How Important Is the Role of the Internal Anal Sphincter in Fecal Continence? An Experimental Study in Dogs

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It is a generalized concept that the internal anal sphincter (IAS) plays a significant role in fecal continence by generating high pressure in the anal canal at rest and relaxing during rectal distention. Agreement also exists on the importance of internal sphincter-saving anoplasty on anorectal malformations in establishing anal continence. Twelve dogs were divided into four groups. Group 1, a control group, was subjected to a perirectal dissection only. Group 2 underwent the same perirectal dissection plus a 2-cm resection of the anal canal. Group 3 underwent the perirectal dissection plus a 4-cm resection of the anal canal, and group 4 underwent perirectal dissection and transposition of the anus to the posterior lateral portion of the voluntary muscle mass. Clinical continence was evaluated, and manometric results were compared with preoperative measurements. All dogs in groups 1, 2, and 3 were clinically continent without soiling except one in group 3, and also manometric results showed minimal change between preoperative and postoperative anal pressure profiles. The transposed anus of group 4 showed continuous fecal soiling. The anal resting pressure (ARP) was also decreased but still existed in this group. This experimental study showed that the IAS contributes to the anal resting tone. However, resection of the IAS did not completely interfere with fecal continence. The smooth muscle of pulled-through rectum seemed to partly take over the function of the IAS.

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INDEX WORDS: Internal sphincter; anorectal malformations; fecal continence; anal resting pressure; rectoanal inhibitory reflex.

BEFORE Peña and Devries (1982)1 introduced the posterior midsagittal approach for anorectoplasty (PSARP) of anorectal malformations, the major concern of pediatric surgeons had been how to position the rectum in an anatomically normal position without damage to the voluntary muscles. The anatomical results have improved remarkably with this procedure, and the functional results have also been better than with other procedures; however, normal bowel control still could not be achieved in many patients.

Recently several pediatric surgeons2-6 have paid attention to the internal anal sphincter (IAS) during operations on anorectal malformations because several follow-up results after anoplasty showed relatively good continence in patients with high anal resting pressure (ARP) and normal rectoanal inhibitory reflex (RAIR).2-10 Also Lembrecht and Lierse11 in 1987 microscopically showed the presence of the IAS in neonatal pigs with various types of imperforate anus. It has been well known that the IAS generates high pressure in the anal canal at rest and relaxes during rectal distention. However, there are still unanswered questions regarding the significance of the ARP and the RAIR in fecal continence. Is it possible to maintain normal continence without the IAS?

The purpose of this study is to evaluate the role of the IAS in fecal continence by noting the change in bowel movements and the anal pressure after resection of the anorectum in dogs.

MATERIALS AND METHODS

Twelve mongrel dogs, 3 to 6 months old and weighing 10 to 14 kg, were divided into four groups of 3 animals each. Bowel movement patterns were observed for 1 week before operation, and preoperative manometric examinations were carried out in all the animals. Bowels were prepared with ampicillin (50 mg/kg/d orally), amikacin (15 mg/kg/d intramuscularly) for 48 hours, Colonyte (1,000 mL/d orally) (Taekwang Pharmaceutical Co, Ltd, Seoul, Korea) for 24 hours, and a saline enema two times before operation. All manometric examinations and operations were done under general anesthesia with intravenous Enobarbitol (pentobarbital sodium, 25 mg/kg) (Hanrim Pharmaceutical Co, Ltd, Seoul, Korea) injection.

Group 1, a control group, was subjected to only a circumferential dissection of the anorectum through a posterior midline skin incision, without any voluntary muscle division or split. The perirectal dissection was performed to the level of pelvic peritoneum, without damage to the voluntary muscle. Anoplasty was done with 5-0 Vicryl sutures in the original anal position. Group 2 underwent the same perirectal dissection as group 1, as well as a 2-cm resection of the terminal bowel. The cut end of the proximal bowel was pulled through to the skin level, and anchoring sutures were placed between the rectal wall and the perirectal tissue to prevent mucosal prolapse. All voluntary muscle was preserved, and the anoplasty was done in the same manner as used in group 1. Group 3 underwent the same perirectal dissection and a 4-cm resection of the anorectum (Fig 1). The cut end of the proximal bowel was brought down to the skin, and many anchoring sutures were placed to prevent mucosal prolapse. Group 4 had the same perirectal dissection, and the dissected anorectum was pulled through a new canal made posterolaterally out of the voluntary muscle. Postoperatively all dogs had antibiotic therapy with intravenous injection of cefalothin (50 mg/kg/d) and amikacin (15
Fig 1. Perirectal dissection and a 4-cm resection of the distal bowel through a posterior midline skin incision.

mg/kg/d) for 24 hours and then oral ampicillin (50 mg/kg/d) for 3 days. A liquid diet was started the day after the operation and was continued for 2 days, followed by a regular diet.

