



SERVICAL DILATATION MEASURING DEVICE

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ABSTRACT

Childbirth represents a physiological phenomenon encountered by females subsequent to the gestational process, necessitating the assistance of healthcare professionals for its monitoring also evaluation. Presently, the manual assessment of cervical dilation through digital palpation by obstetricians or midwives remains the prevailing approach. Nonetheless, manual cervical manipulation is administered by healthcare providers in various clinical settings, leading to subjective also potentially imprecise diagnostic results, which heavily depend on the skill also clinical judgment of the provider. This study aims to examine the development of cervical dilation measurement tools from 1998 to 2015. It underscores the imperative for a tool capable of delivering impartial also precise assessments devoid of human influence. This inquiry adopts a literature review methodology, employing Evidence Based Practice (EBP) as the framework for exploration, leveraging Google Scholar as the primary database. The retrieved literature, spanning from 1995 to 2005, exclusively comprises international journals. Within this systematic scrutiny, apparatuses utilized for dilation measurement are systematically cataloged as per their operational principles also clinical utility. The analysis suggests that image data processing technology holds considerable promise for refinement into instrumentation dedicated to cervical dilation assessment.

Keywords: cervix; childbirth; dilatation

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INTRODUCTION

Throughout pregnancy, the cervix typically undergoes numerous physiological transformations aimed at facilitating the safe also smooth delivery of the fetus. Notably, there is a softening also enhanced flexibility in the tissues lining the cervical canal. Additionally, there is an augmentation in the diameter of the cervical canal. Ultimately, this culminates in full cervical dilation, enabling unhindered passage for the fetus.(Yulizawati dkk, 2019) Labor entails uterine contractions that aid in the progressive enlargement of the cervix. The process of cervical dilatation is typically categorized into two phases: the latent phase also the active phase. These phases can be discerned through the evaluation of contractions also the examination of the female genitalia using a method known as Vaginal Toucher (VT). (Dahlen et al., 2013). Monitoring cervical diameter during labor is crucial for diagnostic purposes, guiding subsequent interventions. Given its significance, accurately measuring cervical dilatation is essential for assessing labor progress also furnishing precise information regarding dilation.(States, 2007).

Assessment of cervical dilation is presently regarded as the foremost parameter for effective labor management. Historically, measurements of cervical dilatation were utilized to track labor progression also serve as the foundation for decisions regarding interventions such as labor induction or cesarean delivery.(Heriani, 2016)

Throughout the process of childbirth, one or more obstetricians or midwives are engaged in actively monitoring the patient, typically through various examinations. However, the predominant method employed for assessing cervical dilatation involves manual examination by obstetricians or midwives using their fingers. Nonetheless, this method is encumbered by limitations such as inaccuracy, subjectivity contingent upon the examiner's skill, also discomfort experienced by the patient.(Dewiani et al., 2019) This study recognized the necessity for a device capable of delivering unbiased also precise assessments unaffected by human variables. Despite various proposals for such instruments by studyers, none have obtained clinical approval to date. The ideal device should possess attributes of user-friendliness, accuracy, safety, also patient convenience. The development of such a device holds the potential to enhance measurement precision, diminish uncertainty in cervical opening evaluations during labor, also facilitate digital documentation.

What doctors or midwives require is a specialized device that offers ease of use also ensures precise measurement of cervical dilation. From the patient's perspective, the device should prioritize safety also comfort. Therefore, there remains a significant opportunity to design a device that adheres to these principles also functionalities.(Huhn & Brost, 2004) As per the findings of the study, the primary factor contributing to postpartum infections stems from repeated internal examinations (VT).(Widyatuti, 2008). Extended duration of labor leads to increased frequency of internal examinations. Study conducted in Uganda revealed that excessive vaginal examinations can lead to puerperal infections. These infections result from the introduction of germs or bacteria from the helper's gloves during internal examinations. This study aims to identify the factors contributing to postpartum infections.(Idyawati, 2022)

METHOD

This study presents a thorough literature review aimed at identifying devices for measuring cervical dilatation. The search strategy employed utilized keywords such as "dilatation" also "cervix" to gather relevant articles. From the literature review, five articles were identified that elucidated the principles underlying cervical dilatation measurement also were readily accessible. The primary objective of this study was to explore cervical dilatation measurement devices spanning the period from 1998 to 2015. The search strategy involved keywords related to "dilatation" also "cervix," as well as "dilatation" also "measurement." The initial investigation aimed to assess the agreement between transperineal ultrasound measurements also digital examinations regarding cervical dilatation during labor. The study involved 59 women with singleton fetal head presentation at term pregnancy at Skane University Hospital, Lund, Sweden. Findings indicated an average disparity of 0.9 cm in cervical dilatation between ultrasound also digital examination measurements. The second study, a pilot investigation, utilized 2D ultrasound technology to evaluate cervical dilatation throughout labor. Carried out on 21 nulliparous women with a singleton fetus presenting cephalically, the study demonstrated a positive correlation between 2D ultrasound measurements also digital examination findings.

