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Chapter

Anatomical and Surgical Principles of Ventral Hernia Repairs

*Chrysanthi Papageorgopoulou, Konstantinos Nikolakopoulos,
Fotios Efthymiou and Charalampos Seretis*

Abstract

Hernias comprise a growing problem in surgical science. The most recent classification scheme for hernias emphasizes on the size of defect as well as on whether it is an incisional hernia. The latter group includes complex hernias, namely hernias that can not be managed with simple surgical techniques. This can be accomplished with retromuscular repairs or the more complex anterior and posterior component separation techniques. An anatomic repair is usually reinforced with interposition of mesh. Newest techniques, such as the use of botulinum toxin to induce temporary paralysis of the lateral abdominal wall musculature, referred to as chemical component separation, now present new tools in the restoration of anatomy-based repairs. The chapter entitled “Anatomical and surgical principles of ventral hernia repairs” aims to describe the anatomical and surgical principles of current practice regarding the repair of ventral -primary and incisional-hernias.

Keywords: hernia, ventral, surgery, anatomy

1. Introduction

Ventral hernias constitute a significant percentage of abdominal wall hernias, making the topic of relevant surgical anatomy and operative principles a fundamental one for the general surgeons, as well as urologists, gynecologists and vascular surgeons who perform operations within the peritoneal cavity. Historically, their management can be as simple as placement of a few interrupted sutures to close the hernia defect, but can also be as demanding as a complex abdominal wall reconstruction for patients with loss of domain. Without a doubt, knowledge of the basic surgical anatomy principles and up-to-date operative techniques is mandatory for the avoidance of perioperative complications and reduction of future hernia recurrences. In this chapter, we aim to address these theoretical and practical issues, aiming to facilitate the formation of a structured individualized approach for the operating surgeons.

2. Principles of surgical anatomy of the anterior abdominal wall

The anterior abdominal wall is an anatomically complex structure, comprising of skin, subcuticular adipose tissue, myofascial complexes and parietal peritoneum. Its

central component is formed by the muscle fibers of the rectus abdominis, which are encased within an aponeurotic sheath and extend from the costal margins to the pubis [1, 2]. The anterior and posterior layers of these sheaths fuse in the midline, forming the linea alba [3]. The lateral border of the recti muscles have a convex shape which forms the semilunar line [4]. Lateral to the rectus sheath, three distinct muscles are identified: the external oblique, internal oblique and transversus abdominis muscles [5]. The external oblique muscle lies most superficially of the three and runs in an inferior and medial direction. Immediately deep to that, the internal oblique muscle is encountered coursing in a crossing direction to the external oblique muscle fibers. Finally, the deepest-lying muscle is the transversus abdominis, which travels, in accordance to its name, in a transverse direction. Of particular importance to the surgical repair of the ventral hernias are the aponeuroses which invest the above-mentioned anterior abdominal wall muscles and form the fascial sheath of the recti muscles, apart from investing their native muscle. Having as a landmark the arcuate line (or semicircular line of Douglas), which forms the axis between the right and left anterior superior iliac spines, the anterior rectus sheath is formed mainly by the external oblique aponeurosis and the external layer of the internal oblique aponeurosis, while the posterior rectus sheath is formed by the internal layer of the internal oblique aponeurosis, the transversus abdominis aponeurosis and the transversalis fascia. Inferiorly to the level of the arcuate line, the anterior rectus sheath is formed by layers of the aponeurosis of the external oblique, internal oblique and transversus abdominis muscles, while the posterior rectus sheath is absent, with transversalis fascia being the only pre-peritoneal fascial component of the recti complex [6]. Regarding its blood supply, the vast majority of inflow comes from the inferior and superior epigastric arteries, as well as complexes of the subcostal and lumbar arteries; venous outflow follows the main arterial branches [7, 8]. Finally, innervation is originating from the thoracic and lumbar spine, and more specifically between the levels of T4-L1 spinal nerves [9]. From a technical perspective, perforating branches encountered during the dissection of the subcuticular layer flaps are critical for the viability of the anterior abdominal wall skin and should be preserved as possible; the same accounts for the neurovascular bundles which are encountered during dissection along the retrorectus space, as they are absolutely vital for the perfusion and functionality of the anterior abdominal wall [10, 11].

