

Morphofunctional Characteristics of the Hymen in Girls of the First and Second Childhood Age Groups Among Uzbek Population

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Abstract The results of forensic medical examinations of 84 girls from the Uzbek population belonging to the age categories of the first childhood (4-7 years) and the second childhood ages (8-11 years), who were permanent residents of the Surkhandarya region of the Republic of Uzbekistan, were analyzed. The geographic zone of this region differs from other areas by its relatively warm climate, and the entire territory belongs to the hot arid zone. It was established that the morphofunctional state of the hymen in girls of the first childhood (4-7 years) in the Uzbek population was characterized by annular, crescent-shaped, and oval-rounded forms, with a less elastic and almost non-stretchable consistency. In girls of the second childhood (8-11 years), the hymenal morphology was represented by annular, oval, rounded-oval, and crescent-shaped forms, with a slightly stretchable consistency. Mean hymenal parameters in girls of the first childhood were as follows: wall height - 0.4 ± 0.02 (medium height), wall thickness - 0.1 ± 0.01 (thin), and hymenal orifice diameter - 1.0 ± 0.05 (small). The same parameters in group of girls of the second childhood were: hymenal wall height - 0.4 ± 0.02 (medium height), wall thickness - 0.2 ± 0.01 (thin), and natural orifice diameter - 1.15 ± 0.08 (medium).

Keywords Girls, Uzbek population, First and second childhood, Hymen, Morphofunctional state, Metric parameters, Diagnostics, Significance, Expert evaluation

1. Introduction

The study of the morphofunctional state of the hymen (virginal membrane) and the determination of its integrity is of decisive importance in consideration of cases related to sexual assaults and indecent acts. Furthermore, the assessment of hymenal morphology has significant medicolegal and sociocultural implications for the development of national normative standards. In this regard, the establishment of anatomical forms and morphological characteristics of hymen at different ages of girls and across various populations represents a national necessity.

The morphofunctional state of hymen exhibits considerable variability depending on degree of growth and development of girls and plays an important role in preparation of forensic medical reports on disputed sexual conditions and crimes against sexual freedom. Unfortunately, the morphofunctional characteristics of hymen at different stages of childhood are

insufficiently described in literature, or presented in a highly fragmented manner [12]. Moreover, current rules and standards of forensic medical examination in the Republic of Uzbekistan practically do not take into account its morphofunctional features in relation to age-specific developmental categories of girls [5,3].

Aim of the study is systematization of the morphofunctional properties of hymen and determination of its metric parameters in girls of the Uzbek population within the age categories of the first and second childhood.

2. Materials and Methods

A literature review about morphofunctional characteristics of the hymen in relation to the stages of growth and development of girls was carried out. In addition, the results of forensic medical examinations (FME) of 84 girls from the Uzbek population within the age categories of the first childhood (4-7 years) and the second childhood (8-11 years) were analyzed. The examinations were conducted basing on rules issued by judicial-investigative authorities and upon requests from parents of children. Examined girls were permanent residents of the Surkhandarya region of the

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Republic of Uzbekistan, a territory distinguished from other regions by its warm climatic conditions, with the entire area belonging to hot arid zone. Age categories of the girls were established in accordance with international recommendations and the biological age periodization of humans [2].

Anthropometric assessment, body constitution and nutritional status, as well as the degree of development of secondary sexual characteristics and external genitalia, including the nature of genital and extragenital injuries were determined during the FME. The study of the morphofunctional properties and metric parameters of the hymen was conducted in accordance with the criteria outlined in the morphofunctional classification by A.N. Samoylichenko (1994) and in compliance with Appendix No. 3 to Order No. 153 of the Ministry of Health of the Republic of Uzbekistan dated June 2, 2012 [4,3].

With parental consent, digital photographs of the hymen were obtained using a calibrated scale ruler for forensic documentation [1]. The metric parameters were subjected to statistical processing on a personal computer.

3. Results and Discussion

Embryologically, the hymen develops from the urogenital sinus, specifically from the Müllerian duct and the sinovaginal bulb at approximately the 12th week of gestation. By the third month of pregnancy, it fuses with the paramesonephric duct, forming the vaginal plate and subsequently the vaginal lumen. However, the caudal portion of the duct, distant from the cavity of the urogenital sinus, remains free, which is referred to as the virginal membrane (hymen).

