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# Accuracy of the Peak Day of Cervical Mucus as a Biological Marker of Fertility

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# Accuracy of the peak day of cervical mucus as a biological marker of fertility

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**Abstract:** *The (PD) peak day of cervical mucus is an important biologic marker for the self-determination of the optimal time of fertility in a woman's menstrual cycle. The purpose of this article is to provide evidence (literature and empiric) for the accuracy of the PD of cervical mucus as a biologic marker of peak fertility and the estimated day of ovulation. An analysis of data from four published studies that compared the self-determination of the PD of cervical mucus with the urinary luteinizing hormone (LH) surge was conducted. The four studies yielded 108 menstrual cycle charts from 53 women participants. The 108 cycles ranged in length from 22 to 75 days (mean 29.4 SD 6.0). Ninety-three of the 108 cycles had both an identified PD and LH surge. Data charts showed that 97.8% of the PD fell within  $\pm 4$  days of the estimated day of ovulation. Use of a standardized mucus cycle scoring system indicated that the peak in cervical mucus ratings was highest on the day of the LH surge. Self-determination of the PD of cervical mucus is a very accurate means of determining peak fertility and a fairly accurate means of determining the day of ovulation and the beginning of the end of the fertile time.*

## 1. Introduction

The "Peak Day" (PD) of cervical mucus is an important indicator of fertility for modern methods of natural family planning (NFP). The PD coincides closely with the peak of fertility and the day of ovulation in the woman's menstrual cycle. For couples trying to achieve pregnancy, having intercourse on PD is an optimal time for conception. The PD is also a marker for the beginning of the end of fertility. Once a woman detects her PD, she knows that after 3 days there is little or no chance of being fertile until her next menstruation. The purpose of this work was to provide evidence (literature and empiric) for the accuracy of the PD as a natural biologic marker of fertility.

### 1.1. Published research on the accuracy of self-detected PD

Since 1972, a number of studies have been published that correlated the self-detected peak symptom of cervical mucus with a hormonally estimated day of ovulation. Billings et al. [1] taught 22 woman volunteers how to "recognize a pattern of vaginal mucous discharge" and to record their observations in a daily record. The "peak symptom" was defined as "the occurrence of clear, slippery, lubricative mucus, having the physical characteristics of raw white of egg

(Spinnbarkeit).” The day of ovulation was estimated through serial measurement of plasma LH. They found that ovulation occurred a mean of 0.9 days after the peak symptom, with a range of 3 days after to 2 days before. Flynn and Lynch [2] correlated cervical mucus ratings with plasma LH, estradiol and progesterone with nine healthy woman subjects who generated 29 menstrual cycles. The PD was defined as the day of maximum mucus grading (MMG) based on a system that ranged from -1 (dry sensation) to 9 (wet, slippery, variable amount). The MMG occurred an average of 0.45 days before the estimated day of ovulation by plasma LH, with a range of 2 days before and 1 day after.

Hilgers et al. [3] used serum progesterone levels to determine the estimated day of ovulation among 24 healthy woman subjects. The peak symptom was defined as “the last day of the clear, stretchy, and or lubricative discharge.” They found, in 65 hormonally confirmed cycles, that ovulation occurred from 3 days before to 3 days after the peak symptom with a mean of 0.31 days before the peak symptom. Cortisi et al. [4] conducted a similar study to determine the correlation of ovarian steroid hormones with the peak in cervical mucus in 27 healthy young Italian women. They defined the PD as “the last day on which the mucus was observed to be slippery, stringy and/or lubricative” and the estimated day of ovulation was determined as the day after the plasma LH surge. In 31 of 32 ovulatory cycles, they found that ovulation occurred from 1 day before to 1 day after the peak symptom with a mean of 0.0 days. A more recent study compared the peak in cervical mucus with an estimated day of ovulation determined by the peak of urinary estrone glucuronide through use of the ovarian monitor developed by Brown et al. [5]. The day of peak mucus varied plus or minus 3 days of the estimated day of ovulation in 100% of the 127 cycles generated by 37 women participants.