3. Types of ventral hernias

With the term “ventral hernia” we tend to describe the epigastric hernias, umbilical/paraumbilical hernias, as well as the anterior abdominal wall incisional hernias [12]. Epigastric hernia any primary hernia located in the epigastric region of the anterior abdominal wall, topographically located anywhere on the axis of linea alba between the xiphoid process and 1–2 cm superiorly to the umbilical ring. They represent a true anatomical defect between the avascular fibers of the linea alba and usually contain pre-peritoneal adipose tissue, greater omentum, parts of the small or large bowel [13]. Very infrequently the stomach or even the solid organs of the upper abdomen, have been reported to protrude through large epigastric hernia defects, however these reports are rather scarce in the literature [14]. It has to be noted, that in many individuals, there is a laxity of the linea alba and the anterior abdominal wall myofascial complexes, which clinically can manifestate as a “bulge” during Valsalva’s maneuver between the recti muscles in the epigastric region and not surprisingly

can be mistaken as a ventral hernia. This condition, in which only laxity of the linea alba exists without the presence of a defined, true anatomical defect exists, is called deverification of recti and its operative management is completely different of a typical ventral hernia [15]. Therefore, the operating surgeon should have a low threshold for assessing these patients with a further imaging modality (ie ultrasound, compute tomography or dynamic magnetic resonance scans) to confidently differentiate between the two conditions.

Umbilical/paraumbilical hernias, as the onomatology implies, are the hernias whose defects arise through or adjacent to the umbilical ring, and can be congenital or develop later in life. Of note, the vast majority of the umbilical hernia defects that can be seen in infancy, will self-obliterate by the 5th year of age in more than three quarters of the patients [16]. With respect to those hernias arising during adult life, any factor which can increase the intra-abdominal pressure (obesity, ascites, chronic cough, pregnancy, chronic straining due to constipation) or weaken the strength of the anterior abdominal wall (connective tissue diseases, smoking, auto-immune disorders), could be implicated in their pathogenesis [17].

Incisional hernias occur at the sites of previous sites of surgical incisions and hence commonly are encountered in the midline (laparotomy), right iliac fossa (appendectomy), right upper quadrant (open cholecystectomy), lower abdomen (cesarean section, gynecological procedures), as well as the insertion sites of laparoscopic ports (port-site hernias). With respect to the time of their occurrence, the vast majority of incisional hernias occurs within the first 5 years post surgery, stressing the need for extended follow-up of the patients who are at high risk for development of incisional hernias [18]. Incisional hernias at sites of previous hernia repairs can also be described as “recurrent” hernias. Special note should be made to the parastomal hernias and other less common types, such as the semilunar and obturator hernias, which although technically arising from myofascial defects of the anterior trunk, they are traditionally not included in the category of ventral hernias and hence they are not addressed in this chapter.

4. Principles of pre-operative assessment, planning and decision-making

Thorough clinical examination is the first key step in the diagnostic pathway of the patients with ventral hernia. Despite the limitations which can be expected when it comes for instance to the examination of a morbidly obese patient, physical examination is essential to allow an initial estimation of the hernia features, such as size, reducibility and presence of multiple defects. Detailed history regarding the relevant symptomatology and accompanying medical comorbidities, as well as previous abdominal operations is critical prior to planning any hernia repair. From a medico-legal point of view, we tend to reserve a minimum of 20-min consultation slot for each new referral in our outpatient clinic, in order to avoid time pressure during the patients’ initial assessment. In addition, for “straightforward” cases of ventral hernias (ie small primary defects in fit patients), where the patient can be put directly on the waiting list, we strongly advise that the operating surgeon and the patient counter-sign the consent form for the procedure during the visit in the clinic rather than on the day of the actual operation, to ensure mutual understanding of the procedure details and associated risks and implications.

