External Genital Proportions in Prepubertal Girls: A Morphometric Reference for Female Genitoplasty

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Study received hospital ethics committee approval.

Values of measurements in all age groups and additional tables are available at http://www.pediatrikcerrahi.org.

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Purpose: An understanding of normal genital anatomy is essential for a successful surgical approach and outcome in feminizing genitoplasty. We sought to establish genital standards in female children through external genital measurements taken from the end of the neonatal period until the beginning of adolescence.

Materials and Methods: This prospective study included 205 females who were anesthetized for surgery for various diagnoses between January 2007 and March 2008. Patient age ranged from 1 month to 10 years. Patients were divided into 4 age groups—1 to 12, 13 to 24, 25 to 60 and 61 to 120 months. Information on patient age, height, weight and, for patients younger than 1 year, head circumference was retrieved from patient charts. Measurements of clitoris length, clitoris width, labia majora length, left and right labia minora length and width, and perineal distance were recorded.

Results: Specific equations were generated using these values to estimate the expected external genital structure dimensions in girls. Length of labia majora vs age, length of labia majora vs body weight, perineal distance vs body weight, clitoral width vs body weight and clitoral length vs age reference percentile curves were prepared.

Conclusions: The equations and percentile curves generated can be used as a guide in prospective feminizing genitoplasty. Furthermore, patients and their families can be informed regarding the variability of external genitalia dimensions. This information should ensure a healthier appreciation of the postoperative genitalia by patients and their families.

Key Words: female; sex differentiation disorders; surgery, plastic; urogenital abnormalities; urologic surgical procedures

Disorders of sexual development are relatively rare congenital malformations. Some of these disorders require feminizing genitoplasty. The goal of a feminizing surgery is to construct female appearing external genitalia that will support normal psychosexual development, and to fabricate a functional vagina that will allow menstruation and sexual activity.[1] An understanding of the normal genital anatomy is essential for a successful surgical approach and outcome.

Recognition of corresponding standards for external genitalia, like those adopted for followup of growth throughout childhood starting from the neonatal period up to adolescence, is critical in diagnosing a variety of genetic diseases and syndromes. These data would prevent overestimation or underestimation of genital anomalies.[2] We sought to establish genital standards in female children through external genital measurements taken from the

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end of the neonatal period until the beginning of adolescence.

MATERIALS AND METHODS

This prospective study included 205 female children who were anesthetized for surgery for various diagnoses at the pediatric surgery clinic of Diskapi Children's Research and Training Hospital between January 2007 and March 2008. Patient age ranged from 1 month to 10 years. Patients were divided into 4 age groups, ie 1 to 12, 13 to 24, 25 to 60 and 61 to 120 months. Patients with a history of genital surgery, anorectal malformation, genitoendocrine problems and developmental anomaly or burns in the genital area were excluded from the study, as were neonates and patients who were older than 10 years or had entered puberty. Hospital ethics committee approval and parental consents were obtained to conduct the study.

Data Collection and Procedure

Information on patient age, height, weight and, for patients younger than 1 year, head circumference was retrieved from the patient charts. Measurements of clitoris length, clitoris width, labia majora length, left and right labia minora length and width, and perineal distance were recorded. Each measurement was taken with the patient in the supine position following placement in the semigynecological position through hip flexion. A digital caliper with 0.01 mm sensitivity was used to take the measurements (fig. 1). The tips of the measuring caliper were rounded to avoid skin damage. Care was taken not to damage instrument sensitivity throughout this process and accuracy was checked. The measurement points used are presented in figure 2. All measurements were taken by the first author to avoid interobserver variability.

Statistical Analysis

Data analysis was performed using SPSS® for Windows, version 11.5. Data are presented as mean ± standard deviation. The differences among age groups were evaluated using one-way ANOVA post hoc Tukey test. The post hoc Tukey test was used to differentiate the group that differed from the others when the p value from the one-way ANOVA was statistically significant. The degree of association between continuous variables was calculated using Pearson's r correlation coefficients for preparation of the multivariate linear regression analyses. The dependent variables were clitoris length, clitoris width, labia majora and minora length, labia minora width and perineal measurement, whereas age, weight and height were the independent factors. The stepwise multiple linear regression method was used to determine the independent predictors that affected the dependent variables the most. Coefficients of regression and 95% CIs were calculated for all significant independent variables. A p value of less than 0.05 was considered statistically significant.

