Original Article

The Effectiveness of the Modified Mueller–Hillis Maneuver in Predicting Successful Vaginal Delivery in Late Active Phase of First Stage of Labor

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Background: Cephalopelvic disproportion is one of the most common indications for cesarean section. Abnormal labor patterns have been used to identify this condition for many years, but early diagnosis is sometimes quite difficult.

Objective: To determine the accuracy of the modified Mueller-Hillis maneuver in predicting successful vaginal delivery in the late active phase of the first stage of labor.

Materials and Methods: From July 1st 2009 to August 31st 2010, a diagnostic test was performed of pregnant women admitted to the Labor Room in Rajavithi Hospital who met the following inclusion criteria: singleton pregnancy; labor pain, vertex presentation, and gestational age between 37 and 42 weeks. The exclusion criteria were medical or obstetric complications, or induction of labor with uterotonic agent. The modified Mueller-Hillis maneuver was performed by a single operator applying fundal pressure and assessing the descent of the fetal head in the late active phase of the first stage of labor (cervical dilatation ≥8 cm). Descent of the fetal head of 1 cm or more was interpreted as a positive result, and successful vaginal delivery was defined as spontaneous vaginal delivery without instrumentation.

Results: Two hundred and twenty-six women were enrolled, 214 of whom had positive results, with 212 successful vaginal deliveries, one case of delivery by forceps extraction, and another of cesarean delivery. Of the 12 cases with negative results, 4 had successful vaginal delivery while the others were delivered by cesarean section. The sensitivity, specificity, accuracy, positive and negative predictive values of the positive test were 98.2%, 88.9%, 97.8%, 99.5%, and 66.7%, respectively.

Conclusion: The modified Mueller-Hillis technique performed in the late active phase of the first stage of labor yielded excellent results in terms of diagnostic parameters such as sensitivity, specificity, accuracy and positive predictive values, but the negative predictive values were only fair.

Keywords: Modified Mueller-Hillis maneuver, Vaginal delivery, First stage of labor

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Dystocia, commonly known as cephalopelvic disproportion (CPD), is defined as an obstructed labor resulting from disparity between the size of the fetal head and the maternal pelvis[1]. Abnormal labor patterns have been used to diagnose this condition for many years, but early diagnosis is sometimes quite difficult. Mueller[2] was the first obstetrician to establish a simple maneuver involving examination of the descent of the fetal presentation by the doctor while an assistant applied fundal pressure. Forty-five years later, Hillis[3] modified this maneuver to allow a single operator to perform pelvic examination with one hand and apply fundal pressure with the other. This modified Mueller–Hillis (mMH) technique has been used to predict various labor abnormalities[4] as well as successful vaginal delivery[5]. However, these studies have involved the use of the maneuver at various points of active labor[6], and some have included the second stage of labor[4,5]. The present study was carried out to assess the diagnostic performance of the mMH maneuver in examinations by a single examiner (NJ) during the late active phase of the first stage of labor (cervical dilatation ≥8 cm).

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Materials and Methods

This research protocol was approved by the ethics committee of Rajavithi Hospital (No. 46/2552). The present study was conducted in the Labor Room (LR) of Rajavithi Hospital between July 1st 2009 and August 31st 2010. The inclusion criteria were: age 20 to 34 years; gestational age 37 to 42 weeks; singleton pregnancy; labor pain and cephalic presentation. Patients were excluded if they had medical or obstetric complications or if they were treated with

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uterotonic agents. The hospital's ethics committee approved the study and, after appropriate counseling, written informed consent was obtained from the participants who were recruited after diagnosis of the active phase of the first stage of labor when cervical dilatation was ≥8 cm to full dilatation.

