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Function of the human hymen

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Abstract — The few existing hypotheses for the function of the human hymen are weak. These are briefly reviewed, and a new hypothesis is proposed. We suggest that the appearance of the juvenile human hymen is based on 'premature' birth, following which infant helplessness and a subsequent advantage for vaginal protection from external sources of infection allowed natural selection to increase its persistence well into juvenile life.

Humans are unique members of the primate group, with males and females possessing sexual characteristics different from other hominoids (apes). Still not satisfactorily explained are concealed ovulation (1,2) permanent breast (3–6) and the lack of a baculum (7). Although noted often, another sexual structure has no satisfactory explanation. According to most sources, human females are the only animal to possess a hymen (2,5,8), but abnormal occurrences in a heifer (9) and a spaniel (10) have been reported. Hymens have been reported in African elephants, where in fact the hymen is not broken by mating, but only during birth (11).

The function of this structure is unknown (12,13), and the few explanations, upon critical consideration, are largely unsatisfactorily. This paper examines the existing hypotheses for the likely function of this unique structure and proposes a more plausible explanation.

Male and female reproductive systems develop from the same embryological precursors, and each part has a homologue in the other sex (14). Explanations for male nipples have been based on these similarities (15). Human male and female external genitalia are the same at 5–6 weeks of embryological development (8). Only after 4 months, under the influence of androgens, do the genitals of the male fetus become unmistakably distinguishable from a female fetus. Until late in a female's fetal life, the lumen of the vagina is separated from the cavity of the urogenital sinus by the hymen. During the perinatal period it ruptures and remains as a fold of mucous membrane around the entrance to the vagina. Failure of the inferior end of the vagina to perforate results in blockage of the vagina, and the condition known as imperforate hymen (14). A fetal hymen is expected in other animals with similar developmental sequences. We predict the discovery of a hymen at least in the fetuses of other primates.

In normal human infants the hymen remains as a membranous partition, variable in shape and size, surrounding the vaginal orifice. It takes a variety of forms, but is typically circular or crescentic. Occasionally, it may be multiple, lacking or imperforate (8,14). It occurs in all normal newborn infants but is much varied in form (16). The degree of closure is often reduced by 1 year of age, with annular often becoming crescentic (17). It may be structured

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by activities other than sexual intercourse, but traditionally it is believed that first intercourse breaks the hymen, causing female pain and bleeding (18). There is no evidence for juvenile hymens in any of the great apes (5), which suggests that it originated in the hominid line. This delicate membrane has no known physiological function, but its psychological and cultural significance as a sign of virginity has been enormous (8).

Few hypotheses have been suggested for the function of the hymen. It is important to remember in evaluating these existing hypotheses that the current usage of a structure does not require that it was evolved for that purpose. Such co-option of existing structures for a new purpose has been termed exaptation (19).

Sexual selection by males is one existing hypothesis for the evolution of the hymen. In many societies virginity of wives is highly desired and even demanded. Virginity tests to ensure the hymen is intact and ritual defloration prior to marriage (8) led Smith (5) to suggest that in this way males can be sure of the partner's virginity. Dickemann (unpublished manuscript cited in ref. 5) supports this view and suggests that selection could operate against 'non-virgin' females (or those lacking a hymen) in such cultures. Indeed, among the Yungar people of Australia, girls without intact hymens before marriage were starved, tortured, or even killed (8). Selection on females at this level, however, does not account for the initial appearance and increase in frequency of the trait, and is most likely an example of exaptation.

A second hypothesis stems from Morgan's (20) suggestion that humans have an aquatic past (see also ref. 21) with the hymen evolving to protect the vagina from marine 'pollution', perhaps in an analogous fashion to the ear coverings in true seals. Her explanations for the lack of complete coverage and obvious loss of protection following sexual maturity are weak; she suggests incomplete evolution for the first problem and that any advantage is preferable for the second.

The hymen has also been proposed as a structure that will increase the retention of sperm and hence raise fertilization success. This seems very unlikely as even if the hymen remained during sexual maturity in humans, the pool of sperm is still far from the site where fertilization occurs.

We propose instead, that the hymen is an embryological structure that has been retained into the juvenile period. The change to upright posture and concomitant reduction in the size of the birth canal led to a shorter gestation period for human infants relative to the apes (1,22,23,24). Following this change to 'premature' birth, the hymen remained in newborn infants, and natural selection extended the persistence of this structure into childhood and beyond.

With the greater helplessness of human infants relative to other great apes (23,25), infection due to inability to clean the vaginal area may be a significant cause of mortality. Thus any structure that limited fecal or other material from entering the vagina would be favored by natural selection. The hymen, persisting into infants, has thus been exapted to serve a protective function. Because of range of conditions of hymen expression exist, natural selection can act to select for hymen-possessing females. The advent of clothing such as swaddling cloths may be a factor in reducing the ability for natural or self cleaning. The hymen would lower the infection rate and influence fitness of those females retaining the hymen for longer periods. Given the number and frequency of adult vaginal infections (8) any additional protection, even in infants, should be an advantage. In addition the self-cleaning ability of the pre-pubertal vagina is less developed than in mature females (S. Horowitz, pers. comm.), further enhancing the need for vaginal protection. Examination of the infection level in infants with intact versus non-intact hymens would be valuable in supporting or rejecting this hypothesis. Some additional support for the importance of protection is the retention of the labia majora in human females. In non-human female primates, the labia majora are much reduced after the infant-juvenile period (26,27). This retention may enhance protection of the genital tract (28).

The existing sexual selection hypothesis, which allows males to determine non-virgin females, and other cultural practices, may also act to increase the fitness of those females with hymens. It would be of interest to determine the extent to which the hymen is developed due to culture. For example, in societies which value an intact hymen, it may be more developed than in societies with little or no interest in the structure. Climate may also play a role; in warm climes where infants require no clothing, risk of infection may be less than in cooler areas with swaddled infants, and thus the selection for a juvenile hymen weaker. Such correlations would allow the relative contribution of the protective and cultural function hypotheses to be evaluated.

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