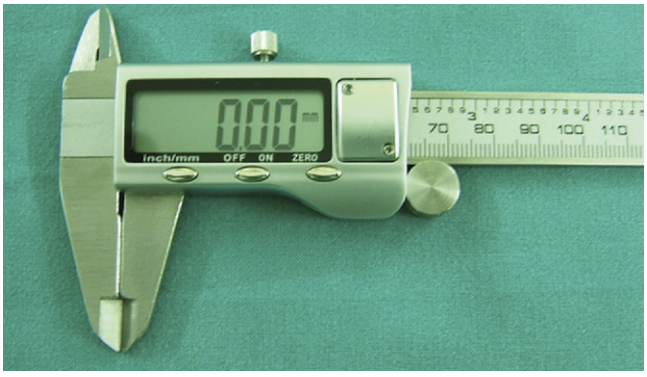

Figure 1. Digital caliper used to take measurements

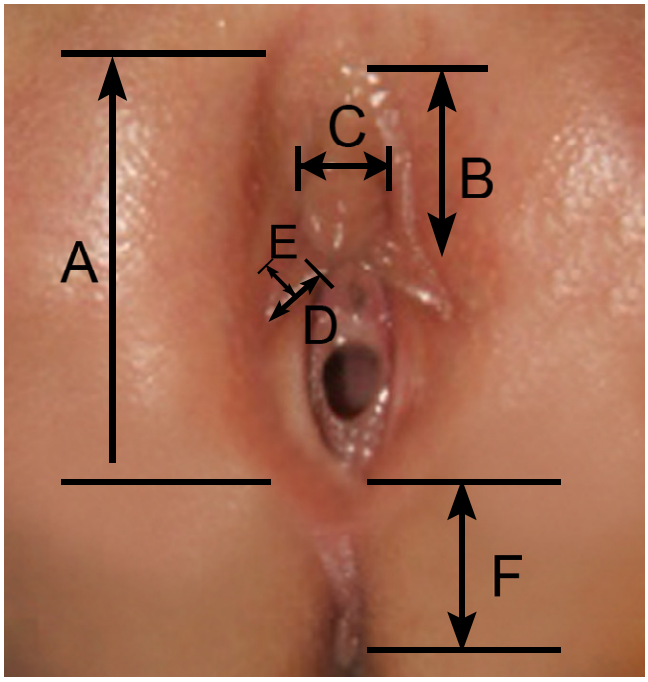

Figure 2. Measurement points. *A,* length of labia majora. *B,* length of clitoris. *C,* width of clitoris. *D,* length of labia minora. *E,* width of labia minora. *F,* perineal distance.

Least mean square is one of the most commonly used methods in smoothing reference centile curves. Its parameters consist of Box-Cox power, mean or median and coefficient of variation.[3] A Box-Cox power transformation is used to obtain data that closely approximate a normal distribution.[4] The 3 LMS parameters are determined from the smoothened data curves.[5] We organized parameter estimation under age or weight intervals. Specific centiles were generated using the LMS values of specific age points. The 3rd, 10th, 25th, 50th, 75th, 90th and 97th centiles were acquired using the estimated LMS values. Reliability analysis was accomplished using the intraclass correlation analysis on remeasurements taken by the first author from 20 patients.

RESULTS

Specific equations were generated using measurements taken for height, body weight, clitoris length, clitoris width, labia majora length, left and right

Table 1

External Genital Structure	Equation
Clitoris length	7.710 mm + (1.087 × yrs age)
Clitoris width	4.624 mm + (0.135 × yrs age)
Labia majora length	13.477 mm + (0.492 × kg body wt) + (0.147 × cm ht)
Labia minora length	6.198 mm + (0.231 × kg body wt)
Labia minora width	3.20 mm + (0.089 × kg body wt)
Perineal distance	10.314 mm + (0.230 × kg body wt)

labia minora length and width, and perineal distance to estimate the expected external genital structure dimensions in girls (table 1). A multiregression table explaining the equations was prepared (table 2). Furthermore, length of labia majora vs body weight, length of labia majora vs height, length of labia minora vs body weight, width of labia minora vs body weight, clitoral width vs age, clitoral length vs age and perineal distance vs body weight reference percentile curves were prepared (figs. 3 and 4).