In every case, the second author (NJ) performed mMH, which was defined as pelvic examination with the right hand to assess fetal head descent with fundal pressure applied with the left hand of the same operator. Pressure was applied gradually until reaching the maximum possible and then slowly released. The fetal head's descent was measured using the interspinous diameter as zero station, with centimeters above it labeled -1, -2, and -3, and centimeters below labeled +1, +2, and +3. The procedures were not performed during uterine contractions. All participants were managed routinely by the doctor-in-charge and the authors were not involved in any decision-making, including mode of delivery. Positive mMH was defined as fetal head descent ≥1 cm and negative mMH was defined as fetal head descent <1 cm.

Review of the literature revealed that there has been no equivalent study of this maneuver specifically in the late active phase of first stage of labor. March MR *et al*[4], who used mMH in the second stage of labor, found that the ratio of spontaneous vaginal delivery in the positive mMH group was 82%, and data from their study were used for sample size calculation in this research using the formula:[7]

$$n = \frac{Z^2_{\alpha/2}pq}{d^2}$$

where: n = number of required sample; p = proportion of spontaneous vaginal delivery in the positive mMH group = 0.82; q = 1-p; d = error of estimation at 5% = 0.05; and $Z_{\alpha/2}$ = standard value from Table Z at confidence level = 1.96. Data from labor records such as mode of delivery, fetal head position at delivery, birth weight, Apgar score at 1 and 5 min, station at examination when the maneuver was done, and gestational age, were obtained after their deliveries and analyzed using the IBM SPSS statistics version 22.0. Chi-square test (x^2), unpaired t-test and Fisher exact test were used to analyze the appropriate data, and statistical significance was set at $p<0.05$. The diagnostic performance parameters for positive mMH were calculated with spontaneous vaginal delivery used as the reference standard.

Results

Two hundred and twenty-six pregnant participants were enrolled in the study. Of the 214 positive mMH cases, 212 (99.1%) were spontaneous vaginal deliveries, 1 was delivered by cesarean section and 1 case required forceps extraction. Of the total 12 negative mMH cases, 4 (33.3%) were spontaneous vaginal deliveries while 8 (66.7%) were delivered by cesarean section (Figure 1).

The indication for the one cesarean section in the positive mMH case was cephalopelvic disproportion (CPD). In the negative mMH group, all cesarean sections were due to CPD: 5 because of arrest of dilatation and 3 due to protraction of descent with prolonged deceleration phase. The indication for forceps extraction in the positive mMH group was prolonged second stage. Table 1 displays the demographic characteristics of the parturients and shows that only gravidity and parity were significantly different

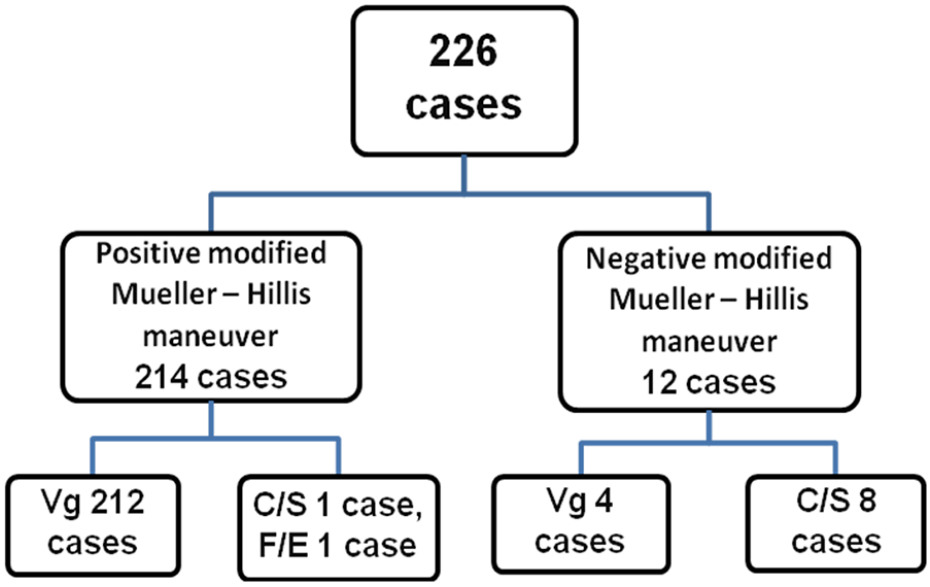

Figure 1. Result of modified Mueller-Hillis maneuver (mMH), Vg = Vaginal delivery, C/S = Cesarean section, F/E = Forceps extraction.

