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HERNIAS, AORTIC SURGERY AND REVIEW OF THE LITERATURE ON INCISIONAL HERNIAS

Kile, kirurgija aorte i pregled literature incizijskih hernija

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Abstract

Objectives: To study the relation of incisional hernias after abdominal aortic surgery and to study the recommendations for prevention of incisional hernias in general.

Methods: An extensive search in Pub-Med was conducted. We used the following MeSH terms; abdominal aortic aneurysm; incisional hernia; inguinal hernia; incisional hernia and radiology, abdominal wound closure, we also did a "snow-falling" search with the above terms.

Results: Still today there is no unanimity concerning the relation of aortic or aortoiliac pathology and incisional or inguinal hernias although the majority of studies suggest that there is a possible increase in the prevalence of incisional hernias after aortic surgery.

Conclusions: In order to lessen the possibilities of incisional hernias suture length to wound length ration should be more that 4:1. Sutures should be tied without excessive tension and either a slowly absorbable or nonabsorbable suture material should be used. Use a suture USP 2/0 mounted on a small needle. Place stitches in the aponeurosis only and 5 to 8 mm from the wound edge and 4 to 5 mm apart.

Key words

incisional hernia, aortic surgery, recommendations, abdominal wound suture, prevention of incisional hernias

Sažetak

Ciljevi: Ispitivanje veze između incizijske hernije i operacije abdominalne aorte te općenito proučiti preporuke za prevenciju incizijske hernije.

Metode: Provedena je opsežna potraga u Pub-Medu. Koristili smo sljedeće MeSH uvjete; aneurizma abdominalne aorte; incizijska hernija; ingvinalna hernija; incizijska hernija i radiologija, zatvaranje abdominalnih rana, također je korištena „snow-falling" potraga s navedenim ključnim riječima.

Rezultati: Do danas ne postoji jednoglasnost u pogledu odnosa aorte i aortoilijačne patologije te incizijske ili ingvinalne hernije, iako većina studija ukazuje na to da je moguće povećanje učestalosti incizijske hernije nakon operacije na aorti.

Zaključak: Kako bismo smanjili mogućnost pojave incizijske hernije, dužina šava u odnosu na dužinu rane morala bi biti više od 4:1. Šavove treba vezati bez pretjeranog zatezivanja te za šivanje treba koristiti materijal koji upija sporo ili ne upija uopće. Koristite šav USP 2/0 na maloj igli. Kao mjesto uboda odaberite aponeurozu samo 5 do 8 mm od ruba rane, u razmaku 4 do 5 mm.

Ključne riječi

incizijska hernija, kirurgija aorte, preporuke, šav abdominalne rane, prevencija incizijske hernije

Acronyms:

AAA= Abdominal Aortic Aneurysm, AWHs=Abdominal Wall Hernias, VIHs= ventral incisional hernias, AOD= Aortic Occlusive Disease, ASA= American Society of Anaesthesiology, BMI= Body Mass Index, MAIH= Midline Abdominal Wall Incisional Hernia, SL= Suture Length, WL= Wound Length, AIOD= Aortoiliac occlusive disease, SPE= Surgeon's Physical Examination.

Introduction

The first modern classification of IHs that we found was that of Hall KA et al. [1], who in their study, define two distinct types of VIH that they identified. Focal defects, adjacent to the umbilicus, were present in only five patients (out of 41 with hernia) and diffuse bulging in the remainder. The less frequent, focal periumbilical

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defects appeared to be the result of poor technique when using a running closure. The diffuse defects, manifest by attenuation of the intervening fascia and displacement of the rectus muscles, are more difficult to prevent and more likely to recur. Most patients, however, presented with a diffuse bulging of the abdominal wall extending from the xiphistemum to the umbilicus. Discomfort localized to the region of the hernia was the most common presenting symptom [1].