The external appearance of external genitalia and hymen depends on age, constitutional, hormonal, and socio-ethnic factors, and varies considerably at different stages of female life. In newborns, hymen has a superficial location and is richly vascularized. Maternal hormones transferred through the placenta exert a pronounced stimulatory effect on tissues sensitive to estrogens. This is particularly evident in the hymenal tissue, which becomes bright red, thickened, protruding, and swollen. Such stimulation persists for more than a month. Subsequently, infant's hypothalamic-pituitary-gonadal system becomes activated, producing gonadal estrogens, thereby suppressing further stimulation of hymen. As a result, by 2-4 years of age, hymen becomes thin, atrophic, and highly susceptible to trauma. Between the ages of 7-11 years, the hypothalamic-pituitary-gonadal axis is reactivated, leading to thickening of hymen and an increase in the size of hymenal orifice. By the age of 9-13 years, estrogen-sensitive tissues acquire mature characteristics, and hymen becomes thickened, elastic, and capable of stretching. Menstrual bleeding typically begins during this period [14,11,7,17,15,10].

There are highly variable anatomical forms of hymen. The most common types include annular, crescent-shaped (semilunar), septate, redundant (labial), cribriform (with multiple orifices), fimbriated (dentate), and imperforate (without a natural opening). The imperforate hymen may

occur at any age, but is most frequently observed in newborns. The crescent-shaped (semilunar) form is more prevalent in prepubertal period, where hymenal wall in the region corresponding to 11 to 1 o'clock on the clock face is absent. The labial form is most often observed in highly affected by estrogen women and is characterized by abundant tissue [16]. According to Al-Khateeb N.G.H. et al. (2023), the most frequent hymenal type was annular – 60 cases (47.2%), followed by horseshoe-shaped – 44 cases (34.5%); the least frequent were crescent-shaped – 3 cases (2.4%) and imperforate – 1 case (0.8%). Hymens of medium thickness constituted a large proportion of observations – 59 out of 127 cases (46.5%) [8].

It is also important to establish the value of transhymenal diameter for further evaluation of the morphofunctional state of hymen. In the examination of 105 girls of pubertal age (from 6 months to 10 years), it was determined that the transhymenal diameter averaged 2.3 mm with an annual increase of approximately 1 mm [19]. Similar data were reported by Berenson A.B. et al. (2000).

The depth of the hymenal location may vary from 1.5 cm to 4.6 cm (in obese women) above the vaginal surface. Hymen does not contain glandular or muscular elements and, in adults, represents a relatively avascular membrane [13]. Hymenal membrane is considered thin if its thickness is less than 1 mm, as observed in prepubertal children, can be considered medium in cases of thickness is about 2 mm, and considered to be thick in cases of thickness exceeding 2 mm. Hymen may be elastic (stretchable) or less elastic. Hymenal orifice may be relatively narrow or reach up to 4 cm in diameter. Openings of medium size are frequently observed – 45 out of 127 cases (35.4%), whereas large and narrow openings accounted for 37 (29.1%) and 35 (27.6%) cases, respectively. The annular form of hymen of thin consistency, with a narrow orifice and a smooth free edge, is characteristic in younger girls. Changes in hymenal thickness, form, and orifice size, as well as other characteristics, may occur with age-related development. However, as emphasized by several researchers, measurement of hymenal orifice size has no forensic significance for the evaluation of its condition. This is explained by the fact that various disorders, such as vaginismus-described as recurrent or persistent involuntary spasm of the muscles of the outer portion of the vagina-may influence vaginal orifice size [18]. In our opinion, however, the size of the natural hymenal orifice should be documented in the forensic medical report.

