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# PREAPONEUROTIC ENDOSCOPIC REPAIR OF RECTUS DIASTASIS

Surgery

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## ABSTRACT

Diastasis recti is often considered a variant of midline hernia, leading to both functional symptoms and cosmetic concerns. It is especially common among pregnant and postpartum individuals. Multiple treatment approaches exist, with the pre-aponeurotic endoscopic repair (REPA) gaining recognition as a minimally invasive and effective technique. This method is frequently combined with abdominoplasty to optimize aesthetic and structural outcomes. Minimally invasive techniques are generally preferred over open surgery due to their association with lower complication and recurrence rates. This review outlines the role of REPA in the management of diastasis recti, discussing its surgical advantages, diagnostic considerations, and rehabilitation strategies. It also summarizes current literature and evidence supporting REPA as a reliable and effective treatment option.

## KEYWORDS

Diastasis recti, Endoscopic repair, Abdominal Cavity, Hernia

## INTRODUCTION

Diastasis recti, also known as rectus abdominis diastasis, divarication of the rectus muscles, or abdominal muscle separation, involves an abnormal gap between the two rectus abdominis muscles. This condition results from the stretching and thinning of the linea alba, leading to a noticeable bulge of abdominal contents. It is considered a variant of midline hernia and holds both aesthetic and clinical importance due to its functional and visual impact.[1] Diastasis recti abdominis (DRA) typically occurs between the xiphoid process and the umbilicus and can vary in width from a few millimeters to several centimeters. Unlike true hernias, DRA does not involve a defect in the fascia. The choice of treatment depends on the severity of the condition and may involve noninvasive, minimally invasive, or invasive approaches. While physical therapy and surgery are both valid treatment options, surgical correction often yields more definitive results. One such minimally invasive technique is pre-aponeurotic endoscopic repair (REPA), which can be performed alongside abdominoplasty. This approach involves creating a pre-aponeurotic space bilaterally at the level of the iliac fossae by dissecting through the subcutaneous tissue, followed by the use of a suprapubic entry point to carry out the endoscopic repair. [2] The posterior layer is closed using barbed sutures, followed by abdominal wall reinforcement with a polypropylene mesh, after which surgical drains are inserted. [3,4]

### Epidemiology

Rectus diastasis has a reported prevalence of up to 60% and is most frequently observed in elderly men and women during or after pregnancy. One of the primary contributing factors is increased intra-abdominal pressure, which causes the linea alba to stretch and weaken, particularly during pregnancy. While the inter-rectus distance (IRD) often reduces naturally in the postpartum period, physiotherapists generally recommend avoiding intense physical activity for at least 12 weeks after delivery, as the abdominal wall may still lack the strength to handle additional strain.[3] Diastasis recti can also develop in children and adolescents exposed to acute stressors, such as persistent coughing from pertussis or intense physical activity. The risk is heightened in cases involving immature connective tissues, marked weight loss, or chronic constipation, all of which may further weaken an already compromised anterior abdominal wall.[3,4]

### Changes In The Anatomy Of The Rectus Abdominis

The rectus abdominis muscles, located on either side of the human abdomen, are divided by the linea alba—a central band of connective tissue. The width of this structure defines the space between the two rectus muscles.[5] The rectus abdominis muscles generally measure about 10 mm in thickness, though in athletes and bodybuilders, they can be more developed, reaching up to 20 mm. These muscles are divided into smaller sections by tendinous intersections and primarily attach superiorly to the fifth rib. As shown in Figure 1, the linea alba remains relatively narrow when the abdominal wall is intact and functioning normally. Given their close anatomical relationship with the lumbar spine and pelvis, the rectus muscles are crucial for supporting upper body posture. During pregnancy, these muscles are affected as the uterus enlarges to accommodate the developing fetus.[5,6]

During pregnancy, the rectus abdominis muscles are placed under considerable strain, causing the connective tissue known as the linea alba to stretch and separate. Normally, after childbirth, these muscles are expected to realign, and the linea alba should narrow. However, when this realignment does not occur within the first eight weeks postpartum, the condition known as Diastasis Recti Abdominis (DRA) may develop, as illustrated in Figure 1. In this condition, a noticeable ridge may appear along the midline, extending vertically from the xiphisternum to the umbilicus. Individuals with DRA often present with symptoms such as abdominal bulging, pelvic and lower back pain, poor posture, and difficulty lifting objects. In some cases, the condition may be complicated by a hernia. Diagnosis can typically be made through physical examination or confirmed via abdominal ultrasound. [7,8]

