

Reliability of the Carousel simulator for assessing labor cervical dilation in medical obstetrics education

Sartorao-Filho, Carlos Izaias^{1,2}, Sartorao, Ana Luisa Varrone², Terribile, Diogo Coutinho², Barbosa, Angelica Mercia Pascon¹, Rudge, Marilza Vieira da Cunha¹

1. University of Sao Paulo State, Faculty of Medicine of Botucatu, Brazil

2. Educational Foundation of the Municipality of Assis, Faculty of Medicine, Brazil.

Corresponding author:

Carlos Izaias Sartoro-Filho, Benedito Spinardi street, 1440. Assis city, Sao Paulo State, Brazil. ZIP 19815-110 Phone: +551833242122.

Word count: 1854

Synopsis: We demonstrated the reliability of a novel simulator device used for digital vaginal examination of cervical dilation during labor for medical education.

Objective: To determine the reliability of the "Carousel" simulator in medical education for obstetric exams. Cervical dilation exam training in pregnant women exposes patients to additional uncomfortable and health-risk procedures, a gold standard, and does not objectively evaluate the medical student's competence.

Method: We studied the reliability of training internship medical students in obstetrics. Participating students were assigned to take the exam of digital assessment of the cervical dilation on the simulator. Classes performed twelve consecutive randomly blind predetermined cervical dilation exams using the "Carousel" simulator. The exact answer and the answer with certainty within 1 cm plus or minus were registered and analyzed. Incorrect or outlier answers were considered with a cut-off of two or more centimeters from the dilation. A dispersion graph for each centimeter of dilation simulation was constructed.

Results: Sixty-six medical obstetricians took part, performing 396 examinations. Thus, we observed 49 outliers (12.37%) in simulated assessments. According to the analysis, we did not observe outliers from dilation 1 to 4; dilation 7 to 9 had a higher index of outlier measurements. We did not consider any dilation simulation dispersion graphic as a null correlation. A strong correlation was seen in the dilation 1 to 6 and the dilation 10. The dilations 7, 8, and 9 showed a weak correlation.

Conclusion: We prove that the model is reliable for student learning. We did not see a null correlation in the dispersion graphic analysis from the simulations. The simulator is an essential study tool capable of reducing the embarrassment and

possible harm caused by the excessive and repetitive number of in vivo digital vaginal examinations for learning this skill. Novel studies are proposed to improve the simulator device and the method, mainly to estimate the adequate repetitions and training needed before in vivo practice.

Keywords: simulator; medical education; gynecology; obstetrics; labor

Introduction

The "Carousel" simulator model was developed and patented to facilitate and provide better teaching, understanding, and accuracy of cervical dilation assessment during labor. [1] The classic training scheme for the cervical examination involves a student examining a woman in labor after a professional midwifery practitioner repeats the examination to determine the accuracy of the assessment. There is no objective assessment of the intern or a predetermined competency level for this skill. The subjective and imprecise nature of the birth cervical examination is evident in studies investigating this skill's performance. Studies using rigid cervical models have shown accuracy rates of approximately 49% [2] and 58% [3] and intra-observer variability of 52%. [2] The accuracy assessment on the "soft" cervix, more realistic and made of foam, showed even lower results of just 19%. [4]

Based on these assessments of healthcare provider accuracy, there is a field for improvement in training this skill. Furthermore, the in vivo study causes anxiety for the student and exposes the patient to additional cervical examinations, which can cause harm. [2-4] The training steps that involve the precision necessary for the exam, the best frequency and interval of training sessions, or the number of repetitions required to reach the appropriate level of accuracy still need to be well defined in the literature. We did not find data in the literature to objectively assess the medical student's ability in this planned activity. To evaluate and minimize these problems, we created a training program using the simulator model called Carousel, patented by Sartorao Filho et al. in 2021 [1], which allows simulated obstetric cervical dilation examination, like the model used by Huhn and Brost [4]. The "Carousel" provides, in a single device, the possibility of a blind simulation of all options and clinical conditions during labor. We hypothesize that the "Carousel" simulator will provide reliable training. Thus, the simulator will increase the precision of the skills required for the activity of undergraduate medical students in the adequate recognition of cervical dilation during labor.

