Genital Injuries Resulting from Sexual Abuse: A Longitudinal Study

John McCann, MD, Joan Voris, MD, and Mary Simon, MD

ABSTRACT. Three children who incurred genital injuries as a result of sexual assaults were followed up on a longitudinal basis to document the anatomical changes which ensued. The subjects, who were 4 months, 4 years 5 months, and 9 years of age, were followed up for periods ranging from 14 months to 3 years. A multi-method examination approach and a 35-mm camera mounted on a colposcope were used to examine and record their injuries. Signs of the acute damage disappeared rapidly, and the wounds healed without complications. Following the resolution of the acute injuries, the changes created by the trauma remained relatively stable throughout the prepubertal years. The most persistent findings were irregular hymenal edges and narrow rims at the point of the injury. Over time the jagged, angular margins smoothed off. Disruption of the hymen exposed underlying longitudinal intravaginal ridges whose hymenal attachments created mounds or projections. There was little apparent scar formation. Even the injuries to the posterior fourchettes healed with minimal scar tissue and left only the slightest evidence of the trauma. With the onset of puberty, the hymenal changes in the oldest subject were obscured by the hypertrophy of this membrane. An examination technique which used a Q-tip to separate the redundant tissues demonstrated that the signs of trauma had survived. Pediatrics 1992;89:307-317; child sexual abuse, hymen, sexual abuse, prepubertal genital injuries, healing process.

The medical profession’s recent interest in the anatomy of the prepubertal girl’s genitalia has been generated by the dramatic increase in the number of reported cases of sexually abused children. In increasing numbers, health care providers are being asked by concerned parents and members of child protective agencies to make a determination as to whether or not there is physical evidence of sexual molestation. Until recently, physicians performing these evaluations had to rely on either their own experience or reports of findings of children who were suspected of having been sexually abused. Although this information was valuable, examiners were handicapped by the lack of information available as to what constituted “normal” genital anatomy.1-5 Because of several recent articles in medical publications, that problem is being remedied.6-10

Two major pieces of information still missing are how the healing process of an injury affects the genital anatomy of the prepubertal girl and whether signs of trauma persist after the onset of puberty. Except for an article on the unusual development of an imperforate hymen secondary to formation of scar tissue following a sexual assault,11 a follow-up study which found a decrease in the size of the hymenal orifice in girls who had been molested previously12 and an account that dealt primarily with adult women who had been abused sexually,13 there is only one study which followed up children with anogenital injuries on a longitudinal basis, and the longest any child was followed up in that report was 3 months.14 Detailed information about the changes which occur as a result of trauma to the anogenital region is an essential ingredient in the ability to be able to predict accurately the outcome of a wound, speculate as to its cause, or estimate the time interval since its occurrence. Although the following three cases will not provide all those answers, they will add to the body of knowledge regarding the healing process of these injuries.

METHODS

Three girls were selected from a group of 14 subjects who were participants in a project designed to determine the effect of the healing process on anogenital injuries. This project, approved by the Human Subjects Review Committee followed up, on a longitudinal basis, children who acquired a single acute anogenital injury from either an accident or a sexual assault. All 14 subjects were girls whose ages ranged from 4 months to 12 years. One half of the subjects were white and one half were Hispanic.

All evaluations of the children were performed by a member of the Childhood Sexual Abuse Evaluation Team from a county-sponsored teaching hospital. As part of the project, a complete history was obtained, a physical examination was performed, and cultures for sexually transmitted disease were collected if indicated. A cryomedics Magnavari 4000 colposcope with an attached 35-mm Olympus camera was used to evaluate the genitalia and to record the findings. The colposcopic photographs were analyzed by members of the Childhood Sexual Abuse Evaluation Team during regular case review sessions. A previously described method was used for recording the hymenal anterior-posterior (vertical) and lateral (horizontal) orifice diameters.15

Cases of sexual abuse were reported to a law enforcement agency and/or to a Department of Social Service’s child protection unit and appropriate evidential specimens collected. If the injury was extensive, a gynecologist was consulted. All families with abused children were encouraged to take advantage of the counseling services which were available.

