THE RELATION OF BASAL BODY TEMPERATURE TO FERTILITY AND STERILITY IN WOMEN

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PERIODS of fertility and sterility undoubtedly occur during the menstrual cycle in the human female. These have been explained on theories for each of which some inadequacy must be admitted even with the most careful application of the principles embodied.

In this essay we present data which offer a practical method for the regulation of conception in fertile women. They may also be valuable in the study of women who are reputedly barren.

In the newer experimental approach to the subject of human ovulation many methods have been investigated. Most of these are in fair agreement. Some methods, however, are unsuitable for determining the day of rupture of the ovarian follicle and, in all, the difficulty of forecasting variability has been the chief handicap to practical application.

In the older literature pregnancy has been reported by different observers to result from exposure on nearly every day of the menstrual cycle. As late as 1927 Dickinson[3] made an exhaustive survey of existing data and came to the conclusion that unexpected variability in ovulation constitutes a major hazard to estimation of temporary sterility by any set rule of thumb. At the very date of publication of Dickinson's conclusion there were in progress two investigations which have considerably clarified the dating of human ovulation.

Ogino,[14, 15] following the method of L. Fraenkel,[6] made an estimate of the ovulation date in the menstrual cycle by inspecting the ovaries in 83 laparotomies. He claimed a fertile period lasting from the nineteenth to the twelfth day before the oncoming menstrual period. This is not far from Fraenkel's observations published nineteen years previously (1911), although Ogino advocated a relationship of ovulation to the following, not to the preceding, menstruation.

Knaus[12] investigated the reactivity of the uterus to pituitrin and found that the human uterus contracts vigorously up to a date near the middle of the menstrual month when it suddenly becomes almost unresponsive. From existing experimental data he reasoned that corpus luteum inhibition produces the falling off in response and that since the corpus luteum requires about two days after rupture of the ovarian follicle to produce its effect, ovulation must have occurred two days before the negative response is observed. Knaus emphasized the correlation between ovulation thus determined and the oncoming menstruation, claiming ovulation on the fourteenth day preceding menstruation.

Hartman[7, 8] studied the time of ovulation in the macaque by rectal palpation of the uterus and ovaries, confirming his observations by laparotomy. He further extended his investigation by securing pre-arranged conceptions and recovered embryos of known age from precise dating of fertilization. Subsequently he published a comprehensive critique of all the available data up to 1936. In this contribution[9] he set down a review of his own data placing ovulation in the female macaque between the eighth and twenty-first days of the cycle. He is unwilling

to accept the narrowness of span of fertility as advocated by the Ogino-Knaus law, but is quite convinced that a safe period does exist expecially during the last quarter of the menstrual cycle.

The data collected by Papanicolaou[16] by the vaginal smear method indicate that in some women it is possible to determine ovulation within a span of two or three days. This information shows the highest number of ovulations to occur on days eleven, twelve, and thirteen with a range from days seven to seventeen. This method has both clinical and experimental application.

Studies by microscopic section of uterine mucous membrane as reported by Schroeder[18] distinguish between nonsecretory (preovulatory) and secretory (post-ovulatory) phases of the mucous glands in the endometrium. Evaluation by this method is in keeping with the theory that ovulation occurs between the fourteenth and sixteenth days of the cycle. This method has been opposed by Evans and Swezy,[5] the objection being that it is unreliable but Hartman[9, 10] defends it lending support from his observations on macaques.

Recently Burr, Hill and Allen[1] have applied the principle of electrical potential change to the study of follicle rupture and have been able to record showers of impulses of nervous origin at the time of ovulation in rabbits and more recently[2] also in women.

In the effort to obtain further information on human ovulation, I began, in 1930, to collect instances of carefully recorded coital exposure which resulted in pregnancy. By establishment of a special "cooperative" clinic at the Maternal Health Association of Cleveland, Ohio, I enlisted the assistance of young women planning pregnancy and willing to serve in an experiment in which the time of the midperiod could be determined.

For several years the women were instructed to keep menstrual records and note particularly signs of the midperiod (Mittelschmerz). On the basis of their cycles and midperiods thus defined, exposures were permitted often for a period of several months during what we believed to be the sterile days of the cycle, then a single exposure at the midperiod when we believed conception possible. The results from this experiment emphasized the need for more precise determination of the time of ovulation. Commencing in 1935 morning rectal temperatures were also taken by the women, and since then this has been a routine procedure.