Method

The Faculty of Medicine of Botucatu – University of São Paulo State developed the project between August 1, 2022, and November 30, 2022. It was applied among medical students from the internship program at the Faculty of Medicine of the Educational Foundation of the Municipality of Assis, Brazil. Students with prior experience caring for women in labor were excluded. The project does not required ethics approval in order to not include any access to identifiable private subjects information

We used the "Carousel" simulator [1]. In the "Carousel" model, distinct stages of cervical dilation were constructed with various rigid combinations (0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 centimeters) to allow reproducing the variability found in clinical

practice in the evolution of the dilation phases of labor. All participants who agreed to participate received prior guidance and training and signed the Free and Informed Consent Form. The data collection occurred between August 1, 2022, and November 30, 2022. All participants who voluntarily consented to participate received prior training. The training and subsequent data collection assessments were conducted by the project's leading researcher in classrooms or teaching environments. During the initial cervical examination session, students measured their fingers to understand better how their dimensions can be used to estimate cervical dilation and learned the obstetric vaginal examination technique. For each participating student, twelve random sequences of dilations were predetermined in the simulator, ranging from 1 to 10 cm. After preparing the simulator, the student inserted his fingers with a latex glove blindly through the opening that simulated the vulva and vagina to perform an examination and estimate the dilation. The evaluator prepared twelve predetermined random sequences. We discharged the first six examinations from each participant, and the last six examination responses were recorded for later verification and analysis. Accuracy and proximity within 1 cm plus or minus were used to estimate the dilation because these margins of error have already been investigated in other studies. (2,3,5) Additionally, accuracy within 1 cm is considered relevant because discerning this change per hour is necessary to determine whether labor progresses appropriately over time. [5] Therefore, simulations in which the evaluation differed by +/- 2 or more centimeters from the expected result were considered "wrong" or as an outlier response. The sample size used was considered adequate based on the most extensive study found in the literature. [3] We used the Excel

We plotted the data from each simulated centimeter of the dilation exam, obtaining a dispersion graphic. We considered the null correlation when the points do not follow a positive or negative trend, demonstrating a dispersion between the points equal to or more than 2 cm from the simulated dilation.

Results

Sixty-six medical students participated, with a total of 396 examinations. Thus, we observed 49 considered examinations as outliers (12,37%). Figure 2 demonstrate the dispersion graphic analysis for each centimeter of dilation simulated. Table 1 demonstrates the minimum, and maximum variation results, the number of exams realized, and the number of outliers for each centimeter simulated. According to the results, the examination of the dilation 6, 7, 8, and 9 centimeters had the higher index of outliers measurements during the simulation. The dispersion amplitude of the examination was higher in the simulation of the 8 cm (-5 to +1 cm). We did not consider any dilation simulation dispersion graphic as a null correlation. A strong correlation was observed in the dilation 1 to 6 and the dilation 10. The dilations 7, 8, and 9 demonstrated a weak correlation.

Discussion

The study's results with the Carousel simulator for evaluating cervical dilation proved that the model is reliable for student learning. The simulator is an

essential study device capable of reducing the embarrassment and harm caused by the excessive and repetitive number of in vivo vaginal assessments for learning the digital assessment of cervical dilation during labor. After executing the simulation training, the measurement error rate was approximately 12.37%. Phelps et al. reported a similar error rate (11.5%) in a simulator study. [3] Buchmann and Libhaber published an in vivo study with a measurement error rate between experts and non-experts of 11.0%. [5] The present study supplies parameters to confirm the reliability of the "Carousel" simulation model in the objective assessment of cervical dilation in labor simulation. The study not only shows the reliability of the simulator model and this type of training but may also help define many crucial training parameters through the cumulative summation technique. This critical information can be used to construct an evidence-based simulation to personalize training for each student and medical staff while objectively assessing their competency to perform this essential obstetric skill.

