

Anal Sphincter: A Comprehensive Review

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Abstract

Keywords

- Anus
- Sphincter
- Incontinence

Anal incontinence is of potential clinical interest and significance. Comprehensive knowledge of anal clinical anatomy and function is essential to understand pathophysiological processes that lead to sphincter malfunction. We review anatomy, physiology and surgical pathology of the anal sphincter. We also discuss surgical procedures which are used in cases of fecal incontinence.

Introduction

Anal incontinence:

Anal (Fecal, Bowel) incontinence, results in loss of control of feces and gas passage.¹ It often occurs along with urinary incontinence. Many patients with urinary incontinence also have fecal incontinence. Fecal incontinence is very hard on patients with a serious impact on their quality of life. Symptoms of fecal incontinence may range from a small occasional leakage to a daily devastating condition; which affects patients' self-image, confidence and their ability to have a normal lifestyle. Most patients with fecal incontinence do not share this problem with their close friends, families, or even their physicians. But in order to avoid humiliation they limit their social life which leads to loneliness and depression. Studies have estimated that the incidence of fecal incontinence is over 7% of the population.² It occurs in both men and women with a slightly higher prevalence in women. A study in 2008 on 1,961 women showed that about 9% of them experienced some sort of stool leakage, at least once a month. Since aging results in decrease of the quality of connective tissues and muscles the incidence of fecal incontinence increases.³

Causes and Diagnosis of anal incontinence:

Damage to the anal sphincters is by far the most common cause of bowel incontinence. These damages stem from vaginal childbirth⁴, diarrhea⁵, inflammatory bowel disease⁶, nerve damages⁷ and radiation damage to the rectum.⁸

The initial diagnosis approach is physical examination with a gloved finger inserted into the rectum and checking the strength of the sphincter muscle. Other examinations such as stool testing⁹, endoscopy¹⁰, anorectal manometry¹⁰, endosonography¹¹ and MRI defecography^{12, 13} are also helpful in discovering the underlying cause of bowel incontinence.

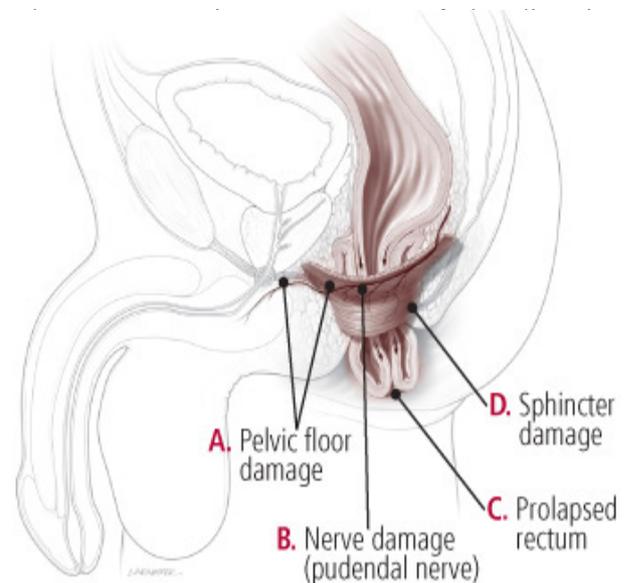
Anatomy of anal canal and fecal incontinence:

The anal canal (approximately 2.3-3.5 cm long) is the last segment of the colon, extending from the upper aspect of the pelvic diaphragm to the anus. The internal sphincter of the anus is an involuntary sphincter supplied by parasympathetic fibers which relaxes in response to pressure (gas or feces). The external anal sphincter has three portions which are¹⁴:

- a) The subcutaneous external sphincter.
- b) The superficial external sphincter.
- c) The deep external sphincter.

The external sphincter is voluntary and receives its nerve primarily by S4 through the inferior rectal nerve. The internal sphincter is actually the circular muscle coat of the rectum but very much thicker. It starts just above the ano-rectal ring and is tubular, completely encircling almost the whole length of the anal canal. It extends downwards almost to the lower end of the anal canal and its lower edge is just above the level of the anal inter-muscular depression. It does not terminate in the upper part of the canal as described in most textbooks of anatomy.¹⁴

The anal canal has different nerve supplies above and below the pectinate line. The part above the pectinate line has a visceral innervation originating from the inferior hypogastric plexus. Since it is visceral, this part only reacts to stretch of the canal wall. Distal to the pectinate line, the innervation is somatic and receives its supply from the inferior rectal nerves (branches of the pudendal nerve). Thus, it is sensitive to pain, temperature, and touch.¹⁴



Figur 1. Damages to nerves or muscles of pelvic floor in fecal incontinence (<https://www.drugs.com/health-guide/fecal-incontinence.html>).