In the early years of our experiment we accumulated information on the duration of the menstrual cycle in the women under observation and recorded their ability to distinguish midmenstrual signs which might be indicative of ovulation. We learned that the signs associated with ovulation are extremely varied and in many women are not recognizable. However, in some women there are definite sensations which, if recorded on the menstrual calendar, can be considered to date the ovulation. This is borne out by the fact that in 15 women, a single exposure at the time of subjective sensation has resulted in pregnancy. The sensations range from a slight temporary discomfort on one or other side of the lower abdomen to severe pain lasting for several hours. In some women there is a vaginal discharge at the midperiod, lasting from one to three days, and there may also be a small amount of bleeding. In one woman there was a regular one-day diarrhea at this time and in several others there were headache and sleeplessness. It seems evident

that symptoms may appear over a period of three days, these symptoms usually being more pronounced in those women who have had some inflammatory process in the uterus or oviducts. Rupture of the follicle may actually be felt by the woman after careful observation of her own temperature curve.

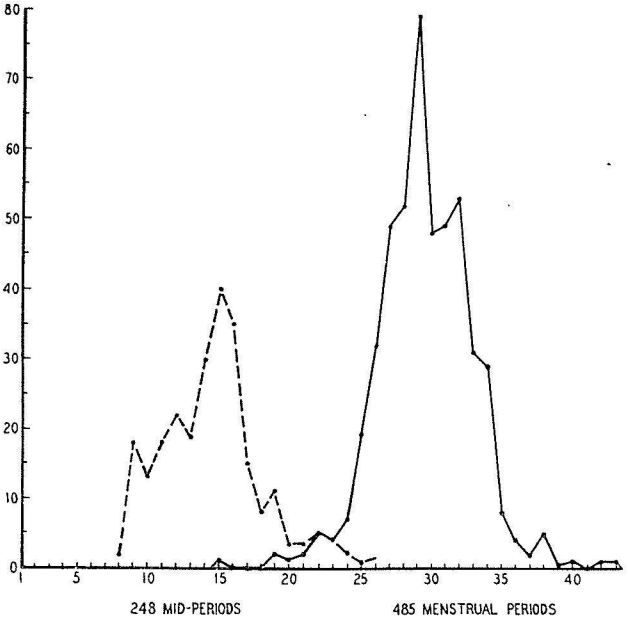

Fig. 1.—The incidence of the midperiod and duration of menstrual cycle. The majority of ovulations indicated by this determination of the midperiod falls between days nine and nineteen of the menstrual cycle with the highest incidence occurring on days fourteen, fifteen, and sixteen.

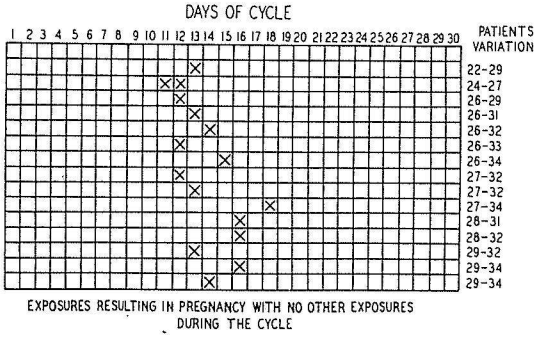

Fig. 2.—Sixteen planned pregnancies successfully started by using midperiod symptoms as indicative of ovarian follicle rupture.

A summary of the menstrual cycles and the observed midperiods is given in Fig. 1. It will be seen that the conformation of the curve of menstrual cycle is very similar in our group to that surveyed by Engle and Shelesnyak[4] in 1934 and by others. The menstrual cycles in our women, whose ages range from twenty-five to thirty-six years, are very much more regular than those reported in younger women by Engle

and Shelesnyak. This is a fairly well-recognized stability that takes place within the older age group of which this evidence is an example. Our women are all married and living with their husbands. Many have had one or more children. There has been no selection on the basis of economic status. A midperiod indication is claimed by about 50 per cent of the women in our group and varies with the length of the cycle.

Fig. 2 shows the range in day of exposure in 16 planned pregnancies successfully started by using midperiod symptoms as indicative of ovarian follicle rupture. There were no exposures during the cycle other than those indicated and no subsequent exposures until after pregnancy had been proved. It will be noted that no pregnancy occurred before the eleventh day of the cycle nor after the eighteenth day regardless of cycle length. It is important to note that pregnancy never occurred at any other date of the menstrual cycle despite exposures permitted in previous months during the assumed sterile days.

Although the midperiod determination yielded interesting data, it is not a method of precision.

