Vaginal Reconstruction for Ambiguous Genitalia and Congenital Absence of the Vagina: A 27-Year Experience

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Background/Purpose: Gender assignment to a neonate with ambiguous genitalia is crucial. Patients with an absent vagina require the construction of an artificial vagina. In an effort to improve care, the authors have categorized their experience with this group of children.

Methods: Since 1974, we cared for 114 patients with anomalies of the genitalia. There were 53 genotypic girls with congenital adrenal hyperplasia (CAH), 16 genotypic boys with testicular feminization syndrome (TFS), 13 with mixed gonadal dysgenesis (MGD), 9 with Mayer-Rokitansky syndrome, and 4 true hermaphrodites. The remaining 19 had other genital abnormalities.

Results: After 1980, patients with CAH underwent clitoral recession and vaginoplasty. All patients with TFS were raised as girls and underwent orchidectomy. Eleven of the MGD patients were given a female sex assignment and underwent gonadectomy. Twenty-eight patients underwent intestinal vaginoplasty including 8 of the TFS patients, 9 with Mayer-Rokitansky syndrome, 8 patients with cloacal anomalies, 2 patients for rhabdomyosarcoma, and 1 of the MGD patients.

Conclusions: (1) This review emphasizes the range of diagnoses the surgeon must be prepared to address in patients with ambiguous genitalia. (2) Colovaginoplasty is an excellent procedure for replacement of a completely absent vagina. (3) Continued evaluation of this group will delineate appropriate timing and choice of procedure.

INDEX WORDS: Ambiguous genitalia, vaginal agenesis, colovaginoplasty, congenital adrenal hyperplasia, Mayer-Rokitansky syndrome.

THE INCIDENCE of congenital anomalies of the genitalia varies from 1 in 4,000 to 1 in 10,000 births because of differences in the definition of ambiguous genitalia.[1] One screening program involving almost 2 million newborns found the incidence of all types of congenital adrenal hyperplasia, the most common diagnosis in patients with ambiguous genitalia, to be 1 in 16,000 live births.[2] Despite the infrequency of such anomalies, the surgeon must be aware of the variety of presentations and the appropriate treatment for each. We previously reported on a group of 69 children with ambiguous genitalia operated on at our institution.[3] We now have gained experience with vaginal surgery in 114 infants and children over the past 27 years and have categorized this group in an effort to understand better the important issues of timing of surgery and effectiveness of reconstruction.

MATERIALS AND METHODS

All patients born with ambiguous genitalia who underwent any surgical procedure at our institution between July 1974 and January 2001 were reviewed retrospectively. Diagnoses were categorized into the following groups: congenital adrenal hyperplasia (CAH), mixed gonadal dysgenesis (MGD), testicular feminization syndrome (TFS), Mayer-Rokitansky syndrome, true hermaphrodites, and other anomalies. Patients seen in the newborn period were evaluated jointly by the pediatric endocrine service, the neonatology service, and the pediatric surgery service. Diagnostic workup involved chromosomal analysis, blood and urine steroid measurements, abdominal radiographs and ultrasound, and retrograde genitogram. The genitogram was performed by insertion of a Foley catheter into the distal perineal opening followed by low-pressure injection of a water-soluble contrast agent under fluoroscopy. Patients were analyzed for age at operation, operative procedure, and sex of rearing. Follow-up was obtained through routine clinic visits. This study was approved by the Institutional Review Board (IRB) of the University of Michigan Health System.

RESULTS

There were 53 patients with CAH treated at our institution, most in the newborn period. All patients were genotypic girls. The age at operation ranged from 2 weeks to 18 years and is shown in Fig 1. The majority of patients were operated on before 1 year of age. The various operations performed in this group of patients are depicted in Table 1. Forty-six patients underwent perineal vaginoplasty with or without clitoral surgery. Sixteen of the early patients in the series underwent vagi-

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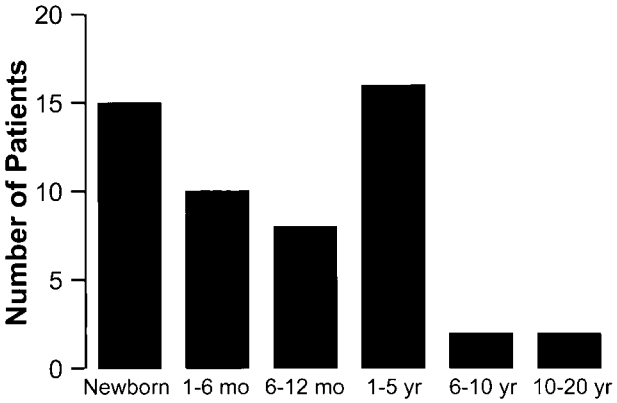

Fig 1. Congenital adrenal hyperplasia, age at operation.

