Received: 1 April 2024 | Revised: 3 May 2024 | Accepted: 9 May 2024

DOI: 10.1002/ags3.12824

AGSurg Annals of Gastroenterological Surgery Open Access WILEY

REVIEW ARTICLE

Tailoring rectal cancer surgery: Surgical approaches and anatomical insights during deep pelvic dissection for optimal outcomes in low-lying rectal cancer

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Abstract

This review article explores advanced surgical approaches and anatomical insights for tailoring rectal cancer surgery, particularly focusing on low-lying rectal cancer. With the evolution of imaging technologies, precise preoperative planning has become possible, enhancing the visualization of anatomy surrounding the rectum and enabling more accurate assessments of circumferential resection margin (CRM) involvement. The article emphasizes the dynamic nature of rectal cancer treatment, advocating for individualized surgical planning based on comprehensive preoperative imaging and intraoperative assessment. This approach aims to optimize patient care by integrating recent advancements and anatomical insights into clinical practice for the management of low-lying rectal cancer. Particularly, the article discusses the importance of customizing the excision of Denonvilliers' fascia (DVF) based on tumor characteristics for optimal oncologic and functional outcomes, especially for anteriorly located tumors. It highlights the need for precise dissection techniques to ensure a negative CRM while preserving critical anatomical structures. Additionally, the review addresses the surgical management of tumors at the anorectal ring and introduces the Gate Approach for deep anterolateral pelvic dissection. Special attention is given to tumors impacting the membranous and prostate urethra, emphasizing tailored surgical approaches to balance complete tumor resection with the preservation of urogenital functions.

KEYWORDS
anatomy, rectal neoplasm, surgery

This article was written based on 2020 JSGS invited lecture presentation.

1 | INTRODUCTION

The landscape of lower rectal cancer management has undergone significant evolution, primarily characterized by the integration of total neoadjuvant therapy (TNT) and advancements in imaging technologies. These developments have revolutionized preoperative planning, offering enhanced visualization of the rectum and related structures and enabling more precise assessments of circumferential resection margin (CRM) involvement.[1,2]

Tracing back to the seminal work of Heald, the introduction of sharp pelvic dissection along embryological planes transformed rectal cancer surgery.[3] Total mesorectal excision (TME) emerged as a pivotal technique, drastically reducing local recurrence rates and improving functional outcomes.[1] The synergy of high-resolution magnetic resonance imaging (MRI) with surgical techniques has further refined patient selection, especially in cases involving anal sphincter invasion or high risk of incomplete resection, leading to the development of tailored preoperative treatments like chemoradiotherapy or TNT.[2,4]

Recent clinical trials such as RAPIDO, PRODIGE 23, and PROSPECT have underscored the benefits of these advanced approaches over conventional methods for locally advanced rectal cancer, sparking ongoing debates.[5–7] The PROSPECT trials, for instance, highlighted that preoperative FOLFOX treatment is not inferior to preoperative chemoradiotherapy in terms of disease-free survival and local recurrence.[7] This suggests the potential for omitting radiotherapy in certain scenarios without increasing recurrence risks. The OPRA trial further demonstrated that patients adopting a "watch and wait" (WW) approach and later requiring TME due to tumor regrowth had survival rates equivalent to those advised to undergo TME after TNT for incomplete response.[8] Choosing a WW strategy in patients with a complete clinical response (cCR) showed excellent survival outcomes and allowed them to avoid surgery-related morbidities, such as temporary or permanent stoma, and complications affecting voiding, sexual function, and defecation, which can significantly impact quality of life.[9–11] This paradigm shift underscores the dynamic nature of rectal cancer treatment, continually adapting to new evidence and techniques to optimize patient care.

Recently, for even early-stage rectal cancer such as cT2-3N0M0, WW after TNT strategy has been examined for its efficacy as an alternative to radical surgery in Japan (Towards trial).[12] However, while preoperative chemoradiation can be considered for organ preservation, with the expectation of possible cCR, it's important to highlight that for cT2 low rectal cancer around the anorectal junction or lower, upfront surgery is often the recommended approach. In this scenario, the surgeon's proficiency in deep pelvic dissection is imperative to ensure that oncologic and functional outcomes are not compromised.

In this review article, we aim to comprehensively deal with and discuss the surgical approaches and anatomical insights pertinent to deep pelvic dissection for low-lying rectal cancer. Our goal is to elucidate the critical nuances and recent advancements in these surgical techniques, providing a detailed understanding that may guide clinical practice and improve patient outcomes.

2 | TAILORED EXCISION OF DENONVILLIERS' FASCIA IN RECTAL CANCER SURGERY

In rectal cancer surgery, particularly for anteriorly located tumors, the excision of Denonvilliers' fascia (DVF) requires a highly customized approach. This is especially crucial for cT3 tumors with a thin mesorectum, which are more susceptible to positive CRMs. Tailoring the excision of DVF based on the tumor's specific location and depth of invasion is key to achieving optimal oncologic as well as functional outcomes.

Anteriorly located rectal cancers, historically associated with poorer oncologic outcomes, necessitate a strategic surgical approach. The excision of DVF in these cases must be carefully planned to ensure complete TME while minimizing CRM involvement. This involves a discerning technique where the dissection plane is adjusted according to the tumor's anatomical position.

For instance, in tumors located at the seminal vesicle level, the dissection should start anterior to the DVF but switch to behind the DVF at the prostate level. This approach ensures that the excision is tailored to the tumor's characteristics, thereby maximizing the chances of a negative CRM and preserving key anatomical structures such as neurovascular bundle (NVB).

Based on our perspectives, this customized approach to DVF excision is a critical aspect of low-lying rectal cancer surgery, reflecting the understanding of subtle differences of pelvic anatomy required for successful outcomes. It underscores the importance of individualized surgical planning based on detailed preoperative imaging and intraoperative assessment.

Heald and Moran[13] highlighted that dissection during rectal cancer surgery should ideally occur anterior to the DVF, observing that the DVF is positioned closer to the rectum than the prostate, forming the anterior surface of the mesorectum. This anatomical relationship complicates separation but is crucial for reducing local recurrence rates by ensuring a comprehensive mesorectal excision.[13] Similarly, Kraima et al supported dissection anterior to the DVF, treating it as analogous to the mesorectal fascia, thus advocating for its inclusion in TME to enhance oncologic outcomes.[14] However, these approaches pose a risk to sexual and voiding functions due to potential damage to the intricate network of pelvic nerves. Karima et al also cautioned that selecting the optimal surgical plane for superior oncologic results could compromise these critical functions.

Contrastingly, other studies have advocated for a dissection plane posterior to the DVF. Sugihara et al, through morphologic and clinical analyses, identified numerous communicating branches from the bilateral pelvic plexus on the DVF's ventral side, closely linked to urogenital function, thus suggesting the preservation of these nerves to maintain urogenital function.[15] Furthermore, Muroka

et al[16] presented findings that the DVF consists of multiple layers rather than a single layer and is not adherent to the prostatic capsule, particularly towards the prostate's posterolateral aspect. This nonadherence suggests that the space between the DVF and the prostatic capsule, filled with loose areolar tissue and the NVB, could be a safer plane for dissection, minimizing damage to critical nerve structures.[16]

The literatures mentioned above underscores the complexity of surgical approaches in rectal cancer treatment, particularly the debate over the dissection plane relative to the DVF, balancing the need for thorough oncologic resection with the preservation of urogenital functions.

