

Minimal Invasive Surgery and Therapy (MIS and MIT) in Hirschsprung's Patients

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INTRODUCTION

The generally accepted treatment for Hirschsprung's disease is through surgical intervention. Currently, the recognized techniques include the Swenson technique, which is less frequently used as the operation is delicate and can give rise to complications; the Duhamel technique, which is arguably the simplest approach and consistently provides good results; and the Soave technique, which also provides good results but is often more complex than the Duhamel approach. However, surgical and diagnostic procedures of the future will evolve from embracing current technologies that enable minimally invasive approaches to extremely targeted, localized, and high-precision endoluminal techniques. This requires entirely new types of surgical tools capable of entering the human body through natural orifices (by insertion, ingestion, or inhalation), very small incisions (injections), or even through skin absorption and maybe configuring themselves in complex kinetic structures at the specific site of intervention. Moreover, such approaches necessitate modification of classic surgical techniques. While the advantages of minimally invasive surgery and minimally invasive therapy (MIS and MIT) are widely acknowledged, this chapter serves to highlight the advantages of such procedures in pediatric medicine, both at the diagnostic

and intervention levels and the consequent implications to classic surgical techniques. The particular focus of the chapter pertains to the specific advantages the following techniques can bring into pediatric diagnostic and surgical techniques in the case of Hirschsprung's disease: (1) endoluminal miniaturized tools for gastrointestinal endoscopy, (2) gastrointestinal capsules for digestion (e.g., M2A capsule), and (3) laparoscopic tools for surgery. Both technological and economic perspectives are discussed.

BACKGROUND

Hirschsprung's disease (also known as congenital megacolon or congenital intestinal aganglionosis) occurs when some of the nerve cells that are normally present in the intestine do not form properly while a baby is developing during pregnancy. In children with Hirschsprung's disease, a lack of nerve cells in part of the intestine interrupts the signal from the brain and prevents peristalsis in that segment of the intestine. Because stool cannot move forward normally, the intestine can become partially or completely obstructed (blocked) and begins to expand to a larger than normal size. Today it is agreed that Hirschsprung's disease can only be cured through surgery (Rehbein, Morger,

Kundert & Meher-Ruge, 1966; Soper & Figueroa, 1971; San Luis, Nemoto & Beardmore, 1968; Soave, 1964)). The goals of the surgical treatment are to establish regular and spontaneous bowel function and maintain complete continence.

The three recognized surgical techniques include (1) the Swenson technique, developed by Swenson in 1947 but today is less frequently used, as the operation is delicate and can give rise to complications; (2) the Duhamel technique, which is arguably the simplest approach and consistently provides good results; and (3) the Soave technique, which also provides good results but is often more complex than the Duhamel approach.

With the advent of technologies, minimally invasive surgery (MIS) is becoming more and more prevalent in various areas of surgery. Essentially, MIS is done through small incisions using specialized techniques, including miniature cameras with microscopes, tiny fiber-optic flashlights, and high-definition monitors, so that surgeons in many specialties can perform surgery through an incision that requires only a stitch or two to close. For patients, MIS has several benefits since it can minimize pain, speed up recovery, and eliminate potential complications. For health care delivery, MIS represents an avenue to offer high-quality health care delivery and yet minimize costs associated with longer hospital stays and recovery. The area of pediatric surgery has only just begun to investigate the possibilities of incorporating MIS techniques. We discuss the role of MIS and MIT in the context of Hirschsprung's disease.

MIS/MIT TECHNIQUES AND TOOLS

MIS and MIT are growing and evolving areas that use many tools and techniques. Depending on the specific treatment domain (e.g., spine surgery vs. gastrointestinal surgery) naturally different tools and techniques are more suitable. Three MIS/MIT techniques that are particularly suitable in the context of pediatric gastrointestinal treatment include:

1. Endoluminal miniaturized tools for gastrointestinal endoscopy
2. Gastrointestinal capsules for digestion
3. Laparoscopic tools for surgery

We briefly discuss each in turn.

ENDOLUMINAL MINIATURIZED TOOLS FOR GASTROINTESTINAL ENDOSCOPY

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Pediatric gastroenterology, which was born in the early 1970s, is nowadays increasingly related to the application of gastrointestinal endoscopy for the diagnosis and treatment of digestive diseases in children (Gilger, 2001; Olives et al., 2004).

Today, gastrointestinal endoscopy plays an important role in the diagnosis of manifold pathologies, including Hirschsprung's disease (HD), which may be detected by three tests: contrast enema X-rays, manometry, and biopsy (North American Society for Pediatric Gastroenterology Hepatology, and Nutrition). In particular, rectal suction has recently demonstrated to be the most accurate test for diagnosing HD (De Lorijn et al., 2005). This procedure enables preoperative histochemistry on mucosal-submucosal specimens for proper enteric nervous system (ENS) evaluation (Martucciello et al., 2005). It is traditionally performed using the biopsy tool conceived by Noblett (Campbell & Noblett, 1969; Noblett, 1969) in the late 1960s. By using this instrument, a physician can create suction within the lumen and then use a cutter for mucosa sampling. Although such a system is atraumatic and easy to use, it requires two operators, while the size of the specimen and the depth of sampling are inconstant. In order to overcome all these limitations, Prato, Martucciello, and Jasonni (2001) have devised the "Solo-RBT." More recently, Bio-Optica has developed a kit for enzymatic-histochemistry.

Although barium enema is not essential to confirm the diagnosis of HD in many cases, it is useful in evaluating the level of aganglionosis and aids in the decision regarding the surgical approach (i.e., transanal, transabdominal laparoscopic, or open). Manometry, although not necessary, is generally exploited with rectal biopsy and barium (Martucciello et al., 2005).

It is assumed that the development of biopsy instrumentation could benefit by both the advancements in microfabrication technologies and the employment of new and biocompatible materials. For example, by exploiting Wired Electrical Discharge Machining (WEDM) and Nitinol, miniaturized biopsy tools for a gentle approach to the GI tract are feasible (Menciassi, Moglia, Gorini, Pernorio, Stefanini & Dario (2005). Biopsy could be eventually customized for usage in pediatrics, where minimization of intrusion is critical due to the narrow spaces. Nonetheless, biopsy can be

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