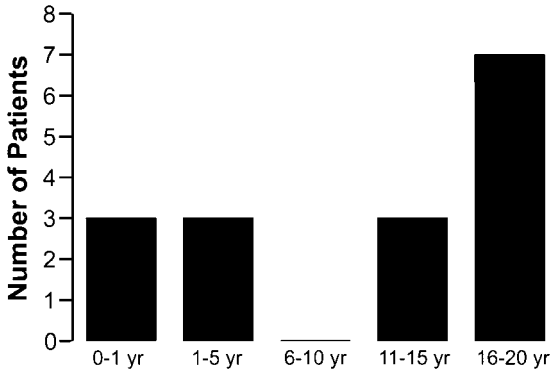

Fig 2. Testicular feminization syndrome, age at operation.

noplasty and clitoral resection, all before 1980. Twenty-three patients since 1980 have undergone perineal vaginoplasty and clitoral recession. Seven patients underwent vaginoplasty alone with no clitoral surgery. Seven patients underwent a vaginal pull-through, one with clitoral resection and 6 with clitoral recession. Four of the pull-throughs in the 1970s and 1980s utilized the Hendren technique; the last 3 pull-throughs utilized the Passerini operation.

Sixteen patients were genotypic boys who received the diagnosis of testicular feminization syndrome. The age at operation varied from 1 week to 18 years and is depicted in Fig 2. More patients presented for reconstruction after puberty than in the newborn period. The various operations performed are shown in Table 2. All patients underwent gonadectomy. One patient underwent gonadectomy alone. Four patients also underwent bilateral inguinal herniorrhaphy, 3 patients underwent clitoral recession and vaginoplasty, and 8 patients underwent vaginal reconstruction using a segment of intestine. Ileum was used in 2 cases, sigmoid colon in 5 other cases, and one patient underwent reconstruction using a duplicated cecum.

There were 13 children treated for mixed gonadal dysgenesis. Age at operation varied from 2 weeks to 19 years and is depicted in Fig 3. Half of the patients were operated on before 6 months of age. Most patients underwent bilateral inguinal herniorrhaphy, bilateral gonadectomy, clitoral recession, and vaginoplasty and were raised as girls. One patient underwent vaginal reconstruction using sigmoid colon. Two patients were reared as boys because of the parents' choice and underwent hysterectomy and hypospadias repair. Chromosomal analysis showed most commonly a 45, XO/XY composition in 10 patients. The other 3 patients showed various forms of mosaicism as shown in Table 3.

Nine genotypic girls were operated on for Mayer-Rokitansky syndrome. Age at operation ranged from 15 years to 17 years. All patients underwent a sigmoid colon vaginoplasty. Follow-up ranged from 6 to 12 years. All patients required weekly dilations for the first 6 months to 1 year. All 9 patients who underwent intestinal vaginoplasty are sexually active, require no lubrication, and experience no dyspareunia.

Four patients were diagnosed as true hermaphrodites. The age at diagnosis ranged from newborn to 6 months. Two of these patients with the chromosomal composition of 46,XY were raised as girls and underwent bilateral inguinal herniorrhaphy, bilateral gonadectomy, and vaginoplasty. One patient with the chromosomal composition of 46,XX underwent a gonadal biopsy showing elements of ova and testis and was lost to follow-up. The fourth patient with a chromosomal analysis showing a 46,XX/XY mosaic underwent hysterectomy, right salpingo-oophorectomy, and was raised as a boy at the parents' request.