The current classification for hernias is the classification adopted by the European Hernia Society [2] (EHS). Several members of the EHS board and some invitees gathered for two days to discuss the development of an EHS classification for primary and incisional abdominal wall hernias.

As far as the definition of an incisional hernia (IH) is concerned, they decided to use the definition proposed by Korenkov M et al. [3]: "Any abdominal wall gap with or without a bulge in the area of a postoperative scar perceptible or palpable by clinical examination or imaging" [2, 4].

Traditionally, this clinical examination includes abdominal wall inspection and palpation with the patient supine and standing, as well as during "Valsalva" maneuvers. The examiner looks for a bulge and, if a hernia is believed to be present, the examiner attempts to define the fascial edges. In cases where the fascial defect is small and/or the patient obese, hernias can be missed on physical examination [4].

IHs following laparotomy, irrelevant of pathology, is one of the most frequent long-term complications, affecting up to 20% of unselected patients and up to 50% of high-risk (e. g. obese) patients [5–7].

Risk factors are male sex, smoking, postoperative wound complications, obesity, advanced age, postoperative pulmonary complications, jaundice, abdominal distension, emergency operation, reuse of a previous incision, pregnancy, postoperative chemotherapy, steroids, malnutrition, ascites and peritoneal dialysis [8–10]. Most of these risk factors are associated with excessive strain on the incision or poor wound healing [8].

Wound infection is the most important risk factor, with hernias four times more likely to occur after wound infection [8, 11]. Eight to 29% of the IHs are asymptomatic and, therefore, remain unaccounted for, if the patient is not examined physically [12–14].

Lord RSA et al. [15] found a relation between high blood loss at operation and subsequent hernia formation. This was not confirmed by other studies [16–18].

Prevalence of incisional hernias after aortic surgery

Incisional hernias are reported to be more common in patients with abdominal aortic aneurismal (AAA) disease than in others [19], but the etiologic factors have not been identified [1, 19, 20]. This number may be higher as only <50% of MAIHs occurs within the first postoperative year, whereas 35% develop ≥5 years afterwards [21].

Data on this complication following aortic reconstruction has indicated an overall incidence of 35%, independent of the incision [1, 15–17, 20, 22–28].

Hall K et al. found that patients with AAA have a higher incidence of VIHs and recurrent AWHs without a corresponding increase in patient related risk factors than patients without an aneurysm, suggesting that as yet unidentified etiologic factors may contribute to the development of AWHs in these patients [1].

Henriksen N et al. conducted the first large-scale nationwide study in Denmark. They studied 2597 patients to evaluate the association between aortic reconstructive surgery and the risk of incisional hernia repair in a multivariate model. Risk factors independently associated with incisional hernia repair in their study were AAA repair and BMI ≥25.0 kg/m2[19]. In this study, the cumulative risk of incisional hernia repair was 11% for AAA patients, leading to a 1.6-fold higher risk of incisional hernia repair for AAA patients compared with AOD patients after adjustment for age, ASA score, and BMI [19].

The Danish study is the biggest study in the literature (2597 patients) where the frequency of incisional hernias was presented separately. Most of previous studies were retrospective reviews from selected centers with a maximum of 300 medical files [1, 17, 20, 24, 26, 29].

Three of the studies [27, 30, 31] conducted a prospective follow up of the patients; however, the number of patients was still <300. Furthermore, these studies only included vascular surgeries approaching the aorta through the midline. Two recent meta-analyses assembled the data from these studies and concluded that the risk of developing an incisional hernia after aortic reconstructive surgery through a midline incision was 2.8-fold higher for AAA patients than for AOD patients [25, 32]. However, there was substantial heterogeneity in trial designs, and the overall number of patients was small.