Our next step was the recording of early morning rectal temperature in the hope of more accurately dating ovulation, for Van de Velde[19] in 1904 reported variations in body temperature during the menstrual cycle and in 1929 confirmed his observations by supplemental data.[20]

Further information is essential because of occasional irregularities found in the cycles of all women. Harvey and Crockett[11] had already reported in 1932 the temperature record of one woman. Dr. Rubenstein, carrying on a parallel investigation in this laboratory, has recorded routine daily temperatures on a group of women and has recently published his findings.[17]

In arranging for single exposure pregnancies one must have ascertained the approximate ovulation date; even then, as is shown in our records of 81 women, pregnancy may not occur until after several timed exposures. The rhythmic rise and fall in the twenty-four-hour temperature record is an established fact, the lowest point being reached usually in the early morning. To standardize the procedure our women recorded their rectal temperature each morning before rising. This routine was carried out at approximately the same time every day. The temperatures were read and recorded to tenths of a degree. When these temperature records are plotted, the resulting curve usually shows that just before menstruation begins there is a slight fall in the temperature which, in most women, reaches 98° F. This level is maintained during the period of flow. At the end of the period there may be a temporary lowering of the temperature which then rises to somewhat above 98° before falling abruptly to reach its lowest level at the midperiod when it may descend to 97° or even lower. After this fall the temperature rises to a level usually above 98° F. and remains practically stationary until the onset of the next menstrual period. This phase is usually regarded as the lutein phase. It is true that not all menstrual cycles show these clear-cut variations, but in the 67 women studied this variation was characteristic of more than 80 per cent of the menstrual cycles.

Fig. 3 shows six successive menstrual cycles in one woman whose temperature curve presents a midperiod low level ascertained to coincide with ovulation through the occurrence of pregnancy from exposure at this precise date and this date only. In this woman, after pregnancy started, there was a fall of temperature at about the time of the expected ovulation of the succeeding cycle. Of 20 women whose pregnancies were planned from the temperature curve (Fig. 4), two, of whom this is one, showed a temperature drop at the first midperiod date at commencement of pregnancy. In the other 18, the temperature remained continuously between 98.5° and 99.5° F. after conception. From

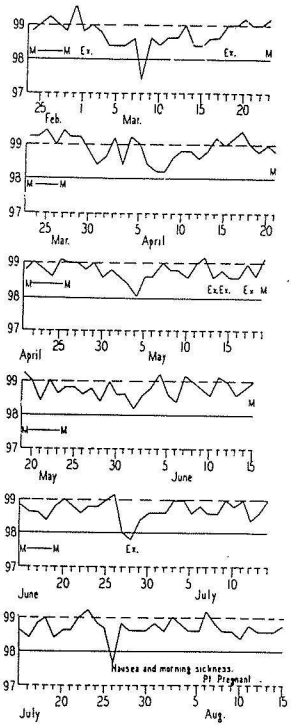

Fig. 3.

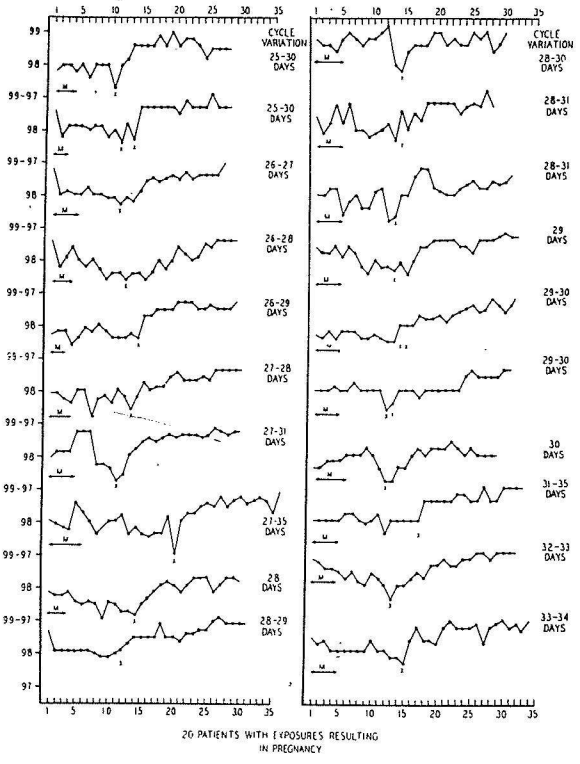

Fig. 4.

Fig. 3.—Six successive menstrual cycles in one woman whose temperature curve presents a midperiod low level ascertained to coincide with ovulation through the occurrence of pregnancy from exposure at this precise date and this date only.

