Fetal phallic growth and penile standards for newborn male infants

No appreciable difference in size of the fetal clitoris versus the fetal penis was noted until 14 weeks' gestation, which is after the period of masculine differentiation of the external genitals. However, significant differences in the rate of penile and clitoral growth were evident in second trimester fetuses. The majority of the prenatal growth of the penis occurs after 14 weeks gestation at an almost linear rate. The penile stretched length of the full-term infant was 3.5 cm ± 0.7 cm and the diameter was 1.1 cm ± 0.2 cm.

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STANDARDS of penile size are available only from two months of age to adulthood.[1] The purpose of this report is to set forth norms for penile size for premature and full-term infants as well as the growth pattern of the phallus during fetal life.

MATERIALS AND METHODS

Fetal phallic measurements were determined on 68 male and 33 female formalin-fixed spontaneous and induced abortuses without obvious anomaly. Their sex determination was based on external morphologic criteria alone, and conceptual age was calculated from crown-rump length. Differences in sexual morphology of the external genitals were clearly evident by gross examination at 12 weeks conceptual age and by examination with a dissecting microscope at 8 weeks. Seven anencephalic formalin-fixed fetuses were also examined. Penile measurements were obtained from 76 apparently normal premature (39) and full-term (37)

male newborn infants. Their gestational ages were determined by history and Dubowitz evaluation.[2] Two infants who were small for gestational age, seven who were large for gestational age, and four twins were excluded from the calculation of normative standards.

Penile length in the newborn infant was determined from the pubic ramus to the tip of the glans penis by placing the end of a straight-edge ruler against the pubic ramus and applying traction along the length of the phallus to the point of increased resistance, an easily appreciated end point. The location of the tip of the glans

Abbreviations used	
hCG:	placental chorionic gonadotropin
LH:	luteinizing hormone

penis was determined by palpation, as all infants were measured prior to circumcision. Schonfeld[1] has previously shown that stretched penile length is the most consistent measure of phallic length and correlates closely with the erect penile length. Flaccid penile length was also determined on 57 newborn infants for comparison. The formalin-fixed specimens were measured without traction. Phallic diameter was determined by passing a hole gauge graduated in sixty-fourths of an inch over the phallus with the foreskin unretracted. The smallest diameter hole which could be passed over the phallus on the return pass without bunching the foreskin was taken to be the diameter. Results were converted to their millimeter equivalent. Maximum diameter was also calculated from linen tape measure-
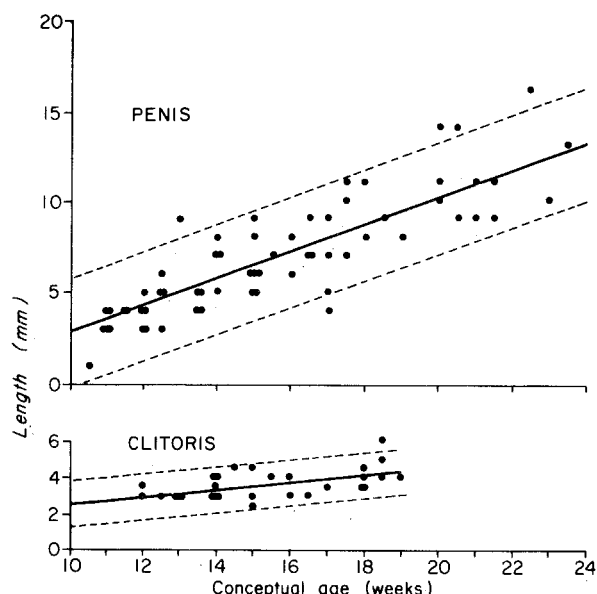
Fig. 1. Phallic length of normal formalin-fixed male and female fetuses, showing the lines of mean ± 2 SD. The line for 68 males has a correlation coefficient of 0.89 and the line for 33 females has a correlation coefficient of 0.63.
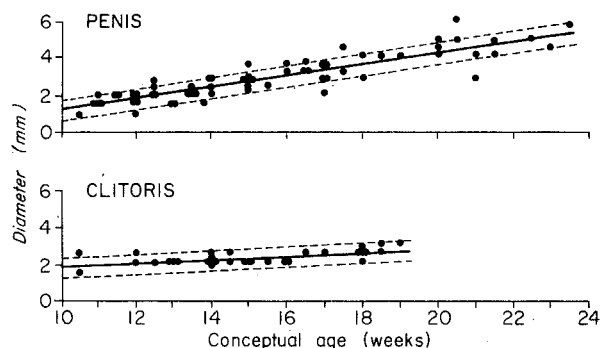

