



Rectus abdominis diastasis

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INTRODUCTION — Rectus abdominis diastasis (RAD; diastasis recti, divarication of the rectus abdominis, abdominal muscle separation) is an anatomic term describing a condition in which the two rectus muscles are separated by an abnormal distance [1,2]. Acquired RAD can result from any number of conditions that weaken the linea alba, resulting in protrusion of abdominal contents.

The definition, clinical features, and management of RAD are reviewed here. RAD is not to be confused with abdominal wall hernia, which is a potentially serious condition that can lead to bowel obstruction. (See "[Overview of abdominal wall hernias in adults](#)".)

DEFINITION — The anterior abdominal wall consists of the abdominal rectus muscles separated by the linea alba, which is a fusion of the external and internal abdominal oblique muscle and transversus abdominis aponeuroses [3-5]. (See "[Anatomy of the abdominal wall](#)", section on 'Muscles'.)

Rectus abdominis diastasis (RAD) describes a condition in which an abnormally wide distance separates the two rectus muscles. However, there is controversy regarding what constitutes a normal inter-rectus distance, at what level measurements should be taken, and by what means, and thus, when the distance can be considered abnormal [1]. We consider any separation more than 2 cm to be abnormal.

What is considered abnormal may differ below as compared with above the umbilicus. In one anatomic study, the normal width of the linea alba in nulliparous women from 20 to 45 years of age with a body mass index <30 was up to 15 mm at the xiphoid, up to 22 mm at 3 cm above the umbilicus and up to 16 mm at 2 cm below the umbilicus [5]. In another anatomic study, the width of the linea alba ranged from 11 to 21 mm when measured from the xiphoid process to the umbilicus, and decreased from 11 mm to 2 mm when measured from the umbilicus to the pubic symphysis. The thickness of the linea alba ranged from 900 to 1200 micrometers between the xiphoid and the umbilicus, and increased from 1700 to 2400 micrometers from the umbilicus to the pubic symphysis [6].

In a biomechanical study, the subumbilical region exhibited a higher coefficient of elasticity than the supra-umbilical portion, but no significant difference in resistance was found between the different portions of the abdominal wall that were studied [7]. In his study:

- <45 years of age diastasis was defined as a separation >10 mm above the umbilicus, 27 mm at the umbilical ring, and 9 mm below the umbilicus.
- >45 years of age diastasis was defined as a separation >15 mm above the umbilicus, 27 mm at the umbilical ring, and 14 mm below the umbilicus.

CLASSIFICATION AND RISK FACTORS — Abdominal wall defects, including rectus abdominis diastasis (RAD), can be congenital or acquired. Acquired RAD is a condition with laxity of the linea alba. Several anatomic classifications for abdominal wall defects have been proposed [8]. Specifically for diastasis, these include quantitative and qualitative classifications [5,7,8]. The Beer classification established the normal width (values between the 10th and 90th percentiles) of the linea alba at different locations in 150 nulliparous women. These measurements are 15 mm at the xiphoid, 22 mm 3 cm above the umbilicus, and 16 mm 2 cm below the umbilicus [5].

Ventral wall formation is a circumferential convergence of the cephalic, caudal, and lateral abdominal wall folds toward the umbilicus [9]. Several congenital anomalies are associated with defects of the anterior abdominal wall [3,10]. The severity of the abdominal wall malformation depends on the timing and degree of involvement of the somatic and visceral layers. Syndromes associated with hypoplasia of the abdominal wall muscles that include hypoplasia and/or separation of the midline musculature include the Cantrell pentalogy (thoracoabdominal syndrome), Beckwith-Wiedemann syndrome, Opitz syndrome, midline defect syndrome and prune belly syndrome. A congenital type rectus abdominis diastasis can occur as an abdominal wall maturation deficiency without an associated sequence or syndrome through an autosomal dominant transmission [3]. (See "[Birth defects: Approach to evaluation](#)".)