2.1 | Understanding the DVF in rectal cancer surgery: A micro-CT (computed tomography) perspective

Recent findings from the study "Three-dimensional anatomy of the DVF after micro-CT reconstruction" provide crucial insights into the surgical approach for rectal cancer, particularly concerning the DVF.[17] The micro-CT images reveal the DVF as a continuous, multilayered structure with variations across its medial and lateral portions. This nuanced anatomy plays a pivotal role in determining the surgical dissection plane during anterior TME.[17]

Debate points in this literature:

- Surgical plane relative to DVF: The study highlights a key debate in rectal cancer surgery; whether the correct TME plane should be anterior or posterior to the DVF. The findings suggest that the plane posterior to DVF can serve as an adequate dissection plane for anterior TME, aligning with the principle of preserving the Mesorectal fascia (MRF) intact unless the tumor is locally advanced or anteriorly located.
- Preservation of autonomic nerves: The study also sheds light on the relationship between the DVF, the pelvic autonomic nerves (PAN), and the NVB. The PAN, located between the DVF and seminal vesicles/prostate, indicating that a surgical plane anterior to the DVF may risk erectile dysfunction in males due to potential damage to the NVB. The dissection plane should ideally be posterior to the DVF to avoid damaging the NVBs, as the DVF is fused with the prostatic fascia at this level.
- Technical variations in DVF excision are dictated by the T Stage and the necessity for CRM negativity: The strategy for DVF excision is adapted based on tumor staging. In the case of early-stage tumors (eg, T1, T2), it may be possible to preserve the DVF, thereby minimizing the risk of nerve damage while still ensuring CRM negativity (Figure 1A). Conversely, for more advanced tumors (eg, T3, T4), particularly those located anteriorly near the seminal vesicles and prostate, excision of the DVF may be essential to secure CRM negativity. As demonstrated in Figure 1B, for clinical T3 mid rectal cancer that is in close proximity to the DVF, meticulous excision of the DVF is crucial until an adequate margin is achieved (prostate level in this Figure 1B). At this critical point, the DVF ought to be divided from the upper part, with careful attention to preserving the anatomical structures below the dividing level. In other words, the

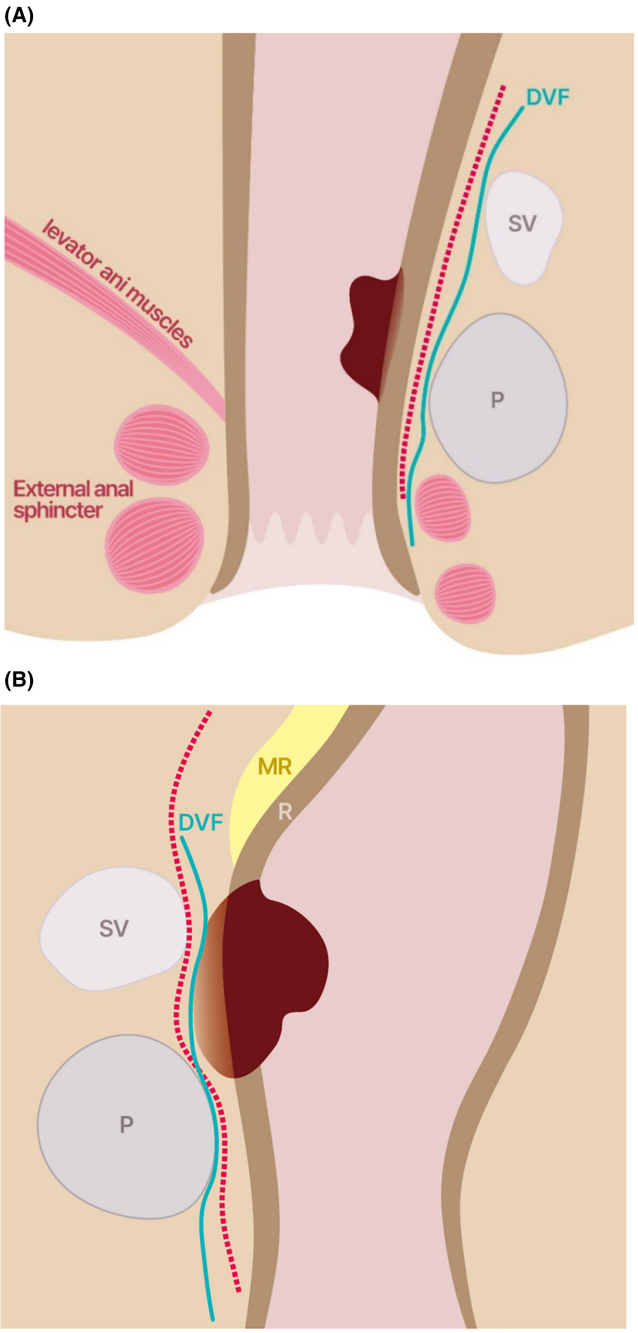


FIGURE 1 The schematic sagittal view of the pelvis illustrating the anterior dissection plane suggested according to the depth of invasion of tumor, which is anteriorly located. (A) The red dotted line depicts the suggested dissection plane for early-stage tumors (eg, T1, T2), preserving the Denonvilliers' fascia (DVF, green line) and reducing the risk of nerve damage while ensuring circumferential margin (CRM) negativity. (B) For more advanced tumors (eg, T3, T4), especially those anteriorly located, excising the DVF might be necessary to achieve CRM negativity. DVF, Denonvilliers' fascia; MR, mesorectum; P, prostate; R, rectum; SV, seminal vesicles.

dissection plane should be changed from an anterior to a posterior plane relative to the DVF at the prostate level, a strategic shift that helps to avoid unnecessary harm to the NVB—vital for genitourinary functionality—and the membranous urethra. This approach is proposed as the 'customized DVF excision' technique.

3 | ANORECTAL RING TUMORS: SURGICAL CONSIDERATIONS AND SOLUTIONS

The management of tumors located at the anorectal ring presents unique surgical challenges, particularly when considering the involvement of the levator ani muscle plate. These tumors, often situated roughly 4 cm from the anal verge, require meticulous surgical planning and execution to achieve optimal oncologic outcomes while preserving functional integrity.

