

Advances in the diagnosis and treatment of gastrointestinal tumors under the concept of super minimally invasive surgery

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INTRODUCTION

Super minimally invasive surgery (SMIS) represents a paradigm shift in gastrointestinal tumor surgery, focusing on preserving organ integrity while delivering therapeutic outcomes equivalent to traditional methods.^[1] This concept has emerged in response to the limitations of minimally invasive surgery (MIS) and open surgery, which often results in the resection of not only the lesions but also parts of the organ itself, leading to potential functional impairments and quality of life issues.^[1] SMIS emphasizes maintaining organ integrity and functional stability while removing lesions.^[1] This article aims to explore the new paradigm of diagnosis and treatment of digestive tract tumors changed by the SMIS concept.

SMIS FOR EARLY GASTRIC CANCER

Currently, surgical treatment is the first choice for early gastric cancer (EGC), but conventional or minimally invasive surgery (MIS) often leads to organ loss and excessive lymph node (LN) clearance, causing various adverse effects. Recent studies have focused on the effect of over-resection of non-tumor bearing LN on tumor metastasis. LNs are essential for initiating and sustaining adaptive immune responses. And the removal of LN hinders the generation of anti-cancer immune responses, which are enhanced by immune checkpoint blockade (ICB).^[2] Surgery may disrupt internal homeostasis, promoting the activation and progression of primary

tumors or distant metastases.^[2] Thus, individualized surgery is needed to balance the risks and benefits of LN resection while addressing treatment efficacy and organ preservation.

Stratifying lymph node risk in EGC can help to prevent overtreatment and improve clinical outcomes. The Japanese Society of Endoscopy, in its 2nd edition of EGC, recommended that the percentage of LN metastasis should be determined in the range of 1.0% to 10.6%, depending on the size of the tumor, histologic type, submucosal invasion (SM) and whether there is an ulcer (Table 1).^[3] Given the limitations of this assessment method, developing multi-modal LN tracking probes for tumor targeting has become a crucial and urgent focus in SMIS.

The current innovative strategies for SMIS are as follows.^[4] Firstly, the SMIS with endoscopic non-full thickness resection (non-EFTR), traditionally known as endoscopic submucosal dissection (ESD) or endoscopic submucosal tunnel dissection (ESTD), has been widely developed for decades. And This is an option to treat EGC at Tis, T1a-M1 phases. Secondly, the new technique of SMIS with endoscopic full thickness resection (EFTR) could be applied to treat EGC at T1a-M2, some T1a-M3 and T1b phases. Thirdly, the combination of double endoscopies to perform SMIS with EFTR + LN resection to treat EGC at some T1a~M3 and T1b phases. The cure degree was determined by the general pathological condition of the patients undergoing SMIS.

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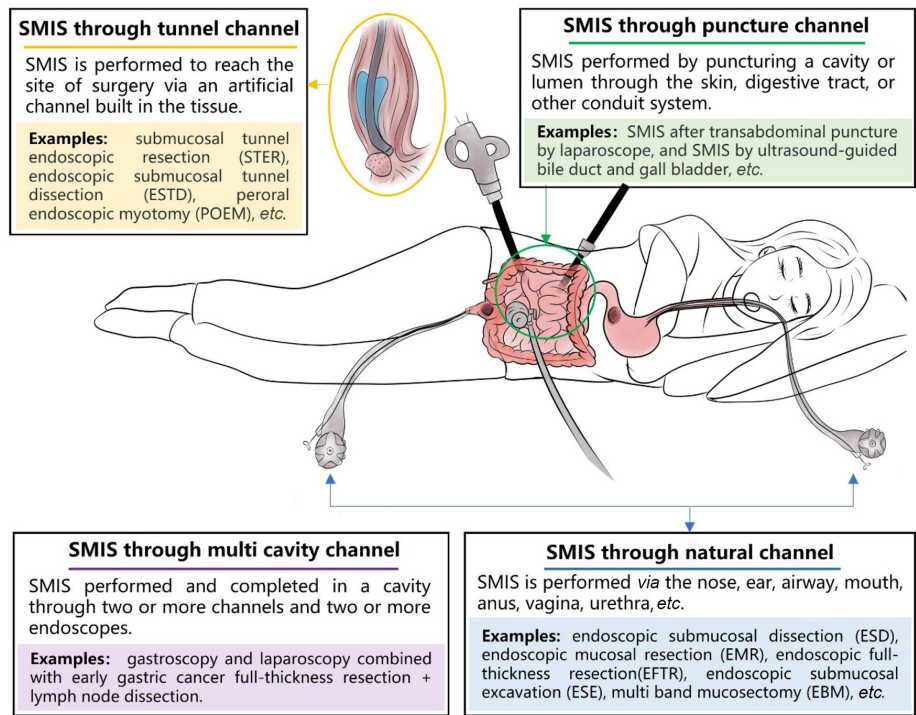