The enrollment for the project occurred during one of the follow-up examination sessions. After rapport had been established and the child’s medical needs cared for, the parents and older children were given an explanation of the purpose of the study. Those who agreed to participate were asked to sign a consent form. They were told that they could withdraw from the study at any time and still continue to receive their care at the Center. An attempt was made to reschedule the children at intervals of 24 hours, 62 hours, 1 week, 3 weeks, 6 weeks, 3 months, 6 months, 12 months, and then annually. The families were compensated $25.00 for their travel.
CASE REPORTS

Patient 1
A 4-month-old female infant was sexually assaulted by her father. The mother, after discovering her daughter’s diaper soaked in blood, took her to the local hospital where she was examined and treated. An actively bleeding laceration, that extended from the posterior fourchette through the vaginal ring, was repaired with four 6-0 Vicryl sutures under general anesthesia. The vaginal wall was not injured. The child was examined with a colposcope for the first time on the third post-assault day. Eventually she was examined five times during a 14-month period. Cultures were negative, and her injuries healed without complications.

Patient 2
A 4 1/2-year-old girl was examined in the emergency department within several hours after a sexual assault. She was alert and in no acute distress. Vital signs were stable, and although there was blood on her dress and legs, no evidence of active bleeding was noted. Surgical repair was not required. The initial colposcopic examination was performed the following day in the Child Sexual Abuse Evaluation Team occurred on the third post-assault day when her injuries were photographed (see Fig. 21). This presented a small band of scar tissue that formed adjacent to a hymenal transection in the 9 year old (Fig 21). This was a result of the healing process of the children's anogenital injuries, which resulted from the trauma quickly subsided. The erythema and edema noted in the hymen of both the 4 month old and 9 year old 3 days after their assaults were gone by the time they returned at 18 and 11 days, respectively (see Figs 1 and 19). The submucosal hemorrhage in the 4 year old had disappeared by the time she was re-examined 27 days later (see Figs 10 and 11). Because of the difference in the type of injury, the tissue changes in the 4 year old had a unique appearance. Unlike the wounds in the other two children, her hymenal injury was only a partial transection and did not result in an irregular, jagged border. Although the membrane on either side of the laceration did not separate initially (see Fig. 9), when it did part, there was no evidence of a jagged edge, only a narrow rim with a peaked appearance at the point of the transection (see Fig. 11). The smooth, rolled edges along the lateral margins of her orifice were caused by the hymen folding back upon itself. However, in all three children, the tears were located on the posterior rims of their hymens between the 3 and 9 o’clock positions.

The sharp jagged edges of the damaged hymens in both the 4 month old (see Fig 1) and the 9 year old (see Fig 17) gradually smoothed out as healing took place. The injuries in all three children appeared to heal with relatively little scar tissue. An exception was a small band of scar tissue that formed adjacent to a hymenal transection in the 9 year old (Fig 21). This synchiec developed at the junction between the hymen and the wall of the vestibule, not on the hymen itself. The small avascular appearing area noted at the base of the injury in the 4 year old during the knee-chest approach initially was considered to be scar tissue (see Figs 11, 14, and 16). Because it dis-
appeared when the child was in a supine position, it was concluded that this finding was not the result of scar tissue formation.

The injury to the posterior fourchette in the 4 month old infant also healed swiftly. By the time she was 1 year old, this area showed little evidence of prior trauma (see Fig 6). When the 9 year old first was examined with a colposcope 3 days after her assault, she was noted to have a 5-mm long labial adhesion. It is unclear whether the labial adhesion antedated the attack or whether these tissues had adhered in this short period of time.

The hymenal disruptions caused two other findings to emerge. The first was the appearance of small mounds or projections on the edge of the hymen and the second was the discovery of intravaginal ridges attached to these irregularities. These structures were found in all three girls. In the 4 month old, they appeared at the 2 and 9 o’clock positions during the second follow-up examination (see Fig 3). A similar small projection/intravaginal ridge appeared at the 9 o’clock position in the 4 year old after the two halves of the torn hymen separated (see Fig 16). And in the 9 year old, an intravaginal ridge attached to a small projection was noted at the 9 o’clock position during the supine labial traction approach (see Fig 19). The triangular shaped midline mounds located on the anterior vaginal wall of the 4 year old were considered to be anterior vaginal columns, a normal finding (Figs 10 through 13, 15 and 16).20,21

DISCUSSION

It is well recognized that injuries in children tend to heal rapidly.14 The amount of scar tissue that develops apparently depends on whether the wound heals by regeneration or repair.22 The healing of superficial wounds usually progresses through a process of “regeneration” that involves four separate stages. These include thrombosis and inflammation, regeneration of epithelium over the denuded surface, multiplication of new cells, and differentiation of the new epithelium.23 Although this process progresses at a variable rate, a superficial injury will usually be covered again with epithelium at a rate of 1 mm per 24 hours. Wound healing by regeneration may be complete within 48 to 72 hours, while further differentiation of new epithelium may take 5 to 7 days. Final restoration of normal tissue may take up to 6 weeks.22