Postoperative fecal continence was clinically evaluated for 2 months with regard to frequency of bowel movements, perineal soiling, and the shape of stools piled or scattered in the bottom of the cages. Those observations were compared with preoperative patterns. Anorectal manometric examinations were performed three times in every dog, at 4, 8, and 12 weeks postoperatively. Anorectal pressure profiles at rest and during rectal ballooning were recorded via a three-channel pressure measurement unit (Model-65, Martin Groger GmbH & Co KG, Munich, Germany). The anal pressure was measured at a distance of between 1 and 2 cm from the anal verge, depending on where the highest pressure was recorded. The manometric results were compared with preoperative pressure profiles.

RESULTS

Perineal Appearance

All six dogs in groups 1 and 2, and one dog in group 3 had normal perineal appearance without mucosal prolapse or soiling. Two dogs in group 3 had mucosal prolapse (Fig 2) and one of them showed minor perineal soiling. All three dogs in group 4 showed continuous fecal soiling without mucosal prolapse (Fig 3).

Bowel Habits

All nine dogs in groups 1, 2, and 3 had no definite change of their bowel movement pattern compared with preoperative observations. They usually had one or two regular bowel movements per day without perineal soiling, even though mucosal prolapse was seen in two dogs in group 3. All three dogs of group 4 showed fecal incontinence, with continuous leaking of feces, and multiple small pieces of feces were scattered in their cages (Table 1). Postoperative anal stricture was seen in one of three incontinent dogs.

Manometric Results

The anal and the rectal pressure profiles at rest were 11 to 18 mm Hg (mean, 14.5 mm Hg) and 5 to 8 mm Hg (mean, 6.6 mm Hg) respectively in normal dogs. The rectal pressures at rest were essentially the same after the four different operations. The RAIR was shown in only 8 of 12 dogs before operation, and the relaxation had little relation to the volume of rectal inflation. The RAIR was equivocal in the other 4 dogs because the relaxation during rectal inflation was too small to be interpreted as RAIR.

DISCUSSION

The goal of operations for anorectal malformations is to attain fecal continence. Normal bowel control requires delicate coordination between diverse elements related to fecal continence: sensibility of the anorectum, voluntary muscle action (external sphincter and levator ani), internal sphincter, angulation between rectum and anal canal, flutter valve action of the anal canal, colonic motility, and reservoir function of the rectum. Among these elements there is general agreement about the importance of voluntary

Fig 2. Perineal appearance showing mucosal prolapse after 4-cm resection of the anorectum.
ROLE OF IAS IN FECAL CONTINENCE

muscle action and sensation in fecal continence because voluntary bowel control cannot be expected without these two functions. However, the role of the IAS in fecal continence is still debatable. It has been reported that patients with good continence after anoplasty showed a higher ARP and a more positive rate of RAIR than patients with poor results. The high ARP was thought to be more important by some investigators, and the presence of RAIR by others.

The IAS is surrounded by a voluntary muscle mass. Because of this situation, exact functional evaluation by individual investigation of the force of each muscle seems not to be possible. Some investigators have attempted to isolate the contribution of the IAS to the resting tone by various pressure measurements, under spinal anesthesia, under general anesthesia with or without muscle relaxant, or after pudendal block. By these studies it has become a popularized concept that the ARP is mainly generated by the IAS.

Another function of the IAS is to relax in response to rectal distension. Since the RAIR was first demonstrated by Gowers and Sanderson in 1877, many studies have attempted to search for the mechanism of this reflex, and the results suggested that the IAS solely produced this relaxation by local reflex. Pharmacological studies of IAS have shown that nonadrenergic noncholinergic inhibitory neurons (purineric neurons) are responsible for this reflex mechanism. The RAIR was shown in patients with paraplegia, cauda equina, and bilateral sacral amputation who did not have any voluntary bowel control.

The importance of the IAS preservation during anorectoplasty might be overemphasized. Even if the patients with anorectal malformations have the IAS in the terminal bowel or around the fistula, complete dissection of the anterior rectal wall in that area is not possible because it shares its wall with the urethra or vagina. In addition to this, the distal part of the terminal bowel or the fistula is usually trimmed off for good perineal appearance. Therefore, if we could preserve the IAS, it would be only a small portion of the upper part of the internal sphincter muscle. Interestingly, Holschneider and Hecker reported that normal RAIR and anorectal pressure profiles had been shown in patients with a rectal cuff that was made of the reversed smooth muscle of the pulled-through colon. It seems that the smooth muscle of the colon took over the role of the IAS.