All measured parameters showed an increase in linear correlation with the advance of age, height and body weight. Furthermore, age was determined to be the most important factor affecting clitoral length and width. While age and height were the most influential factors affecting labia majora length, body weight appeared to be the main factor influencing labia minora dimensions. Body weight was also the factor that most influenced perineal distance. Although measurements of right and left labia minora dimensions differed in 25% of the patients, this difference was not statistically significant ($p > 0.05$). Therefore, we generated an equation involving only 1 labium minus dimension. Reliability analysis accomplished using the intraclass correlation analysis on remeasurements taken from 20 patients was 0.96 to 1.00 for all measurements with 95% CI ($p < 0.001$).

DISCUSSION

The goal of genitoplasty is to achieve a functional and cosmetic outcome, which makes understanding of normal genital anatomy essential for a successful surgical approach. The major factor is the subjective decision of the surgeon, as there are no objective criteria to be used in female genitoplasty. For example the length and width of the clitoris and labium depends on the personal experience and cosmetic perspective of the surgeon.

There are many studies related to the anatomy of external male genitalia. Although a penile percentile study on boys was performed as early as 1942,[6] studies on female genitalia are rare and are mostly limited to clitoral size.[7,8] In fact, no studies on the size of the external genitalia in girls could be identified in the English or Turkish literature.

Studies on adults, except those on the size of the clitoris, are also rare. For example no decision was reached on the 3-dimensional shape of the vagina in a recent study.[9] Similarly the average diameter of the clitoral glans in women, and the length and protrusion of the clitoris in the relaxed and aroused state are not well documented.[10]

To our knowledge there are only 2 studies on the anatomy of external genitalia in women. Schober et al provided a questionnaire to 50 healthy, sexually active women 20 to 56 years old with no history of genital surgery.[10] This self-report questionnaire contained written text and images enabling women

Table 2

Independent Variables	Regression Coefficients (mm)	p Value	Lower 95% CI	Upper 95% CI	R^2
Clitoris length:					
Invariable	7.710	<0.001	6.957	8.463	0.558
Age (yrs)	1.087	<0.001	0.945	1.229	
Clitoris width:					
Invariable	4.624	<0.001	4.356	4.893	0.129
Age (yrs)	0.135	<0.001	0.084	0.186	
Labia majora length:					
Invariable	13.477	<0.001	6.891	20.064	0.586
Kg body wt	0.492	0.004	0.159	0.825	
Cm ht	0.147	0.012	0.032	0.261	
Labia minora length:					
Invariable	6.198	<0.001	4.994	7.403	0.222
Kg body wt	0.231	<0.001	0.168	0.294	
Labia minora width:					
Invariable	3.200	<0.001	2.550	3.850	0.124
Kg body wt	0.089	<0.001	0.055	0.123	
Perineal distance:					
Invariable	10.314	<0.001	9.305	11.324	0.287
Kg body wt	0.230	<0.001	0.177	0.284	