Deeper injuries usually involve the process of “repair,” which includes the formation of granulation tissue and the subsequent development of scar tissue.22 Injuries healing by repair replace coagulated blood by granulation tissue, which over time causes the wound to contract. Initially, granulation tissue will have a red or “neovascular” appearance. As the wound matures, the vascular and cellular component decreases causing a contraction of the tissues. The tissues then become paler in color and smaller in size. Most scars will mature in 60 days.22

As expected, the injuries to the hymens of the three girls in this report healed rapidly.14 Although scar tissue has been reported as part of the healing process of genital injuries,23,24 there was little evidence of that type of tissue repair in these children. However, other changes did occur with the passage of time. One of the most notable transformations was the “smoothing off” of the irregular edges of the damaged tissues. The jagged hymenal projection in the 4 month old (see Fig 1) became a tag-like appendage (see Fig 6), and the edges of the transection (see Fig 17) in the 9 year old rounded off (see Fig 22) even before the redundancy of her hymen hid it from view. One finding that did persist in all three girls was the narrow hymenal rim at the point of the injury.

As previously recognized, the interpretation of the results of a girl’s genital examination may be influenced by a variety of factors including: age,10,11,12,29-30 hormonal effect,6,23,31 individual variation,6,25-32 state of relaxation,10,11,32,35 time interval between the assault and the evaluation,10,12,24,25,36 as well as the examination technique.6,8,9,15,17,30,37 The results of this study were affected by several of these variables.

Age and the concomitant hormonal effect, proved to be a factor in the evaluation in two of the three subjects. In the 4-month-old infant, the hormonal effect upon the tissues was manifested by a thickened, redundant hymen which hampered the evaluations (see Figs 2 and 4). As this influence waned, the hymenal tissue gradually thinned out and the signs of trauma became more obvious. In an opposite sequence of changes, the hymen of the 9 year old was relatively thin initially, and her injuries were readily apparent (see Figs 17, 19, and 20). As her tissues became thickened and more redundant in response to the onset of puberty, evidence of the transection disappeared into the folds of her hymen (see Figs 23 through 26).

The examination technique utilized during the evaluations also had an effect on the results. The supine labial traction method and the prone knee-choest position were more effective in the identification of the changes caused by the assaults than was the labial separation approach. The labial separation technique failed to separate the edges of the hymen in either the 4 month old or in the 9 year old (see Figs 2, 4, 18). The knee-choest approach was particularly helpful in delineating the transections in the 9 year old while she was in Tanner Stage I of secondary development (see Figs 20 and 22).

Although hymenal orifice size has received a great deal of attention as a parameter for the identification of the abused child, the size of this orifice in these three girls was of relatively little assistance in verifying that an assault had occurred.10,17,33,35,41 The trans-hymenal horizontal measurements obtained during the supine labial separation method were greater than 4 mm in only 4 of 17 examinations (Table 1). Recently, the value of this measurement as a reliable marker has been called into question by the fact that its dimensions can fluctuate as a result of a number of variables.39

The discovery of intravaginal longitudinal ridges in association with mounds or projections on the edge of the hymen appeared to be the result of the disruption of the hymenal membrane. When first discovered, intravaginal longitudinal ridges were thought to be post-traumatic scars or synechiae.1,5,7,16,25 In a recent study of nonabused prepubertal children, these same
structures were found in 90% of the subjects when an attempt was made to look behind the intact hymen.9

The tissue changes which occurred in these children who had been injured in a single isolated assault cannot necessarily be extrapolated to the child who had been sexually misused on multiple occasions. Unlike many of the children who are chronically abused, each of these girls experienced both pain and bleeding. Their injuries on the posterior rim of the hymen were consistent with penile penetration and were not inevitably the same changes which might result from fondling or other forms of sexual molestation.10

In summary, the genital injuries of these children healed rapidly. Over time, the jagged, irregular margins of the hymen created by these acute injuries smoothed out and became difficult to detect without the use of a multimethod examination technique. The changes did remain stable while the children were in Tanner Stage I of secondary sexual development. However, the narrow hymenal rim at the point of the injury, which was a persistent finding, disappeared as the 9 year old entered puberty. The mounds/projections discovered on the lateral edges of the hymen proved to be the attachments to naturally occurring intravaginal ridges and it was their exposure, not their existence, which proved meaningful. Following these single isolated episodes of abuse, the hymenal injuries healed with a minimum of scar tissue formation and even the deep lacerations of the posterior fourchettes left little evidence of the trauma they had suffered. The difficulty encountered in the detection of the signs of injury after healing had occurred served as a reminder of the importance of the history, the subtlety of the changes, and the challenging nature of the medical evaluation of the sexually abused child.