Table 1. Demographic characteristics

Factors	Positive mMH (n = 214)	Negative mMH (n = 12)	Total (n = 226)	*p*-value
Age (years)				
Mean ± SD	26.70±3.81	28.21±3.22	26.70±3.84	0.176
Race				1.000
Thai	165 (77.1)	10 (83.3)	175 (77.4)	
Other	49 (22.9)	2 (16.7)	51 (22.6)	
BMI (kg/m^2)				
Mean ± SD	21.70±3.91	22.84±3.50	21.71±3.90	0.305
Height (cms)				
Mean ± SD	154.71±5.62	152.62±5.11	154.60±5.64	0.518
≤145	8 (3.7)	1 (4.3)	9 (4.0)	0.497
>145	206 (96.3)	11 (95.7)	217 (96.0)	
Gravidity				
Median (min-max)	2 (1 to 5)	1 (1 to 2)	2 (1 to 5)	<0.001*
1	79 (36.5)	11 (91.7)	90 (39.8)	
2	76 (35.5)	1 (8.3)	77 (34.1)	
3	48 (22.4)	0 (0.0)	48 (21.2)	
>3	11 (5.2)	0 (0.0)	11 (4.8)	
Parity				
Median (min-max)	1 (0 to 4)	0 (0 to 0)	1 (0 to 4)	<0.001*
0	92 (43.0)	12 (100.0)	104 (46.0)	
1	80 (37.4)	0 (0.0)	80 (35.4)	
2	39 (18.2)	0 (0.0)	39 (17.3)	
≥3	3 (1.4)	0 (0.0)	3 (1.3)	

Value are represented as mean ± SD, median (min-max) and number (percent), * Significant at $p<0.05$
Positive mMH = descent of the fetal head ≥1 cm; Negative mMH = descent of the fetal head <1 cm

between the positive and negative mMH groups. Most subjects were of Thai race, and obstetric outcomes are shown in Table 2. All outcomes except gestational age (GA) and birthweight (BW) were significantly different. The first stage of labor in the negative mMH group was abnormal in all cases but almost completely normal in the positive mMH group (99.1%). Abnormal position at delivery was significantly more prevalent in the negative mMH group than in the positive one. Table 3 displays the diagnostic performance of mMH in predicting vaginal delivery and shows that all parameters were excellent except negative predictive values (NPV).

Discussion

The Mueller–Hillis maneuver has long been used to predict dystocia[6] and successful vaginal delivery[5]. The timing of examination has varied between studies: March et al[4] performed it in the second stage of labor; Thorp et al[6] in the active labor (unlabeled stage of labor); and Intamoll[5] in the active phase of the first or second stage of labor. The high PPV (99.1%) in the present study was similar to values found by Intamoll[5] and March et al[4] (91.0 to 100.0% and 100.0% respectively). The sensitivity of the present research (98.1%) was higher than that found in the study by March et al[4] (82.3%) even though the specificity of the present research (80.0%) was lower than in their study (100.0%)[4]. The negative predictive value of the present study (66.7%), similar to that in March et al's study[4] (42.1%), was the only negative aspect of the maneuver. The unreliability of prediction of negative mMH was probably due to the fact that the proportion of negative mMH (5.3%) in this research was lower than in the studies carried out by March et al[4] (27.1%) and Thorp et al[6] (23.6%), and a larger population in the present study could have improved the prediction of negative mMH. Almost all demographic characteristics between the positive and negative mMH groups were statistically significantly different except GA and BW, and this is similar to the findings of the research of March et al[4] except in terms of vaginal operation delivery and abnormal first stage of labor.