Fig. 4.—The record of the last menstrual cycle in each of twenty women to illustrate the identification of ovulation with the approximate date of the midperiod low temperature. The date of exposure is marked by a cross and the duration of menstruation by a double-headed arrow.

the records of these two women one may hazard the suggestion that when nausea occurs it starts at the date of the midperiod following conception.

Fig. 4 gives the record of the last menstrual cycle in each of 20 women to illustrate identification of ovulation with approximate date of the midperiod low temperature. No pregnancy occurred before the tenth day or after the twentieth day of the cycle regardless of cycle

length. In no woman did pregnancy occur more than three days before or one day beyond the initial rise of temperature from the midperiod low level. After conception the temperature no longer undergoes a cyclic change except in those few women who menstruate or perhaps even ovulate after pregnancy starts. The temperature during pregnancy remains high as in the last part of the menstrual cycle and can be used as a sign of pregnancy before other methods of diagnosis are positive. From the records of these women we find it possible to diagnose pregnancy also by a persistent tenderness of the breasts more pronounced than that usual in the premenstrual days. This exaggerated

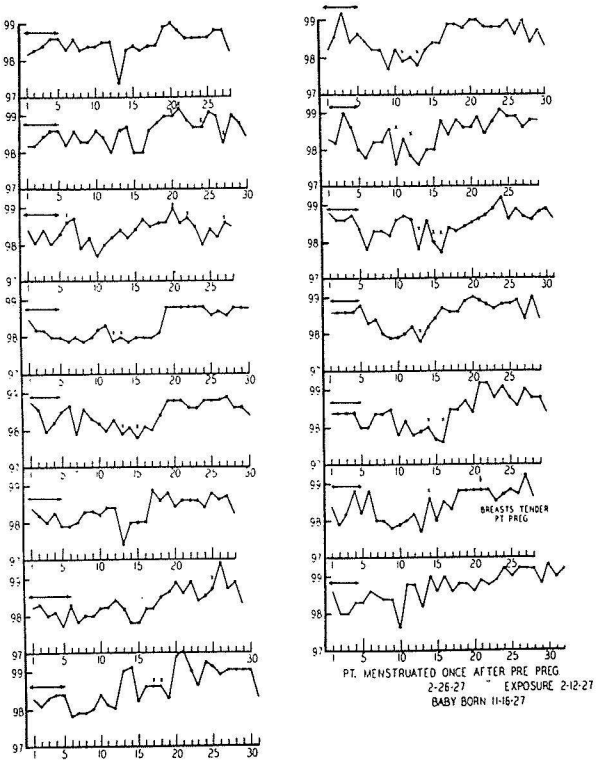

Fig. 5.—The temperature and exposure records of one woman over fifteen menstrual months preceding pregnancy to illustrate the close relationship between exposure and midperiod low temperature with its implied ovulation which must be fulfilled in order to ensure conception.

tenderness always appears before the missed menstrual period. In one woman it occurred on the fifth day after exposure, a finding which suggests an occasional earlier date for implantation than the tenth day after fertilization as claimed by Hartman.[9]

In every woman the morning nausea started at what by computation would be the date of the next ovulation after conception. Hence morning sickness of pregnancy may be related to a change in the ovulation cycle.

Fig. 5 represents the temperature and exposure records of one woman over fifteen menstrual months preceding pregnancy to illustrate the

close relationship which must be fulfilled between exposure and midperiod low temperature with its implied ovulation in order to ensure conception. Exposure has apparently little chance of prematurely rupturing the ovarian follicle, since this woman had exposures in several months on the day before the temperature rise began but pregnancy did not ensue. She became pregnant, however, the first time she had an exposure on the day after the rise began. This would indicate that the viability of the sperm is less than twenty-four hours.

In other women studied, repeated exposure just after the low temperature level failed to produce pregnancy; this indicates a viability of the ovum of not more than thirty-six hours.

It will also be observed from this record that a subsequent full menstruation occurred after pregnancy had started and that conception took place fourteen days before the onset of the period. This particular woman also menstruated once after a preceding pregnancy.

The human fertile period is herein shown to vary from woman to woman and from cycle to cycle. It is necessary to study each woman's variation in order to understand her particular variability. As a simple method of determining the time of ovulation, the basal rectal temperature is offered, since it is a procedure which is easy to follow and since it bears a close relationship to the time of ovulation as shown by the above reported case records.