In cases of uncertainty regarding the actual extent of the hernia, presence of multiple subclinical defects, previous failed hernia repairs, as well as in cases where

co-existing intra-abdominal pathology warrants exclusion, we strongly advocate for the performance of additional imaging essays of the anterior abdominal wall, with computed tomography (CT) scan being the modality of choice. Anecdotally, in our practice, we tend to almost routinely perform CT scans pre-operatively in all patients with significant size defects, in order to pre-empt the need for implementation of abdominal wall reconstructive adjunct techniques (discussed later), as well as in patients with recurrent incisional hernias, as the clinical examination can easily miss small and subclinical at the time defects. Regarding pre-operative optimisation, smoking cessation is mandatory, due to its well-known impact on post-operative wound infections, hernia recurrence rates and pulmonary complications. Especially in cases with major defects, pre-operative consultation by the anaesthesiologist is also sought, so as to correct any outstanding medical issues, in conjunction with the patient's general/family practitioners. Finally, the patients with complex ventral hernias benefit from a pre-habilitation structured intervention programme including nutritionist, physiotherapist and psychologist, aiding both the physical and mental preparation. Special note should be given to the increased popularity of implementation of specialist hernia multi-disciplinary team meetings (MDTs), as it happens with the surgical oncology patients' tumor boards [19]. The benefits of these meetings, with the participation of all the medical and allied health professionals who will be involved in the care of complex hernia patients, is the central co-ordination of care, ability to assess the patient and his/her surgical problem through a more holistic approach, ability to involve other surgical specialities in a proactive manner (eg plastic surgeons in cases of abdominal wall reconstructions) and promotion of institutional expertise through continuous monitoring of patient outcomes during the follow-up periods.

5. Principles of technical approaches and operative strategies

Upon identification of the clinical need to repair a ventral hernia, the next key questions arise: "open or laparoscopic?", "mesh or primary suture?", "if to use a mesh, where should that be placed?"

With respect to the open versus laparoscopic approach, the expansion of minimally invasive techniques and the attracting concept to the patients has resulted in a significant decrease of the number of ventral hernia cases performed with the traditional open approach. The well-known benefits of laparoscopic surgery, such as reduced hospital stay, improved post-operative pain control, less tissue handling, better cosmesis due to the performance of smaller incisions, have to be considered in ventral hernia repairs [20, 21]. However, one should also bear in mind that laparoscopic surgery has its own natural limitations, like the need for a minimum of three separate incisions (laparoscope, two operating trocars) to perform the procedure, requirement of a medically stable patient who can tolerate the pneumoperitoneum and afford physically a probably longer operative time (excluding essentially the patients with significant co-morbidities or the critically unwell patients with incarcerated-strangulated ventral hernias), absence of extensive intra-abdominal adhesions, which could be the case in patients with incisional hernias and absence of intra-abdominal contamination in particular cases, like the ones with expected need for previous mesh explantation etc. [22]. Obviously, prior laparoscopic surgery experience of the team plays a crucial role here, allowing to "push the envelope" sometimes with undertaking laparoscopic hernia repair in more complex than the average cases. Sometimes

though the operating surgeon should bear in mind that the preferable way is the easiest and fastest one, taking into account that most ventral hernia repairs could be safely performed in the traditional open fashion even by a surgical trainee; hence, complicating a straightforward open case for no reason will potentially just result in avoidable morbidity.