Treatments for Bowel Incontinence:

Treatments are usually selected based on the cause of incontinence. Often, multiple treatments are required to control the symptoms of incontinence. Nonsurgical approaches like: proper diet (with large amount of fibers)¹⁵, drugs such as Imodium¹⁶,

Lomotil¹⁷ and Hyoscyamine¹⁸, exercise like bowel training¹⁵ are initial treatment approaches recommended for bowel incontinence. If disruption of muscles due to injury from childbirth or external trauma is the cause, the usual methods of treatment are not useful and surgical approaches are suggested.¹⁹

1. Surgery approaches:

Surgery is proposed for people whose bowel incontinence could not be treated via noninvasive treatments. The types of surgery include:

1.1 Sphincteroplasty (sphincter repair):

Sphincteroplasty is a useful approach when the sphincter suffers from a tear. In this method the separated ends are brought together. When sphincteroplasty is done immediately after the trauma occurs; it is referred to as primary. Whilst secondary or delayed sphincter repair may be done years after the original trauma usually because the trauma went unrecognized at the time it occurred. At first the sphincter is cut and the muscle ends are stitched tightly together end to end and overlapping in some cases. Sphincteroplasty is at times combined with a procedure to tighten the pelvic floor. Most patients who undergo this procedure experience incontinence again after 5 years which might be due to pelvic floor nerve damage. If the trauma is related to obstetric ruptures primary sphincter repair is usually not successful. Residual sphincter defects usually remain in nearly 50% of cases; in which repeated sphincteroplasty is needed.^{20, 21}

1.2 Postanal repair

This procedure is applied to restore fecal continence by correction of the anorectal angle and increasing the length of the anal canal for patients with denervation of the pelvic floor (for e.g. descending perineum syndrome).²²

1.3 Dynamic graciloplasty

In this procedure a muscle from the inner thigh (the gracilis muscle) is wrapped around the anus like a new sphincter (neosphincter). The sphincter in its natural state is able to automatically contract for long periods of time unlike the gracilis muscle; because its muscle fibers are mostly type II, fast-twitch, fatigable fibers thus this procedure is not useful by its own. Therefore, dynamic graciloplasty is used in which a neurostimulation device with an

impulse generator is implanted to help the muscle tolerate prolonged contractions. This way over time, the muscle gradually becomes composed of type I, slow twitch, fatigue resistant fibers. At the time of defecation the patient uses a magnetic device which deactivates the electrical stimulation resulting in relaxation of the muscular contraction and enabling a voluntary defecation. This method is used in cases where the anal sphincter is completely destroyed and there is a large gap between ends that could not be repaired surgically. The stimulator is implanted within the muscle near the gracilis nerve, and the impulse generator device is implanted under the skin. The operation is successful in 40-60% of cases and is dependent on surgeon experience. Complications rates are high and include: device problems 15%, infections 28%, and leg pain 13% which are usually treatable.²³

1.4 Anal encirclement (Thiersch procedure)

This procedure is mainly used for the treatment of rectal prolapse and entails encircling the anal canal with an implanted foreign material. Different materials including fascia strips, silver wire, nylon, silk, and silastic bands have been used. The classic Thiersch operation was carried out using silver or stainless wire by Gabriel for the first time in 1951. The wires were prone to breakage, also with applying pressure necrosis of the tissue would occur.²⁴ After Gabriel, two other research groups used other types of materials which were more successful. One group applied propylene mesh (Marlex) as encirclement material which is not affected by strong acids, alkalis or organic solvents. The results of the mesh was such excellent that the procedure is preferable to others.²⁵ Another group used a strip of Dacron-impregnated silastic sheet (Dow Corning) as an elastic fiber sling for encirclement. There were no breakdowns, deterioration or tissue rejection in this operation.²⁴ This method effectively enhances the anal sphincter and narrows the anal canal and helps with its barrier function for the stool, without altering the voluntary control. Complications include: infection, fecal impaction, erosion of encirclement through anal canal.^{26,27}

2. Sacral nerve stimulator

This method was originally used for the treatment

of urinary incontinence. In this method an implanted pulse generator (IPG) which is made of lead is inserted and generates a low amplitude electric current to a sacral nerve (usually S2-S4). By stimulating the sacral nerve a contraction within the pelvic floor is generated. Eventually these contractions restore the strength of the muscles within the pelvic floor.²⁸ This system is approved by FDA as Interstim trademark by the MEDtronic company.

Despite these promising results, this technique has complications such as: the need for reoperation in case of infection, IPG site pain and lead migration (15%), lead migration (12%), infection (10%) and pain (3%).²⁹

Sphincter cuff device

Another invention consists of the Acticone® Neosphincter which is applicable in patients with severe incontinence. It's an adaptation of the artificial urinary sphincter which is made from a solid silicone elastomer and consists of three fluid-filled apparatus which include: a cuff implanted around the anal canal, a balloon that regulates pressure and a control pump.

