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SURGICAL ENDOSCOPY
and Other Interventional Techniques

Findings of pelvic musculature and efficacy of laparoscopic muscle stimulator in laparoscopy-assisted anorectal pull-through for high imperforate anus

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Abstract
Background: Laparoscopic findings of levator muscle and the efficacy of laparoscopic muscle stimulator (LMS) in infants with high imperforate anus have not been reported.
Methods: Twelve patients underwent laparoscopically assisted anorectoplasty for high imperforate anus. Following laparoscopic dissection of the distal rectum and division of the fistula, levator muscles in the pelvic floor were stimulated with a 5-mm-diameter LMS. Dilatation was done by inserting a guidewire and balloon catheter through the center of the levator muscle sling and muscle complex. Rectal pull-through and anastomosis between the rectum and anus were successfully completed.
Results: LMS showed good contraction of levator muscles and enhanced accurate midline placement of pull-through rectum. LMS was particularly useful in observing weak muscles in infants with rectovesical fistula.
Conclusions: Laparoscopy and LMS offer excellent visualization of the pelvic musculature and precise tract of rectal pull-through. Fecal continence will be assessed by long-term follow-up.

Key words: Imperforate anus — Anorectoplasty — Laparoscopy — Muscle stimulator

Anorectal malformations are challenging for pediatric surgeons since many children with these malformations suffer from fecal incontinence after anorectoplasty [2]. For the past two decades, posterior sagittal anorectoplasty (PSARP) has been the standard method for surgical management of high imperforate anus [3, 9, 10]. Although surgical complications are avoided by PSARP, there are several postoperative complications associated with it. Peña's and Hong's [9] study of a large series of patients who underwent PSARP showed that 25% of the patients were totally incontinent, and only 37.5% were continent. Despite improved short- and mid-term functional outcomes, severe constipation and overflow incontinence continue to be a major postoperative complication after PSARP [10, 11].

Recently, a new technique using laparoscopy was reported to have considerably minimized the postoperative complications associated with PSARP [4]. The technique utilizes minimal perineal dissection, preservation of the distal rectum, and accurate placement of the rectum in the center of the sphincter muscles. Despite the advantages, this technique has its limitations. In cases with rectovesical fistula, it is difficult to accurately detect the center of the immature levator muscles, even when using a perineal muscle stimulator. Here, we report the efficacy of laparoscopic muscle stimulator and precise findings of the weak pelvic musculature of high imperforate anus in laparoscopically assisted anorectoplasty (LAARP).

Materials and methods

Since May 2000, 12 patients (9 boys and 3 girls) have undergone assisted anorectoplasty LAARP for high imperforate anus (2 rectovesical fistulae, 6 rectourethral fistulae, 2 rectovaginal fistulae, 1 rectocloacal fistula, and 1 rectal agenesis). Hospital charts, surgical notes, and videotapes of the procedure were reviewed. At birth, all patients underwent loop right transverse colostomy for high imperforate anus.

To define the site of communication of rectal fistulae with genitourinary structures, they underwent distal colostography and urethral fistulograpy before anorectoplasty. Under general anesthesia using muscular relaxants, the patient was placed in a supine position, and the lower abdomen, perineum, and bilateral lower extremities were disinfected. Using the open technique, a 5-mm trocar for a camera was inserted through a small incision of the umbilicus. The abdominal cavity was insufflated with carbon dioxide to a pressure of 8 mmHg, and two additional 5-mm working ports were inserted in the lower abdomen on either side. A 5-mm Harmonic Scalpel (Ethicon Endo-Surgery, Cincinnati, OH, USA) was used to dissect the distal rectum and mesorectum. As the rectum tapered distally, the fistula to the urethra or vagina was identified, ligated using 2–0 absorbable sutures, and sharply divided. After division of fistula, the distal fistula was

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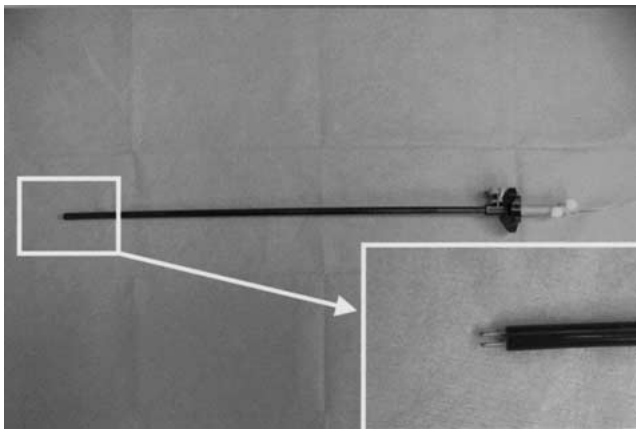