### Treatment Modalities Of DRA

Treatment strategies for DRA are generally categorized into non-invasive, minimally invasive, and invasive approaches, based on the condition's severity. Non-invasive methods primarily involve conservative interventions such as abdominal binders, physiotherapy, and visceral manipulation. This section offers a comprehensive overview of the various therapeutic modalities available for managing DRA.[9]

#### *Conservative Therapy*

Conservative treatment for DRA typically involves abdominal binders, electrical stimulation, manual therapy, and targeted exercises. Among these, therapeutic exercise is the most widely adopted intervention, while abdominal binders are also commonly recommended by healthcare professionals. In the early postpartum phase, binders help provide structural support to the abdominal wall, aiding in symptom relief and promoting muscle recovery.[9]

#### *Physical Therapy With No Physical Exercise*

The effectiveness of non-exercise physical therapies-such as abdominal binders, kinesiotaping, electrical stimulation, and manual therapy-for managing DRA is still not well established in the literature. El-Mekawy et al. conducted a study to assess the impact of abdominal exercises versus the use of an abdominal support belt on IRD and abdominal muscle function. Thirty primiparous postpartum women were enrolled and divided equally into two groups. The first group used abdominal belts starting from the second day after delivery until six weeks postpartum, while the second group performed abdominal exercises three times per week during the same period. Results showed that abdominal exercises led to a significant improvement in abdominal muscle strength. The main goal of therapeutic exercise in postpartum women with DRA is to reduce the widened IRD. [9,10]

#### *Physical Exercise Therapy*

For women with DRA, targeted exercise is recommended as a conservative intervention beginning around six to eight weeks after childbirth. Physiotherapy is widely regarded as a first-line treatment, with therapists often prescribing specific abdominal exercises during both pregnancy and the postpartum period. Postpartum exercise

programs primarily aim to reduce IRD. However, there has been a lack of standardized therapeutic protocols, and the selection of exercises has largely been guided by clinical judgment and individual patient responses. While studies indicate that exercise can be beneficial in managing DRA, the available evidence remains limited. Most exercise programs emphasize activation of the rectus abdominis (RA) and/or transverse abdominis (TrA) muscles. When conservative treatments do not yield satisfactory results-especially in severe cases-surgical correction is considered. Both conservative and surgical approaches aim to restore abdominal wall morphology, improve physical function, and enhance quality of life. Surgical techniques for DRA repair include open, laparoscopic, and endoscopic methods.[9]

***Surgery***

1. Open Approach

Open surgical repair of DRA is generally associated with low rates of recurrence and complications, most of which are minor. Abdominoplasty remains the most commonly performed surgical procedure for DRA correction and may be conducted with or without abdominal wall plication. While plication enhances both functional and cosmetic outcomes, abdominoplasty primarily targets excess skin.[11]

Several incision techniques are available, including transverse suprapubic, midline supraumbilical, left suprapubic, and midline ventral incisions. In cases where DRA is accompanied by a hernia, a peri-umbilical incision combined with abdominoplasty is typically preferred. For mild to moderate forms of DRA, simple plication of the linea alba is often adequate. This can be performed using open, laparoscopic, or hybrid approaches, with or without mesh reinforcement. [11,12]

2. Laparoscopic Approach

Laparoscopic surgery offers a minimally invasive option for managing DRA and has gained popularity due to its favorable short-term outcomes. This approach has shown encouraging results, including low recurrence rates, even without the use of prosthetic mesh. Indications for laparoscopic repair include not only aesthetic enhancement but also functional restoration of the abdominal wall. Overall, laparoscopy serves as a reliable and effective technique for the surgical treatment of DRA. [13]

**Endoscopic Techniques For DRA Repair**

Endoscopic techniques are recognized for their minimally invasive nature, low morbidity, and reduced recurrence rates. Suppose the procedure proves unsuccessful or complications arise. In that case, it can be converted to an open surgery at any point, necessitating that surgeons skilled in endoscopic approaches are also competent in open surgical methods. One such minimally invasive technique, pre-aponeurotic endoscopic repair (REPA), is specifically used to correct rectus diastasis-a condition characterized by the midline separation of the rectus abdominis muscles.