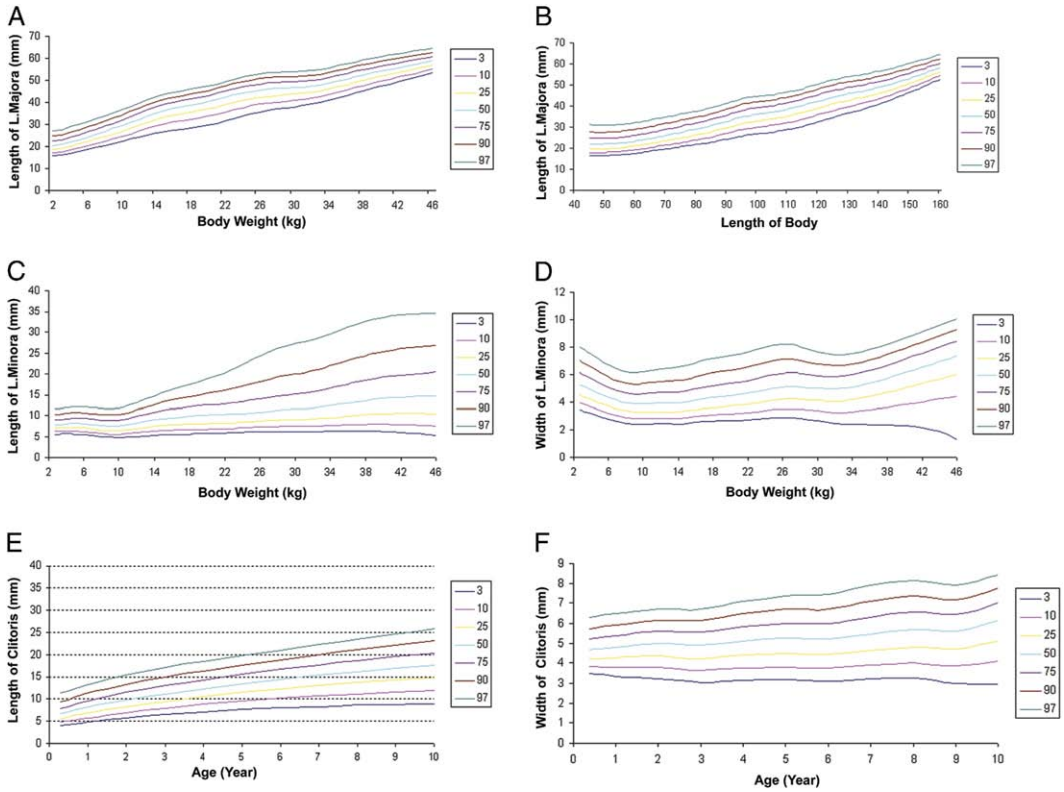

Figure 3. *A,* reference percentile curves for length of labia majora vs body weight. *B,* reference percentile curves for length of labia majora vs height. *C,* reference percentile curves for length of labia minora vs body weight. *D,* reference percentile curves for width of labia minora vs body weight. *E,* reference percentile curves for clitoral length vs age. *F,* reference percentile curves for clitoral width vs age. *L,* labia.

to rate the appearance, size and position of the clitoris and vagina, as well as the intensity of orgasm and effort required to achieve orgasm in specified areas around the clitoris and within the vagina. Only 46% of women reported that the clitoris had a moderate size and was raised. Other responses were small and raised, large and slightly long, large, raised or very long.

A study by Lloyd et al involved examination and measurement of 50 women.[11] This study revealed that there is far greater diversity than previously documented regarding labial and clitoral size, color and rugosity, vaginal length and urethral position.

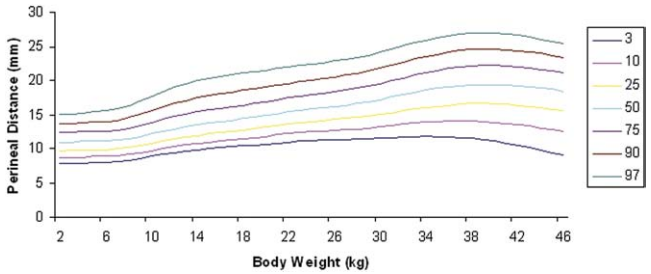

Figure 4. Reference percentile curves for perineal distance vs body weight.

In our study we measured the clitoris length, clitoris width, labia majora length, left and right labia minora length and width, and perineal distance. Similar to the 2 studies in women, significant variations existed in the measurements of the external genital organs despite similar body parameters among children of the same age. For example while a 9-year-old girl (height 143 cm, weight 36 kg, BMI 17.6) had a clitoris size of 2.5 mm, another 9-year-old (height 130 cm, weight 24 kg, BMI 14.2) had a clitoris size of 23.62 mm. Similarly the right and left labia minora sizes differed, although this difference was not statistically significant. As an example of variability, the respective lengths of the right and left labia minora of a 2-year-old patient were 9.51 and 5.54 mm, and the widths were 3.05 and 1.38 mm (fig. 5). Therefore, we determined that the right and left labia minora differed in size and were asymmetrical not only among patients of the same age group, but also within the same patient.

