

Fallacy of the Fundal Height*

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Summary: The method of estimating gestational age from the height of the fundus uteri during pregnancy has been investigated. Such wide variations occur in the length of the maternal abdomen and umbilical position and in the level of the uterine fundus at each gestational age that the method is not reliable. Assessment of uterine size by pelvic examination in the first trimester of pregnancy correlates more closely with gestational age than assessments made by abdominal palpation of the uterus at a later time.

Introduction

During pregnancy abdominal palpation at intervals normally shows a progressive increase in the height of the uterine fundus. Traditionally this clinical sign is used as a measure of fetal maturity. The temporal relationships between fundal heights and abdominal landmarks are commonly presented as a diagram (Fig. 1). The increase in fundal height corresponds

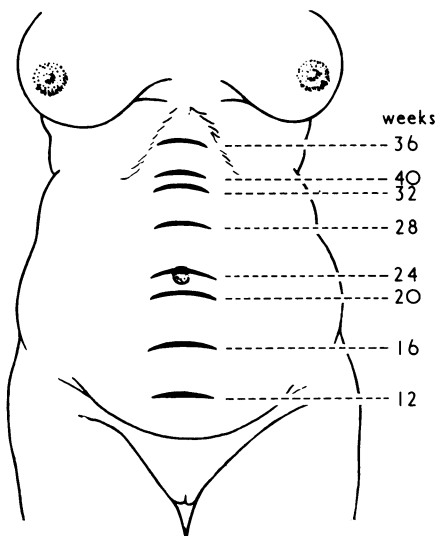


FIG. 1.—Traditional example of the relationship of the uterine fundus to abdominal landmarks at different gestation intervals throughout pregnancy. (Reproduced, by permission, from *The Queen Charlotte's Textbook of Obstetrics*, 1970, 12th ed., p. 77. Churchill, London.)

approximately to a rise of 1 in. (2.5 cm.) each fortnight. It is widely held that the uterine fundus reaches the level of the umbilicus by the 24th week of gestation and the tip of the xiphisternum by the 36th week. Thereafter the fundus falls 1 in. (2.5 cm.) in four weeks.

In this paper results are presented of a detailed study of the variations which occur in abdominal length and landmarks in pregnant women. Also, an assessment is made of

the value of the measured height of the uterine fundus as an index of gestational age.

Methods

Both serial and random measurements of the height of the uterine fundus, umbilicus, and xiphisternum above the symphysis pubis were made by tape and caliper. Because of abdominal curvature measurements made by tape invariably exceeded caliper measurements. The difference between readings was $\frac{1}{2}$ in. (1.3 cm.) or less in all women under 28 weeks pregnant, except for 13% who, because of obesity or lax abdominal musculature, showed undue protruberance of the lower abdomen in early pregnancy. After 28 weeks' gestation the difference between tape and caliper readings was more than $\frac{1}{2}$ in. (1.3 cm.) in all but 25% of patients, who were slim or whose abdominal muscles were firm enough to prevent the normal abdominal distension of pregnancy.

All observations were made by one technician or by us. In 50 women independent measurements of the uterine fundus and abdominal landmarks were made by two of the three observers in turn. With tape or caliper the measurements were the same to within $\frac{1}{2}$ in. (1.3 cm.) in 85% of the patients. During early pregnancy estimates of gestational age were made clinically by pelvic examination and also by ultrasound measurements of the fetal biparietal diameter (Campbell, 1969).

Results

Before 28 Weeks' Gestation

Altogether 233 patients were measured. The abdominal length between symphysis pubis and xiphisternum was 10-12 in. (25-30 cm.) in 47 (20%), 12½-14½ in. (31.5-36.5 cm.) in 167 (72%), and 15-17 in. (38-43 cm.) in 19 (8%). The position of the umbilicus in these three groups varied from 4½ to 7½ in. (11.5 to 19 cm.) above the symphysis pubis. In each group a wide scatter was observed in the level of the fundal height at