Fig. 2. Phallic diameter of normal formalin-fixed male and female fetuses, showing lines of mean ± 2 SD. The line for 68 males has a correlation coefficient of 0.92 and the line for 33 females has a correlation coefficient of 0.78.

ment of penile circumference in 55 infants and from visual determination of diameter using a millimeter scale placed alongside the penis in 54 infants. When measurement of either length or breadth was less than 5 mm a caliper was utilized to determine the dimension.

The best fit lines of growth in Fig. 1 to 4 were obtained by linear least squares regression, and the standard deviations and the correlation coefficients were determined using the Wang Computer Programs CAL360-STAT-3 and CAL360-STAT-4.

RESULTS

The growth rates of the early fetal clitoris and of the penis and the mid and late gestation penis are essen-

tially linear as indicated in Figs. 1 to 4. Prolonged formalin fixation can result in small changes in organ size[3]; therefore, the data on formalin-fixed specimens should only be taken to show the patterns of fetal penile and clitoral growth and not to provide norms of fetal penile and clitoral size. Penile and clitoral sizes, which are initially comparable, show rapidly divergent growth. The rates of growth of the early fetal penis, 0.72 mm/wk, and the early fetal clitoris, 0.20 mm/wk, are significantly different at a p value of less than 0.0005. The early fetal (data from formalin-fixed specimens) and premature and newborn penile growth lines do not intersect because of differences in measuring technique. The mean full-term penile size of 3.5 × 1.1 cm is slightly smaller than the 3.7 × 1.3 cm dimensions reported by Schonfeld in 2-month-old infants, the youngest age for his normative data. Masculine differentiation of the external genitals in the seven male anencephalic fetuses was normal, but phallic length was small, being equal to or less than the third percentile for gestational age.

The mean difference between stretched and flaccid penile lengths was 18% with a standard deviation of 5%, showing an appreciable difference between the two measurements. Phallic diameter derived from measurement of circumference was 1.8% larger than the template-derived diameter, with a standard deviation of 5.3%, a close correlation (the null hypothesis is not rejected at 5% probability). However, the visually determined diameter was a less consistent measure, being 5.2% greater than the template diameter, with a standard deviation of 8.1% (the null hypothesis is rejected at 5% level of significance).

DISCUSSION

The mean term stretched penile size derived from the current data is 3.5 × 1.1 cm. The third and ninety-seventh percentile for the penile length are 2.8 cm and 4.2 cm and for the diameter are 0.9 cm and 1.3 cm, respectively. Utilization of various methods indicated that the most useful and reproducible measure of penile size is the stretched length. A small penis may provide a clue to fetal testosterone insufficiency, either secondary to hypothalamic-pituitary insufficiency or to primary testicular insufficiency. Recognition of micropenis in the genetically male infant is important because of the recent therapeutic utilization of short-term testosterone therapy in early life to enlarge the micropenis to within normal size for age.[4]

The growth pattern of the fetal phallus, demonstrated by the current data, is of interest from endocrinologic and developmental standpoints. Prior to 8 to 9 weeks postconception the external genitals exist in a largely
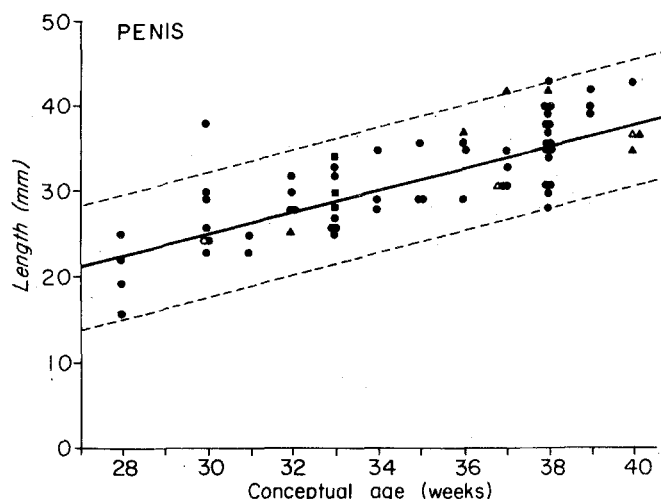
Fig. 3. Stretched phallic length of 63 normal premature and full-term male infants (●), showing lines of mean ± 2 SD. Correlation coefficient is 0.80. Superimposed are data for two small-for-gestational age infants (Δ), seven large-for-gestation age infants (▲), and four twins (■), all of which are in the normal range.

