Normal anatomic relationships in prepubescent female external genitalia

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Abstract *Objective:* Female congenital abnormalities and concomitant ambiguous genitalia constitute the primary reason for female genital reconstruction, however, objective data describing normal female anatomy is lacking. The aim of this study is to describe the normal anatomical relationships and size of the external genital structures in prepubescent females.
Materials and methods: Data were collected prospectively from consecutive Tanner stage 1 females undergoing surgery unrelated to the genitalia. Recorded measurements included: clitoris length and width, length from clitoris to anus, clitoris to urethra, clitoris to posterior labia majora, mucosa behind vagina or posterior fourchette, and radius to labia minora at vagina. Patients were stratified by age into four age groups: <2 years, 2—5 years, 5—11 years and >11 years.
Results: Fifty-six patients met inclusion criteria. Clitoral width was similar in all age groups. The regression plots for the remaining measurements modeled on age all show a significant linear growth distribution.
Conclusions: The average clitoral width was 3.8 mm, which remained constant between age groups. Clitoral length, length from clitoris to anus, clitoris to posterior labia majora, clitoris to urethra and posterior fourchette length increased across age groups. This study provides insight into the dimensions of normal external genitalia in tanner stage 1 females.
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Introduction

Female congenital abnormalities and concomitant ambiguous genitalia constitute the primary reason for female genital reconstruction in the pediatric population, with congenital adrenal hyperplasia being the most common etiology. Surgical repair of ambiguous genitalia aims to create a normal external female genital appearance, promote normal urinary function, maintain normal innervation and facilitate normal sexual function. Reconstruction is generally undertaken between two to six months of age [1–3]. A prerequisite for successful reconstruction is a detailed understanding of the normal anatomic relationships of prepubescent female genitalia. Despite widespread use of surgical intervention, many aspects are still uncertain, including timing of genitoplasty, surgical technique, and long-term functional and cosmetic outcomes [2,4]. While descriptions of normal male genitalia are widespread [5–8], objective published data describing normal female anatomy is lacking. The aim of this study is to describe the normal anatomical relationships and size of the external genital structures in prepubescent females.

Materials and methods

Institutional Review Board approval was granted separately from two institutions (UT Southwestern and Children's Hospital Colorado). Data was collected prospectively. Consecutive Tanner stage 1 females undergoing urologic surgery unrelated to the external genitalia were invited from the two institutions to participate in this study. Exclusion criteria included patients with prior genital surgery, anomalous external genitalia, anorectal anomaly, developmental delay or current infection. After informed consent was obtained, demographic data were recorded and genital measurements obtained with a standard metric ruler. An attending surgeon or urology resident performed the examination under general anesthesia with the patient in a supine position. In total, six individuals performed the measurements by providing gentle traction on either side of the labia majora to expose the labia minora and the clitoris. Recorded measurements included: clitoris length and width, length from clitoris to anus, clitoris to urethra, clitoris to posterior labia majora, mucosa behind vagina or posterior fourchette, and radius to labia minora at vagina (Fig. 1). Patients were stratified by age into four age groups: <2 years, 2–5 years, 5–11 years and >11 years.

Descriptive statistics of mean ± standard deviation of the seven distances measured across age categories were tabulated. Least squares regression analyses of distances measured were plotted as a function of age. A correlation analysis was used to determine the degree of association between the distances measured calculated using Pearson's r correlation coefficients. A ratio of the distances measured with Clitoris to Posterior Fourchette as the denominator was calculated.

Results

Fifty-six patients met inclusion criteria and were enrolled in the study. The number of children recruited into each age group were 14, 9, 27 and 6 patients in the <2 years, 2–5 years, 5–11 years and >11 year age groups, respectively. Mean weight was 9.3, 15.2, 23.1 and 58.6 kg for the <2 years, 2–5 years, 5–11 years and >11 year age groups, respectively. Genital measurements are displayed in Table 1. As seen in Table 1, clitoral width was similar in all age groups and so, dropped from subsequent analyses. The regression plots for the remaining six distances measured, modeled on age, all showed a linear growth distribution with a significant P-value of the F statistic in all models (maximum P-value = 0.001). However, the adjusted R-square for clitoral length had the lowest value at P = 0.255, indicating that clitoral length may not exhibit as much variation during growth through prepubertal development and into puberty. Conversely, posterior fourchette distance and radius to labia majora exhibited a strong upward trend from the regression line in the two teenage subjects. This deviation in the two teenagers was also present in other regressions, but not as strongly evident. Because of the upward trend in these eldest subjects, their records were not used in the correlation analysis.

The Pearson Correlation Coefficients for subjects less than 13-years of age are presented in Table 2. The clitoral length was only weakly associated to any of the other measurements and had insignificant P-values for all coefficients, except with that of age. The clitoris to posterior labia majora distance was significantly and quite strongly correlated to all other measures, with the exception of clitoral length. Because of its strong association to the other comprehensive distances measured it was used as a baseline unit measure from which the others could be summarized. The clitoris to posterior fourchette distance was used as a denominator for calculating ratios using the other measurements in the numerators to obtain an average per unit distance (See Fig. 2).

Discussion

This purpose of this study was to describe normal prepubescent female genitalia. The goal of the study was to provide the reconstructive surgeon with reference data to aid with female genital reconstruction for all congenital anomalies. Ideally, measurements used to direct feminizing genitoplasty will lead to more standardized reconstruction, enhanced results and improved psychological development. In the study's cohort, the average clitoral width was 3.8 mm (SD + 1.5), which remained constant between age groups. However, clitoral length, length from clitoris to anus, clitoris to posterior labia majora, clitoris to urethra and posterior fourchette length increased across age groups.

The clitoris to posterior fourchette distance demonstrated the strongest correlation coefficient, which was used as a benchmark to establish ratios for the other measurements. These ratios are displayed in Fig. 2, with the clitoris to posterior labia majora distance serving as the denominator. They are also displayed in the accompanying diagram, since relative ratios may be more helpful to the reconstructive surgeon rather than millimeter measurements.

To the authors' knowledge, there has been only one other study quantitatively describing prepubescent female