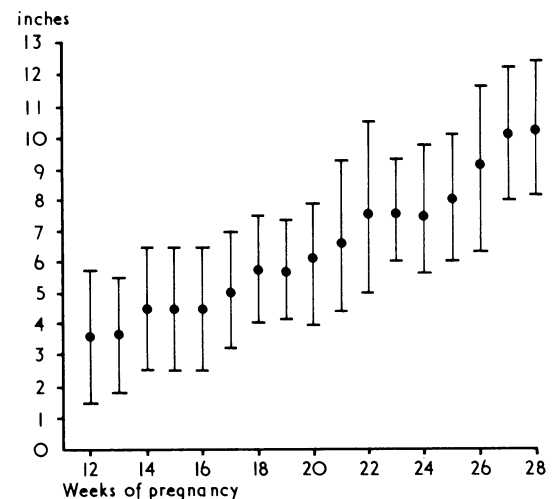


FIG. 2.—Average height of the uterine fundus above the symphysis pubis, with 2 standard deviations, before 28 weeks' gestation, in patients of abdominal length 12½-14½ in. (31.5-36.5 cm.).

* Some of the results included in this paper were included in a prize-winning essay presented by R.A.U. for the Queen Charlotte's and Chelsea Hospitals Research Prize, 1969.

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each gestational age. Commonly, the fundus was found at or above the umbilicus from 18 weeks' gestation onwards.

The average fundal height, with 95% confidence limits, obtained from 20 to 25 observations made at each gestational age in patients whose abdominal length was 12½-14½ in. (31.5-36.5 cm) by tape and caliper is shown in Fig. 2. Despite a general increase in the fundal height, variations observed at each gestational age are so wide it is impossible to gauge fetal maturity from the fundal level more accurately than to within eight weeks.

Gestational Age (Weeks)

By Dates	By Pelvic Examination	By Ultrasound
12	20	18
10	10	10
13	15	12*
11	10	10
12	12	12
12	12	12
11	11	11
13	16	13*
11	14	11*
10	14	10*
12	14	12
9	9	9
11	10	11
8	6	8
12	14	12
9	20	6*
11	11	11
12	12	12
10	14	9*
13	13	13
12	12	12
10	12	11
11	12	10
16	12	12
8	9	8
14	19	16*
13	11	11

*Ultrasound and clinical assessment of gestational age differ by more than two weeks.

Ultrasound measurement of the fetal biparietal diameter was undertaken in 27 patients on whom a pelvic examination had been performed during the first trimester. All vaginal examinations were performed by obstetricians of more than nine months' experience. A closer correlation was found between uterine size and fetal maturity at this time than at later stages of pregnancy. Nevertheless, a discrepancy of more than two weeks between the clinical assessment of uterine size and the ultrasonic estimate of gestational age occurred in 26% of patients (see Table).

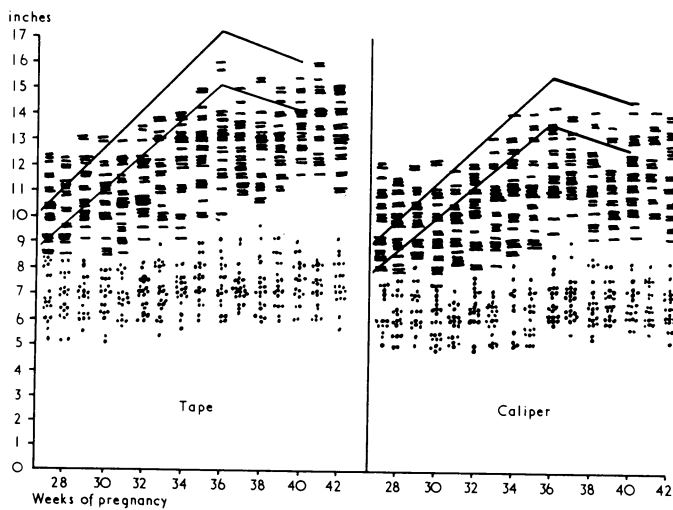


FIG. 3.—Variations observed in the height of the umbilicus (·) and uterine fundus (-) above the symphysis pubis after 28 weeks' gestation, measured by tape and caliper in patients of abdominal length 15-17 in. (38-43 cm.) (tape). The upper and lower limits of the traditional level of the uterine fundus in abdomens of these lengths is shown by continuous black lines.