Acquired RAD is due to weakening of the abdominal wall tissues due to a variety of factors that result in abdominal muscle separation and laxity with or without protrusion of the abdominal contents. The risk factors for acquired RAD are below.

One question raised by some investigators is whether the protrusion of abdominal contents is due solely to laxity of the linea alba, or if other factors affecting the abdominal musculature also contribute [4]. In a study of 92 abdominoplasty patients, the authors concluded that abdominal wall protrusion is caused by the stretching of the entire abdominal wall and not only the linea alba [4]. Abdominal wall protrusions occurred without diastasis, and flat abdomens exhibited diastasis. The linea alba had a limited range of stretch regardless of the abdominal girth. The widest diastasis (supraumbilical/infraumbilical) frequently did not correspond to the site of the protrusion.

The fascia can become thinned due to stretching, which can be caused by elevated intra-abdominal pressure, such as in pregnancy and obesity [1], or prior abdominal surgery [4]. An association of rectus abdominis diastasis with other disorders known to affect connective tissue suggests an inherent tissue weakness [11].

Patients with acquired RAD typically have one of two profiles: middle-aged and older men with central obesity, or small, fit women who have carried a large fetus or twins to term. In men, rectus abdominis diastasis can occur without abdominal obesity, or abdominal skin relaxation (ie, related to dramatic weight loss) [12].

Pregnancy — Pregnancy increases the risk of developing rectus abdominis diastasis (RAD); however, not all women develop diastasis during the course of pregnancy, and among those who do, RAD is associated with conditions that are related to weakening of other tissues. The amount of the separation can increase, decrease, or stay the same in the postpartum period. While preemptive exercise may prevent diastasis, whether postpartum exercise can resolve diastasis is reviewed below. (See '[Postpartum exercise](#)' below.)

The inter-rectus distance was measured in women from 36 weeks of gestation to 12 weeks postpartum in one study [13]. The distance increased 200 to 400 percent at 12 weeks postpartum compared with the measurement at 36 weeks of gestation. A separate study used ultrasound to measure the inter-rectus distance for 84 healthy primiparous women at three locations along the linea alba at three points in time in the course of their pregnancy [14]. A diagnosis of rectus abdominis diastasis was defined as 16 mm at 2 cm below the umbilicus. The prevalence of diastasis was 100 percent at gestational week 35 and decreased to 39 percent at six months postpartum. Prepregnancy body mass index (BMI), weight gain, baby's birth weight, or abdominal circumference

was not different between women with and without diastasis at six months postpartum. Women with diastasis at six months postpartum were not more likely to report lumbo-pelvic pain compared with women without diastasis.

In a study of women who needed abdominal hysterectomies, 38 percent had RAD, but most were mild [2]. A higher prevalence at 52 percent was found in other studies that have also identified older age, higher gravity and parity, weak pelvic floor musculature and recurrent caesarian section for patients with versus without diastasis [15,16]. A cross-sectional study found that the incidence of rectus abdominis diastasis peaked in the third trimester group, remained high in the women in the immediate postpartum group, and declined, but did not disappear, in the later postpartum group [17].

Prevention of diastasis — A systematic review identified four studies that included 228 women evaluating the effect of exercise during the antenatal period [18]. Exercise significantly reduced the risk of developing RAD (relative risk [RR] 0.65, 95% CI 0.46-0.92).

Obesity — Obesity is a risk factor for incisional hernia related to increased lateral stress. A similar mechanism may contribute to the development of RAD in obese patients. Gradual weight gain can cause the rectus muscles to increasingly separate above the umbilicus [12]. However, there are few studies specifically documenting obesity as a risk factor.

Aneurysm — RAD may be associated with aneurysmal disease, which also results from weakening of the tissues. Some, but not all studies, support such an association. In one study, rectus abdominis diastasis was more prevalent in subjects with abdominal aortic aneurysm compared with subjects with peripheral artery disease (12/18 [67 percent] versus 4/24 [17 percent]) [11]. Another study found no significant difference in inter-rectus distance between those with AAA and controls [19].