Fig. 1. Laparoscopic muscle stimulator (LMS). The diameter of the shaft of the LMS is 5 mm and the length of the tips of the electrodes (insert) is 6 mm.

additionally ligated using a pretied suture (Endoloop, Ethicon, Somerville, NJ, USA) for prevention of leakage. As the divided distal rectum was retracted cephalad out of the pelvis, blunt dissection using laparoscopic muscle stimulator (LMS; newly developed by the Division of Medical Engineering, Saitama Children's Medical Center; Fig. 1) allowed precise examination of the levator muscles in the pelvic floor. Once the pubococcygeus muscle was visualized clearly, the puborectal muscle sling was stimulated with a 5-mm-diameter LMS. LMS visibly contracted the puborectal muscle and distinctly showed the center of the puborectal sling. Subsequent blunt dissection of the midline of puborectal muscle presented the center of the top of the muscle complex described by Peña et al. [3, 9].

Externally, the anal area of the perineum was mapped using a transcutaneous muscle stimulator (Peña Muscle Stimulator, Radionics, Burlington, MA, USA) and guided by maximum contraction; perineal dissection was performed at the center of the external anal sphincter muscle. Under laparoscopic vision, a 19-gauge needle was inserted from the area of the perineal dissection through the center of the puborectal muscle sling and muscle complex. Dilatation for the pull-through tunnel was done by inserting a guidewire (Percutaneous Introducer Kit, Bard, Salt Lake City, UT, USA) and a 15-mm balloon catheter (Rigiflex, Boston Scientific, Waterston, MA, USA). A 5-mm trocar was inserted from the perineum into the center of the pelvic muscles, and the divided rectum was grasped and pulled onto the perineum while removing the trocar. After four anchoring sutures, anastomosis between the rectum and anus was completed with interrupted 4–0 absorbable sutures. A 6-mm silicon soft drain was inserted into the left bottom of the pelvic floor through the 5-mm working port on the left lower abdomen, and the other two ports were closed with 4–0 absorbable sutures.

Results

Laparoscopically assisted rectal pull-through and anastomosis between the rectum and anus were successfully completed in all patients. Clinical characteristics of the patients are summarized in Table 1. There were no problems in acquiring enough length of distal rectum for pull-through in LAARP. Postoperative anal mucosal prolapse was observed in patients 1 and 3 due to a wide dissection of the distal rectum without anchoring sutures between rectum and external sphincter muscle. The development of puborectal muscle sling was dependent on the site of the rectal fistula. Figure 2 shows a rectourethral prostatic fistula in patient 12. Laparoscopy precisely showed the prostate and vas structures and the communication of the rectourethral fistula with the entrance of the urethra. Figure 3 shows the laparoscopic view of pelvic floor in patient 12 with the rectourethral prostatic fistula. Although the puborectal muscle sling and muscle complex were not developed, LMS stimulated the immature muscles well sufficiently so that contraction of these muscles revealed the accurate position of rectal pull-through. The puborectal muscle sling and muscle complex in cases with rectovesical fistula were even more immaturely developed than in cases with rectourethral fistula (Fig. 4). On the other hand, puborectal muscles in females were very well developed because, compared to rectourethral or rectovesical fistulae, most rectovaginal fistulae are located at a lower site. Hence, the center of the puborectal sling and muscle complex was easily determined by LMS. There was only one case with rectocloacal fistula, but the length of her urogenital sinus was approximately 2.5 cm. In this case, LAARP and posterior flap vaginoplasty were performed simultaneously. Laparoscopy precisely showed communication of the rectal fistula with the left vagina and the center of puborectal muscle sling [6].

LMS contracted both puborectal muscle sling and the top of the muscle complex in all patients. In cases of lower rectovaginal fistula (patient 8) and lower rectourethral fistula (patient 3), the laparoscopic view revealed the center of pelvic muscles accurately even without LMS. However, LMS was appreciably effective in detecting the center of the puborectal muscle in cases with rectovesical fistula or rectourethral prostatic fistula that had very immature puborectal muscles.