Results of our research demonstrated that girls of the Uzbek population in the age group of first childhood (4-7 years) were characterized by body height ranging from 75.0 cm to 126.0 cm (mean 111.0 ± 1.70 cm, most frequently 105.0 ± 1.70 cm, $p \geq 0.001$) and body weight ranging from 11.0 kg to 30.0 kg (mean 22.0 ± 0.71 kg, most frequently 18.0 ± 0.71 kg, $p \geq 0.01$). In girls of the second childhood category (8-11 years), these parameters were as follows: body height from 110.0 cm to 150.0 cm (mean 136.0 ± 1.56 cm, most frequently 141.0 ± 1.56 cm, $p \geq 0.003$) and body weight from 19.0 kg to 56.0 kg (mean 38.0 ± 1.42 kg, most

frequently 36.0 ± 1.42 kg, $p \geq 0.07$). The development of secondary sexual characteristics generally corresponded to chronological age. The labia were elastic and anatomically well-formed. The mucosa of the vestibule, in the absence of trauma, demonstrated a uniform pinkish-red color. No developmental anomalies or signs of disease were identified.

Extragenital injuries were found in 8 girls of the first childhood group, represented by contusions of oval or elongated shape measuring 1.5x0.8 cm to 3.5x1.0 cm on the anteromedial surfaces of the thighs and shoulders, as well as abrasions of linear or semilunar shape measuring 2.5x0.2 cm to 3.5x0.5 cm located on the forearms, knees, and the anterolateral and medial surfaces of the thighs. Contusions of 1-2 days' duration were violet-bluish or bluish-purple with edema, by days 3-5 they were bluish with a yellow-greenish hue and without edema, by days 8-9 they became pale yellow with indistinct borders. Abrasions of 1-2 days' duration had delicate reddish crusts, by days 3-5 the crusts became denser, pale-reddish, and elevated above the skin surface, by day 9 the crusts had detached, leaving smooth pale-pink surfaces barely distinguishable from adjacent intact skin.

Injury to genital tissues was found in 6 girls of the first childhood group, including submucosal hemorrhages, mucosal lacerations of the vestibule with hemorrhage ($n=2$), and lacerations of the posterior commissure extending to the perineum ($n=2$). Submucosal hemorrhages identified one day post-trauma were dark red, measuring 0.1x0.3 cm to 1.0x2.0 cm, accompanied by pronounced edema and tenderness. In one girl examined on the 5th day post-trauma, hemorrhages were pale reddish with minimal edema and no pain. Lacerations of the posterior commissure on day 2 post-trauma ranged from 0.1x0.4 cm to 3.0x0.3 cm, characterized by minor bleeding from the wound base, markedly edematous dark-red margins, and surrounding hemorrhagic foci. By day 5, signs of tissue regeneration with significant reduction of edema and faint pale-red hemorrhages were observed.

In 6 girls of the second childhood group, extragenital injuries were identified, including contusions on the posterior surface of the right shoulder, anterior and right lateral surfaces of the neck, anterior surface of the leg, left buttock, and anterolateral chest, measuring 1.5x1.0 cm to 3.5x1.5 cm, mostly oval or elongated-oval in shape. Abrasions were also found on the face, scapular region, dorsum of the hands and fingers, of linear, semilunar, or irregular shape, ranging from 0.8x0.1 cm to 4.0x0.5 cm. Contusions of one day's duration appeared violet-pink, on days 2-3 violet-bluish, by days 3-5 bluish with greenish-yellow hues, by days 6-8 greenish-bluish, and by days 9-10 pale yellow with indistinct margins.

Genital injuries were documented in 2 girls of the second childhood group in the form of submucosal hemorrhages: in one case at hymenal base in the right lateral segment, and in another in the posterior navicular fossa, measuring 1.3x0.3 cm and 0.8x0.5 cm, respectively, both dark red with marked edema (one day post-trauma).

The morphofunctional state of hymen in girls of the first childhood group was characterized by annular ($n=17$), semilunar ($n=11$), and oval-round ($n=7$) forms, with low

elasticity and minimal distensibility. Free margin of the hymen was smooth in most cases, although in some instances waviness or shallow natural notches with smooth thin edges were observed.

Hymenal wall height ranged from 0.25 cm to 0.7 cm (most frequently 0.5 ± 0.02 cm, $p \geq 0.04$), thickness from 0.1 to 0.35 cm (most frequently 0.1 ± 0.01 cm, $p \geq 0.02$), and natural orifice size from 0.15 to 1.3 cm (most frequently 1.0 ± 0.05 cm, $p \geq 0.1$).

In the second childhood group (8-11 years), hymenal morphology was represented by annular ($n=23$), oval ($n=12$), oval-round ($n=8$), and semilunar ($n=6$) forms.