Nineteen patients had other genital abnormalities including 8 patients with severe urogenital sinus abnormal-

Table 1. Operations Performed for Congenital Adrenal Hyperplasia

Operation	No. of Patients
Perineal vaginoplasty	46
Clitoral resection	16
Clitoral recession	23
No clitoral surgery	7
Vaginal pullthrough	7
Clitoral resection	1
Clitoral recession	6

Table 2. Operations Performed for Testicular Feminization Syndrome

Operation	No. of Patients
Gonadectomy alone	1
With BIH	4
With clitoral recess/vaginoplasty	3
With intestinal vaginoplasty	8
Ileal	2
Colon	5
Duplicate cecum	1

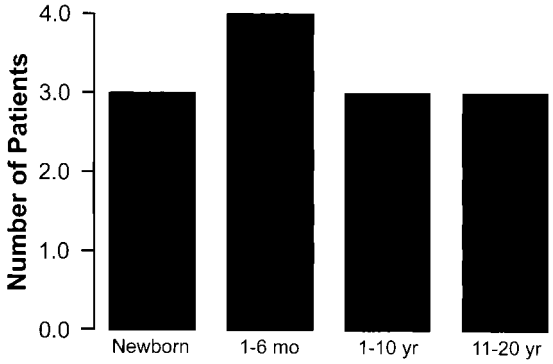

Fig 3. Mixed gonadal dysgenesis, age at operation.

ities, 8 patients with cloacal anomalies who underwent colovaginoplasties, 2 patients who required a colovaginoplasty after resection of a rhabdomyosarcoma arising in the vagina, and 1 patient with vaginal atresia who underwent perineal vaginoplasty.

DISCUSSION

This series shows the wide variety of diagnoses grouped under the heading of ambiguous genitalia with which the pediatric surgeon must be familiar. Some of the diagnoses result in a fairly uniform approach to therapy. For example, at our institution, most patients with a diagnosis of congenital adrenal hyperplasia and clitoral hypertrophy undergo a clitoral recession and vaginoplasty. Most of our patients (63%) undergo this surgical reconstruction before the age of 6 months. The surgical approaches to testicular feminization syndrome or Mayer-Rokitansky syndrome are likewise fairly standard at our institution. Those patients who require vaginal reconstruction undergo an intestinal vaginoplasty. In contrast to the patients with CAH, the patients with TFS undergo reconstruction much later, 60% after the age of 15. This obviously relates to the differences in timing of diagnosis. Most of the CAH patients are diagnosed in the newborn period, whereas many of the TFS and Mayer-Rokitansky patients are not diagnosed until there is a failure to start menses. We believe there is less risk of stenosis of the vaginoplasty when it is done after puberty.

Our treatment approach to CAH is similar to that of other institutions. Our choice for reconstruction of the vagina in the 28 intestinal vaginoplasties, however, differs from other approaches. The patients in our series who underwent intestinal vaginoplasty are summarized in Table 4. The goals of therapy in vaginal reconstruction include the following: fertility if at all possible, adequate sexual function without the need for continual dilations or lubrication, and elimination of the risk of malignant change of intraabdominal gonads. Some options for reconstruction are listed in Table 5 and include the Frank procedure,[4] the McIndoe procedure,[5] and the laparoscopic traction approach as described by Vecchietti.[6] The Frank procedure involves progressive nonsurgical dilation with graduated dilators used for 20 minutes a day. A 43% success rate was reported, and failures were attributed to previous hymenal surgery and lack of compliance.[7] The McIndoe procedure involves dissection of the space between the rectum and the bladder with placement of a mold in the space and diligent use of dilators during the epithelialization of the neovagina. The mold typically is covered with a split-thickness skin graft harvested from the thigh or buttock. Complication rates are small (1% to 10%) and include failure of the graft to take, hematoma, and fistula.[8] A drawback to this method is the requirement for lubricants. The Vecchietti procedure involves intraabdominal traction applied to the perineal membrane causing invagination over the course of 7 to 9 days.[9] A laparoscopic modification of this technique has been used with good success but still requires the use of dilators.[6]

Table 3. Chromosomal Analysis of Mixed Gonadal Dysgenesis

Chromosomal Analysis	No. of Patients
45,XO/XY	10
45,XO/46,XY+Y	1
46,XY/49,XXXXY	1
45,XO/46,XY/47,XXY	1

Table 4. Summary of Intestinal Vaginoplasties

Diagnosis	No.	Segment of Bowel
Mayer-Rokitansky syndrome	9	All sigmoid colon
Testicular Feminization syndrome	8	5 sigmoid, 2 ileum, 1 duplicate cecum
Cloacal anomalies	8	All sigmoid colon
Mixed gonadal dysgenesis	1	Sigmoid colon
Rhabdomyosarcoma of uterus	2	Sigmoid colon