The digital vaginal examination remains the most practical instrument for the analysis of cervical dilation. Reports in the past indicate that mechanical cervimeters were inconvenient for clinical practice. Thus, for clinical assessment, digital assessment of cervical dilatation remains sufficient. [6] Studies using bidimensional and three-dimensional intrapartum ultrasonography, showed a high agreement for this purpose with no statistical difference for the success rate. [7]

As advantages, participation and execution of this type of simulation do not violate legal and ethical standards. Participants will benefit from the simulation by gaining greater insight into this skill. The study will make it possible to plan a strategy to minimize discomfort and potential damage caused by training when carried out directly on patients. Innovative studies are proposed to improve the simulator and the method, mainly to estimate adequate repetitions and training before in vivo practice. Moreover, the simulator can be used for the assessment of the De Lee/Hodge planes and the assessment of the multiple variety of fetal position and presentation during labor.

Conclusion

The Carousel simulator proved a reliable method for students learning to perform and measure digital cervical dilation in obstetrics. The simulator is an essential study device capable of reducing embarrassment and damage caused by the excessive and repetitive number of vaginal exams in vivo. Novel studies are proposed to improve the simulator and the method, mainly to estimate the appropriate number of repetitions training before in vivo clinical practice.

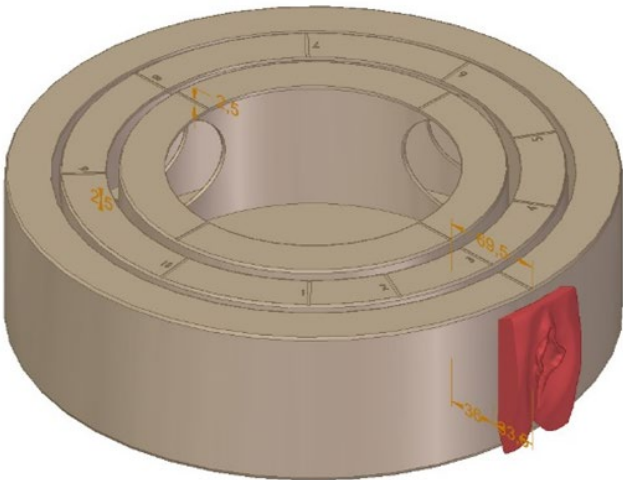
Authors' contributions: all the authors declare that contributed to: Substantial contributions to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work; AND Drafting the work or reviewing it critically for important intellectual content; AND Final approval of the version to be published; AND Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Disclosure of Financial and Non-Financial Relationships and Activities, and Conflicts of Interest: the authors declare no conflicts of interest and non-financial relationships or fundings.