CLINICAL FEATURES — Rectus abdominis diastasis (RAD) may or may not be associated with symptoms. Excessive abdominal muscle separation can compromise the function of the anterior abdominal wall.

RAD is usually quite apparent on physical examination. When a patient with RAD raises his or her head and begins to sit up, the increase in intraabdominal pressure as the two rectus muscles contract can result in a diffuse fusiform bulge, often with a protrusion of abdominal contents into the thinned, bulged midline fascia, which can be seen as a prominent ridge extending from the xiphoid to the umbilicus. However, protrusion of abdominal contents may not occur. But, RAD does **not** represent an abdominal wall hernia; there is no fascial defect and, therefore, no risk of incarceration or strangulation. Ventral hernia can coexist with RAD, however, particularly if there has been a previous laparotomy, so differential diagnosis is important.

DIAGNOSIS — Most typically, rectus abdominis diastasis can be diagnosed based on a simple physical examination as described above [2]. Measurements of the distance between the rectus abdominis muscles can be taken at rest and during contraction at several levels along the linea alba to determine if they are abnormal. A pair of dial calipers is used in many research studies, but these are not likely to be readily available to most physicians. The reliability of and the need for a more accurate measuring tool has been suggested [20]. In certain circumstances (eg, obese patient), imaging will be needed to demonstrate widening of the linea alba.

Imaging — If the diagnosis is in question, ultrasonography is a validated noninvasive, repeatable method that can be used to confirm diastasis, exclude other sources for such a bulge, and plan surgery [5,21-24]. Computed tomography (CT) of the abdomen can also be used to accurately determine the inter-rectus distance and further define abdominal wall anatomy [25].

DIFFERENTIAL DIAGNOSIS — The experienced practitioner can usually readily distinguish rectus abdominis diastasis from incisional, congenital, or acquired midline hernias of the abdominal wall. While a true hernia is associated with a fascial defect, patients with rectus abdominis diastasis have **no** detectable fascial defect when they are supine (figure 1 and figure 2).

Incisional hernias are found in the presence of an obvious surgical incision. Congenital or acquired midline hernias of the abdominal wall are confined to the umbilicus or the epigastrium. Epigastric hernias are generally focal and ≤ 2 cm in diameter. (See "[Overview of abdominal wall hernias in adults](#)".)

MANAGEMENT — There are few data to guide management of rectus abdominis diastasis (RAD). Two randomized trials have focused on comparisons of varying types of mesh, or sutures for the repair of rectus abdominis diastasis [25,26]. The remainder of studies consists of a handful of small, retrospective reviews [27].

RAD does not represent a true hernia, and thus, it does not necessarily require repair. Conservative management with weight loss and exercise are advised as a first-line treatment [1]. For symptomatic patients in whom conservative management does not improve RAD, abdominoplasty with rectus abdominis plication, with or without mesh reinforcement, is a surgical option and usually considered an elective cosmetic procedure.

Weight loss — Weight loss should be encouraged, but often does not improve the diastasis. If significant weight loss is achieved and maintained, elective plication of the linea alba can be considered. (See "[Surgical repair](#)" below.)

Postpartum exercise — Exercise programs can be used to help regain some degree of strength in the midline in the postpartum setting [18]. A systematic review identified three studies, one of which was randomized [18]. In the randomized trial, 50 pregnant women were randomly assigned to a postpartum exercise protocol or no exercise in the immediate postpartum period [28]. The intervention group had a greater mean decrease in the inter-rectus distance compared with controls (0.44 cm [13 percent] versus 0.17 cm [5 percent]).

The Tupler technique is another nonsurgical method of correcting or improving diastasis recti. This technique is focused on allowing the damaged connective tissue to repair itself by offloading pressure by wearing an abdominal splint or binder-like device. The program typically takes 18 weeks and modified exercise programs are initiated at six weeks [29]. Peer reviewed publications are lacking.