In the third study, a straightforward device for measuring cervical dilatation during labor was examined. Results revealed that measurements obtained with the instrument displayed an error margin of +/-1 cm compared to manual measurements. There is a widely held belief that

digital cervical examinations introduce vaginal microorganisms into the cervical canal. While this practice raises minimal concerns in the presence of intact membranes, clinicians often refrain from digital examinations in cases of ruptured membranes, particularly in preterm pregnancies, due to apprehensions regarding the introduction of vaginal microorganisms into the cervix also uterus. (Imseis et al., 1999). The fourth investigation assessed the precision also intra-observer consistency of simulated measurements of cervical dilatation also dilation. The study revealed that cervical dilatation measurement through digital examination exhibited considerable accuracy. However, the presence of intra-observer variability emerged as a significant factor to consider in evaluating labor dysfunction. The fifth study, a longitudinal examination, observed 144 women undergoing spontaneous labor or labor induction. Findings indicated that purple lines were detectable in the majority of women during labor. Furthermore, there existed a positive association between the length of purple lines also both cervical dilatation also fetal head position.(Ariani & Yusnilasari, 2023)

RESULTS

The review of literature identified a sum of 5 articles meeting the specified inclusion criteria also study topics, detailed in Table 1. The publications resulting from searches conducted on Google Scholar, ScienceDirect, also PubMed are outlined in the table provided below:

Table 1.
Data on article characteristics collected (n= 5)

No	Title and Researcher	Research Design	Sample	Result
1	Agreement between transperineal ultrasound measurements also digital examinations of cervical dilatation during labor. Sigurlaug Benediktsdottir1*, Torbjørn M. Eggebø2,3 also Kjell Å. Salvesen (2015)	Between October 2013 also June 2014, a prospective observational study was conducted at Lund's Skane University Hospital in Sweden. Women at term with a single fetus in cephalic presentation underwent cervical dilatation evaluations during labor, utilizing both ultrasounds also digital vaginal examinations. The study assessed the concordance between ultrasound also digital examination methods also examined the repeatability of ultrasound measurements by the same observer.	In a cohort of 59 women, ultrasound measurements were juxtaposed with clinical assessments. The average cervical dilatation recorded via ultrasound was 3.8 cm, with a median of 3.3 cm, whereas the mean cervical dilatation determined by palpation was 4.7 cm, with a median of 4.0 cm.	Cervical dilatation was effectively evaluated using ultrasound in 61 out of 86 women, constituting a success rate of 71%. The average disparity between cervical dilatation also ultrasound measurement was 0.9 cm (95% CI 0.47-1.34). The interclass correlation coefficient (ICC) was determined to be 0.83 (95% CI 0.72-0.90). Intra-observer repeatability was assessed in 26 women, resulting in an intra-observer ICC of 0.99 (95% CI 0.97-0.99). The

				repeatability coefficient was calculated as ± 0.68 (95% CI 0.45-0.91).
2	Simple two-dimensional ultrasound technique to assess intrapartum cervical dilatation: a pilot study. W. A. HASSAN*, T. M. EGGEBO†, M. FERGUSON‡ also C. LEES / 2013	The study employs a comparative methodology to evaluate two measurement methods: two-dimensional (2D) ultrasound also digital measurements. This study design allows studyers to determine the degree of agreement between the two measurement modalities.	Twenty-one nulliparous women in labor with a singleton fetus in cephalic presentation underwent 2D transperineal ultrasound assessments, during which cervical dilatation was measured either prior to or following a digital vaginal examination.	Nineteen cases out of twenty-one yielded satisfactory quality images of the cervix. A positive correlation was noted between the 2D ultrasound measurement of cervical dilatation also the digital vaginal examination (Pearson coefficient $r = 0.821$, $n = 19$, $P < 0.001$). Bland-Altman analysis demonstrated an average difference of 0.08 cm between digital also ultrasound measurements (95% limits of agreement: -1.83 to 2.00), with an average absolute difference of 1.24 cm. The Intraclass Correlation Coefficient (ICC) between the two methods stood at 0.81 (95% CI, 0.58-0.92).
3	Simple instrument for measuring cervical dilatation during labour. Milorad Letic / 2004	Experimental investigation employing a post-test only control group design approach	Clinical assessments were conducted on 12 parturients carrying a single fetus in the vertex position with cervical dilatation ranging from 3 to 4 cm.	The measurement results fell within a margin of error of ± 1 cm compared to manual assessments. There were no reported adverse effects associated with the instrument's use. However, the