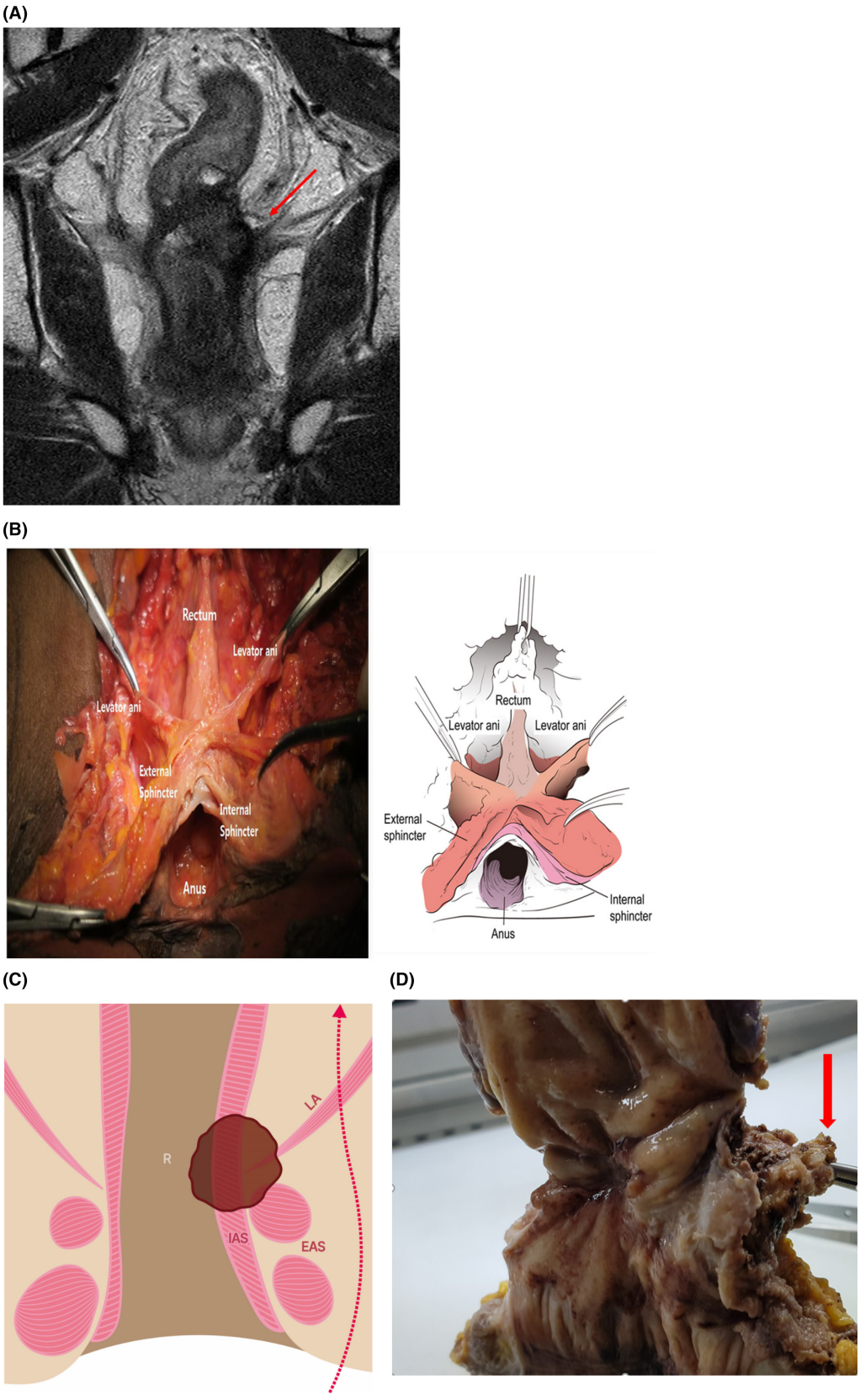
3.1 | Challenges in surgical management

- Levator ani muscle plate involvement: Tumors at the anorectal ring sparing the external and internal anal sphincters but invading the levator ani muscle plate necessitate a comprehensive approach. The excision of the involved levator ani muscle is critical for achieving negative CRMs. However, exposure and accurate division of this muscle plate are technically demanding and carry a risk of positive CRM if not performed correctly.[18,19] Partial excision of the levator ani muscle technique has been introduced.[20] This technique can be applied to patients who have tumors at the level of the anorectal junction with levator ani muscle invasion. It involves TME, dissection towards the levaotr ani muscles, and unilateral excision of the involved levator ani muscle via intersphincteric plane.[19,20] Preoperative chemoradiotherapy has facilitated sphincter-preserving surgery like partial excision of the levator ani muscle technique by achieving marked down-sizing and down-staging in the patients with unilateral levator ani muscle plate involvement with intact external sphincter. In a series of 13 patients, outcomes include one local recurrence at the anastomotic site 4 mo postsurgery, two systemic recurrences (lung and liver) at 25 and 6 mo, respectively, with a 3-y local recurrence rate of 14.4%. Functional outcomes reported include incontinence in two patients, with a mean Wexner score of 9.4 among 6 of 13 patients undergoing ileostomy reversal.[18] Given the preliminary nature of this technique, further exploration and long-term follow-up are necessary to fully understand the implications of the partial excision of the levator ani muscle technique. The accumulation of more case experiences and long-term follow-up will be crucial for evaluating the long-term efficacy and safety of this approach, especially in terms of local control, systemic recurrence rates, and functional outcomes.
- Abdominoperineal resection considerations: Abdominoperineal resection (APR), traditionally known as the Miles operation, has been a cornerstone in the surgical management of low rectal cancer since its inception in 1907. This procedure, however, has been critiqued for its association with a high risk of specimen waisting, as well as elevated rates of local recurrence and perineal wound complications. These concerns have necessitated the evolution of surgical techniques, leading to the introduction of the extralevator abdominoperineal excision (ELAPE).[21] ELAPE aims to mitigate the limitations of traditional APR by adopting a more extensive posterior perineal approach, which results in the extraction of a cylindrical specimen and effectively avoids the "waisting" phenomenon associated with conventional APR.

For tumors that invade the external anal sphincter and/or levator ani muscles (Figure 2A), APR remains a frequently indicated procedure. However, traditional APR techniques have faced criticism for less favorable oncologic outcomes, including higher risks of intraoperative rectal perforation and involvement of the CRM, when compared to low anterior resection.[1] The ELAPE technique addresses these shortcomings by providing a broader perineal approach, which has shown potential in improving oncologic outcomes. The surgical approach choice—between traditional APR and ELAPE—largely depends on specific tumor characteristics, particularly its proximity to and involvement of the levator ani muscle. A thorough understanding of the anatomical relationship between the levator ani muscle, its variations, angles, and its interaction with the rectum, is pivotal for achieving successful surgical outcomes.

The cadaveric work and its schematic view (Figure 2B) have shed light on the complex anatomical relationship among the rectum, levator ani muscle-a group of a thin sheet of striated muscles that forms the pelvic floor, akin to the diaphragm and shaped like a funneland the sphincter complex. These insights are crucial for surgical planning, particularly for the ELAPE procedure, where the lateral resection margin aims for a cylindrical specimen shape. By excising the levator ani muscle while keeping it attached to the rectum

FIGURE 2 Rectal tumor that invades the external anal sphincter and levator ani muscles, which is a candidate for abdominoperineal resection and extralevator abdominoperineal excision (ELAPE). (A) Magnetic resonance image of low rectal tumor (red arrow) invading the external anal sphincter and levator ani muscles. (B) The cadaveric work and the schematic view illustrating the relationship between the levator ani muscles, sphincter complex, and the rectum. (C) The schematic coronal view of the low rectal tumor invading the external anal sphincter and levator ani muscles. The red dotted line indicates a suggested ELAPE line. (D) Specimen after ELAPE for the low rectal tumor invading the external anal sphincter and levator ani muscles. The red arrow indicates levator ani muscle plate excised. (Reproduced from Lee and Kim Ann Coloproctol. 2018;34(2):59–71, with permission). EAS, external anal sphincter; IAS, internal anal sphincter; LA, levator ani muscle; R, rectum.



from the pelvic floor, ELAPE seeks to prevent specimen "wasting" (Figure 2C,D). Optimal surgical field visualization during ELAPE is often enhanced by positioning patients in the jackknife position, facilitating better access and visibility for the surgeon.