Review studies are divided in two categories, prospective and retrospective. There is a bias in favor of prospective studies. We fully agree with the comment of Jim Chandler, MD (Boulder, Colorado), at the presentation of the study of Hall et al, presented at the 47th Annual Meeting of the Southwestern Surgical Congress, San Antonio, Texas, April 28–26, 1995, saying that "It may sound like heresy, but a retrospective assessment of this particular subject may be less bias vulnerable than a prospective study. We can be confident that these wounds were closed with

equivalent care, since there was no motivation to do otherwise. In the prospective setting, knowledge that the boss has a study underway to test his pet hypothesis that aortic aneurysm patients have a systemic defect making them prone to wound hernias might engender extra care in the wound closures of certain patients. Maybe the wound closures would be more carefully done in aneurysm patients because of their putative hernia proclivity, or more care might be lavished in closing aortoiliac occlusion disease patients to avoid excessive umbrage from having a hernia develop in the "wrong group." So, I like this particular retrospective study" [1].

Liapis CD et al. found that the development of a postoperative incisional hernia after AAA surgical repair had an incidence of 16.2% versus 7.4% after aortofemoral reconstruction. Patients electively operated on for AAA have a 3.8-fold increase of developing a postoperative incisional hernia over patients operated on for peripheral occlusive disease (POD) [30].

Takagi et al. from Japan conducted a systematic review to determine the incidence of postoperative incisional hernia in patients with AAA compared to those with AOD [25]. They concluded that patients with abdominal aortic aneurysm appear to have an approximately 3-fold increased risk for both inguinal and postoperative incisional hernia compared to patients with aortoiliac occlusive disease.

Gruppo M et al. from Italy evaluated the formation of incisional hernia in 1065 patients who underwent elective operations for AAA and AOD using midline incision, they found that both AAA and AOD had a similar incidence of MAIH, which they attributed to wound closure technique. The same was concluded by Hall KA et al. who found that "there was no statistical difference in the incidence of IHs in patients with AAA compared to those with AIOD (22% versus 17%, P<0.001)" [1].

Israelsson LA conducted a prospective study of 1023 patients, 85 of these with aneurysmal disease. Wounds were continuously closed and the suture technique was monitored by the suture length to wound length ratio and they studied the rate of incisional hernia at 12 months [33]. Contrary to the previous studies they concluded that "the rate of incisional hernia is similar in patients with abdominal aortic aneurysmal disease and others".

They attributed the fact that other studies had different results to the fact that patients with aneurysmal disease were less often sutured with a ratio of four or more than others and went on commending that "The higher hernia rate in patients with aneurysmal disease reported in previous studies was thus not confirmed in this study and there was no indication of an inherent defect in wound healing in these patients [33].

Prevalence of inguinal hernia after aortic surgery

In 1984, Cannon and colleagues suggested an association between abdominal aortic aneurysm (AAA) and inguinal hernia [34]. Systemic proteolytic activity degrading connective tissues was proposed as a common etiological factor [35]. It was also suggested that men with an inguinal hernia could be a target for selective AAA screening [36, 37].

Antoniou GA et al. conducted a study and found that, in their institution, male patients with inguinal hernia have a 4-fold increased prevalence of AAAs compared with control subjects without hernias [38].

Patients with AAA have a greater propensity for history of abdominal wall hernia, especially inguinal hernia. The reported incidence of inguinal hernia varies between 19% and 41% in patients with aneurysm disease, compared with 5% to 20% in patients with aortic occlusive disease [1, 26, 27, 34, 39].

Golledge JR et al. [40] evaluated inguinal hernia prevalence in a large cohort of 12 203 men enrolled in an AAA screening program. They found a significantly higher prevalence of (inguinal) hernia in patients with an AAA (266 of 873, 30.5%) than in patients without an AAA (2883 of 10 872, 26.5%) (P = 0.01).