Hymenal wall height varied from 0.15 cm to 0.9 cm (most frequently 0.3 ± 0.2 cm, $p \geq 0.03$), thickness from 0.1 to 0.5 cm (most frequently 0.2 ± 0.01 cm, $p \geq 0.02$), and natural orifice size from 0.1 cm to 1.65 cm (most frequently 1.2 ± 0.08 cm, $p \geq 0.15$).

It should be noted that the state of free hymenal edge was not consistently described in forensic reports. In some cases, the edge was noted to be smooth, wavy, or with natural notches at the 2, 3, 4, and 5 o'clock positions, with smooth margins. Based on these descriptions, hymen in these girls appeared poorly distensible and less elastic.

According to Abdullah S. Al Herbish (2001) of King Khalid University Hospital and the National Guard Hospital of Saudi Arabia, who examined hymenal morphology of 345 full-term neonates aged 1-3 days, 60% ($n=207$) had an annular hymen, 22% ($n=76$) sleeve-like (a subtype of annular), 12.5% ($n=43$) fimbriated, 4.9% ($n=17$) semilunar, and 0.6% ($n=2$) other forms. The author emphasized racial variability in hymenal configuration and noted that in absence of estrogenic influence at older ages, hymenal forms may undergo transformation, such as conversion of annular types into semilunar [6].

In our observations, as noted above, in girls of the Uzbek population during first childhood (4-7 years), annular, semilunar, and oval-round hymenal forms were nearly equally represented. In the second childhood group, annular and oval types predominated over semilunar and oval-round forms.

According to A.N. Samoylichenko (1994), hymenal evolution is age-dependent. In girls under 1 year, hymen has a ridge-like form with a rounded edge (height 0.2-0.3 cm, thickness 0.25 cm, orifice diameter ~0.5 cm). At 1-3 years, average height is 0.32 cm, thickness 0.23 cm, orifice 0.54 cm, occasionally up to 0.9-1.0 cm. By 7-11 years, height ranges from 0.2-0.8 cm, orifice 0.5-1.3 cm, though distensibility may allow up to 2.0-2.5 cm. At 12-15 years, mean height is 0.6 cm, thickness 0.23 cm, orifice diameter 2.93 cm (sometimes up to 3.2 cm). At 16-18 years, mean height is 0.62 cm, thickness 0.22 cm, and orifice ~2.20 cm. The author recommends describing hymen in 12-16-year-old girls by the following parameters: height (high >0.5 cm, medium 0.4-0.5 cm, low <0.4 cm), thickness (thin <0.25 cm, thick ≥ 0.25 cm), distensibility (slight, moderate, marked), elasticity (slight, moderate, high), and orifice size (large >2.5 cm, medium 1.5-2.5 cm, small 0.5-1.5 cm), along with margin configuration [4].

In our study, mean hymenal parameters in Uzbek girls of first childhood were: wall height 0.4 ± 0.02 cm (medium), thickness 0.1 ± 0.01 cm (thin), orifice diameter 1.0 ± 0.05 cm (small). In second childhood, the parameters were: wall height 0.4 ± 0.02 cm (medium), thickness 0.2 ± 0.01 cm (thin), and orifice diameter 1.15 ± 0.08 cm (medium).

4. Conclusions

1. Determining the morphofunctional characteristics of hymen has important medical, legal, social and cultural implications for the development of national standards. Accordingly, establishing its anatomical forms, morphologic properties, and metric parameters across different age groups and populations is a national necessity;
2. In Uzbek girls of first childhood (4-7 years), hymen was most commonly annular, semilunar, or oval-round in shape, with low elasticity and minimal distensibility. In the second childhood group (8-11 years), annular, oval, oval-round, and semilunar forms were observed, generally with low distensibility;
3. Mean hymenal parameters in the first childhood group were: wall height 0.4 ± 0.02 cm (medium), wall thickness 0.1 ± 0.01 cm (thin), and orifice diameter 1.0 ± 0.05 cm (small). In the second childhood group, parameters were: wall height 0.4 ± 0.02 cm (medium), thickness 0.2 ± 0.01 cm (thin), and orifice diameter 1.15 ± 0.08 cm (medium);
4. Represented data may be applied in forensic evaluation of hymenal status in the specified age groups, as well as in the development of national regulatory guidelines.

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