Patient selection for ELAPE specifically targets low rectal tumors with involvement of the levator complex, indicated for T3 or T4 tumors located within 6 cm from the anal verge or those exhibiting poor response to preoperative chemoradiotherapy. The surgical

technique itself is meticulous, involving initial closure of the anus with a purse-string suture, identification of anatomic landmarks for the elliptical incision, and careful mobilization of the mesorectum up to the levator muscles, with the dissection continuing along the outer surface of the levator muscles.

4 | A CAUTION AT COMPLETE TME AT LOWER RECTUM

Performing TME at the lower rectum presents unique challenges due to the anatomical complexities of this region. The success of TME in this area is crucial for achieving optimal oncologic outcomes, but it requires a careful and precise surgical approach to avoid potential complications. The MRF varies in thickness and clarity of delineation along the lower rectum. This inconsistency can lead to difficulties in identifying the correct surgical plane, increasing the risk of nerve damage and incomplete TME.[22] The lower rectum's proximity to neurovascular structures and the pelvic plexus heightens the risk of nerve damage, which can result in urinary and sexual dysfunction.[23–25]

- Multilayered MRF: The MRF surrounding the mid and lower rectum is multilayered, with the MRF and parietal fascia forming the 'holy plane.' This structure is crucial for guiding surgeons in TME.[23]
- Variable MRF architecture: The MRF does not maintain a uniform structure; instead, it displays interruptions and variations in thickness, particularly at the anterolateral lower rectum. This variability may lead to challenges in identifying the correct dissection plane and necessitate wider excisions in certain cases, especially for anteriorly located tumors.[26]
- Location of autonomic nerves: The autonomic nerves lie laterally adjacent to the MRF, requires sharp dissection onto the MRF to preserve these nerves, which are essential for maintaining urinary and sexual functions.[23–26]
- Implications for surgical practice: In situations where the MRF is difficult to define during the dissection of the anterolateral part of the lower rectum, the study results suggest that considering broader excisions beyond its boundaries may be advisable. In the lower rectum, the MRF closely approaches the muscularis propria of the rectum and seamlessly extends into the intersphincteric space, presenting challenges for radiological evaluation of tumor invasion.[26]

This comprehensive description of the MRF's intricate arrangement underscores the importance of a meticulous and informed surgical approach in TME, particularly at the anterolateral side of the lower rectum. Understanding the variable nature of the MRF and the location of autonomic nerves is key to achieving optimal oncologic outcomes while preserving key functional aspects. Radiologic assessments and surgical plans should consider these anatomical details to ensure the best possible outcomes for patients undergoing rectal cancer surgery.

5 | ANAL CANAL TUMORS: SURGICAL TECHNIQUES AND RECTOURETHRALIS MUSCLE CONSIDERATIONS

5.1 | Addressing tumors within the surgical anal canal and the careful consideration of ISR vs APR

In rectal cancer surgery, addressing tumors in the anal canal demands a sophisticated approach, focusing on sphincter preservation and considering the rectourethralis muscle for low-lying tumors. The strategic choice between Intersphincteric resection (ISR) and APR is dictated by the tumor's extent of invasion into the anal sphincters, with the objective of optimizing both oncologic and functional outcomes.

ISR, introduced by Schiessel et al in 1994, targets tumors limited to the internal sphincter, aiming to preserve the external sphincter and levator ani muscles.[27] This approach enhances the CRM and is designed to balance cancer control with the preservation of anal function. ISR can be classified into three types: partial, subtotal, and total, based on the extent of internal sphincter resection, as illustrated in Figure 3.

Conversely, APR is required for tumors that breach the internal sphincter's boundaries, necessitating the complete removal of the anus, rectum, and part of the sigmoid colon. This approach highlights the detailed surgical planning needed in rectal cancer treatment based on tumor invasion.

An extensive analysis of 303 ISR patients over 25 y by Denost et al showed a 5-y local recurrence rate of 4.9% and a disease-free survival rate of 73%.[28] A broader study in Japan providing the results of analysis based on a questionnaire consisting of 35 items to investigate the indication criteria and long-term result of ISR involving 2125 patients revealed a 5-y disease-free survival rate of 92.8% for stage I, 89.3% for stage II, and 73.6% for stage III cancers, with a 5-y cumulative local recurrence rate of 11.5% over a follow-up period of 58 mo.[29]

A study comparing ultra-low anterior resection (uLAR) with vs without ISR for low rectal cancer in 146 patients found significant differences in major fecal incontinence—75.9% in ISR patients vs 49.3% in the uLAR without ISR group ($p = 0.016$).[30] The median Wexner score, indicative of fecal incontinence severity, was significantly higher in the ISR group than in the uLAR without ISR group (14 vs 10, $p = 0.043$), underscoring the impact on quality of life.[30] Mucosal prolapse at the anastomosis site represents a complication following ISR, with reported incidences between 4.5% to 8%. A few studies have documented attempts at surgical correction through either a new end-to-end anastomosis or the Delorme procedure.[31–33]

These findings illustrate the challenge of achieving a balance between oncologic efficacy and functional preservation in rectal cancer surgery. ISR, as a focused option for select patients, demonstrates notable oncologic success and significantly influences postoperative quality of life, particularly concerning fecal incontinence. The decision to proceed with ISR or APR necessitates a comprehensive evaluation of these aspects to ensure a personalized treatment

strategy that optimizes both oncologic and functional outcomes for patients with rectal cancer.

5.2 | Intersphincteric space and technical tips for ISR

Tsukada et al meticulously quantified the attachment lengths of the longitudinal muscle to the levator ani muscle, finding mean lengths of 9.2 mm anterolaterally, 5.0 mm laterally, and 2.4 mm posteriorly.[34] This anatomical insight underpins the surgical technique for ISR, particularly highlighting the strategic approach for detaching the rectum from the surrounding levator ani muscle. The study emphasizes the importance of a sequential dissection approach, starting with the posterior attachment from the levator ani muscle due to its minimal thickness of longitudinal muscle of the rectum, followed by the lateral and then the anterolateral parts, ensuring the preservation of adjacent organs during ISR. For effective ISR, the preference for the transabdominal approach is noted, allowing for comprehensive dissection down to the anal hiatus at the pelvic floor level. The procedural specifics underscore the importance of verifying sufficient colon length and achieving stable pelvic dissection to the level of the pelvic floor. After then, the technique involves making a circumferential incision via the transanal approach administering bupivacaine with epinephrine at the intersphincteric groove, with dissection proceeding posteriorly, then anterolaterally, and finally anteriorly (Figure 4).