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ILLUSTRATIONS

The following colposcopic photographs were taken at a magnification of 10 X. Unless otherwise specified, the transhymenal measurements are recorded with the anterior-posterior (vertical) measurement first, followed by the lateral (horizontal) dimension.

CASE 1

1st Examination: 3 days post-assault. Age, 4 months.
Fig 1. Supine labial traction: moderate amount of fecal material present. Sutures are visible in posterior fourchette. Hymen is inflamed and edematous with a jagged mound of hymenal tissue adjacent to midline transection (A). Hymenal orifice: 6 mm x 4 mm.

CASE 1

2nd Examination: 18 days post-assault. Age, 5 months.
Fig 2. Supine labial separation: sutures present in posterior fourchette. Redundant hymen covers vaginal introitus. Erythema is no longer present.

Fig 1.

Fig 2.

2nd Examination: 18 days post-assault. Age, 5 months.
Fig 3. Supine labial traction: edema and erythema gone. The jagged edge of hymenal tissue is visible posterior to left labia minora (A). The hymen is thick and redundant with torn portion of hymen opened outward exposing edematous intravaginal ridges (B). The margin is irregular with a notch present at 6 o’clock (C). Hymenal orifice: 6 mm x 6 mm.

Fig 3.
CASE 1

4th Examination: 5 months post-assault. Age, 10 months.

Fig 4. Supine labial separation: superficial dehiscence of posterior fourchette during examination (A). Hymen is thick and redundant, margins are difficult to visualize. Groove in hymen at 5 o'clock is only indication of the presence of the transection (B). Hymenal orifice: 1 mm x 1 mm.

5th Examination: 14 months post-assault. Age, 1 year 7 months.

Fig 6. Supine labial separation: hymen thick and redundant with normal vascular pattern. Former jagged hymenal edge at 5 o'clock now has appearance of a tag (A). Posterior fourchette well healed leaving a faint midline irregular avascular appearance (B). Hymenal orifice: 5 mm x 3 mm.

CASE 1

5th Examination: 14 months post-assault. Age, 1 year 7 months.

Fig 7. Supine labial traction: hymenal notch with narrow rim persists at the 7 o'clock position (A). Hymenal orifice: 6 mm x 4 mm.

4th Examination: 5 months post-assault. Age, 10 months.

Fig 5. Supine labial traction: hymenal orifice appears enlarged as posterior portion of hymen collapses outward. A narrow hymenal rim is now apparent. The jagged irregular margin is now smooth and rounded (A). Intravaginal ridges at 3 and 10 o'clock are exposed but normal in appearance (B). Hymenal orifice: 8 mm x 6 mm.

Fig 6.
CASE 2

1st Examination: 20 hours post-assault. Age, 4 years 5 months.
Fig 8. Supine labial traction: a zone of submucosal hemorrhage present in the fossa navicularis. The hymen is mildly redundant and edematous with a small irregular groove noted at the 5 o’clock position (A). Hymenal orifice: 4 mm x 3 mm.

2nd Examination: 27 days post-assault. Age, 4 years 6 months.
Fig 10. Supine labial traction: the two leafs of the hymen on either side of the previously noted groove have separated creating a larger hymenal orifice. Hymenal rim has an angular appearance with a “V”-shaped configuration at 5 o’clock (A). Hymenal orifice: 6 mm x 4 mm.

1st Examination: 20 hours post-assault. Age, 4 years 5 months.
Fig 9. Prone knee-chest position. A dark narrow linear lesion on the hymen at 11 o’clock marks an incomplete transection of the hymenal membrane (A). Hymenal orifice: 6 mm x 4 mm.
CASE 2

2nd Examination: 27 days post-assault. Age, 4 years 6 months.

Fig 11. Prone knee-chest position: hymenal orifice previously covered by hymen (A). The two flaps of torn hymen are folded back on either side of the transection (B). The margins are smooth except for a small projection at 9 o'clock that forms an attachment to an intravaginal ridge (C). The posterior rim of the hymen is less than a millimeter in width (D). The prominent midline mound anteriorly is an anterior column, a normal variant (E). Hymenal orifice: 7 mm x 5 mm.

CASE 2

4th Examination: 5 months post-assault. Age, 4 years 10 months.

Fig 13. Supine labial traction. Hymenal edges smooth except for small notch at 5 o'clock position (A).