After 28 Weeks' Gestation

A further 240 patients were measured. The abdominal length by tape from symphysis pubis to xiphisternum was 12½-14½ in. (31.5-36.5 cm.) in 72 (30%) and 15-17 in. (38-43 cm.) in 168 (70%). Caliper measurements in these groups were, on average, 2 in. (5 cm.) less. In both groups the position of the umbilicus varied from 5 to 9 in. (12.5 to 23 cm.) above the symphysis pubis (Fig. 3). In both groups also variation of 4 to 6 in. (10 to 15 cm.) was observed in the level of the fundal height at each gestational age, whether measured by tape or caliper. This variation is equivalent to a difference in fetal maturity of about 8-12 weeks.

Tape and caliper measurements obtained in patients whose abdominal length was 15-17 in. (38-43 cm.) by tape are shown in Fig. 3. From the 30th week of pregnancy onwards the level of the fundus at each gestational age is usually less than the level expected from classical descriptions of uterine enlargement during pregnancy. No obvious diminution in fundal height was noted during the last month of pregnancy. Similar results were found in patients whose abdominal length was 12½-14½ in. (31.5-36.5 cm.) by tape.

Discussion

The traditional practice of assessing gestational age by relating the height of the uterine fundus to abdominal landmarks implies either that fetal growth is standard throughout pregnancy and maternal abdomens are all standard size or that fetal size at any gestational age is related to the length of the maternal abdomen. Neither implication is correct.

This study has shown a biological variation of 7 in. (17.5 cm.) in the abdominal length of pregnant women. This variation is equivalent to a difference of 14 weeks' gestation if it is assumed that the uterus grows about 1 in. (2.5 cm.) each fortnight. Variations of up to 5 in. (12.5 cm.) in umbilical position amount to a difference of about 10 weeks in fetal maturity. At the same period of gestation patients of different abdominal length showed no appreciable difference in the level of their uterine fundus. When palpated in abdomens of different lengths, however, uteri of the same height could easily mislead the clinician to an inaccurate assessment of fetal maturity (Fig. 4).

Considerable variations in the fundal height of all patients were noted at each gestation interval in this study. The scatter

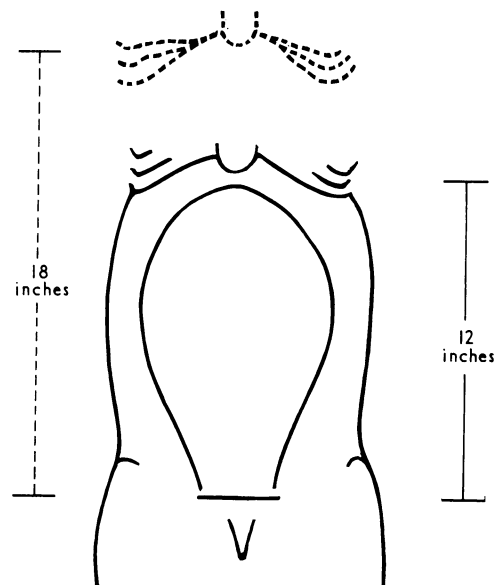


FIG. 4.—Gestational age appears to differ when uteri of identical size are palpated in abdomens of different lengths.

of measurements indicate that for any particular fundal level there is up to eight weeks' variation in gestational age. In practice, therefore, the clinical detection of a baby "large for dates" or "small for dates" necessitates at least four to six weeks' difference between the traditional level of the fundus and the fundal height observed.

No standard rate of uterine growth was discovered in this study and sometimes no detectable increase in the level of the fundus occurred throughout four weeks of pregnancy. The most informative index of fetal maturity was the size of the whole uterus when assessed by pelvic examination in the first

trimester of pregnancy. At a later stage neither the level of the uterine fundus nor its relationship to abdominal landmarks provided a reliable guide to gestational age.

We acknowledge the work undertaken during this study by our research technician, Miss Susan Taylor.

REFERENCE

Campbell, S. (1969). *Journal of Obstetrics and Gynaecology of the British Commonwealth*, 76, 603.