5.3 | Rectourethralis muscle considerations

The rectourethralis muscle, located at the junction of the rectum and urethra, is a key landmark in APR and ISR. Its preservation is crucial for maintaining urinary function. The rectourethralis muscle arises from the anterior surface of the rectum and inserts into the perineal body. It is positioned posterior to the urethra, anterior to the rectal wall, and lateral to the levator ani muscle. It appears Y-shaped, with its arms extending into the rectal wall and attaching to the levator ani and perineal body. The distance from the urethral sphincter and the rectourethralis muscle is ~1 cm, and the thickness of the rectourethralis muscle ranges from 2 to 10 mm.[35]

Planellas et al[36] found that urethral injury occurred in 0.73% of cases within their clinical series. Notably, the incidence increased to 1.64% among high-risk patients, specifically men with middle and distal rectal lesions. Technique-specific analysis revealed that urethral injuries were documented in 3.2% of cases undergoing transanal TME and in 4% of APR. These incidence rates surpass those of other studies, which have calculated urethral injury rates across a broad patient cohort without stratifying for risk level.[36] To reduce the incidence of urethral injuries, it is imperative to have a clear understanding of anatomical landmark structures.

During ISR and APR, special attention must be given to avoid damaging the rectourethralis muscle, especially in tumors not involving this muscle. This requires precise dissection techniques and a thorough understanding of the pelvic anatomy. Careful dissection around the DVF is essential until reaching the prostate level, with the rectourethralis muscle being carefully preserved unless directly invaded by the tumor. This approach ensures that the dissection remains posterior to the DVF, safeguarding the rectourethralis muscle, thus maintaining its separation from the urethra and rectum. Such meticulous dissection, informed by previous anatomical studies highlighting the path of the DVF to the perineum and its termination at the rectourethralis muscle (Figure 5A), underscores the importance of anatomical landmarks like the DVF and rectourethralis muscle for both oncologic and functional safety.[37,38] The decision to preserve or resect the

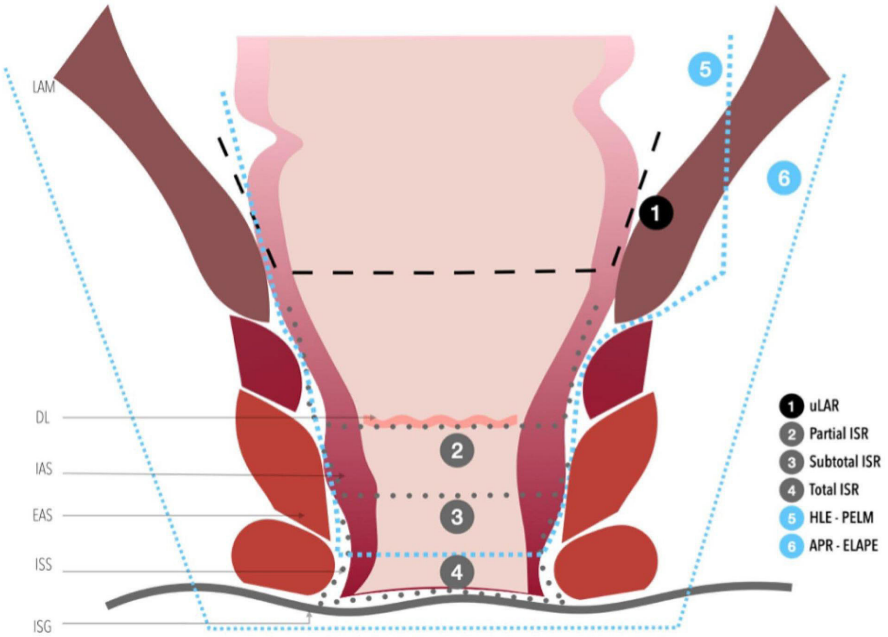


FIGURE 3 The schematic view of various surgical strategies for low rectal tumor ① uLAR. ② partial ISR ③ subtotal ISR ④ total ISR ⑤ HLE with ISR ⑥ APR/ELAPE. (Adopted from Varela and NK Kim Ann Coloproctol 2021;37(6):395–424 with permission). APR, abdominoperineal resection; DL, dentate line; EAS, external anal sphincter; ELAPE, extralevator abdominoperineal excision; HLE, hemilevator excision; IAS, internal anal sphincter; ISG, intersphincteric groove; ISR, intersphincteric resection; ISS, intersphincteric space; LAM, levator ani muscle; PELM, partial excision of LAM; uLAR, ultralow rectal resection.

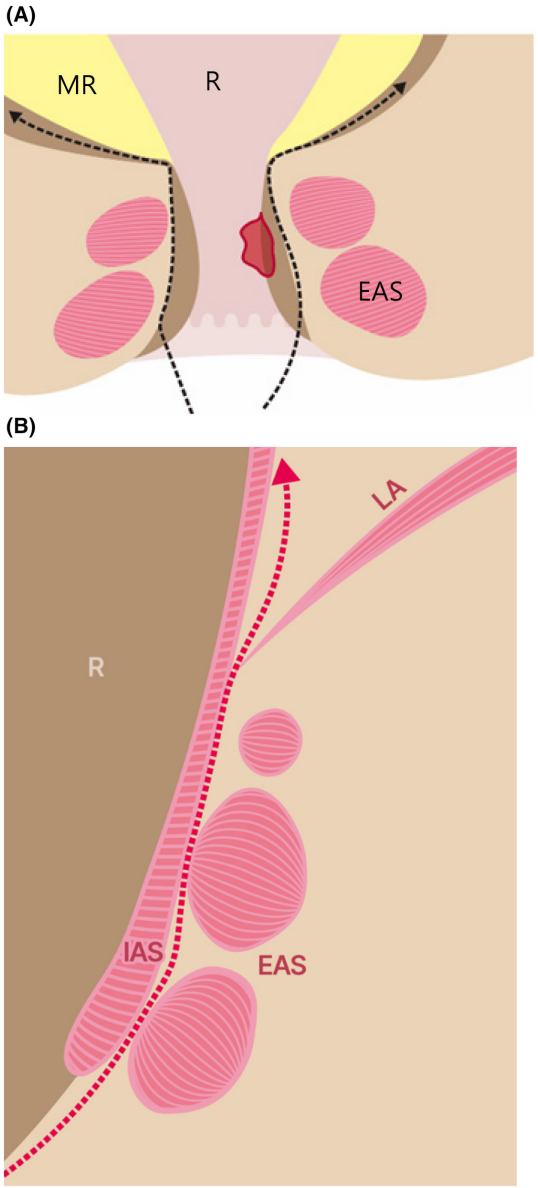


FIGURE 4 The schematic view of transanal approach for intersphincteric resection. (A) Coronal view depicting the suggested dissection line (black dotted lines) of transanal approach for ISR for the T1/2 low rectal cancer. (B) Sagittal view depicting the suggested dissection line (red dotted lines) of transanal approach for ISR in the T1/2 low rectal cancer. EAS, external anal sphincter; ISR, intersphincteric resection; LA, levator ani muscle; MR, mesorectum; R, rectum.