Takagi et al. [25] in their study, examined five studies which reported the incidence of inguinal hernia in aortic disease [1, 26, 27, 29, 31]. Three studies [27, 29, 31] demonstrated a statistically significant increased risk of inguinal hernia in patients with AAA. Pooled analysis of the five studies [1, 26, 27, 29, 31] (representing 787 patients) demonstrated that patients with AAA had a 2.9-fold increased risk of inguinal hernia relative to patients with AOD (25.6% versus 11.9%, OR 2.85, 95% CI 1.71-4.77, p < 0.0001). There was no heterogeneity of results (p = 0.2254) nor publication bias (p = 0.3272). In sensitivity analyses, exclusion of any single study from the analysis did not substantively alter the overall result of our analysis [25].

In a recent study from Denmark, Henriksen NA et al. [19] conducted a research to test the hypothesis of an association between inguinal hernia and AAA in male patients. The aim was to compare the diagnosis of inguinal hernia and the presence of an AAA in a large population-based cohort undergoing systematic screening for AAA by ultrasonography. The cohort comprised men participating in AAA screening in the Central Region of Denmark from 2008 to 2010 (the VIVA trial) [41]. A total of 25 000 people were randomized to screening and 75% attended [41, 42]. All participants had ultrasonography and their aortic diameter was measured. Data on age, body mass index (BMI), smoking status, hypertension, diabetes and family history of AAA were also recorded.

They concluded that "in contrast to smaller patient-

based studies, this large population-based study found no association between inguinal hernia and AAA [19]".

Natural history of incisional hernias

The majority of significant incisional hernias develop in the two years following surgery [43], although the incidence increases with length of review such that 35% appear 5–10 years following surgery [21]. Late incisional hernia formation may result from inadequate suture length or the 'sawing' action of non-absorbable suture material on the abdominal wall [44].

Type of incision

The incidence of incisional hernia after abdominal aortic surgery repair is influenced by the type of incision. It is lower in patients who had a transverse incision [16]. The incidence of IHs in AAA repair does not differ between a transperitoneal or retroperitoneal approach in aortic surgery [45, 46].

The size of the hernia was an independent risk factor for recurrence in two retrospective studies, in which "approximating" (edge-to-edge) fascial repairs [47, 48] and "overlapping" repairs [49] were evaluated, but not in another study [50].

Among patients with midline abdominal incisional hernias, mesh repair is superior to suture repair with regard to the recurrence of hernia, regardless of the size of the hernia [28].

Recurrence rates after primary repair of IHs are reported from 30% to 50% [1]; Sitzmann JV and McFadden DW [51] have reported a 2.5% recurrence rate in patients using internal retention sutures. Even after mesh repair of incisional hernia, there is a further recurrence rate of up to 50% [1, 28, 52].

Kind of sutures

It is recommended that the suture material must contribute to the strength of the wound during a sufficiently long period and, as the aponeurosis heals rather slowly, it needs support of the suture for at least 6 weeks [53]. It is advocated that to decrease the risk of incisional hernia formation, the fascia should be closed with slowly absorbable (total resorption >180 days) or non-absorbable sutures and with a suture length at least four-times greater than the wound length [6, 33, 54].

Experimentally, fascial wounds reach their maximum tensile strength at 200 to 300 days compared to 14 to 21 days for skin [55, 56]. Therefore, sutures of appropriate durability and tensile strength should be selected when closing these wounds [57].

Although Hall KA et al. in the early part of their study [1], they used braided absorbable suture (Dexon and Vicryl), they claim that "it appears unlikely that the type of suture material alone was a major contributing factor" [1]. Both braided absorbable and monofilament nonabsorbable sutures have been shown to be equally efficacious in closing midline incisions in prospective studies [58]. Furthermore, the incidence of VIH has remained unchanged despite the use of nonabsorbable monofilament suture [1].

At present, polydioxanone is the only slowly absorbable monofilament suture material that has been evaluated in comparison with a nonabsorbable suture – a randomized trial also monitoring the quality of the suture technique [59].

Furthermore, the use of long-lasting absorbable suture material compared with nonabsorbable suture material decreases postoperative pain and wound infection [18, 60–62].