Preliminary Communications

Endocrine Function in Male and Female Homosexuals

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Summary: Serial assays of hormones and their metabolites are reported in the urine of three male and four female homosexuals. Urinary testosterone levels were abnormally low in the two men who practised exclusive homosexuality and were within the normal range in the third, who had both homosexual and heterosexual relationships. In the women assays were generally performed throughout one menstrual cycle; in three the pattern of hormone excretion was ovulatory in character, while in the fourth evidence for ovulation was equivocal. Levels of testosterone and luteinizing hormone (L.H.) were raised in the female homosexuals, while those for oestrogens, particularly oestrone, were below the range for normal heterosexual subjects during their reproductive life; readings of follicle-stimulating hormone (F.S.H.) and pregnanediol were normal in three women. The data reported here are in keeping with the view that abnormalities in endocrine function may occur in both male and female homosexuals.

INTRODUCTION

It is now recognized that overt homosexuality is not a rare occurrence in the general population and that the condition is more prevalent in men than in women. There remain, however, considerable differences of opinion among authorities in this field as to the precise incidence of homosexuality in either sex (Kinsey *et al.*, 1948; Bancroft, 1970; Kenyon, 1970). Traditionally the condition has been regarded as essentially psychogenic in origin, and a very extensive literature now exists with respect to the psychological factors which are believed to be responsible for its causation.

The emphasis on the psychogenic aspects of homosexuality has tended to obscure the possibility that abnormalities in endocrine function, and in particular some form of hormonal imbalance, might be present and might conceivably play a part in its pathogenesis. At the time of writing the literature contains little reliable information on the endocrinology of homosexuality, and detailed hormone assay studies in men and women with this condition have been reported to a very limited extent indeed.

The aim of the present paper is to contribute to this field by comparing hormone excretion patterns in three male and four female homosexuals with those of normal heterosexual men and women.

CLINICAL MATERIAL

CONTROLS

The heterosexual men and women used as controls were mainly members of the scientific and technical staff of this unit. The findings in these subjects are reported elsewhere

(Ismail *et al.*, 1969; Cooper *et al.*, 1970; Papanicolaou *et al.*, 1970; Adamopoulos and Loraine, 1970). All were volunteers and none admitted to any homosexual inclination or activity. All claimed to be involved in regular heterosexual activity, and none had received medication during the period of investigation.

HOMOSEXUALS

The three men and four women studied were involved in regular homosexual activity throughout the period of study. Only one of them (a man, Subject 3) also admitted to random heterosexual inclinations and experience during this time.

Males.—The ages of the three men were 19, 29, and 33 years. The homosexual role adopted varied in each case, being active and passive at different times, though, in general, one role was preferred. In two subjects buccal smears were taken, and were of the normal male type. The duration of the investigation ranged from 19 to 26 days.

Females.—The four women studied were two pairs of sexual partners; their ages were 23 and 20 years and 21 and 20 years respectively. All were engaged in very active sexual relationships involving daily activity except at the time of menstruation. One of the four admitted to previous heterosexual experience, but at the time of the investigation had become exclusively homosexual, both in inclination and in activity. In three (Subjects 1, 2, and 4) there was a history of irregular menstrual cycles, while in Subject 3 cycles were regular. In Subject 4 a tentative diagnosis of the Stein-Leventhal syndrome had been made. As with the men sexual roles varied, being both active and passive at different times. In Subjects 1, 2, and 4 the period of investigation was one complete menstrual cycle, while in Subject 3 the study continued for 44 days.

HORMONE ASSAY METHODS

Estimations were performed on 48-hour pools of urine, the results being expressed per 24-hour sample. Testosterone and epitestosterone assays were conducted by the method of Ismail and Harkness (1966) as modified by Ismail *et al.* (1968). Estimations of pregnanediol and of oestrone, oestriol, and oestradiol were performed using the techniques of Klopfer *et al.* (1955) and Brown (1955) respectively. Assays for follicle-stimulating hormone (F.S.H.) and luteinizing hormone (L.H.) were conducted by the rat augmentation test of Steelman and Pohley (1953) and the ovarian ascorbic acid depletion test of Parlow (1958) respectively, incorporating the modifications described by Loraine and Adamopoulos (1970). The results of gonadotrophin assays were expressed in international units (i.u.) in terms of the Second International Reference Preparation for Human Menopausal Gonadotrophin. The mean index of precision λ (\pm S. D.) was 0.15 ± 0.03 for the F.S.H. assays and 0.26 ± 0.06 for the L.H. determinations.