The REPA procedure begins under general anaesthesia to ensure patient safety. After sterilizing the operative field, two small incisions are made in the abdominal wall to insert the endoscopic instruments. Careful dissection of the subcutaneous tissue, located between the skin and the underlying abdominal muscles, is performed to establish a pre-aponeurotic workspace. This approach allows access to the separated rectus muscles without entering the abdominal cavity, thereby reducing the risk of complications such as bowel injury. The rectus muscles are then brought back into alignment using barbed sutures, which are strategically placed to restore the natural midline configuration. [4]

The plication technique used in REPA involves suturing the rectus abdominis muscles to reduce the inter-rectus distance and strengthen the abdominal wall. To further reinforce the repair, a polypropylene mesh is placed over the sutured muscles, providing added structural support and helping to prevent recurrence of diastasis recti. After completing the repair, the endoscopic instruments are removed, and the small incisions are closed using sutures or surgical adhesive. These incisions are minimal, typically resulting in very little visible scarring.

Because REPA avoids entering the abdominal cavity, it lowers the risk of complications and allows for a quicker recovery. The precise dissection and limited incisions contribute to improved cosmetic outcomes and reduced postoperative discomfort. Most patients recover rapidly, experience shorter hospital stays, and return to daily activities sooner compared to those undergoing conventional open surgery. The combination of minimal invasiveness and favorable clinical results makes REPA a highly satisfactory option for both patients and surgeons. [1,2]

Bellido Luque et al. carried out a prospective cohort study to assess the feasibility and operative time of aponeurosis plication using an endoscopic technique in patients with diastasis recti abdominis, also categorized as midline hernias. The procedure was performed on twenty-one patients, with IRD measured both before and after surgery via ultrasound. Patients were monitored for an average of twenty months. Although no significant differences were noted between the first and second year of follow-up, a substantial reduction in IRD was observed at all three measured points one month after surgery.[16] The most commonly reported postoperative complication was the formation of seroma. However, patients demonstrated notable cosmetic improvements within the first year after surgery. A significant reduction in back pain was also observed following the procedure. The authors concluded that the technique is both practical and consistently replicable. [14] Köckerling et al. employed a hybrid technique known as endoscopic-assisted linea alba reconstruction with mesh augmentation (ELAR plus) to repair the linea alba and provide mesh reinforcement. This approach was used in patients presenting with DRA in conjunction with symptomatic epigastric and/or umbilical hernias. Among the cases reported, complications were minimal, with only two instances of delayed umbilical wound healing and a single case of seroma. [17]

**Imaging And Evaluation Techniques For DRA**

Recent progress in rehabilitation engineering has played a crucial role in creating specialized, targeted solutions across clinical fields. In physiotherapy, these advancements have improved the efficiency and precision of patient recovery methods, leading to more accessible and structured treatment protocols. This section highlights the use of diagnostic tools such as ultrasound imaging and electromyography (EMG) for evaluating abdominal muscle activity during therapeutic exercise.

**1. Electromyography (EMG)**

EMG is used to detect the electrical signals produced by muscles during contraction. These signals can be recorded using either needle or surface electrodes, with surface electrodes being the preferred non-invasive method. EMG signals provide a detailed representation of muscle activation patterns and are widely applied in fields such as medicine, rehabilitation, ergonomics, and sports science. In exercise therapy, EMG is particularly valuable for analyzing muscle function and patient movement. Its application in evaluating abdominal muscle activity during therapeutic exercises is well-supported in existing literature, with studies examining activation across various joint positions and movement types.