Regarding the use of mesh versus primary suture repair, the globally accepted consensus is that for defects <1 cm primary suture repair is acceptable, while for hernia defects >2 cm the use of prosthetic re-enforcement is advised; for the gray-zone of ventral hernia defects between 1 and 2 cm, an individualized risk/benefit approach is usually followed, balancing between a theoretically higher risk of hernia recurrence versus potential mesh-related complications [23, 24]. At this point, due to the existence of a number of patients who under no circumstances want the insertion of a prosthetic material in their body, the operating surgeon and the patient should have had this relevant discussion during the initial planning consultation and a tissue-only repair is sometimes mandated by the patients' wishes. Another common scenario that deters many surgeons from using mesh and therefore renders the "mesh vs no-mesh" dilemma unnecessary, is the presence of surgical field contamination, although biological meshes could serve as a solution to the problem in cases where augmentation of a simple suture repair is required or as a bridging strategy in patients with loss of domain, where tissue approximation is not deemed possible. The chosen type of mesh can be placed under the subcutaneous tissue layer (onlay), within the myofascial complexes of the abdominal wall (inlay, such as the retro-rectus position), in the pre-peritoneal space (sublay) or under the parietal peritoneum, in a fully intraperitoneal location [25]. All these anatomical spaces have their pros and cons with respect to hernia recurrence rates, technical ease, seroma formation, occurrence of wound infections/breakdowns. The operating surgeon needs to individualize the repair plan and for instance balance the benefit of a straightforward onlay mesh repair with the known higher chance of wound infections and seromas that accompany this technique.

Probably the key to the success of the repair of ventral hernias is the achievement of a tension-free repair with preservation of the blood and nerve supply to the anterior abdominal wall, as discussed earlier. Although this may be relatively easy with small defects, eg up to 5 cm, in cases of wider defects additional strategies might be required for a tension-free repair. Under this notion, the so-called "component separation techniques", with an anterior and posterior approach have been described. Although detailed description of these techniques exceeds the scope of this chapter, the common concept is that by appropriate division of myofascial elements, the release of the anterior abdominal wall components from their tight investments allows to gain more than 5 cm advancement gain in the epigastric region and a smaller but equally significant myofascial medialisation in the suprapubic region, enabling tension-free closure of large defects [26, 27]. Relatively recently, the "chemical component separation" technique has emerged, using Botox injections to paralyze temporarily the anterior abdominal wall musculature at the level of the forthcoming intervention, in order to allow for a more natural relaxation of the muscles and achievement of tension-free closure [28]. Finally, in some centers, the use of progressive pneumoperitoneum is utilized, with the patient undergoing sessions of progressive abdominal wall distension, aiming to mechanically stretch the anterior abdominal wall musculature and facilitate large defects' closure [29].

6. Summary

The management of ventral hernias can be as simple as placement of a few interrupted sutures or as difficult as a formal anterior abdominal wall reconstruction. Careful pre-operative planning with liberal use of appropriate imaging can help to formulate an accurate operative plan and minimize the chance for avoidable complications. The same accounts for the fundamental principle of holistic assessment of the patients and their needs, as well as their expectations. In addition, we strongly advocate routine follow-up of patients who are at high risk of developing incisional hernias, in a similar mindset to the follow-up of patients who undergo curative cancer operations, as early identification of an incisional/recurrent hernia facilitates its management. Finally, one should always bear in mind that the fact that a hernia operation is at the end of the day an “easy operation” is only a misleading stereotype and complex abdominal wall hernias should be ideally approached by experienced surgeons in centers with an established hernia service, rather than being attempted by novice or inexperienced surgeons.

Author details

Chrysanthi Papageorgopoulou¹, Konstantinos Nikolakopoulos¹, Fotios Efthymiou² and Charalampos Seretis^{1,3*}


1 Department of General and Vascular Surgery, General University Hospital of Patras, Achaia, Greece

2 Department of Medical Physics, School of Medicine, University of Patras, Achaia, Greece

3 Medical School, University of Warwick, United Kingdom

*Address all correspondence to: babismed@gmail.com

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