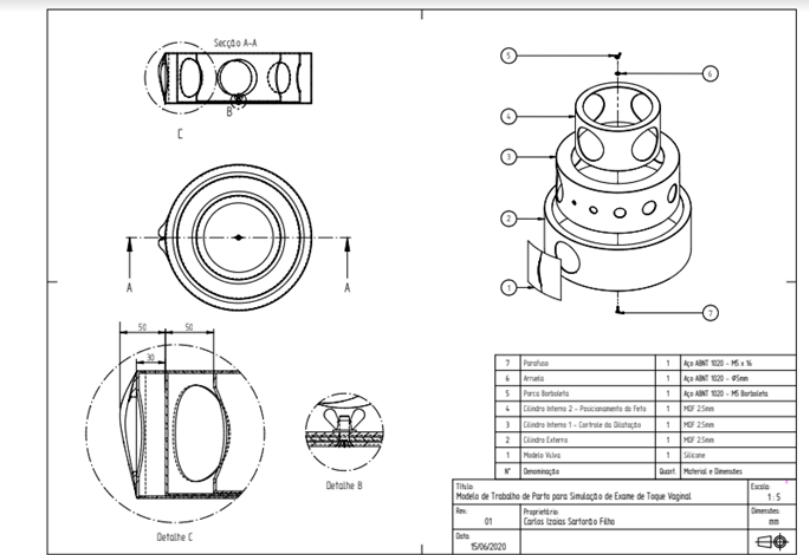
References

1. Sartorao Filho CI, Barbosa AMP, Rudge MVC. The "Carousel": a new simulation model for assessing the female pelvic examination in medical education. *Int J Gynecol Obstet* [Internet]. 2021 Oct [cited 2021 December 26]; Available from: <https://onlinelibrary.wiley.com/doi/full/10.1002/ijgo.13953>
2. Tuffnell DJ, Johnson N, Bryce F, Lilford RJ. Simulation of Cervical Changes in Labour: Reproducibility of Expert Assessment. *Lancet*. 1989;334(8671):1089–90.
3. Phelps JY, Higby K, Smyth MH, Ward JA, Arredondo F, Mayer AR. Accuracy and intraobserver variability of simulated cervical dilatation measurements. *Am J Obstet Gynecol* [Internet]. 1995 Sep [cited 2021 Jun 8];173(3):942–5. Available from: <https://pubmed.ncbi.nlm.nih.gov/7573274/>
4. Huhn KA, Brost BC. Accuracy of simulated cervical dilation and effacement measurements among practitioners. *Am J Obstet Gynecol* [Internet]. 2004 Nov [cited 2021 Jun 8];191(5):1797–9. Available from: <https://linkinghub.elsevier.com/retrieve/pii/S0002937804008464>
5. Buchmann EJ, Libhaber E. Accuracy of cervical assessment in the active phase of labor. *BJOG* [Internet]. 2007 Jul [cited 2021 Dec 26];114(7):833–7. Available from: <https://pubmed.ncbi.nlm.nih.gov/17567418/>
6. van Dessel, T., Frijns, J. H. M., Kok, F. Th. J. G. Th., & Wallenburg, H. C. S. (1991). Assessment of cervical dilatation during labor: a review. *European Journal of Obstetrics & Gynecology and Reproductive Biology*, 41(3), 165–171. [https://doi.org/10.1016/0028-2243\(91\)90019-H](https://doi.org/10.1016/0028-2243(91)90019-H)
7. Wiafe, Y. A., Whitehead, B., Venables, H., & Nakua, E. K. (2016). The effectiveness of intrapartum ultrasonography in assessing cervical dilatation, head station and position: A systematic review and meta-analysis. *Ultrasound*, 24(4), 222–232. <https://doi.org/10.1177/1742271X16673124>

218 Figure 1: The Carousel device developed by Sartorao Filho et al. [1]



219



220
221

Figure 2. Dispersion graphics of the variation in centimeters of the digital measure simulated.