As a real-time diagnostic tool, EMG offers insights into the effectiveness of specific exercises by capturing muscle response during activity. It is considered the gold standard for measuring muscular activation. The signal data reveal which muscles are involved and the dynamics of their engagement. An increase in EMG signal amplitude indicates greater recruitment of muscle fibers, which is associated with strength gains. A study by Robinson et al. demonstrated that both the upper and lower RA muscles are significantly activated during abdominal exercises.[18] Hwang et al. explored abdominal muscle activation using EMG, focusing on the effects of different irradiation intensities during the abdominal drawing-in manoeuvre. Their study revealed that while irradiation alone has limited impact on the transverse abdominis (TrA) when assessed independently, it substantially increases the activation of the abdominal muscle group as a whole. These results indicate that incorporating irradiation may serve as a useful adjunct to enhance the engagement of multiple abdominal muscles during targeted exercises, potentially improving the effectiveness of abdominal strengthening routines.[19]

**2. Ultrasonic imaging (USI)**

USI provides a non-invasive method for visualizing internal organs and tissues. By utilizing high-frequency sound waves, USI produces real-time images that allow for the evaluation of organ function, muscle activity, and blood flow dynamics. In recent years, USI has become increasingly prevalent in rehabilitation, particularly within

physiotherapy, where it has shown diverse applications in managing musculoskeletal conditions. In this context, USI is employed for purposes such as muscle re-education, functional training, and measuring muscle size and thickness.

Although some measurement parameters may show variability, USI has proven to be a dependable technique for assessing abdominal muscles during exercises like the abdominal drawing-in manoeuvre-even when performed by less experienced clinicians. However, inconsistencies in reliability across different testing scenarios highlight the importance of adequate training before integrating USI into clinical rehabilitation protocols.[20, 21] Teyhen et al. performed a cross-sectional study using USI to evaluate changes in TrA and internal oblique muscle thickness following a trunk-strengthening exercise program. The study also included participants with lower back pain, where USI was used to assess abdominal wall adaptations during lumbar spine stabilization exercises.[22]

### Clinical Outcomes And Postoperative Considerations

Recent literature has reported postoperative vasomotor changes in the abdominal skin following REPA, characterized by intermittent erythema localized to the area of subcutaneous dissection, typically triggered by heat exposure or physical exertion. These symptoms resolved spontaneously without long-term effects, suggesting transient vasomotor alterations due to endoscopic manipulation of subcutaneous tissues.

A prospective, randomized study compared recurrence risks and postoperative outcomes across two surgical techniques for rectus diastasis repair-retro muscular polypropylene mesh repair and double-row plication using Quill sutures. Both surgical groups, along with a control group receiving physical training, were evaluated for recurrence, postoperative pain, abdominal muscle strength, and quality of life. Despite isolated instances of early recurrence and seroma formation, both surgical techniques showed significant and comparable improvements in pain relief, functional recovery, and patient-reported outcomes at one-year follow-up.[23]

Additionally, hybrid endoscopic techniques have been explored in complex cases, such as recurrent incisional hernia with prosthetic fistula, showing promising results in terms of functional recovery and recurrence prevention. These emerging approaches underscore the evolving landscape of minimally invasive options in rectus diastasis and hernia repair.[24]

## CONCLUSION

This review highlights that diastasis recti, resulting from weakening and separation of the rectus abdominis muscles due to thinning and widening of the linea alba, can be effectively managed through both conservative and surgical methods. Among the surgical options, preaponeurotic endoscopic repair stands out by offering safe, minimally invasive correction using a reinforced supra-aponeurotic prosthesis. It demonstrates favorable functional and aesthetic outcomes, reduced recurrence, shorter hospital stays, and minimal complications, making it a promising approach in current clinical practice.

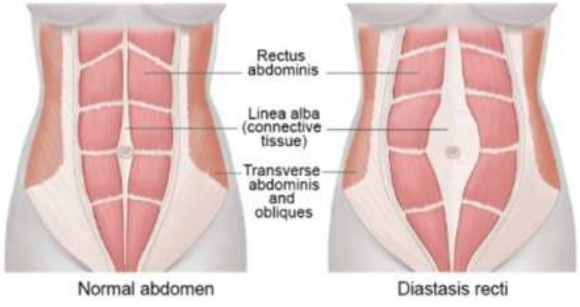


**Fig. 1.** Comparison of Abdominal Muscles in Normal Subjects and DRA Patients [8]

**List of Abbreviations**

**1. DRA** – Diastasis Recti Abdominis
**2. RA** – Rectus Abdominis
**3. TrA** – Transverse Abdominis
**4. REPA** – Pre-aponeurotic Endoscopic Repair
**5. IRD** – Inter-rectus Distance
**6. EMG** – Electromyography
**7. USI** – Ultrasound Imaging
**8. ELAR** – Endoscopic-assisted Linea Alba Reconstruction

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