Interested women can be referred to a physical therapist, who can help develop a postpartum exercise program targeted at strengthening the anterior abdominal wall. For patients with rectus abdominis diastasis as a result of pregnancy, elective plication is a reasonable option once normal prepregnancy weight has been achieved and if there are no plans for future pregnancies.

Spontaneous resolution — Rectus abdominis diastasis in infants often spontaneously resolves as the infant grows and their rectus abdominis strengthens and hypertrophies. Spontaneous resolution has been reported for acquired diastasis, usually in the setting of postpartum diastasis and sometimes associated with specific physiotherapy efforts [13].

SURGICAL REPAIR — The indications for repair of rectus abdominis diastasis depend upon the clinical setting. Some have suggested that the abdominal protrusion, rather than the amount of muscle separation, is more important for determining whether or not to proceed with surgical repair [4,12]. Larger rectus abdominis diastasis can be repaired if the patient has significant symptoms, but it is doubtful that smaller defects require any repair at all [1,30]. However, for women who do not resolve their diastasis in the postpartum period, particularly those with loss of abdominal musculature following multiple pregnancies, repair can improve pulmonary and abdominal wall function. Repair is often performed as a cosmetic abdominoplasty by plastic surgeons. However, plication alone is an option for those without excessive skin laxity, a procedure that is also performed by general surgeons [12]. Depending upon the magnitude of the procedure, an inpatient or outpatient setting may be appropriate [31].

Approaches — There are many methods by which to repair rectus abdominis diastasis. These differ by approach (open versus laparoscopic), numbers of layers of sutures, the position of suture placement, suture material used, and whether or not mesh is used [27,32].

Regardless of approach, to provide an effective repair, plication of the rectus sheath is required. If the defect is congenital, some suggest plication of the posterior as well as the anterior sheath [33].

The approaches may differ for men versus women. In men, the approach is usually through a vertical incision, whereas in women it is through a low transverse Pfannenstiel-type incision [34]. Vertical plication only is generally not felt by some to be enough to improve the waistline [35]. For this reason, transverse plication of the rectus abdominis fascia is also performed to prevent epigastric bulging.

Laparoscopic repair — Laparoscopic approaches to diastasis have been reported [25,36-38]. Indications for total laparoscopic repair include midline/umbilical hernia measuring >2 cm, no prior hernia repair or laparotomy, and no need for abdominoplasty. The only randomized trial comparing open and laparoscopic repair reported a lower rate of complications for the laparoscopic compared with open abdominoplasty groups (15 versus 24 percent) [38]. Four patients required operative reintervention in the open abdominoplasty group for complications of wound healing and hematoma formation.

Abdominoplasty — Diastasis is often corrected in the course of abdominoplasty [25,30,31,33,35,39-49]. The standard abdominoplasty approach is performed by removing excess skin. Liposuction is commonly combined with abdominoplasty to remove excess fat [42,50,51]. Then the skin of the anterior abdominal wall is undermined up to the xiphoid to expose the fascia of the rectus muscles [31]. The umbilicus stays in its native position and a new orifice is made to accommodate it after advancing the abdominal skin inferiorly. The diastasis can be repaired by removing a strip of the widened linea alba and reapproximating the edges of the rectus muscles using running sutures [25].

Plication alone — For mild-to-moderate diastasis recti, suture plication alone can be considered. The fascia medial to the rectus abdominis muscles can be sutured together (plicated) along the vertical midline. This can be performed using a two-layer suture technique or via the triangular suture technique, incorporating the lateral edges of the fascia and the midline of the posterior rectus sheath. In a small trial that compared nylon (permanent) with polydioxanone suture (absorbable) for the repair of diastasis, there were no significant differences in outcomes at six months [25]. Other suture comparisons have also not shown a significant difference in outcomes [52,53].