				instrument did induce minor discomfort among patients during its application.
4	Accuracy also intraobserver variability of simulated cervical dilatation also effacement measurements. John Y. Phelps, MD, Nicholas Lambrou, MD, Daniel Roshanfekr, MD	An experimental study employing a post-test only control group design methodology.	A collective of 828 simulated measurements of cervical diameter also effacement were gathered from 69 distinct examiners.	Cervical diameter also effacement measurements acquired through digital examination are accurate within a margin of error of +/- 1 cm in diameter also +/- 25% in effacement. Intraobserver variability exceeds 35%, which is a significant factor to consider when assessing dysfunctional labor.
5	The Purple line as a measure of labour progres. Ashley Sheperd, Helen Cheyne, Susan Kennedy ,Colette McIntosh,Maggie Styles, Catherine Niven (2010)	Longitudinal Observed	Study The study monitored 144 women, comprising 112 in spontaneous labor also 32 undergoing labor induction, from admission until the final vaginal examination.	The presence of the purple line was observed during labor in 109 women (76%). A moderate positive correlation was identified between the length of the purple line also both cervical dilatation (r = +0.36, n = 66, P = 0.0001) also the station of the fetal head (r = +0.42, n = 56, P < 0.0001).

DISCUSSION

(Benediktsdottir et al., 2015) HASSAN (Hassan et al., 2013) A study was conducted utilizing two-dimensional (2D) ultrasound techniques to assess cervical dilatation during labor, comparing ultrasound measurements with digital assessments. Twenty-one nulliparous women in labor with a singleton fetus in cephalic presentation underwent 2D transperineal

ultrasound examinations, with cervical dilatation measured either before or after digital vaginal examination. Absolute differences were computed, also Bland-Altman analysis was employed to evaluate the mean difference between digital vaginal examination also ultrasound examination regarding cervical dilatation. Satisfactory-quality cervical images were obtained in 19 out of 21 cases, leading to the conclusion that the assessment of cervical dilatation via 2D transperineal ultrasound is feasible, demonstrating close concordance with digital vaginal examination. (Senbekov et al., 2020)

The utilization of ultrasound for evaluating cervical dilatation during labor has not proven widely successful in clinical implementation. Although intrapartum 3D ultrasound has been investigated, its reproducibility has not been adequate to supplant digital vaginal examination during labor.(Zimerman et al., 2009). Moreover, the method is intricate also reliant on the skill of the operator, making it unsuitable for the prompt evaluation of a woman in the delivery unit.(Dietz, 2004) Cervical effacement has been documented, albeit only during the early stages of labor, utilizing two-dimensional transperineal ultrasound in both longitudinal also transverse perspectives. (Ziliani et al., 1995). A non-imaging ultrasound-based computerized system, known as a computerized labor monitor, has been devised to offer continuous, objective evaluation of labor progression.(Sharf et al., 2007) Benediktsdottir conducted a study aimed at comparing 2D ultrasound assessment of cervical dilatation with vaginal examination, as well as investigating the intra-observer variability of ultrasound techniques. The analysis of inter-method agreement involved averaging three ultrasound measurements also one digital assessment. Intra-observer measurement repeatability was assessed by calculating the difference between the highest also lowest measurements, as well as the repeatability coefficient. The variability among the first, second, also third measurements was examined through three-way analysis of variance, also the intra-observer Intraclass Correlation Coefficient (ICC) was computed using a single two-way random variation of measurements. The study concluded that transperineal ultrasound is a viable method for evaluating cervical dilatation, with ultrasound measurements typically registering 1 cm smaller than digital measurements.(Buchmann & Libhaber, 2007)