Figure 1: Diagram of super minimally invasive surgery.

Table 1: The risk for lymph node metastasis in early gastric cancer						
Histologic type	T1a				T1b	
	No ulcer		Ulcer		SM < 500 μ m	SM $\geq$ 500 μ m
	$\leq$ 2 cm	> 2 cm	$\leq$ 3 cm	> 3 cm	$\leq$ 3 cm	Any size
	< 1.0%	< 1.0%	< 1.0%	3.0%	2.6%	1.0%–9.0%
	< 1.0%	2.8%		5.1%		10.6%

SMIS FOR LOW RECTAL CANCER

Surgical treatment remains the primary approach for managing low rectal carcinoma (LRC). Currently, SMIS, emphasizing organ preservation, is the preferred approach for all TNM stages of LRC. Accurate preoperative TNM staging and risk stratification are crucial for selecting optimal therapeutic strategies for LRC. It is still dependent on advances in imaging techniques.^[5] High-resolution MRI and rectal endosonography (REUS) is useful in determining the location, size, degree of invasion, and metastasis of lymph nodes. CT/PET-CT is complementary to MRI to evaluate the status of systemic tumor metastasis.^[5]

Local Excision (LE) surgeries for organ preservation include non-EFTR, EFTR, transanal endoscopic microsurgery (TEM), transanal minimally invasive surgery (TMIS), and intersphincteric resection (ISR), among others. The specific

applications are outlined as follows.^[5] Firstly, SMIS with non-EFTR is applied to treat LRC at Tis, T1a (SM < 1 mm) phases. Secondly, the new technique of SMIS with EFTR, TEM, TMIS and ISR is used to treat LRC at T1a (SM < 1 mm) and T1b (SM > 1 mm) phases. In general, LE of T1 LRC is considered adequate.^[6] Thirdly, for low-risk T2 tumors, the prognosis of LE is inferior to that of radical surgery. LE combined with neoadjuvant chemoradiotherapy shows efficacy comparable to radical surgery. Fourthly, the standard treatment for locally advanced rectal cancer (LARC) at the T3/T4, c/p N1-2, M0 stage currently involves a “sandwich” approach, comprising neoadjuvant chemoradiotherapy (nCRT), TME, and postoperative adjuvant chemotherapy. This may result in 15% to 20% of patients with LRC achieving pathological complete response. Therefore, some researchers recommend a “Watch and Wait, W&W” strategy. However, the local recurrence rate with W&W is 15.7%, and the three-year

Table 2: Implementation principles of SMIS for digestive endoscopy

No.	Principle	Content
1	Preserve organs, anatomical structures, and organ functions unchanged	Remove the disease while preserving as many normal organs and tissues as possible, preserving the anatomy and functions of the body
2	Maintain the integrity of the cavity	Position the entry, route, and target location in the same cavity as possible
3	Prefer the sterile conditions	Strictly adhere to the principle of surgical sterility of multiple cavity channel treatment including surgery or percutaneous puncture
4	Choose a path with no chemical stimulus for the incision	Avoid the tube system of the puncture channel to prevent the injection of chemical fluid into the abdomen and cause infection
5	Prefer the natural cavity as treatment route	With or without natural cavities, natural cavities are preferred
6	Prefer the puncture channel when there are contraindications in the natural cavity	If there is a contraindication for natural cavity access, or if the natural cavity is narrowed or blocked because of congenital or acquired factors, it is preferable to use a puncture passage
7	Prefer the nearest surgical approach	Choose a short distance from the entrance to the surgical site to prevent damage to the surrounding organs or tissues due to long-term surgery
8	Prevent hemorrhage and bleeding in time	Forecast bleeding probability and make preparation beforehand to ensure nearly 100% bleeding
9	Prevent perforation and cavity closure	Estimate the probability of perforation, determine prevention and closure techniques, and ensure the restoration of the integrity and closure of the original human cavity
10	Strictly adhere to the principles of tumor treatment	Strictly adhere to the principles of non-resection of tumor, total block resection, tumor free technique, and metastasis prevention