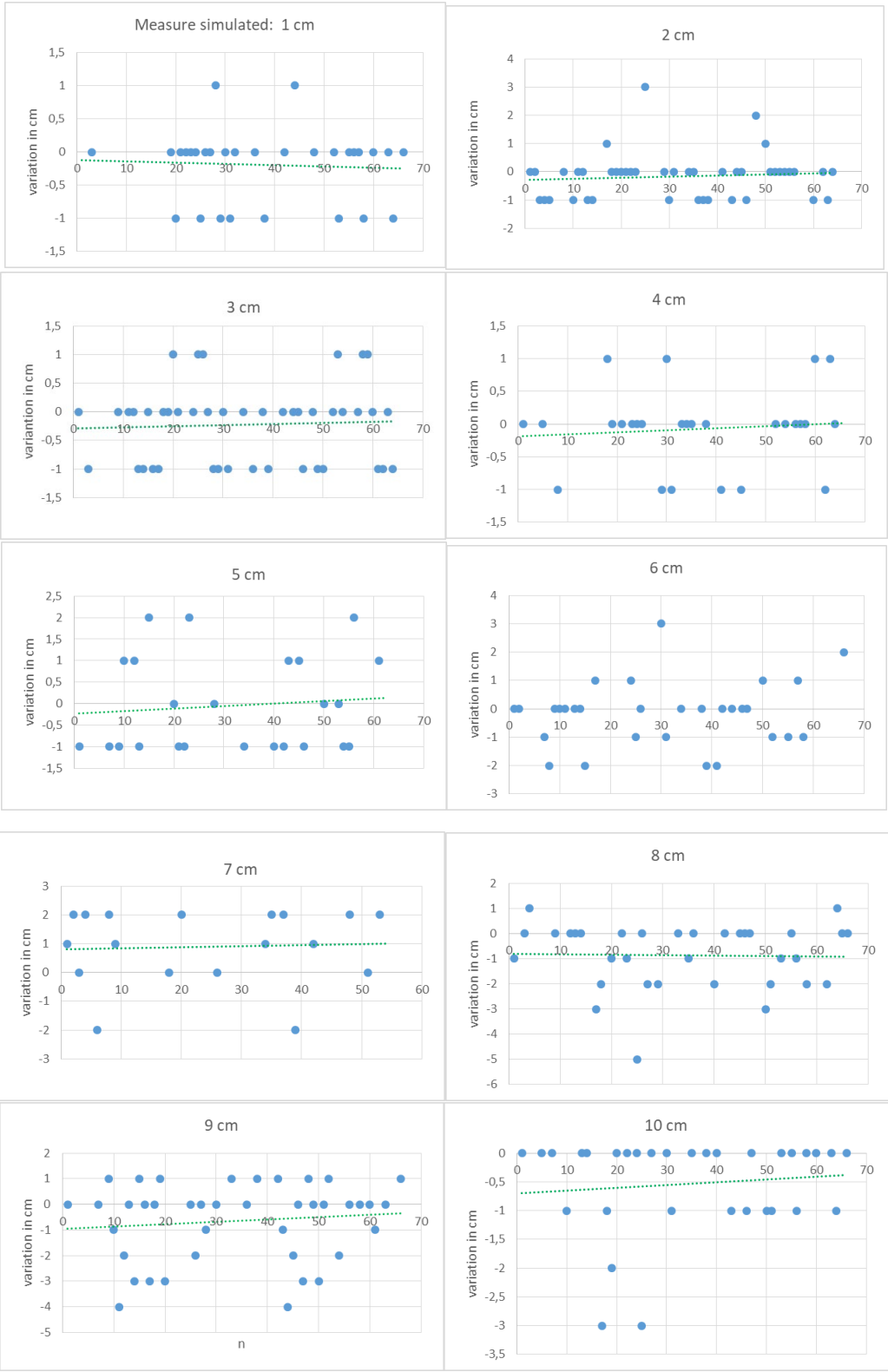


Table 1. Results for each centimeter of dilation simulated.

Dilation	1	2	3	4	5	6	7	8	9	10
Minimum	-1	-1	-1	-1	-2	-2	-2	-5	-4	-3
Maximum	1	3	1	1	2	3	2	1	1	0
N	39	53	48	36	33	36	31	37	46	37
Outliers	0	1	0	0	4	6	11	12	12	3

Dilation, Minimum, and Maximum are expressed in centimeters.



CLINICAL ARTICLE

Reliability of the carousel simulator for assessing labor cervical dilation in medical obstetrics education

[Carlos Izaias Sartorao-Filho](#), [Ana Luisa Varrone Sartorao](#), [Diogo Coutinho Terribile](#), [Angelica Mercia Pascon Barbosa](#), [Marilza Vieira da Cunha Rudge](#)

First published: 30 March 2024

<https://doi.org/10.1002/ijgo.15508>