undifferentiated state.[5] During the first trimester placental chorionic gonadotropin increases to high levels in both male and female fetuses.[6] This is apparently the initial stimulus to testicular Leydig cell hyperplasia[7] and testosterone production, which reaches its maximum fetal level between 11 and 17 weeks gestation,[6] resulting in masculine differentiation of the external genitals. Jost[8] has demonstrated in rabbits that a functioning testes or exogenous source of testosterone is required for normal masculine differentiation of the external genitals. Surprisingly, no appreciable difference between penile and clitoral sizes from 11 to 14 weeks is evident from present data, despite the fact that this is the period of maximum sex differences in serum testosterone concentrations.

Serum hCG levels and Leydig cell hyperplasia decline after 14 weeks gestation followed by a decrease in the serum testosterone levels.[6] At about 18 weeks fetal pituitary luteinizing hormone increases, reaching peak levels by 20 to 26 weeks gestation and then declining slowly to term.[9] Pituitary LH appears to be the stimulus to testosterone production in the latter half of gestation. The limited data on fetal serum testosterone levels between 18 weeks and term indicate declining levels in males, toward sex equal concentrations at term.[10] Paradoxically, it is during the time of declining serum testosterone concentrations, from 16 weeks to term, that the major period of penile growth occurs, with no indication of deceleration in rate. The importance of testosterone in late phallic growth is demonstrated by Jost's[8] experiments of late castration which resulted in decreased phallic growth of normally masculinized genitals. In summary, masculine differentiation of the
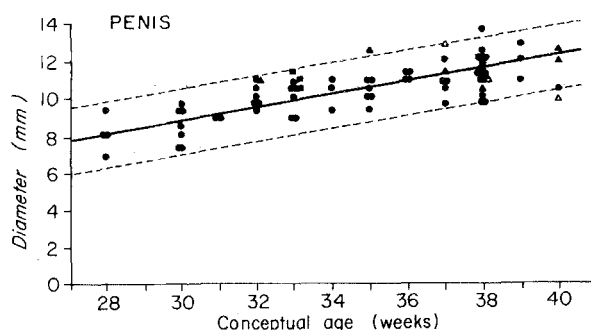

Fig. 4. Phallic diameter of 63 normal premature and full-term male infants (●), showing lines of mean ± 2 SD. Correlation coefficient is 0.82. Superimposed are data for two small-for-gestational age infants (Δ), seven large-for-gestational age infants (▲), and four twins (■), all of which are in the normal range.

phallus seems to be dependent on placental hCG stimulus to production of testicular testosterone which acts on responsive genital tissue between 8 and 14 weeks gestation. Penile growth, however, seems to be largely mediated through a hypothalamus-pituitary LH-testicular testosterone-penis axis between 18 weeks and term.

The foregoing information may be of clinical value in assessing the significance of ambiguous or small genitals in the genetic male. The child with genital tissue resistance to testosterone, as in the testicular feminization syndromes, has varying degrees of both incomplete phallic differentiation and inadequate phallic growth.[11] Primary testicular dysfunction of testosterone production can lead to defects in masculinization and/or micropenis depending on the timing and

degree of testosterone insufficiency. Clinical examples include testicular dysplasia as seen in the XXY syndrome[12] and testicular enzyme defects leading to decreased testosterone production.[13] Hypothalamic or pituitary dysfunction, on the other hand, would not affect the early hCG-stimulated stage of phallic differentiation, but would lead to later decreased phallic growth. This is the situation of the seven anencephalic fetuses studied, as well as those previously reported by Bearn.[14] Similar inadequate growth, but normal differentiation, is seen in the Prader-Willi syndrome,[15] a syndrome in which there is often hypothalamic dysfunction.

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