This variability has also been noted by some surgeons.[12] Such differences do not constitute an anomaly, but reflect the variability of external anatomical structure measurements. A comparison of data was not possible, as similar studies are not present in the English and Turkish literature. This variability

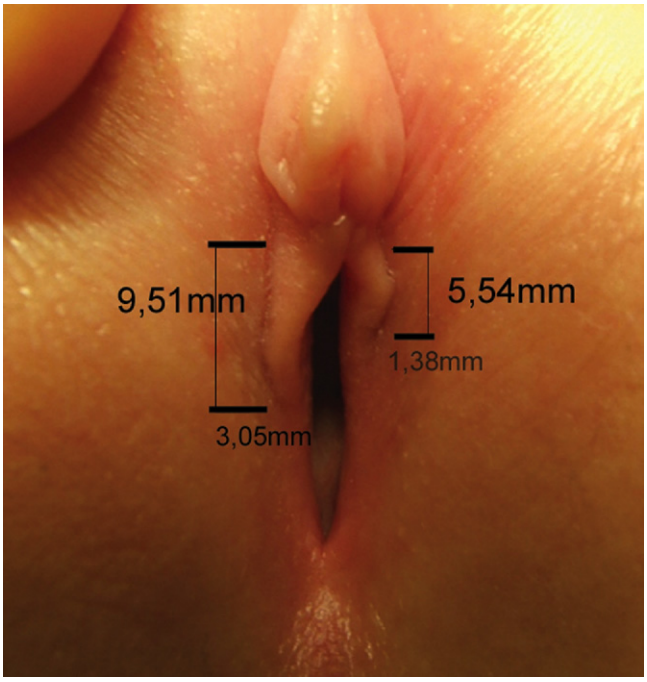

Figure 5. Size difference between right and left labia minora in same girl.

should be considered during surgical reconstruction, and size related issues should be evaluated from a wider perspective, considering the existence of such variability.

Studies have demonstrated little or no change in the clitoris length throughout infancy and, therefore, it is possible to use the neonatal standards throughout infancy.[13] However, in our study there was a statistically significant difference even between the clitoris lengths of patients 1 to 12 months old and 12 to 24 months old. This finding suggests a need to develop separate standards applicable to neonates or patients 0 to 1 year vs 1 to 2 years old.

The penis/clitoris measurement studies in the literature show variability between measurements and among researchers, and suggest the need for a uniform measurement method.[14] In this study all measurements were made by the first author to avoid interobserver variability.

The difficulty of taking a genital measurement in an awake child is a limitation of this study. Initially measurements in awake children were planned so that measurements could be taken in a greater number of patients. However, due to the intensive genital examination that is required for accurate measurement (within 0.01 mm) and the discomfort that was expressed, it was considered not in the best psychological or ethical interest of patients or their families to continue while awake. Therefore, all measurements for this study were obtained while the children were under general anesthesia. Another benefit of having the patient under general anesthesia is the absence of clitoral erection, especially in older children.

Awareness of childhood genital standards not only should contribute to reconstructive surgical procedures, but also should be helpful in the diagnosis and followup of patients with disorders of sex development. Most patients with congenital disorders of sex development are diagnosed in the neonatal period based on an ambiguous genitalia appearance (clitoromegaly, micropenis/macropenis, hypospadias). However, mild or late onset cases that were missed during the neonatal period could subsequently present during infancy or later. Therefore, awareness of the genital standards appropriate for each age group is important.

CONCLUSIONS

The equations and percentile curves presented can be used as guides in prospective feminizing genitoplasty. Furthermore, patients and their families can be informed on the variability of external genitalia dimensions. This information should ensure a healthier appreciation of the postoperative genitalia by patients and their families. Further studies including larger cohorts would enable the development of more sensitive equations and percentiles. Additionally since our study was conducted only in Turkish girls residing in Turkey, measurements from other countries are needed to evaluate racial differences.

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