The artificial bowel sphincter could improve continence and its success rate is impressive but infection is a special concern in this treatment.³⁰ In a study, 28 of 38 patients who had infections owing to the device, required reoperation. Other complications included: constipation, fecal impaction, erosion of the cuff or the pump and pain with activation. The rate of failure in this study was 30%.²⁸ In another study, 112 patients with fecal incontinence were treated with implanted cuff device.

3. German artificial sphincter system (GASS)

The GASS systemic is a new hydraulic muscle used for the treatment of major fecal incontinence. The most important aspect of this device is integration of all functional components into one device with easy surgical implantation and a low risk of infection. It uses elastic compression cuffs in a stiff carrier ring and reservoir cuffs on the outer side. A silicon micro pump which is bidirectional moves liquid between both cuffs. Moving the fluid between the reservoir cuff and the compression cuffs, the sphincter can be relaxed or compressed and continence can be controlled.³²

4. Magnetic anal sphincter device (FENIX)

The very new artificial sphincter is magnetic anal sphincter augmentation which is also used for the treatment of gastroesophageal reflux disease with acceptable results. It has also been used in the management of fecal incontinence. The components of the device are titanium beads which have magnetic cores along with titanium wires. Studies represent the efficacy of this implant so it can be a hopeful method for future treatment.³³⁻³⁶

5. Colostomy

This procedure is used for patients with severe problems in whom other surgical procedures have failed or are not candidates for previously mentioned treatments and patients with spinal injuries. In this procedure a part of the colon is opened and placed outside the abdominal wall. A colostomy bag (**ostomy** pouching system) is placed around the opening of the colon which collects the waste. This pouching system also protects the skin around the colostomy from contamination. A major problem of this method is the presence of an annoying smell and a decrease in self-confidence and quality of life of patients.³⁷ Newer, nonsurgical procedures are also available to treat bowel incontinence, such as:

6. Radiofrequency anal sphincter remodeling (SECCA)

In this system the structure of the muscle is remodeled and improved by delivering RF energy to the internal anal sphincter muscle; which results in better continence. This method targets the underlying problem that causes bowel incontinence, inefficiency of the anal sphincter muscle, without surgery. Since Secca doesn't use surgery, or implantation of a foreign body, it can be used in many patient groups and doesn't interfere with other treatment options. The FDA originally cleared Secca for use in 2002 and issued an updated clearance on the RF1 generator in 2011. Secca has been proven safe and effective in numerous studies and is usually done in an outpatient setting using conscious sedation. It has a low morbidity compared with other treatments, such as sacral nerve stimulation (SNS), bulking injections and surgery.^{38,39}

7. Injectable biomaterials.

7.1 Anal plugs

One of the new inventions for improving bowel

continence is using anal plugs. Anal plugs are devices which are inserted into the rectum (like a suppository) and help to prevent bowel leakage. Anal plugs work well for many people and they experience a positive effect on their quality of life; however, their effectiveness has been found to vary and some people are unable to use them.^{40,41} This device is mainly effective in patients with neurological disorders, impaired anal canal sensation and patients who are institutionalized or immobilized. In some patients with fecal leakage, using an anal plug of cotton wool may prove beneficial.⁴² There is just one commercial anal plug which is procon-2.²⁸ Anal plugs have some disadvantages: they can be hard to retain in the anus^{43, 44}, some people find them uncomfortable complaining that having the plug in position causes a sensation of the need to pass stool.^{40,41,43&45} This may be more of a problem for men than women.⁴⁶ Anal plugs can cause local irritation although they should not cause pain.⁴⁷ Others find anal plugs hard to manage and they are difficult to insert and particularly remove if your hand control is poor.^{40,41&48} There is always the possibility of

leakage from the product onto clothes or furniture.

7.2 Injectable Bulking Agents (Solesta)

It was first described in 1993 by Shafik, who injected a Teflon® paste (Polytef®) into the submucosa of the anus to re-establish the anal 'seal'. The procedure is minimally invasive, cost-effective and can be carried out in a simple outpatient setting. While in the resting position; most of the 'resting anal tone' is maintained by the Internal Anal Sphincter (IAS). Any deficit of the IAS can result in the decrease of resting anal tone and lead to passive fecal incontinence. Methods of application of bulking agents are very varied. These include different materials, injection methods, variable volumes. Studies have reported good results and thus the use of Injectable Bulking Agents is now common. Currently there is only one injectable bulking agent approved by the FDA for the treatment of fecal incontinence: Solesta® (Dextranomer particles suspended in stabilized hyaluronic acid) by Oceana Therapeutics, which was approved in May 2011 for treatment of patients 18 years and older in whom conservative therapy has failed.

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