Several series now have shown the usefulness of intestinal vaginoplasty for reconstruction, and these results are reviewed in Table 6.[10-16,23] The benefits include the limited need for dilations in the postoperative period and the ability of the colonic mucus to act as a lubricant, obviating the need for additional synthetic products. In brief, the technique of colovaginoplasty involves exploration of the abdomen and pelvis through a Pfannenstiel incision or by laparoscopy. In cases of Mayer-Rokitansky syndrome, uterine horn remnants are excised, and ovaries are left in place so that the patient can avoid exogenous hormone replacement and can harvest ova for in vitro fertilization using a surrogate mother if the patient so desires. In cases of TFS, the gonads are removed to eliminate the risk of malignant change. A 10- to 15-cm segment of sigmoid colon is then isolated, preserving the blood supply (Fig 4A). One end is closed in 2 layers to form the vertex of the neovagina. The other end is left open to form the neovaginal orifice (Fig 4B).

Table 5. Some Options for Vaginal Reconstruction

Procedure	Technique	Advantages	Disadvantages
Frank	Graduated dilators	Noninvasive	Noncompliance
McIndoe	STSG covered stent	No intraabdominal surgery	Requires dilators, lubricants
Vecchietti	Intraabdominal traction	Can be laparoscopic	Requires dilators, lubricants
Intestinal vaginoplasty	Bowel as neovagina	No lubricants required	Invasive

The continuity of the colon then is reestablished (Fig 4C). The hymenal region of the vulva is incised in a circular fashion, and the vaginal tract is bluntly dissected between the bladder and rectum to the level of the peritoneal reflection. The peritoneum is incised and the open sigmoid loop pulled down into position. A single-layer anastomosis is performed in the hymenal region (Fig 4D). Although some investigators have reported problems with diversion colitis after this procedure,[17] we have not seen any complications, and all patients have adequate patency and lubrication. In addition, none of our patients have experienced excessive mucus production from the colovaginoplasty.

The question of the timing of surgery is a difficult one to answer, and a great deal of controversy remains surrounding this issue. Some investigators have suggested that the diagnosis of ambiguous genitalia is a neonatal emergency, and interventions should take place immediately to help the parents accept the child more easily.[18] Some have advocated delaying any surgical interventions until the patient can give informed consent during adolescence.[19,20] Most investigators, however, suggest timing most surgeries from the newborn to 3-year-old period. Reasons for this early intervention include better compliance with dilations, lessening of the parents' concerns regarding their "anomalous" child, and the assumption that the child later in life does not remember early interventions. This last assumption has yet to be proven, and follow-up studies need to be performed to better determine the long-term effects of these surgeries. One follow-up study by Randolph et al,[21] reported outcomes as "excellent" in 27 of 37 patients undergoing clitoroplasty in the newborn period. Another study by Lobe et al[22] looked at 58 patients undergoing surgery at a variety of ages and found that there were more complications in the group that were diagnosed and operated on later in life as compared with the group diagnosed and operated on as infants.

Dilations are required postoperatively in a majority of the colovaginoplasty patients. There becomes a balance between the psychologic trauma of the dilations as the patient gets older and the risks of cessation of these dilations, which may result in the complication of stenosis. Because of this balance we have found that it is better if the repair can be performed after puberty when the risk of stenosis is less. When complex reconstructions are done at an earlier age when dilations may be essential, we have performed them under anesthesia to lessen the trauma to the patient. In addition, the reasons to intervene early in patients requiring colovaginoplasty often do not exist because the external genitalia is normal appearing. In patients with CAH and other conditions that involve abnormal-appearing genitalia, the benefits of early intervention outweigh the risks of repeated dilations at a young age.

No matter when the surgical intervention takes place, whether it is a clitoral recession and vaginoplasty in a newborn or a bilateral gonadectomy and colovaginoplasty in a young woman, the surgeon needs to be aware of the great variety of diagnoses and surgical options. A team approach to the care of these complicated patients is essential to help the patient and family cope with such a challenge. The key question is what is the sexual and social adjustment of these patients in late adolescence and adulthood. Thus far, no study has been carried out to answer this question. We have embarked on a prospective study involving the patients with congenital adrenal hyperplasia in our institution to try to shed some light on these issues.