Discussion

The proper care of newborns with anorectal malformations consists of three phases: proper decision making with or without creation of a colostomy in the newborn period, perfect execution of the subsequent pull-through procedure, and dedicated long-term follow-up with knowledge of the anticipated complications. In patients with anorectal malformations, impairments in rectal motility, anorectal sensation, and the anorectal sphincter complex can lead to subsequent problems with fecal continence, even though patients may have a very well reconstructed anus [12]. PSARP as described by Peña et al. [3, 9, 10] has become the standard procedure for surgical management of high imperforate anus. The posterior sagittal incision allows the surgeon to directly visualize the anatomy of the malformation. The main advantages of PSARP are easy separation of the rectum from the vagina or urinary tract and the exposure of puborectal muscle sling and muscle complex. However, this procedure requires a large incision of the pelvic structures that might damage the sphincter muscles as well as the tiny nerves that maintain anorectal sensation and motility.

LAARP has been developed in recent years [4]. This procedure utilizes minimal perineal dissection, preservation of the distal rectum, and accurate placement of the rectum in the center of the sphincter muscles. Laparoscopy provides an excellent opportunity for inspec-

Table 1. Patient characteristics

Patient No.	Age	Age at LAARP	Gender	Fistula	Complications
1	2 years 6 months	9 months	Male	Vesical	PAP, VLBW
2	2 years 3 months	6 months	Female	Vaginal	
3	2 years 1 month	5 months	Male	Urethral	PAP
4	1 year 10 months	6 months	Male	Prostatic	
5	1 year 9 months	6 months	Male	Prostatic	VUR
6	2 years	11 months	Male	Prostatic	VLBW, SB
7	2 years 3 months	1 year 4 months	Male	None	Down's syndrome
8	1 year 3 months	4 months	Female	Vaginal	LRA
9	1 year 9 months	1 year 1 month	Female	Cloacal	BU & DV
10	9 months	4 months	Male	Vesical	VUR
11	5 months	4 months	Male	Prostatic	
12	5 months	5 months	Male	Prostatic	

PAP, postoperative anal prolapse; VLBW, very low-birth-weight infant; VUR, vesicoureteral reflux; SB, spina bifida; LRA, left renal agenesis; BU & DV, bihorn uterus and double vagina

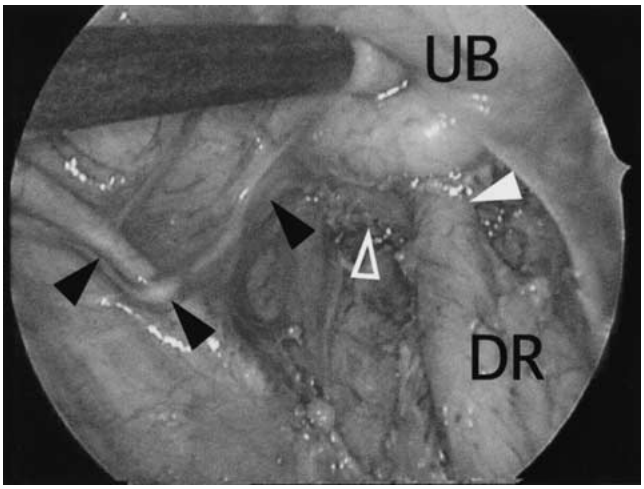

Fig. 2. Rectourethral prostatic fistula in patient 12. Distal rectum (DR) was communicated with prostatic urethra (white closed arrowhead). Prostate (white open arrowhead) and vas (black arrowheads) are easily identified. UB, urinary bladder.

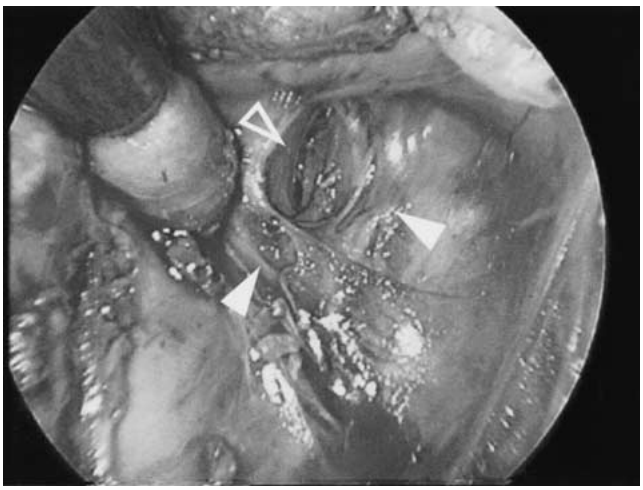

Fig. 3. Pelvic muscles in patient 12 with a rectourethral prostatic fistula. Immature puborectal muscle sling (closed arrowheads) and the center of muscle complex (open arrowhead) are shown.

tion of the condition of the pelvic musculature. The advantages of LAARP are the ease of dissection of the fistula and accurate placement of pull-through rectum