Plication with mesh — For moderate-to-severe diastasis recti, repair can be considered using suture plication and mesh. This mesh can be placed on the surface of the anterior rectus sheath following plication or between the rectus abdominis muscle and posterior rectus sheath, also known as the retrorectus space. The onlay technique consists of a permanent or resorbable mesh placed over the anterior rectus sheath and typically extends from the costal margin to the pubic region. The mesh is usually fixed in position with absorbable sutures [54]. With the retrorectus technique, the redundant posterior sheath is plicated or excised, and a permanent or absorbable mesh is placed and anchored with absorbable sutures [34].

When a diastasis occurs in conjunction with a true hernia, one investigator recommends first managing the hernia followed by a retrorectus dissection, reapproximation of the posterior rectus sheath, placement of a midweight polypropylene mesh, and midline plication of the rectus abdominis muscles [34]. No recurrence of hernia or bulge occurred in 32 patients at 1.5 years using this technique.

Postoperative care and follow-up — Heavy lifting (more than five pounds) is restricted for six weeks postoperatively. Closed suction drains are usually placed and remain for a few days until the output is <30 cc/24 hours. An abdominal binder is considered in women with severe rectus diastasis for compression and comfort. Patients are usually instructed to follow up every three to four days following surgery until the drains are removed, and then again at six weeks.

Complications — Major complications following surgery are uncommon [1]. The nature of complications differs depending upon the surgical approach. Most complications are primarily due to seroma or wound complications, such as skin or flap ischemia, surgical site infection or hypertrophic scarring [12,27,35,38,45,55].

Despite the theoretical risk for deep vein thrombosis (DVT) due to a reduction in venous return and venous pooling due to increased intraabdominal pressure, a systematic review found no DVTs [27].

Complications may be more frequent when mesh is used. In one trial of 64 patients that compared suture repair with mesh repair, short-term superficial wound infection occurred in 31 percent following mesh repair and 18 percent following suture repair, and that seroma occurred in 17 percent following mesh repair and 14 percent following suture repair [26].

Recurrence and other outcomes — Repair of RAD has high rates of initial success, but the reported rate of recurrence is high [27,30,48]. In a systematic review, recurrence occurred in 40 percent of cases, but there was high variability between the reports [27]. Few recurrences are reported in studies with short- or intermediate-term results [34,46,48,52,56]. As examples, in a review of 20 women for whom diastasis recti was repaired using midline plication after abdominoplasty, no recurrences were apparent on magnetic resonance imaging evaluation to 25 months [57]. In another study of retrorectus repair using polypropylene mesh, there were no recurrences at 18 months follow-up [34].

Several studies have assessed longer-term results following diastasis repair. In one small study that used plication alone, no recurrences occurred at an average of 81.2 months follow-up [46]. However, in the report of 63 patients, after a mean follow-up period of 64 months following plication with absorbable mesh, recurrence occurred in 40 percent [35]. In another review where absorbable mesh was used, only one recurrence was reported among 52 women over a mean follow-up of 54 months [50].

Following surgery to correct rectus abdominis diastasis, patient satisfaction with the procedure appears to be generally high [27]. In one trial, patient satisfaction was 90 percent among those repaired using mesh reinforcement and 82 percent for those undergoing suture repair [26]. The authors concluded that there were no appreciable differences between the two techniques in terms of early complications and perceived pain three months following the procedure.

SUMMARY AND RECOMMENDATIONS

- Rectus abdominis diastasis (RAD) is an anatomic term describing a condition in which an abnormal distance separates the two rectus muscles. There is controversy regarding what constitutes a normal inter-rectus distance. We consider a separation of more than 2 cm to be abnormal. (See '[Definition](#)' above.)
- Abdominal wall defects, including RAD, can be congenital or acquired. Acquired RAD is due to weakening of the abdominal wall tissues due to a variety of factors that can result in abdominal muscle separation. Risk factors for RAD include elevated intraabdominal pressure, such as in pregnancy or obesity, prior abdominal surgery, and known connective tissue disorder. (See '[Classification and risk factors](#)' above.)
- Patients with acquired RAD typically have one of two profiles: middle-aged and older men, or small, fit women who have carried a large fetus or twins to term. In men, rectus abdominis diastasis can occur without abdominal obesity, or abdominal skin relaxation.
- RAD is usually quite apparent on physical examination. It can usually be easily distinguished from acquired midline hernias of the abdominal wall, but in certain circumstances, ultrasound (or computed tomography) of the abdomen may be needed. (See '[Clinical features](#)' above.)