Table 6. Intestinal Vaginoplasties

Study	No.	Ileum	Colon	Functional Results	Complications
Turner-Warwick, and Kirby[10] 1990	13	0	13	7 sexually active	None
Wesley and Coran,[11] 1992	6	2	4	6 sexually active	None
Martinez-Mora et al,[12] 1992	19	0	19	19 sexually active	1 with stenosis
Hendren and Atala,[13] 1994	65	38	27	10 sexually active	16 with prolapse
Hitchcock and Malone,[14] 1994	7	0	7	Good overall	1 with stenosis
Hensle and Reily,[15] 1998	31	25	8	20 sexually active	6 with stenosis
Tillem et al,[11] 1998	20	13	6	4 sexually active	2 with stenosis
Parsons et al,[23] 2001	28	0	28	15 sexually active	4 with stenosis
Graziano et al, current study	28	2	26	18 sexually active	None

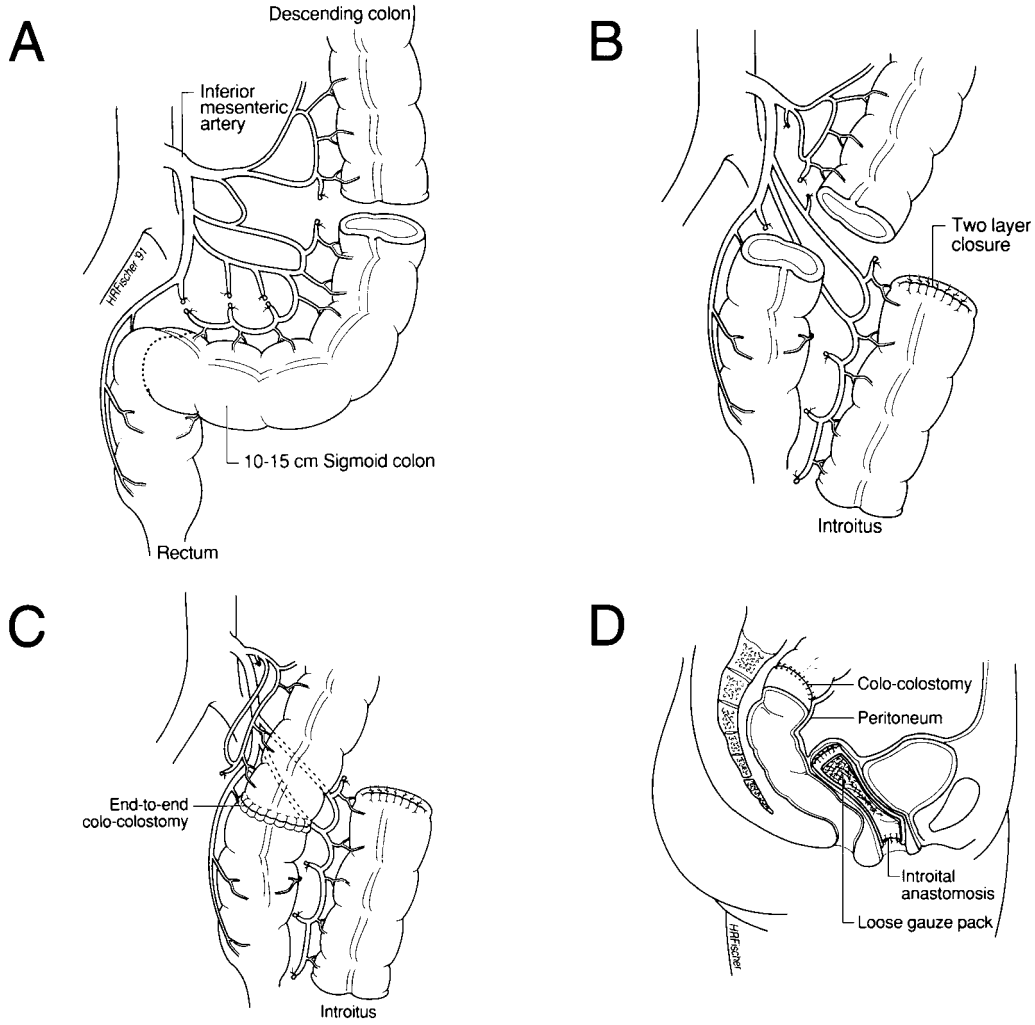

Fig 4. Technique of colovaginoplasty. (A) Isolation of 10 to 15 cm of sigmoid colon. The vascular arcade may be based at one end or the other. The segment end closest to the vascular pedicle is closed in 2 layers to form the apex of the neovagina. (B) The segment is positioned to anastomose to the hymenal ring, avoiding tension on the vascular pedicle. (C) Colocolostomy is completed and the distal end of the colonic segment is anastomosed to the opened rudimentary vaginal pit. (D) The completed vaginoplasty is loosely packed with vaseline gauze, and the peritoneum is closed above the transposed bowel. Reprinted with permission.[11]