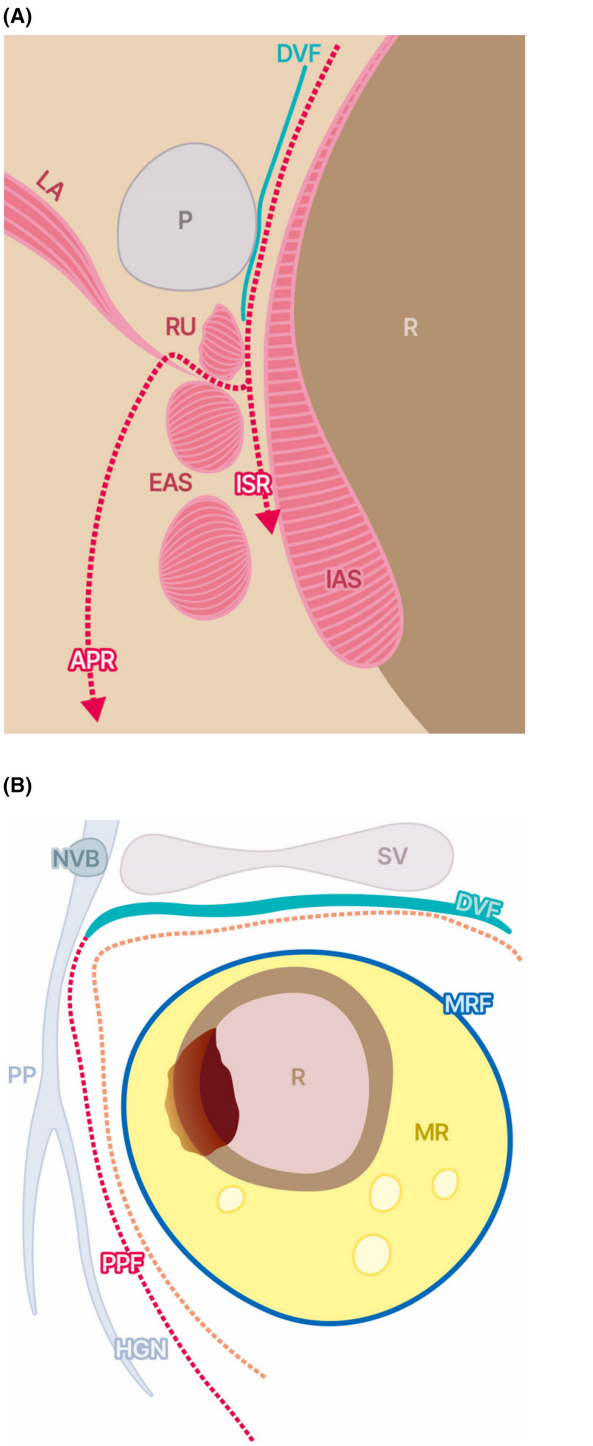


FIGURE 5 The schematic views of the relationship between the rectum and rectourethralis muscle and suggested anterior dissection line. (A) Sagittal view depicting the suggested dissection line of ISR and APR (red dotted lines) for the early low rectal cancer. (B) The schematic view of suggested dissection line for anterior dissection. The orange dotted line indicates proposed dissection line. APR, abdominoperineal resection; DVF, Denonvilliers' fascia; EAS, external anal sphincter; HGN, hypogastric nerve; IAS, internal anal sphincter; ISR, intersphincteric resection; LA, levator ani muscle; MRF, mesorectal fascia; NBV, neurovascular bundle; P, prostate; PP, pelvic plexus; PPF, parietal presacral fascia; R, rectum; RU, rectourethralis muscle; SV, seminal vesicles.

rectourethralis muscle is influenced by the tumor's location and extent. Preservation is ideal for maintaining postoperative urinary continence but may not always be feasible in cases of extensive tumor invasion.

Soga et al highlighted that DVF terminates at the rhabdosphincter and the apical portion of the rectourethralis muscle, suggesting DVF as a landmark for a safe pelvic dissection plane.[39] This termination point enhances the likelihood of preserving the NVB during transabdominal pelvic dissection in the lower pelvis and allows for the conservation of the urethra and urethral sphincter muscle during ISR or

APR through a transanal approach, as the dissection remains posterior to DVF. Therefore, dissection posterior to DVF is considered the most embryologically planned dissection. However, in cases of advanced lower rectal cancer with an anterior presentation, a customized DVF excision is necessary to obtain a negative CRM. He et al[40] observed that the lateral border of DVF macroscopically ran posterolateral to the seminal vesicle, attached to and crossing the pelvic plexus. They noted that DVF consists of numerous fibers that merge with the pelvic wall's connective tissue and partially insert into nerve branches emerging from the pelvic plexus.[40] Additionally, Muraoka et al reported that DVF's lateral extension varies, sometimes connecting with the lateral pelvic fascia and NVB, or moving anteriorly along the prostate capsule, indicating both site-dependent and individual variability in its anatomical presentation[16] (Figure 5B).

The management of tumors within the surgical anal canal and the preservation of the rectourethralis muscle are intricate components of rectal cancer surgery. These procedures require a delicate balance between achieving complete tumor resection and preserving vital functions. Surgeons must consider the tumor's location, extent, and relationship with surrounding structures to determine the most appropriate surgical approach, ensuring optimal oncologic outcomes and quality of life for patients.

