protocol/project development, Data collection and management, Manuscript writing. BDS: Protocol/project development, Data collection. MC: Data collection and manuscript editing. FL: Data collection and manuscript editing. JAE: Data collection and manuscript editing. JLB: Protocol/project development, Validation of data analysis, Manuscript reviewing and editing.

### Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jocn.2023.07.020>.

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