REFERENCES

1. Templeman CL, Lam AM, Hertweck SP: Surgical management of vaginal agenesis. Obstet Gynecol Surv 54:583-591, 1999

2. Therrell BL, Berenbaum SA, Manter-Kapanke V, et al: Results of screening 1.9 million Texas newborns for 21-hydroxylase-deficient congenital adrenal hyperplasia. Pediatrics 101:583-590, 1998

3. Coran AG, Polley TZ: Surgical management of ambiguous genitalia in the infant and child. J Pediatr Surg 26:812-820, 1991

4. Frank RT: The formation of an artificial vagina without operation. Am J Obstet Gyenecol 35:1053-1055, 1938

5. McIndoe AH, Banister JB: An operation for the cure of congenital absence of the vagina. J Obstet Gynecol Br Common 45:490-494, 1938

6. Veronikis DK, McClure GB, Nichols DH: The Vecchietti operation for constructing a neovagina: Indications, instrumentation, and techniques. Obstet Gyenecol 90:301-304, 1997

7. Rock JA, Reeves LA, Retto H, et al: Success following vaginal creation for mullerian agenesis. Fertile Steril 39:809-813, 1983

8. Hojsgaard A, Villadsen I: McIndoe procedure for congenital vaginal agenesis: Complications and results. Br J Plast Surg 48:97-102, 1995

9. Borruto F: Mayer-Rokitansky-Kuster syndrome: Vecchietti's personal series. Clin Exp Obstet Gynecol 19:273-274, 1992

10. Turner-Warwick R, Kirby RS: The construction and reconstruction of the vagina with the colocecum. Surg Gynecol & Obstet 170:132-136, 1990

11. Wesley JR, Coran AG: Intestinal vaginoplasty for congenital absence of the vagina. J Pediatr Surg 27:885-889, 1992

12. Martinez-Mora J, Isnard R, Castellvi A, et al: Neovagina in vaginal agenesis: Surgical methods and long-term results. J Pediatr Surg 27:10-14, 1992

13. Hendren WH, Atala A: Use of bowel for vaginal reconstruction. J Urol 152:752, 1994

14. Hitchcock RJI, Malone PS: Colovaginoplasty in infants and children. Br J Urol 73:196-199, 1994

15. Hensle TW, Reiley EA: Vaginal replacement in children and young adults. J Urol 159:1035, 1998

16. Tillem SM, Stock JA, Hanna MK: Vaginal construction in children. J Urol 160:186-190, 1998

17. Syed HA, Malone PSJ, Hitchcock RJ: Diversion colitis in children with colovaginoplasty. Br J Urol Int 87:857-860, 2001

18. Canty TG: The child with ambiguous genitalia: A neonatal surgical emergency. Ann Surg 186:272-281, 1977

19. Diamond M, Sigmundson HK: Management of intersexuality: Guidelines for dealing with persons with ambiguous genitalia. Arch Pediatr Adolesc Med 151:1046-1050, 1997

20. Krege S, Walz KH, Hauffa BP, et al: Long-term follow-up of female patients with congenital adrenal hyperplasia from 21-hydroxylase deficiency, with special emphasis on the results of vaginoplasty. Br J Urol Int 86:253-259, 2000

21. Randolph J, Hung W, Rathlev MC: Clitoroplasty for females born with ambiguous genitalia: A long-term study of 37 patients. J Pediatr Surg 16:882-887, 1981

22. Lobe TE, Woodall DL, Richards GE, et al: The complications of surgery for intersex: Changing patterns over two decades. J Pediatr Surg 22:651-652, 1987

23. Parsons JK, DeMeester SL, Gearhart JP: Vaginal reconstruction utilizing sigmoid colon: Complications and long term results. J Pediatr Surg (in press)