Fig 12. Illustration of Fig 11 showing the area of hymenal orifice previously covered by hymen (A). Note the two flaps of hymenal tissue of either side of the transection which are folded back upon themselves (B) and the exposed intravaginal ridge (C).

Fig 14. Prone knee-chest position. Somewhat peaked appearance to orifice with narrow hymenal rim (A). Projection at 9 o'clock is hymenal attachment of intravaginal ridge (B). Hymenal orifice: 8 mm x 4 mm.
CASE 2

6th Examinatio: 3 years 4 months post-assault. Age, 7 years 9 months.

Fig 15. Supine labial traction: findings similar to examination at 5 years of age. Notch present a 5 o'clock position with angular margin seen at 7 o'clock position (A). Hymenal orifice: 4 mm x 5 mm.

Fig 16. Prone knee-chest position: the peaked appearance of the orifice still present with narrow hymenal rim posteriorly (A). Intravaginal ridge is attached to hymen at the 9 o'clock position (B). The vascular pattern remains unchanged, and no scar tissue or neovascularity are present. Hymenal orifice: 8 mm x 5 mm.

CASE 3

1st Examination: 3 days post-assault. Age, 9 years. Tanner Stage I.

Fig 17. Supine labial traction: hymenal laceration with jagged edges present at 5 o'clock position (A). A second transection at 9 o'clock position is obscured by inflamed, edematous hymenal tissue (B). Contusion of vestibule wall is at the 5 o'clock position (C). A midline posterior fourchette adhesion is present (D). Multiple small abrasions and contusions are visible. Hymenal orifice: 12 mm x 9 mm.

Fig 18. Supine labial separation: thick, redundant hymenal tissues failed to separate.
CASE 3

**2nd Examination:** 11 days post-assault. Age, 9 years. Tanner Stage I.

*Fig 19.* Supine labial traction: Erythema and edema subsided. The hymenal margin is irregular with notch at the 5 o'clock position (A). The second laceration at 9 o'clock position appears as an indentation of hymen with cleft-like deformity (B). Small mound at same location marks the attachment of an intravaginal ridge (C). Hymenal orifice: 8 mm x 7 mm.

**3rd Examination:** 25 days post-assault. Age, 9 years. Tanner Stage I.

*Fig 21.* Supine labial traction: transection at 5 o'clock position now appears to be a fold in the hymenal membrane (A). A small synechia (scar) is manifested at the 9 o'clock position between the hymen and the wall of the vestibule at the point of the second laceration (B). Anterior flaps (C) developing as hymen becomes thicker and paler in response to hormonal influence. Hymenal orifice: 7 mm x 5 mm.

**2nd Examination:** 11 days post-assault. Age, 9 years. Tanner Stage I.

*Fig 20.* Prone knee-chest position: marked irregularity of the hymenal edge with notches at the 11 (A) and 3 o'clock (B) positions. Narrow hymenal rim with sharp angles is present. Hymenal orifice: 10 mm x 8 mm.

**3rd Examination:** 25 days post-assault. Age, 9 years. Tanner Stage I.

*Fig 22.* Prone knee-chest position: hymenal edge smoother and paler. Narrow angulated hymenal rim present at the 11 (A) and 3 o'clock (B) positions. Hymenal orifice: 12 mm x 9 mm.
CASE 3

5th Examination: 7 months post-assault. Age, 9 years 7 months. Tanner Stage II.
Fig 23. Supine labial traction: labia minora thicker, elongated with increased pigmentation. Hymen redundant, thicker and paler in response to hormonal stimulation. A groove/fold marks location of 5 o'clock hymenal transection (A). Patient rotated slightly to one side. Hymenal orifice: 5 mm x 4 mm.

Fig 23.

6th Examination: 19 months post-assault. Age, 10 years 7 months. Tanner Stage IV.
Fig 25. Supine labial traction: labia minora deeply pigmented and elongated. Hymen thick and redundant with copious amount of leukorrhea present. Transection covered by redundant hymen. Magnification: 16 x.

Fig 25.

5th Examination: 7 months post-assault. Age, 9 years 7 months. Tanner Stage II.
Fig 24. Prone knee-chest position: hymenal tissues on either side of the transection have hypertrophied leaving a midline groove (A). Moderate amount of leukorrhea present. Hymenal orifice: 7 mm x 7 mm.

Fig 24.

Fig 26. Supine labial traction with Q-tip used to separate redundant hymenal tissue: irregular hymenal edges with narrow rim (A) apparent only after tissue separated by a Q-tip (B). No evidence of scar tissue. Magnification 16 x.
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