Whether the IAS is preserved or not, abnormal bowel function after operation on anorectal malformations is still present in a significant number of patients. Lower ARP than normal has been reported even in patients with good continence and normal RAIR. Cheu and Grosfeld reported that the preservation of the IAS could rather result in severe constipation by inhibition of rectal propulsion. Also Rintala et al explained that the constipation after anorectoplasty for imperforate anus might be caused by not only the partially denervated distal rectum during operation, the histologic change of the ectopic anal canal, and the congenital rectal dilatation, but also by the well-preserved IAS and external sphincter. During operation, nerve fibers could be injured because, as Scott showed, the pelvic autonomic nerves entering the rectum through the posterolat-

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**Table 1. Clinical Results**

<table>
<thead>
<tr>
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<th>Mucosal Prolapse</th>
<th>Perineal Soiling</th>
<th>Bowel Movements (per day)</th>
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<tbody>
<tr>
<td>G1 (n = 3)</td>
<td>–</td>
<td>–</td>
<td>1-2</td>
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<tr>
<td>G2 (n = 3)</td>
<td>–</td>
<td>–</td>
<td>1-2</td>
</tr>
<tr>
<td>G3 (n = 3)</td>
<td>2/3</td>
<td>1/3</td>
<td>1-2</td>
</tr>
<tr>
<td>G4 (n = 3)</td>
<td>–</td>
<td>3/3*</td>
<td>Uncountable</td>
</tr>
</tbody>
</table>

*One had postoperative anal stricture.

NOTE: G1, perirectal dissection only; G1, 2-cm resection; G3, 4-cm resection; G4, transposition.
eral surface in cases of high imperforate anus are easily vulnerable while the rectum is being pulled through to the perineum. In addition, Li et al. found that the number, size, and density of sensory nerve endings are reduced, and that the number of motoneurons in the sacrum also significantly decreased in patients with anorectal malformations.

We produced two kinds of animal models, one with absence of the IAS because of resection of the anal canal, and another with absence of surrounding voluntary muscle because of reconstruction of the anorectum out of the voluntary muscle. The first model was subdivided into two groups by length of the anal canal resected to assure the complete elimination of the IAS zone. The second model was provided to show the contribution of the IAS to the ARP with absence of voluntary muscle mass. Although Peña et al. reported that perirectal dissection up to the supravelotor space resulted in mucosal prolapse, fecal soiling, and reduction of ARP, our animals with prolapse had regular bowel movements.

It was impossible to check the bowel movements of all animals every time. We evaluated the fecal continence with perineal soiling, the pattern of scattered feces, and number of fecal piles. Our result suggests that the IAS is not a decisive factor in fecal continence because all animals without IAS maintained their continence clinically. Manometrical examinations supported the clinical results. The interesting finding was the minimal change of the anal resting tone in all dogs with a resection of the anal canal.

According to the previous studies, the ARP generated by the IAS should be diminished and only a small part of the pressure from voluntary muscle should remain. Our study showed that the pulled-through rectum compensated for the function of the anal canal in the resting tone and in fecal continence.

Unfortunately, the RAIR cannot be compared in this study because the reflex was not clearly shown even in some normal dogs who did not have an operation. The others showed the RAIR, but the depression was less pronounced. The length of the anal canal was just 6 to 10 mm in resected cases, and the length of the IAS zone may have been too short to routinely present the RAIR. It is uncertain whether the general anesthesia with intravenous pentobarbital depressed the RAIR; however, large doses of pentobarbital can depress the transmission in autonomic ganglia and reduce the nicotinic excitation by choline esters.

This study attempted to prove the function of the IAS, which could not be solely isolated in vivo, in fecal continence. Although the number of animals studied was small, our results suggest that the IAS may not be a fundamental element in fecal continence because the animals without the IAS were continent with regular bowel movements. Also the reduction of the anal resting tone was not significant. On the other hand, all the animals with anorectum malpositioned out of the voluntary muscle showed fecal soiling. This finding suggests the importance of voluntary muscle in fecal continence.

REFERENCES

17. Goligher J: Surgical anatomy and physiology of the anus,
37. Scott JES: The anatomy of the pelvic autonomic nervous system in cases of high imperforate anus. Surgery 45:1013-1028, 1959