- RAD does not represent a true hernia, and thus, it does not necessarily require repair. Conservative management with weight loss and exercise are advised as a first-line treatment. Surgical repair can improve pulmonary and abdominal wall function. (See '[Management](#)' above.)
- Preemptive exercise may prevent RAD in pregnant women, and for those who develop RAD, postpartum abdominal wall strengthening exercises can improve RAD. For women who do not resolve RAD in spite of conservative measures, abdominoplasty can be considered. (See '[Prevention of diastasis](#)' above and '[Postpartum exercise](#)' above and '[Surgical repair](#)' above.)
- For symptomatic men with RAD who do not respond to conservative measures, abdominoplasty can be considered.
- Plication of the rectus sheath is often performed in conjunction with abdominoplasty; however, plication alone is an option for those without excessive skin laxity. Major complications following surgical repair of RAD are uncommon and depend upon the surgical approach. Recurrence rates are variable depending on the length of follow-up; long-term recurrence rates may be as high as 40 percent. (See '[Surgical repair](#)' above.)

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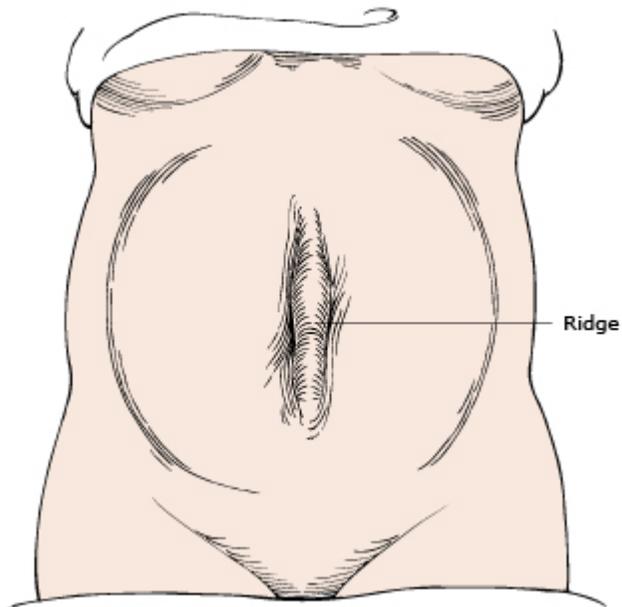
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Topic 100494 Version 5.0