SUMMARY

1. In 35 cases herein reported conception occurred from the tenth to the twentieth days of the menstrual cycle regardless of cycle length.

2. Basal body temperature is a guide to the period of fertility as identified in these studies to occur not more than three days before or one day after the midperiod of the menstrual cycle, with a high incidence at the time of the last low temperature before the lutein phase begins.

3. Breast tenderness of unusual severity occurs before the missed menstrual period, and the morning sickness of pregnancy begins at the time of the next ovulation period after conception starts.

4. The viability of both sperm and ovum is short, probably not exceeding twenty-four hours.

5. Intercourse does not cause follicle rupture.

6. Ovulation and menstruation may occur after conception begins.

7. Studies of basal body temperature may be used as a guide or forecast of unusual ovulations or to supplement other data in studying sterility. There is advantage in this type of study where menstrual physiology is obscure.

REFERENCES

(1) *Burr, H. S., Hill, R. T., and Allen, E.:* Proc. Soc. Exper. Biol. & Med. 33: 109, 1935. (2) *Burr, H. S., et al.:* Science 86: 312, 1937. (3) *Dickinson, R. L.:* AM. J. OBST. & GYNEC. 14: 718, 1927. (4) *Engle, E. T., and Shelesnyak,*

M. C.: Human Biol. 6: 431, 1934. (5) *Evans, H. M., and Swezy, O.:* Mem. Univ. California 9: 119, 1931. (6) *Fraenkel, L.:* Zentralbl. f. Gynäk. 35: 1591, 1911. (7) *Hartman, C. G.:* Contributions to Embryol. 23: 1, 1932. (8) *Idem:* AM. J. OBST. & GYNEC. 26: 600, 1932. (9) *Idem:* Time of Ovulation in Women, a Study on the Fertile Period in the Menstrual Cycle, Baltimore, 1936, Williams & Wilkins. (10) *Idem:* J. Contraception 2: 51, 1937. (11) *Harvey, D. L., and Crockett, H. E.:* Human Biol. 4: 453, 1932. (12) *Knaus, N.:* Zentralbl. f. Gynäk. 53: 2193, 1929. (13) *Idem:* Periodic Fertility and Sterility in Woman: a Natural Method of Birth Control, Tr. by D. H. and K. Kitchen, Vienna, Moudrich, following the German edition in 1934. (14) *Ogino, K.:* Zentralbl f. Gynäk. 54: 464, 1930. (15) *Idem:* Zentralbl. f. Gynäk. 56: 721, 1932. (16) *Papanicolaou, G. N.:* Am. J. Anat. 52: 519, 1933. (17) *Rubenstein, B. B.:* J. Contraception 2: 171, 1937. (18) *Schroeder, Robert:* In Handbuch d. Gynäkologie, 1928 (Veit-Stoeckel), vol. 1. (19) *Van de Velde, T. H.:* Über den Zusammenhang zwischen Ovarialfunction, Wellenbewegung, und Menstrualblutung und über die Enstehung des sogenannten Mittel-Schmerzes, 1904, Haarlem. (20) *Idem:* Ideal Marriage, Its Physiology and Technique. London, 1929, Heinemann.

EXCRETION OF HORMONES IN A CASE OF HABITUAL ABORTION*

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THE purpose of this report is twofold; first to present the urinary estrogenic and gonadotropic hormone findings in a carefully followed case of abortion, and second, to confirm the findings of a report by Cohen and others,[1] and Marrian[2] in which an association between the sudden excretion of free fat-soluble estrogenic hormone and the onset of labor was demonstrated.

The patient studied was a woman of 36 years, anxious to have a child but with the history of two spontaneous abortions at 1.5 and 5 months and one premature labor at 6.5 months in the order noted. The latter pregnancy terminated spontaneously Jan. 8, 1936. It was planned at that time that the patient should collect complete twenty-four-hour urine specimens regularly at weekly intervals during the ensuing year and bring them to the laboratory for the assay of estrogenic and gonadotropic hormones. She was to avoid pregnancy for the first six months of this experiment. This plan was carefully followed. A daily record of intercourse and menstrual periods was kept.

The intervals at which coitus occurred, the date of abortion, and the size of the fetus were such that the probable date of conception could be quite accurately calculated. Unfortunately for the patient the pregnancy under investigation was multiple (twins) and an examination within a few hours after the earliest symptoms of abortion revealed a bulging amnion filling the vaginal vault. The patient promptly aborted twins and subsequently recovered after a stormy four-day febrile reaction.

*Supported by the Christine Breon Fund for Medical Research.