A number of studies have correlated the self-detected PD of cervical mucus with an estimated day of ovulation determined by serial ultrasound of the developing follicle. A small study with six normal parous volunteer women who self-detected the day of the most abundant cervical mucus in 15 menstrual cycles found that the day of peak mucus occurred  $\pm 1$  day of the estimated day of ovulation [6]. The most abundant type of mucus was described in this study as characteristic of “raw egg white.” Hilgers reported two sets of data that correlated the day of follicular rupture as detected by ultrasound with the self-detected PD of cervical mucus [7]. One set of data was generated by 47 infertile women in 33 cycles and in another set with 47 women in 47 cycles. He found that the estimated day of ovulation occurred 100% of the time from +3 to -2 days of the PD.

A more recent study evaluated urinary LH, salivary ferning, beta-glucuronidase, the shift of

BBT, and the peak in cervical mucus with the estimated day of ovulation with 40 women enrolled in a natural family planning (NFP) program [8]. The estimated day of ovulation was the ultrasonic diagnosis of ovulation (i.e., follicular collapse). The results showed that the peak in mucus fell on the estimated day of ovulation 48.3% of the time in the 148 cycles analyzed and close to 100% of the time  $\pm 3$  days of the estimated day of ovulation. Of interest is that the urinary LH surge occurred 100% of the time on the estimated day of ovulation. PD for this study was defined as the last day in which there was a wet, slippery sensation or transparent stretchy mucus.

What is clear from the above studies that correlated the estimated day of ovulation with the self-detected peak in cervical mucus is that the PD of cervical mucus varies around ( $\pm 3$  days) the estimated day of ovulation 97 to 100% of the time. What is also clear is that the most common researched definition of the self-observed PD of cervical mucus is the last day of mucus in a menstrual cycle that has the characteristics of being clear or transparent, stretchy, wet and slippery or lubricative.

## **2. Materials and methods**

This author has conducted and published four studies in which female subjects self-monitored their cervical mucus, their urinary LH, and identified their PD in one to four menstrual cycles [9–12]. The combined data from the four studies provides a fairly large data set to determine the accuracy of the self-detected PD in relation to urinary LH. All four studies were approved by the Marquette University Institutional Review Board and informed consent was obtained from all subjects.

### **2.1. Participants**

The 53 woman participants were clients who were taught the Creighton Model System of NFP and who self-recorded information from their menstrual cycles with natural family planning charts. The average age of the women at the time of the studies was 32.07 years (range 21–45 years) and they had been using the Creighton Model System of NFP from 6 months to over 20 years (average use 6 years). The participants yielded 108 menstrual cycles of charting.

### **2.2. Procedure and measures**

The LH surge in the urine was self-detected through use of the OvuQuick self-test kits. The OvuQuick is based on monoclonal enzyme immunoassay of LH in the urine. The OvuQuick had a reported LH sensitivity of 30 mIU/mL. OvuQuick has shown a 98% agreement with other tests in detecting the LH surge. For the four studies, the last day of a LH surge identified by the woman and charted on the NFP records was used for analysis.

The PD of cervical mucus was determined by means of the Creighton Model System vaginal discharge recording system (VDRS), developed through research conducted at St. Louis and Creighton University [13]. The Creighton model requires that women check for cervical–vaginal mucus by wiping the outside of the vagina (the vulval area) every time they go to the bathroom to void and once before going to bed. The women check mucus for color, stretch, and consistency. The PD of the Creighton Model system is defined as the last day of any mucus that is clear in appearance, stretches an inch or more, or has the sensation of lubrication. Two master educators of the Creighton Model system validated the actual PD recorded on the charts. An inter-rater reliability of 0.97 was obtained, that is, in two cycles the raters did not agree on what was the PD.