For a continuous suture line either single thread or loop sutures can be applied [63, 64]. With the latter two loops are probably often used in long wounds, starting one at each end and tying them together in the middle [33].

Suture technique

There was a debate regarding the use of single or layered closure of abdominal wall incisions. In experimental animals, fascial wounds closed in a single layer have less tensile strength at 8 days than those closed in 2 layers; however, this difference was no longer apparent once the wounds were fully healed [56].

Now it is recommended to close the abdominal wound by "a single layer aponeurotic closure technique without separate closure of the peritoneum" [2].

Although mass suturing of the musculoaponeurotic layers of the abdominal wall is associated with a low incidence of wound dehiscence, the incidence of late incisional hernias remains at about 10% [65, 66].

It is commonly believed that the tension used to approximate the layers of the abdominal wall, using the mass closure technique, may cause mechanical or ischemic injury to the tissues contributing to the development of AWHs [1].

In the study of Hall KA et al. they advocate that "primary repair with interrupted nonabsorbable monofilament suture may be appropriate in patients with small defects. Although none of the periumbilical defects closed using this technique in their study have recurred, recurrence rates of 2% to 10% have been reported" [20].

Although some larger defects may be closed primarily using fascial release incisions as in the Keel repair, prosthetic material such as Marlex mesh or PTFE is usually necessary to reinforce defects too large for primary closure [66–70].

Jenkins was the first to define an ideal ratio on the basis of both clinical trials and a mathematical model, recommending that an SL:WL ratio of at least 4:1 is

necessary for a safe laparotomy closure [71].

Israelsson LA and Millbourn D state in their study 72] that "the quality of the suture technique is easily monitored through the SL to WL ratio, which correlates strongly with the subsequent rate of incisional hernia" [73–75].

A low rate of incisional hernia is achieved when the SL to WL ratio is four or more [73], and with a lower ratio the rate of incisional hernia is four times higher [74–76]. Suturing with a high SL to WL ratio prolongs the operation by a few minutes, but is cost effective because the expense of subsequent incisional hernias is lower [77].

Use of mesh

Despite an optimal closing technique, incisional hernias still develop in a number of patients. The use of prophylactic meshes inserted during primary laparotomy to avoid subsequent incisional hernia formation has been evaluated in high-risk groups such as patients undergoing bariatric surgery, stoma formation, and high-risk gastrointestinal surgery [78–80]. A recent randomized controlled trial evaluated the use of prophylactic mesh insertion vs. sutured fascial closure with nonabsorbable suture in a 4:1 ratio in 85 patients undergoing open elective AAA repair [81]. The incisional hernia rate was significantly decreased in the mesh group, with no increase in the wound infection rate [81].

In a recent study from Greece, Bali C et al. [82], in a prospective randomized clinical study, patients electively treated by open AAA repair were allocated equally to routine abdominal suture closure or to prophylactic placement of bovine pericardium mesh above the fascia. The study end points were: postoperative complications and incidence of incisional hernia at a 3-year follow up. Cumulative proportion of freedom from incisional hernia was 100% for mesh group at 3 years and 74.4% (SE 9.9 %) for control group at 2 years ($p < 0.008$). They concluded that the bovine pericardium mesh reinforcement of fascia closure in patients undergoing open AAA repair showed effectiveness and low complication rate in prophylaxis from incisional herniation. It should be considered as an alternative mesh material in selected patients [82].

O'Hare JL et al. examined the outcome after prophylactic placement of a pre-peritoneal poly-propylene mesh during abdominal closure in consecutive patients having elective AAA repair. At least 30 months after surgery, 28 patients underwent clinical and ultrasound examination of their surgical wound for incisional hernias. Only one patient had a hernia in the original surgical scar. No patients had late mesh-related wound problems. They concluded that pre-peritoneal polypropylene mesh placement is a simple, safe and effective method to decrease the incidence of incisional hernia after AAA repair [83]. Similar results were published by Rogers M et al. [84] and they stressed that it is important that mesh is not used unless a satisfactory peritoneal layer can be developed to prevent adherence to small intestine with the risk of fistulation.