The use of a single operator in the present study, similar to the previous two[4,5], was one of the predominant factors resulting in the excellent diagnostic performance of this test. The prospective study design and the lack of involvement in obstetric decision-making, especially mode of delivery, were the other predominant factors; however, the variation in fundal pressure applied in each case was a limitation of this study even though the operator used the highest possible power in each case.

Conclusion

The modified Mueller-Hillis maneuver performed in the late active phase of the first stage of labor yielded excellent results in terms of diagnostic parameters such as

Table 2. Obstetric outcomes

Factors	Positive mMH (n = 214)	Negative mMH (n = 12)	Total (n = 226)	*p*-value
Gestation age (weeks)				
Mean ± SD	38.41±1.10	38.84±0.91	38.45±1.12	0.159
Station				<0.001*
0	1 (0.5)	6 (50.0)	7 (3.1)	
1	118 (55.1)	6 (50.0)	124 (54.9)	
2	92 (43.0)	0 (0.0)	92 (40.7)	
3	3 (1.4)	0 (0.0)	3 (1.3)	
Position at delivery				0.008*
Normal	213 (99.5)	10 (83.3)	223 (98.7)	
Abnormal	1 (0.5)	2 (16.7)	3 (1.3)	
First stage of labor				<0.001*
Normal	212 (99.1)	0 (0.0)	212 (93.8)	
Abnormal	2 (0.9)	12 (100.0)	14 (6.2)	
Mode of delivery				<0.001*
Vaginal spontaneous	212 (99.1)	4 (33.3)	216 (95.6)	
Forceps extraction	1 (0.5)	0 (0.0)	1 (0.4)	
Cesarean section	1 (0.5)	8 (66.7)	9 (4.0)	
Birthweight (grams)				
Mean ± SD	3,061.01±337.44	3,255.67±262.12	3,071.37±336.28	0.051
Duration of first stage of labor[a] (hours)				
Mean ± SD	6.67±3.43	7.38±0.72	-	
Median (min-max)	6 (0.5 to 18.50)	7 (6.67 to 8.33)	-	
Duration of second stage of labor[a] (minutes)				
Mean ± SD	18.67±16.36	17.05±5.89	-	
Median (min-max)	13 (1 to 93)	16 (14 to 25)	-	

Value are represented as mean ± SD, median (min-max) and number (percent), * Significant at $p<0.05$
a = data of parturients delivered by cesarean section were not included; Normal position = position of the fetal presenting part as occiput anterior; Abnormal position = position of the fetal presenting part such as ROT, LOT, ROP, LOP, OP

Table 3. Diagnotic performance of modified Mueller-Hillis maneuver in predicting vaginal delivery

Modified Mueller-Hillis maneuver	Result		Sense (%)	Spec (%)	Accuracy (%)	PPV (%)	NPV (%)
	Positive	Negative					
Positive	212	2	98.1	80.0	97.3	99.1	66.7
Negative	4	8					

Sense = Sensitivity; PPV = Positive predictive value; Spec = Specificity; NPV = Negative predictive value
Result positive modified Mueller-Hillis maneuver = spontaneous vaginal delivery without any instrumentation; Result negative modified Mueller-Hillis maneuver = cesarean section, forceps or vacuum extraction

sensitivity (98.1%), specificity (80.0%), accuracy (97.3%) and positive predictive value (99.10%), but the negative predictive value (66.7%) was only fair.

What is already known on this topic?

The Modified Mueller-Hillis maneuver (mMH) has been used to predict various labor abnormalities and also successful vaginal delivery; however, previous studies have used it at various points of active labor, and sometimes in the second stage of labor.

What this study adds?

The modified Mueller-Hillis performed in the late active phase of the first stage of labor produced excellent results in terms of diagnostic parameters.

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Potential conflicts of interest

The authors declare no conflict of interest.

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