For analysis accuracy, the estimated time of ovulation (ETO) was considered the day after the last day of the LH surge. Accuracy of the PD was determined by correlating it with the ETO and with the day of the LH surge. For descriptive purposes, the quality and quantity of the cervical mucus was determined on each of the 5 days before the LH surge, the day of the LH surge, the estimated day of ovulation, and the 5 days after by use of the cervical mucus rating system developed by Hilgers [14]. This system has numerical ratings (from 0 –4) for the color, consistency, change and sensation of the recorded cervical mucus. A total score for a given day in the mucus cycle can range from a low of 0 to a high of 16. The system is called the 3C's Mucus Cycle Scoring System or MCSS. The normal range of scores for regular cycles using the MCSS, which is calculated by averaging the scores from the PD and the 5 days preceding PD, is 9.1 to 16.0.

### **3. Results**

#### **3.1. Description of the 108 cycles**

Of the 108 cycles, 95 (87.9%) had an identified LH surge, 106 (98%) cycles had an identified PD, and 93 (86.1%) had both an identified LH surge and PD. The average length of the 108 cycles was 29.5 days (SD = 6.17, range 18–75 days), the length of the pre-ovulatory period averaged 17.1 days (SD = 5.63, range 11–64 days) and the post-ovulatory period averaged 12.4 days (SD = 3.22, range 5–30). The ETO was on average on day 18.1 (SD = 5.63, range 11–64 days), the day of the LH surge was on average on day 16.1 ((SD = 5.6, range 10–63), and the PD was on day 16.9 (SD = 5.4, range 9–63) of the cycles. The mean length of the total mucus cycle (from the beginning of the observed mucus through the PD) was 6.48 days and a range of 0 to 24 days.

For the 104 cycles that a mucus score could be calculated, the mean MCSS was 8.7 (SD = 3.42) with a range of 0.67 to 16.00. The daily average MCSS score for the 93 cycles that had a PD and LH surge had a peak score of 10.5 on the day of the LH surge. The average MCSS drops to 7.7 on the estimated day of ovulation and then to 5.2 the day after the estimated day of ovulation. See Fig. 1 for the full range of MCSS average scores in relation to the estimated day of ovulation.

### **3.2. Accuracy of the PD**

In the 93 cycles that had a PD and LH surge, the PD of the cervical mucus fell on the estimated day of ovulation 35.5% of the time and 26.9% of the time on the day of the LH surge. The PD fell on  $\pm 4$  days of the estimated day of ovulation 97.8% of the time. In one cycle, the PD was 6 days after the estimated day of ovulation and in another 5 days. Furthermore, 72% of the PDs fell from 4 days before, up to and including, the estimated day of ovulation (i.e., in most cycles, the PD comes before or on the day of ovulation). See Fig. 2 for the remaining data that compares the PD with the estimated day of ovulation. The Pearson statistical correlation of the PD with the estimated day of ovulation and with the day of the LH surge was 0.965 ( $p \leq 0.01$ ).

The characteristic of stretchy mucus (i.e., a stretch of one inch or more) was found 55% of the time on the ETO in the 93 cycles that had a PD and LH surge. The characteristic of lubrication was identified in 57% of the cycles on the ETO and the observation of “clear” mucus was identified in 60% of the cycles on the ETO.

## **4. Discussion**

The length of the 108 cycles in this current combined four-study analysis is on average 1 day longer than what is expected when compared to the length of the 6,472 cycles in the World Health Organization (WHO) Multicenter Study of the Ovulation Method of Natural Family Planning [15]. The average cycle length in the current study was 29.5 days compared to 28.5 days in the WHO study. The length of the pre-ovulatory period or follicular phase of the cycles in the current study was 17.1 days (SD = 5.6), which was on average 2 days longer than the WHO study. The post-ovulatory phase or luteal phase was on average 12.4 days (SD = 3.01), which was 1 day shorter than the average length of the WHO study (13.5 days). The difference in the average length was because of the fact that the current study had several very long cycles (65–75 days) in the analysis. The long cycles, however, had normal length luteal phases.