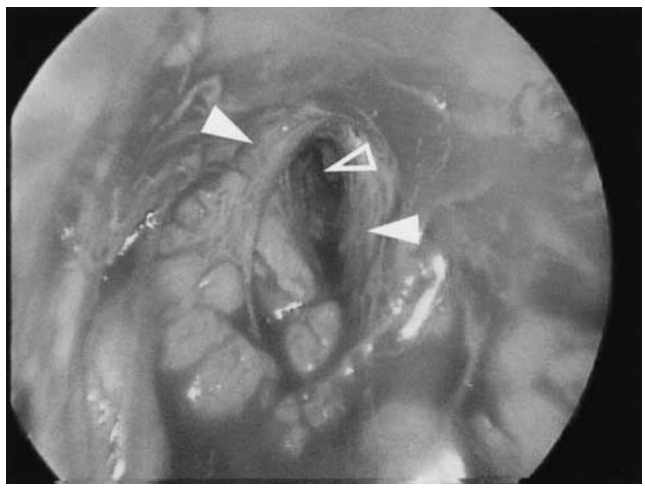

Fig. 4. Pelvic muscles in patient 10 with a rectovesical fistula. More immature puborectal muscle sling (closed arrowheads) and the center of very weak muscle complex (open arrowhead) are shown clearly.

without damage to the pelvic muscles and nerves. Although laparoscopy accurately provides the midline of the pelvic musculature, optimal contraction of the extremely weak puborectal muscle and muscle complex in patients with rectovesical fistula and rectourethral prostatic fistula is not achieved, even with transcutaneous electrostimulation. Our LMS can precisely contract the puborectal muscle sling toward the pubic bone and accurately indicate the small center of the top of the muscle complex, even in patients with rectovesical fistula (Fig. 4). LMS is effective and useful in detecting the structures of the pelvic floor.

In their study, Georgeson et al. [4] performed LAARP as a primary procedure, without prior colostomy. For patients with high imperforate anus, colostomy at birth was thought to be essential for decreasing the risk of complications [12, 13]. However, in addition to the high incidence of complications following colostomy, the techniques of creating colostomy are also controversial [8, 12]. Because early restoration of anorectal continuity would train the perineal musculature and establish brain reflexes, PSARP at birth without prior colostomy is not only feasible but also effective [1, 7]. We speculate that LAARP at birth without prior co-

lostomy might be easier than PSARP because of easy detection of both fistula and puborectal muscle. However, accurate diagnosis of associated anomalies of genitourinary organs and spinal cord and detection of the exact location of communication of the distal rectum and genitourinary system are often difficult prior to anorectoplasty at birth. Information from distal colostograms and urethrograms is invaluable in planning definitive anorectoplasty to achieve excellent anal function. We recommend creating colostomy at birth in patients with high imperforate anus and performing LAARP in early infancy (body weight; 6 or 7 kg: age; 3 or 4 months). Cloaca is the most complex type of imperforate anus, with confluence of the rectum, vagina, and urinary bladder in a urogenital sinus [5]. Most patients with rectocloacal fistula require complicated anorectoplasty with repair of the genitourinary system, such as total urogenital mobilization [10]. The only rectocloacal fistula patient in our series had a 2.5-cm-long urogenital sinus with anomalies of double vagina and bihorn uterus. We successfully performed LAARP combined with a simultaneous perineal posterior flap vaginoplasty at the age of 13 months [6]. Hence, we believe that LAARP combined with perineal vaginoplasty is feasible, that preoperative evaluation including colostogram and endoscopy of the urogenital sinus is essential, and that neither PSARP nor LAARP are recommended at birth.

The only postoperative complication was anal prolapse in the first and third cases of our series. Both these cases underwent wide dissection of distal rectum from the surface of the sacral bone, without anchoring sutures between the rectal wall and the external anal sphincter. Hence, we modified our procedure to minimally dissect the distal rectum and put four stitches of anchoring suture between the pull-through rectum and the external anal sphincter. Since this modification, we have not had any complications after LAARP.

The patients in our series have been followed for 21 months. Anorectal malformations, especially high imperforate anus, are such complex malformations that it is difficult to believe that surgery of any type can change the prognosis of anorectal function dramatically. However, we need to try to develop a surgical procedure for patients with anorectal malformations. The fecal continence of these patients after LAARP will be assessed in long-term follow-up.

In conclusion, LAARP using LMS offers excellent visualization of the pelvic musculature and a precise tract of rectal pull-through. We believe that LAARP can greatly facilitate the achievement of good anal function.

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