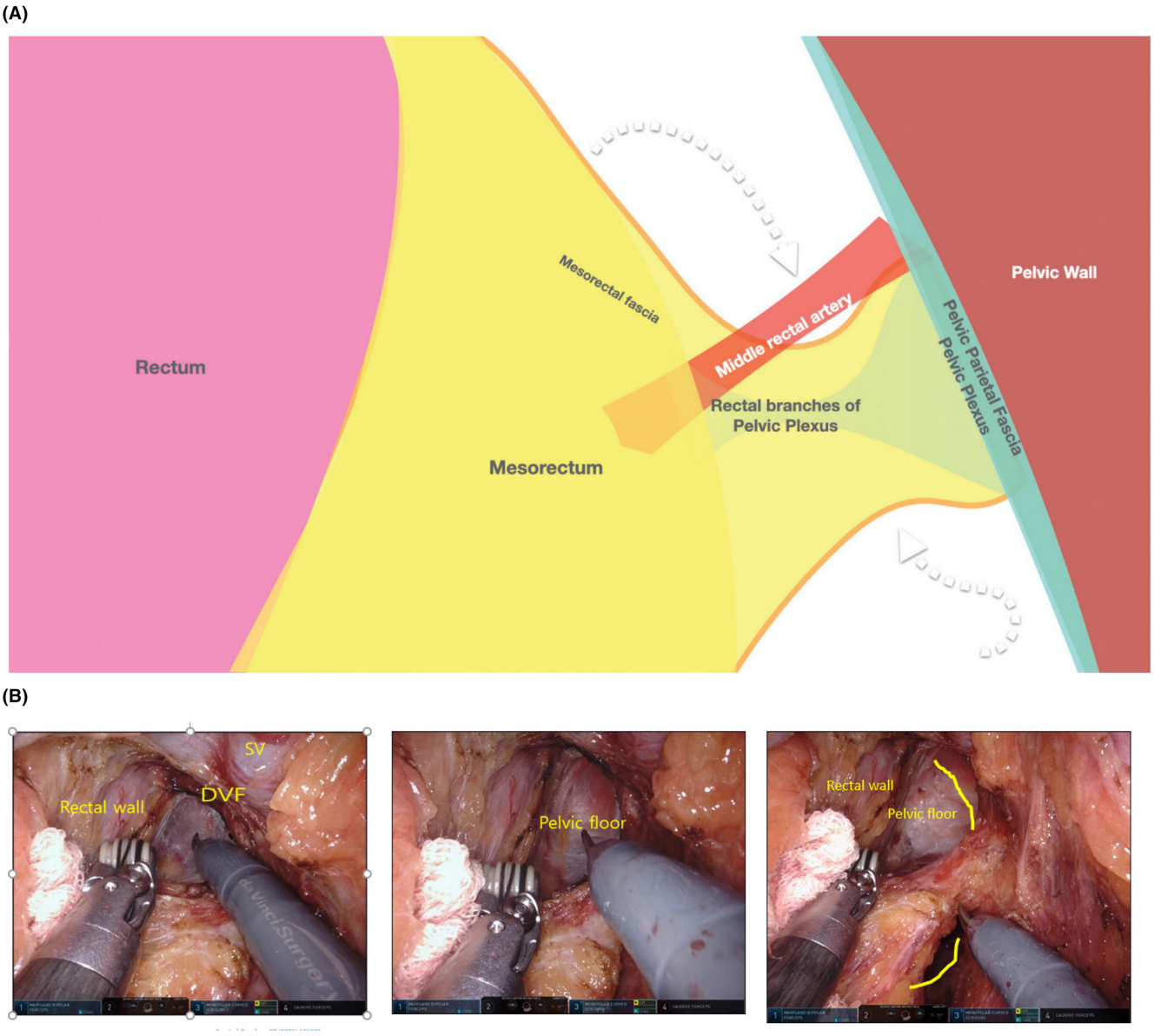


FIGURE 6 The schematic view of and the video clips demonstrating the 'Gate Approach.' (A) The schematic view of the 'Gate Approach' (Reproduced from Cristopher Varela et al. Yonsei Med J 2022 May;63(5):490–492[41] with permission) depicting strategic dissection starting from the seminal vesicle or lateral side of the vagina, progressing towards the lateral part of the mesorectum (right upper white dotted line). The right lower white dotted line in the view, indicating the previous dissection line started from the upper rectum, meets the dissection line configured by the Gate Approach at the middle rectal artery level. (B) The video clips demonstrating 'Gate Approach' (Reproduced from Kim NK et al. Surg Oncol. 2021;37:101535[42] with permission). DVF, Denonvilliers' fascia; SV, seminal vesicle.

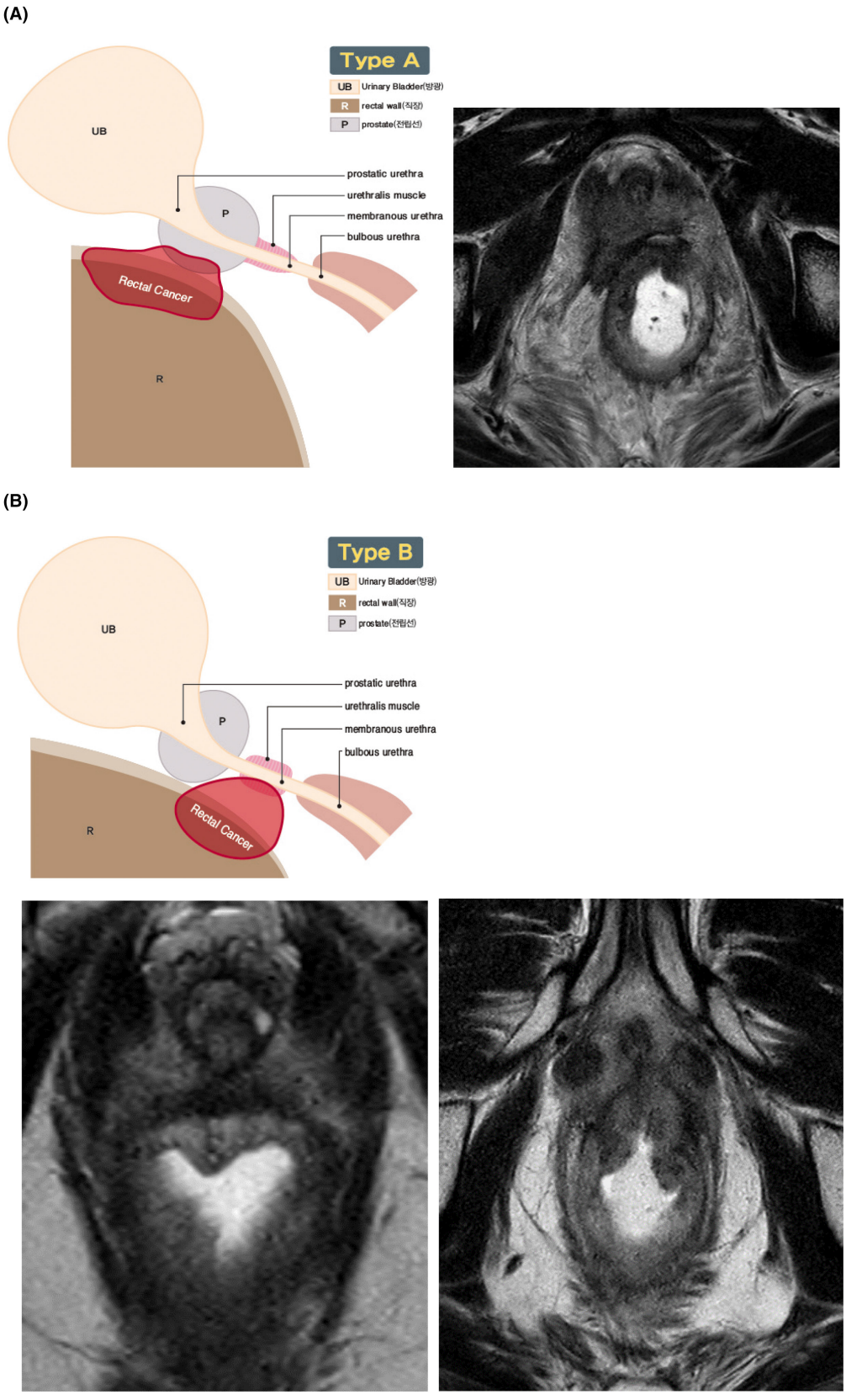


FIGURE 7 The schematic view of surgical management and magnetic resonance images for distal rectal cancer with invasion of prostate and/or membranous or prostate urethra. (A) Type A, low rectal tumor invading the prostate gland, with or without anal sphincter invasion. (B) Type B, low rectal tumor sparing the prostate gland but invading the membranous urethra. (C) Type C, low rectal tumor involving both the prostate (white arrow in the left image) and membranous urethra (red arrow in the right image), possibly extending to the penile root and perineum. P, prostate; PB, perineal body; R, rectum; UB, urinary bladder.