recurrence rate is 22%. Following local regeneration, most patients opt for additional surgery. SMIS with EFTR appears to be a better strategy for these patients.

SMIS FOR GIANT ASTROINTESTINAL STROMAL TUMORS

Imatinib neoadjuvant is indicated for the reduction of surgical procedures in patients with large and/or unfavourable locations (such as cardia, pylorus, and anus, *etc.*) of gastric stromal tumors (GISTs). Imatinib can cause significant tumor shrinkage, softening texture and changes in the composition of stromal tumors, which increases the chance of local surgical resection. MIS achieved success in 72% of patients who were candidates for neoadjuvant imatinib therapy.^[7] Endoscopic SMIS with EFTR offers comparable operative outcomes and is the preferred option for downstaging GISTs to preserve organ function in specific regions.

SMIS CHANNELS

SMIS can be used to cure internal and external diseases by means of four channels, dozens or even hundreds of ways.^[8] In the research of SMIS therapy for gastrointestinal tumors, we have identified four channels: natural cavity channel, tunnel channel, puncture channel, and multi-cavity channel, which can be used in other surgical areas.^[8] The specific SMIS approaches for the four channels are shown in Figure 1.

SMIS can be performed with digestive endoscopy, laparoscopy, thoracoscopy, or other types of endoscopes,

or robotic surgical systems. And The implementation of SMIS relies on various technical methods, such as wound closure techniques (endoscopic metal clip closure, endoscopic suturing, endoscopic purse-string suture with nylon rope, *etc.*), prevention and treatment techniques for gastrointestinal hemorrhage (endoscopic drug spraying hemostasis, endoscopic hemostasis by injection, endoscopic electrocoagulation hemostasis, endoscopic hemostasis by thermocoagulation, *etc.*) and endoscopic assisted traction techniques (clamp and dental floss traction, clamp and elastic ring traction, snare and clamp traction, *etc.*)

In order to carry out SMIS, it is necessary to cooperate closely with each other, which breaks down the barrier between internal and external subjects and advances a new phase in the medical surgical history. Regarding the expansion of its therapeutic applications, SMIS is not limited to gastrointestinal endoscopy. It can also be used in a wide range of organs, such as digestive, urinary, respiratory, nervous, mediastinum, obstetrics and gynecology, *etc.*^[9]

IMPLEMENTATION PRINCIPLES

The SMIS treatment principles for gastrointestinal neoplasms are as follows. First, the surgeon must make a comprehensive assessment of the condition, then the surgeon must perform the precise operation, and then the surgeon must prevent and control the complications. The objective of SMIS is to ensure safe, efficient operations while achieving optimal outcomes and preserving quality of life. To achieve these goals, the surgeon must follow the

ten principles outlined below. (Table 2).^[10]

CONCLUSION

In summary, the development of SMIS has not only changed the traditional operation pattern, reduced the risk of surgery, and improved the quality of life, but also provided a new way for the accurate and individualized therapy of digestive disease. Along with the development of technology and the accumulation of clinical experience, SMIS will play an increasingly vital role in the treatment of gastrointestinal tumors.

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Author Contributions

Chen Q contributed to the conceptualization of the study. Yuan Y drafted the original manuscript and the manuscript was reviewed and edited by Chen Q and Linghu E.

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Ethical Approval

Not applicable.

Informed Consent

Not applicable.

Conflict of Interest

No potential conflict of interest was reported by the

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Use of large language models, AI and machine learning tools

None declared.

Data Availability Statement

No additional data is available.

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