Size and distance of suture's bites

Another field of debate concerning closure of abdominal incisions is the bite size and distance between bites.

Cambell JA et al. in their study "A biomechanical study of suture pullout in linea alba" pointed out that: Optimum security was obtained with bites of at least 1.2 to 1.5cm [85].

In another study, it is advocated that "When closing midline wounds, we take bites approximately 2 cm from the edge of the fascia and 1 cm apart" [1].

One of the commentators in this presentation, Arlo Hermeck, noticed that, often our residents, when making a midline abdominal incision, fail to clean off the fat from the fascia. When these wounds are re-approximated, a fat-to-fat closure results instead of fascia-to-fascia. I've always felt, without any data for support, that this increased the incidence of midline incisional hernias, and I would like your comment on this matter". The presentator replied with "I agree fully. I believe that you need to dissect the skin and subcutaneous tissue off the fascia, especially in obese patients, so that the fascial margins can be clearly defined" [1].

In the addition to the above, Islraelsson JA et al. in a recent study [72], advise that the treatment of dehiscence of abdominal wound should be done by "Placing stitches in strong suture-holding tissue thus implies that sutures are placed at a fairly large distance from the wound edge, and often a distance of 3 cm is necessary" [72]. This implies that placing the suture at distance more than 1 cm from edges is more secure.

Hogstrom H et al. [86], in their study "Suture technique and early breaking strength of intestinal anastomoses and laparotomy wounds", concluded that; "The breaking strength of the sutured fascia, but not that of the colon, was higher when sutures were inserted at the longer distance from the wound edges" [86].

Contrary to the above, Milbourn D in his doctoral research found that; "in midline abdominal incisions closed with a continuous single-layer technique the rate of Surgical Site Infections (SSI) and IH is lower with small stitches than with large [87].

In another randomized trial including 737 patients, the effect on the rate of incisional hernia was studied with small stitches in comparison with large stitches. Closure with small stitches was made with a polydioxanone suture USP 2/0 mounted on a needle so small that

stitches could not be placed more than 5 to 8 mm from the wound edge, only incorporating the aponeurosis. The rate of incisional hernia was 5.6% with small stitches, and was three times higher with large stitches placed more than 10 mm from the wound edge [74]. Closing wounds with many small stitches at close intervals prolonged each operation by about four minutes, but was cost effective owing to the reduced cost for subsequent hernia repairs [74, 87]. The STITCH trial confirmed the above [88].

Suture tension

The next problem with the suture technique is the suture tension.

Mayer et al. [65] have reported a 10% incidence of incisional hernias in wounds closed under normal tension compared to 5.5% in wounds tightly sutured, suggesting that some tension may be necessary for primary healing.

Contrary to the above, Israelsson LA and Millbourn D [72] in their study state that "The tensile strength is higher in wounds approximated with low tension than in wounds closed with high tension". This was confirmed by other studies [72, 89–91].

Radiology

Until the advent of high-quality CT, a surgeon's physical examination (SPE) was the primary modality used for diagnosis of incisional hernias [4].

The clinical diagnosis of an incisional hernia is often difficult, especially in obese patients, those with significant abdominal pain, or those in whom the hernia has dissected along muscle layers [92]. However, plain radiography, radiography performed after administration of barium, and computed tomography allow evaluation of suspected abdominal hernias and detection of those that are clinically occult. The anatomic location of the hernia, the contents, and complications such as incarceration, bowel obstruction, volvulus, and strangulation can be demonstrated with radiologic examination [92].