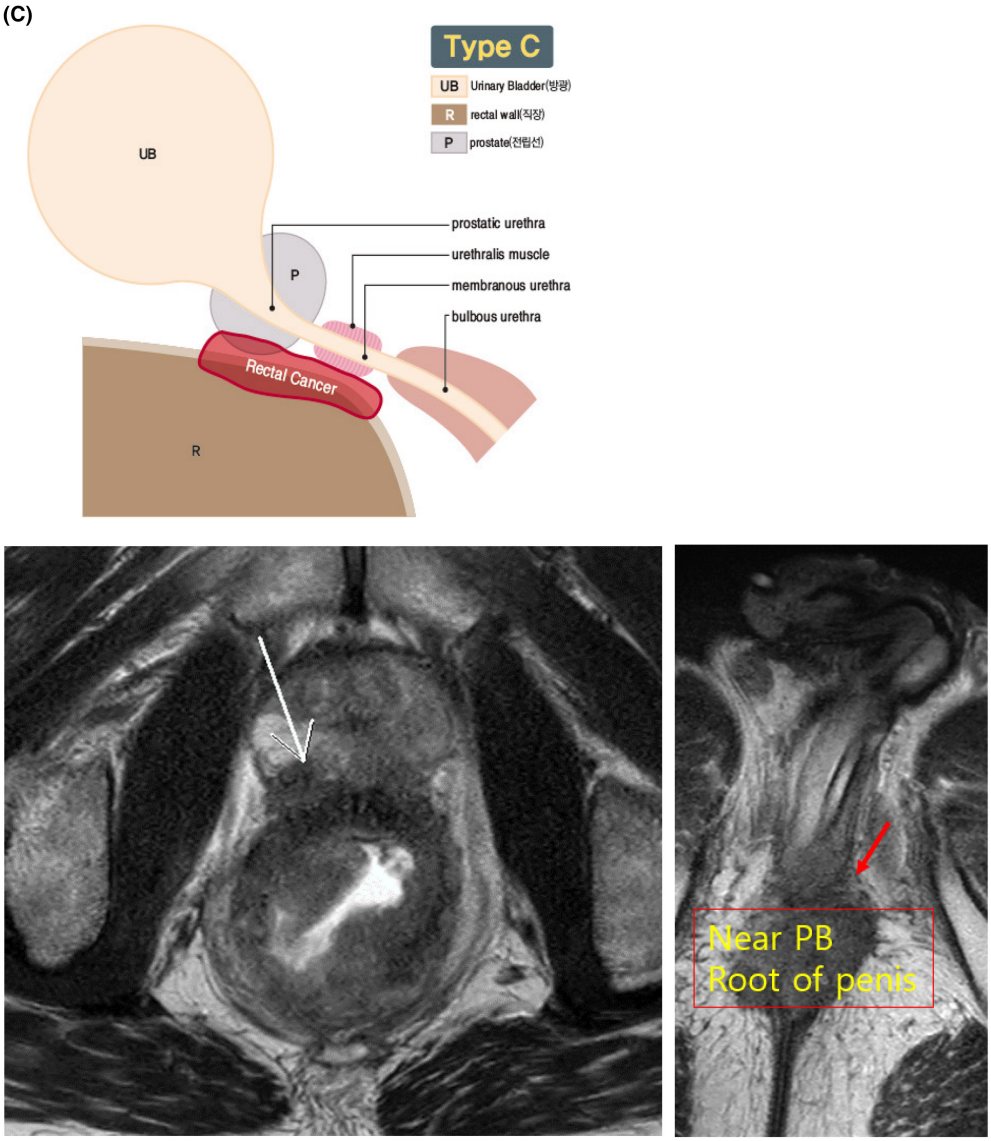


FIGURE 7 (Continued)

6 | SURGICAL EXCELLENCE: UNDERSTANDING AND IMPLEMENTING THE GATE APPROACH

The Gate Approach in rectal cancer surgery is a specialized technique used primarily in TME to facilitate the dissection of the deep anterolateral part of the pelvis.[41,42] This approach involves strategic dissection, starting from the seminal vesicle or lateral side of the vagina, progressing towards the lateral part of the mesorectum, with the aim of creating a 'Gate' between the MRF and the pelvic floor (Figure 6). A critical aspect of this technique is the preservation of the PAN plexus to minimize nerve damage, thereby maintaining urinary and sexual functions postsurgery. The Gate Approach emphasizes the identification of correct surgical planes and often requires enhanced visualization techniques for accurate navigation of the complex pelvic structures. The video vignettes for the Gate Approach are well described in the literature.[41,43] In cases where the rectal MRI sagittal view indicates an extended anterior dissection line, alongside a narrow pelvic outlet or tumor attached to the posterior mesorectum, the Gate Approach could be beneficial.

7 | SURGICAL CONSIDERATIONS FOR DISTAL RECTAL CANCER IMPACTING THE MEMBRANOUS AND PROSTATE URETHRA

In the surgical management of distal rectal cancer with invasion of prostate and/or membranous or prostate urethra, the approach varies based on the extent of invasion. It can be divided into three types (Figure 7). Type A involves cancer invading the prostate gland, with or without anal sphincter invasion, and is typically addressed with ultralow anterior resection or APR combined with prostatectomy, often requiring end-to-end anastomosis for prostate urethra repair.

Type B, where the cancer spares the prostate gland but invades the membranous urethra, may necessitate more complex procedures, including the use of muscular or mucosal flaps for urethral reconstruction. Type C represents a more extensive scenario with cancer involving both the prostate and membranous urethra, possibly extending to the penile root and perineum, requiring pelvic exenteration or APR with additional reconstructive techniques. Each type demands a tailored surgical approach, balancing complete tumor resection with preservation of urogenital functions, underscoring the importance of meticulous preoperative planning and a multidisciplinary treatment approach. This highlights the critical role of thorough presurgical assessment and a collaborative, multidisciplinary approach to treatment. Following TNT or preoperative chemoradiotherapy, the extent of surgical dissection should be determined based on the treatment response and restaging, through discussions within a multidisciplinary team and with the patient, always considering the potential oncologic outcomes and risks of complications.

8 | CONCLUSION

In conclusion, this article has explored a multifaceted landscape in the surgical management of low-lying rectal cancer, emphasizing the critical role of tailored approaches, precise anatomical knowledge, and deep pelvic dissection techniques. The evolving paradigms of TNT, advanced imaging, and individualized treatment strategies have reshaped rectal cancer surgery. By customizing DVF excision, addressing tumors at the anorectal ring, navigating the complexities of the lower rectum, managing tumors in the surgical anal canal, and embracing techniques like the Gate Approach, surgeons can optimize the surgical approach for low-lying rectal cancer. Furthermore, the consideration of distal rectal cancer impacting the membranous and prostate urethra underscores the importance of meticulous preoperative planning and multidisciplinary collaboration. With these insights, rectal cancer surgery continues to advance, striving for the perfect balance between oncologic efficacy and quality of life for patients.

CONFLICT OF INTEREST STATEMENT

The corresponding author is a member of the editorial board for *Annals of Gastroenterological Surgery*; however, he did not interfere with the reviewing or decision process of this article. No other potential conflicts of interest relevant to this article was reported.

ETHICS STATEMENT

Approval of the research protocol: N/A.
Informed Consent: N/A.
Registry and the Registration No. of the study/trial: N/A.
Animal Studies: N/A.

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How to cite this article: Park YY, Kim NK. Tailoring rectal cancer surgery: Surgical approaches and anatomical insights during deep pelvic dissection for optimal outcomes in low-lying rectal cancer. Ann Gastroenterol Surg. 2024;8:761–773. https://doi.org/10.1002/ags3.12824