GRAPHICS

Diastasis recti

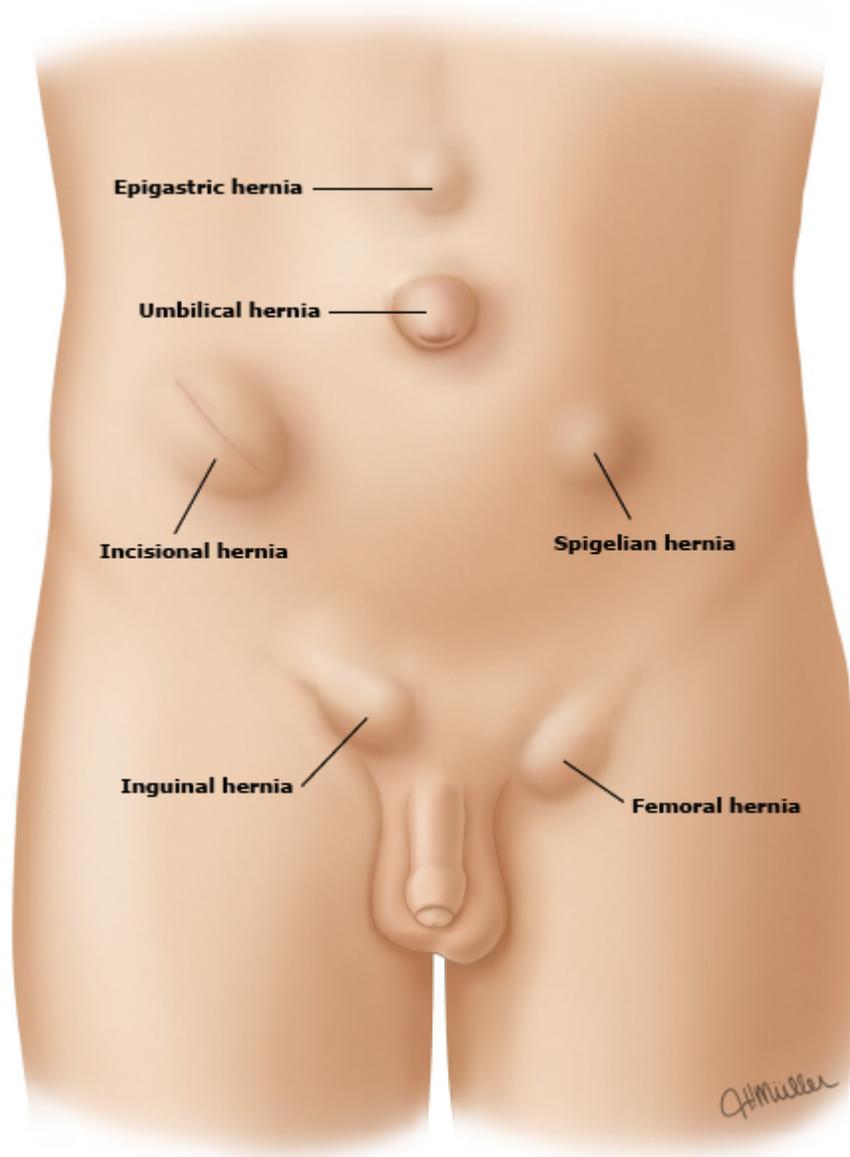


Diastasis recti occurs when bowel protrudes through a separation between the two rectus abdominis muscles. It appears as a midline ridge. The bulge may appear only when client raises head or coughs. The condition is of little significance.

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Abdominal wall hernias



Abdominal wall hernias include incisional hernias which occur along incisions from a prior surgery; umbilical hernias; epigastric hernias, which occur between the umbilicus and xiphoid; spigelian hernias located at the arcuate line; lumbar hernias in the flank (not shown); and groin hernias (inguinal and femoral hernias).

Graphic 52358 Version 3.0

Contributor Disclosures

Maurice Nahabedian, MD Speaker's Bureau: LifeCell [Breast and abdominal wall reconstruction (Acellular dermal matrices)]; Allergan [Breast and abdominal wall reconstruction (Breast implants)]. Consultant/Advisory Boards: LifeCell [Breast and abdominal wall reconstruction (Acellular dermal matrices)]; Allergan [Breast and abdominal wall reconstruction (Breast implants)]. **David C Brooks, MD** Nothing to disclose **Charles E Butler, MD, FACS** Nothing to disclose **Michael Rosen, MD** Grant/Research/Clinical Trial Support: WL Gore; Miromatrix [Mesh (Mesh)]. Speaker's Bureau: WL Gore; Bard [Mesh (Mesh)]. Consultant/Advisory Boards: Artiste Medical [Mesh (Mesh)]. Employment: Medical Director of AHSQC (Americas Hernia Society Quality Collaborative). **Kathryn A Collins, MD, PhD, FACS** Nothing to disclose

Contributor disclosures are reviewed for conflicts of interest by the editorial group. When found, these are addressed by vetting through a multi-level review process, and through requirements for references to be provided to support the content. Appropriately referenced content is required of all authors and must conform to UpToDate standards of evidence.

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