Musella M et al. [27] showed that ultrasonographic evaluation is unreliable in the early detection of abdominal wall hernia, supporting previous studies showing that approximately a half of the patients with abdominal wall hernia less than 5 cm are missed by this technique [93]. In their report, MRI was useful in early diagnosis of abdominal wall hernia, even those of small dimensions [27]. Although the efficacy of ultrasound in diagnosing abdominal wall defects is advocated [94], only CT provides findings comparable to those of MRI [95].

In another study, Beck WC et al. has demonstrated the use of ultrasound to detect incisional hernia formation using dynamic abdominal sonography for hernia with results comparable with CT [96]. Real-time sonography demonstrates bowel peristalsis and acoustic shadowing by bowel loops in the abdominal wall [92].

A few small studies from Greece and Spain evaluating the use of CT as a follow up after incisional hernia repair have found that CT has a sensitivity of 100% and specificity of 97% for detection of recurrence [97, 98]. However, due to the relatively high cost and the exposure to ionizing radiation, CT is not widely used in follow up after hernia repair, particularly if the patient is asymptomatic [4].

Most incisional hernias are easily recognized by careful inspection and palpation. However, there are several situations whereby an accurate clinical diagnosis may be difficult or impossible [99].

Radiography performed with orally administered barium and frequent fluoroscopic inspection is useful in detecting incisional hernias [92]. Areas of surgical scarring should be imaged in profile during performance of the Valsalva maneuver. CT shows the abdominal wall defects and the hernial contents, as well as signs of bowel ischemia. Enteroclysis may be necessary to diagnose small, occult hernias [92].

Gary G. Ghahremani et al. [99] studied the CT of the abdomen of 14 adult patients 2–25 months after laparotomy in order to evaluate intra-abdominal processes. Clinically unsuspected incisional hernias were detected in all cases. These herniations were not disclosed by a previous physical examination because of the patients' obesity, abdominal pain, distension, or various other factors. However, CT scans showed the exact size, location, and content of each incisional hernia [99].

Baucom RB et al. [4] evaluated the accuracy of SPE for detection of incisional hernias compared with CT. They enrolled 181 patients (mean age 54 years, 68% female). Hernia prevalence was 55%. Mean area of hernias was 44.6 cm2. Surgeon physical examination had a low sensitivity (77%) and negative predictive value (77%). This difference was more pronounced in obese patients, with sensitivity of 73% and negative predictive value 69% [4].

They concluded that "surgeon physical examination is inferior to CT for detection of incisional hernia, and fails to detect approximately 23% of hernias. In obese patients, 31% of hernias are missed by surgeon physical examination[4]. This has important implications for clinical follow up and design of studies evaluating hernia recurrence, as ascertainment of this result must be reliable and accurate" [4]. This was confirmed by Rodriguez HE et al. [100] they concluded that radiographic evaluation is more sensitive than clinical observation for detection of ventral hernias. Clinical events and reinterventions related to these radiographic abnormalities are rare. CT was diagnostic modality that helped as diagnosing the hernia [100].

Conclusions

Despite the fact that some studies dispute any relation, the majority of studies indicate a higher prevalence between aortic and aortoiliac pathology and incisional and inguinal hernias.

In order to minimize the rate of IHs after a midline incision [72] we must:

1. Use a slowly absorbable or nonabsorbable suture material.
2. Use a suture USP 2/0 mounted on a small needle.
3. Place stitches: In the aponeurosis only,
4. 5 to 8 mm from the wound edge,
5. 4 to 5 mm apart.
6. Measure the wound length and the suture remnants for calculation of the SL to WL ratio.
7. Document the SL to WL ratio.
8. Do not accept closure with an SL to WL ratio lower than 4 [72].
9. Polydioxanone is the only slowly absorbable suture approved for suturing midline abdominal wounds [59].
10. We can use either a single thread or loop sutures [63, 64].
11. It is suggested that men with an inguinal hernia could be a target for selective AAA screening [36, 37].

Declaration of interest:

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