A final descriptive comparison is that the fertile period of the current study of 9.5 days (SD = 4.0) was comparable to the 9.6 days in the WHO study and the 9.3 days in the Hilgers and

associates study [3, 15]. The mean number of peak mucus days in front of the ETO in the current study and the Hilgers study was 4.2 days [3]. The total number of mucus days in front of the ETO was 5.4 days for the current study and 5.9 days for the Hilgers study.

The average MCSS score of the 107 cycles that had a PD was 8.7. This score falls in the “regular” range and the “intermediate regular” sub-category defined by Hilgers [14]. This means that, on average, the cycles in the current study had normal amounts and quality of mucus. The mean score did not fall in the “limited” or “dry” categories. What is of interest is that the peak in MCSS scores fell on the day before the estimated day of ovulation. According to Wilcox et al. [16] the day before the day of ovulation is the day of peak fecundity. Physiologically, it makes sense that the peak in cervical mucus would be on the day of peak fertility [16].

The results of the current analysis compares well with the results of previous studies that correlated the PD with the estimated day of ovulation [1–3]. The current study results, however, show the PD to be a little more variable. The PDs in the current study had more of a spread around the ETO. The variability is probably a result of the fact that urinary LH was used as the estimator for the ETO rather than serum LH, estrogen:progesterone ratios, or serial ultrasound. Although urinary LH has been shown to be accurate in detecting fertility, the surge in the urinary LH is flatter (i.e., it often occurs over 2 days) [17]. Other reasons for the variance in results could be that some women participants in the current study had cervical inflammation or infections that produced peak-like mucus at times unrelated to fertility or the women might have confused arousal fluid with cervical mucus. Odeblad also pointed out that the cervical secretory cells respond to norepinephrine [18]. He indicated that “stage fright” or undue stress could precipitate the production of peak type cervical mucus at other times than the fertile time.

The study that provides the closest comparison to the current is that of Hilgers et al. [3]. The PD in that study was determined with the same methods of self-detection of cervical mucus (i.e., the Creighton Model System) as the current study. The Hilgers and associates study results showed that the PD fell  $\pm 3$  days of the estimated day of ovulation 98.4% of the time, and in the current analysis it was 96.7% of the time (Table 1) [3]. The percent difference could be because of the different means to determine the estimated day of ovulation. In this current analysis, the woman participants self-detected the peak of cervical mucus and the day of urinary LH. In the Hilgers study, the woman participants only self-detected the peak of cervical mucus. The estimated day of ovulation was determined by a laboratory serum analysis of the rising levels of progesterone.

The findings of this review and analysis show that the PD is a very accurate estimator of

peak fertility in a woman's menstrual cycle and a fairly accurate estimator of the day of ovulation. The PD is fairly accurate in estimating the day of ovulation, in that PD fell  $\pm 4$  days of the estimated day of ovulation 98% of the time. The implication that these findings have for the practice/use of natural family planning to achieve pregnancy is that the self-observation of and monitoring of cervical mucus is very useful for a woman/couple trying to achieve pregnancy. Cervical mucus provides the medium for sperm survival and the mechanism for transport at the peak time of fertility in the menstrual cycle [19]. Having intercourse on the days of (clear, stretchy, lubricative) peak mucus has been shown to optimize the chance of pregnancy [15, 20].

#### **4.1. Implications**

For those couples who are trying to avoid pregnancy, the PD provides the beginning of the end point of fertility. Most methods of NFP that use cervical mucus and the PD as an indicator of peak fertility have the couples count 3 days after the PD before they resume intercourse. The Creighton Model system instructs the couples to count 3 days and to wait until the end of the Day 4 before resuming intercourse. According the findings of this study, if couples wait until the end of Day 4 after the PD, 99% of the time, they will be in the infertile period (luteal) phase of the woman's cycle. The Creighton Model has been found to be 98 –99% method effective in a number of studies and in multiple sites in the United States [21–23].