Considerable study has been undertaken in the field of intrapartum sonography to determine the position of the fetal head during labor also its progression through the birth canal, with the aim of predicting the mode of delivery based on these observations. Traditionally, digital examination has been the conventional approach for assessing fetal head descent, cervical ripening, dilatation, also fetal head position both before also during labor. However, digital examination suffers from inaccuracies, inconsistencies, also low sensitivity. Variability in findings among examiners has been demonstrated to cause distress to the woman also diminish confidence in the examiner.(Motherhood et al., 2012) Milorad Letic (Letić, 2005) devised a straightforward, disposable instrument design for measuring cervical dilatation. This instrument comprises two clips: a measuring tape also a flexible tube. The measuring tape is affixed to one clip also inserted through the flexible tube attached to the other clip. These clips are positioned on opposite edges of the cervix at the 3 o'clock also 9 o'clock positions. The disparity in displacement between the marks on the measuring tape also the end of the flexible tube is gauged. Obstetricians can manipulate also open the clips using the instrument Kocher forceps commonly used during labor. Each clip arm features two holes; one for securing the measuring tape also the other for attaching the flexible tube. Among 12 women in labor, the instrument was effectively utilized in 10 cases, while two attempts were unsuccessful. This study was conducted by Ashley Shepherd et al. in 2010.(Bainuan, 2015) In Scotland, a longitudinal study was conducted, observing 144 women throughout the course of both spontaneous labor also labor induced by medical intervention, from admission until the

completion of internal examination. Women were positioned laterally, also midwives documented the presence or absence of labor lines (referred to as purple lines) immediately before conducting a thorough examination. The length of the purple lines was then measured using a tape measure.

This study confirms the findings of Bryne also Edmonds (Mackay, 1973) The presence of purple lines was observed in the majority of women during active phase labor, demonstrating a relatively high sensitivity also specificity in predicting labor progress across the first stage, second stage, also total labor. Unlike other methods for assessing labor progress, purple lines can indicate progression at various stages concurrently. A moderate positive correlation was identified between the length of the purple line also both cervical dilatation also the station of the fetal head, suggesting that as labor advanced, the purple line elongated. Our findings indicate that over a quarter of vaginal examinations conducted when cervical dilatation ranged from 1 to 2 centimeters revealed the presence of a purple line. This proportion increased to approximately 50% for examinations conducted when dilatation ranged from 3 to 4 centimeters. This study represents the first rigorous examination of the onset of the purple line also its presence before the onset of labor. Additionally, all line examinations were cross-checked by two midwives, enhancing the reliability of the findings. A correlation analysis within subjects was conducted, with weighting as per the number of measurements obtained from each woman. The significance of this analysis, particularly in scenarios where multiple measurements are obtained from the same individual, has been emphasized. (Bland & Altman, 1994) The variability in measurements taken from different individuals typically exceeds the variability observed within measurements taken from the same individual. The digital vaginal examination, utilized to evaluate cervical dilatation, remains the gold standard for assessing labor progress. However, this invasive method poses various risks for laboring mothers, including an increased risk of infection in neonates. Through the utilization of the purple line, it was determined that this non-invasive method can serve as a complementary approach to assess cervical dilatation with high sensitivity also specificity in clinical evaluations of labor progression. (Chuma et al., 2014)

CONCLUSION

Monitoring labor aids in mitigating risks for both the mother also the infant throughout this physiological process. (Azizah et al., 2011) It enables healthcare professionals to enact suitable measures guided by a thorough analysis of comprehensive examination outcomes. Labor entails uterine contractions that facilitate the gradual expansion of the cervix. Considering the significance of assessing cervical dilation in evaluating labor progression, it is crucial to furnish precise information regarding dilation. (Dahlen et al., 2013). Numerous techniques have been proposed for assessing cervical dilatation. Despite the development of various instruments for this purpose, primarily for study applications, none have successfully transitioned into routine clinical obstetrics. An ideal device capable of meeting the needs also standards of both study also clinical settings has yet to be realized. In summary, existing literature reviews on instruments designed for cervical dilatation measurement during labor highlight several study-oriented devices. However, none of these devices, whether intended for study or commercial use, offer a definitive solution for accurately measuring cervical dilation. Consequently, obstetricians also midwives continue to rely solely on digital examinations, despite their limitations. Unlike fields such as surgery or rehabilitation, where advancements in technology have significantly enhanced outcomes, gynecology still predominantly utilizes conventional methods for labor monitoring. For the specific application discussed herein, clinicians require a user-friendly instrument that seamlessly integrates with traditional measurement protocols also delivers precise cervical dilation

readings, free from human error. Additionally, from the patient's perspective, the instrument must prioritize safety also comfort. Future endeavors should focus on selecting optimal functional principles also designs to develop innovative cervimeters.

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