In all of the studies reviewed, the self-detection of PD was an accurate subjective indirect indicator of peak fertility and ovulation. However, there is no indication in the research on how to self-observe these characteristics or how often they need to be observed to maintain the accuracy of detecting the PD. One study had the subjects observe for mucus before and after each micturition, another in the course of normal daily activity, and another indicated the use of white toilet tissue. Future research could help determine the best way(s) to make observations and how often observations need to be made. Other research might discover ways of making the observation of the PD more objective. For example, there might be a simple, accurate and reliable device to measure some physical property of cervical mucus [24]. Further research might also determine if there are more accurate characteristics of PD than others, for example, slipperiness versus stretch. In the final analysis, research might also show that there are multiple ways of determining the PD and that the subjectivity of the woman's observations need only the patience and guidance of a good NFP teacher.

#### **Notes**

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## Appendix

**Table 1**

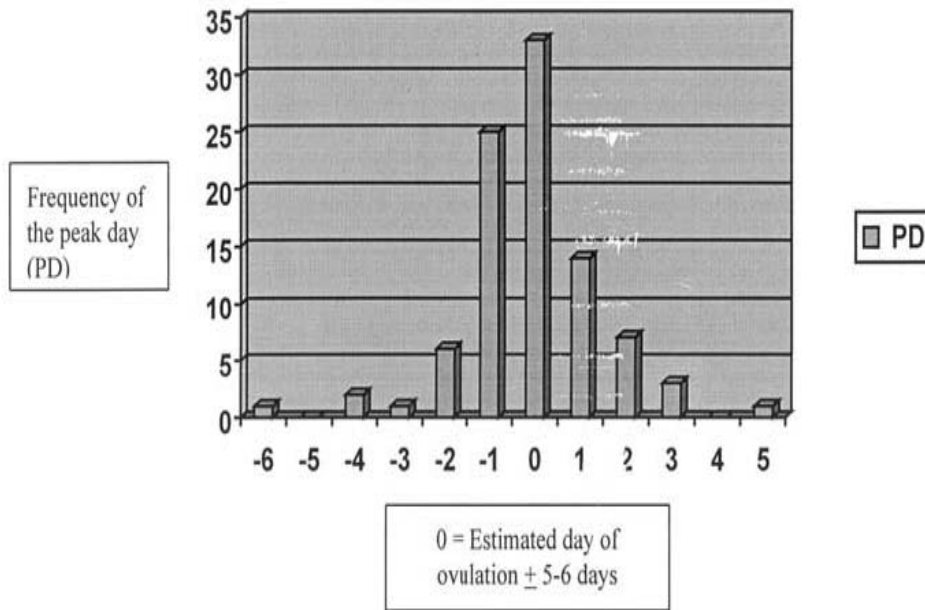
**Estimated time of ovulation to the PD of cervical mucus: comparison of current study results with results from the Hilgers et al. study [3]**

Estimated time of ovulation to peak day	Fehring <sup>a</sup>		Hilgers <sup>b</sup>	
	<i>n</i>	%	<i>n</i>	%
P-4	0	0.0	0	0.0
P-3	3	3.2	1	1.5
P-2	6	6.5	12	18.5
P-1	15	16.1	13	20.0
PD	33	35.5	24	36.9
P+1	25	26.9	9	13.8
P+2	6	6.5	4	6.2
P+3	1	1.1	1	1.5
P+4	2	2.2	0	0.0
Total	91	98.0	64	68.4

<sup>a</sup> In two cycles the estimated time of ovulation fell more than  $\pm 4$  days from the PD of cervical mucus.

<sup>b</sup> In one cycle there was no PD.

**Figure 1**  
Graph of the mean mucus cycle scoring system MSCC scores (n = 93 cycles).



**Figure 2**  
Frequency of the PD of cervical mucus corresponding with the estimated day of ovulation = day 0 (n = 93 cycles).

