Predictive Factors for Intraabdominal Hypertension after Incisional Hernia Repair

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Rezumat

Factori predispozanți pentru apariția hipertensiunii intra-abdominale în urma curei chirurgicale a herniilor incizionale

Acest review de literatură își propune să sintetizeze factorii de risc care predispun la apariția hipertensiunii intraabdominale în urma curei chirurgicale a herniilor incizionale. Cercetarea noastră a utilizat platformele de cercetare Web of Science, Scopus și PubMed și a utilizat ca formulă de căutare: ("Intraabdominal hypertension" OR "intraabdominal pressure" OR "abdominal compartment syndrome") AND "risk factors" AND "incisional hernia". Filtrarea rezultatelor s-a realizat după următoarele criterii: limba: engleză, publish year > 2000 și acces: în extenso. În acest context, am ales să împărțim factorii de risc pentru creșterea PIA în următoarele categorii: cei legați de habitusul și antropometria corpului; cei asociați cu prezența comorbidităților; cei legați de caracteristicile defectului (eventrației) din peretele abdominal; cei asociați actului chirurgical. Printre cei mai importanți pot fi amintiți: indicele de masă corporală, BPOC, eventrațiile de dimensiuni mari cu pierderea dreptului la domiciliu, tehnica chirurgicală utilizată, timpul operator prelungit și tentative repetate de închidere a defectului.

Cuvinte cheie: hipertensiune intraabdominală, hernie incizională, complicațiile reconstrucției peretelui abdominal, factori de risc

Abstract

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quoted in the literature which predispose to intra-abdominal hypertension occurrence following surgical repair of incisional hernias. We used for our research the Web of Science, Scopus and PubMed research platforms and we used the following search formula: ("Intra-abdominal hypertension" OR "intra-abdominal pressure" OR "abdominal compartment syndrome") AND "risk factors" AND "incisional hernia". The results were filtered according to the following criteria: language (English), publish year (>2000) and access (in extenso). In this context, we chose to classify the risk factors for IAP increase in the following categories: (1) those related body habitus and anthropometry; (2) those associated with the presence of comorbidities; (3) those related to the defect of the abdominal wall; (4) those associated with the surgical management. Among the most important risk factors we mention: elevated BMI, chronic obstructive pulmonary disease, large incisional hernias with loss of domain, surgical technique used, prolonged surgeries and repeated attempts to close the defect.

Key words: intra-abdominal hypertension, intra-abdominal pressure, abdominal compartment syndrome, risk factors, incisional hernia

Introduction

Intra-abdominal hypertension (IAH) is defined by the World Society of the Abdominal Compartment Syndrome (1,2) as an increase in intra-abdominal pressure (IAP) above 12 mmHg which can evolve to abdominal compartment syndrome (ACS) when the threshold of 20 mmHg is exceeded and multiple organ failure is associated. Patients at risk of developing IAH/ACS can be divided into two categories: patients who suffer an increase of the intra-abdominal content volume and patients with decreased abdominal volume (management of abdominal wall defects). Both groups can be characterized by an increase of the IAP values, but patients in the first category are prone to further decompensation subsequently to ischemia-reperfusion injuries in the mesenteric area accompanied by the need for hydric resuscitation [IAH occurs in about 40% of the intensive care unit patients (3)]. This type of evolution can only further increase the degree of edema and consequently leads to the intolerance of IAP rise. With regard to the second group, there is a small number of studies reporting IAH/ACS as a complication of abdominal wall reconstruction surgeries. This can be explained by the fact that signs of IAH can occur after repairing the abdominal wall defects, but these are transient, considered

even physiological, and resolute without causing major management problems (4-7). The topic of this article is a relevant one taking into account that the comorbidities of the patient play an important role in the management of abdominal wall defects and the fact that difficult incisional hernias can be successfully surgically approached using current alloplastic techniques (8,9). The purpose of our research is to synthesize the risk factors quoted in the literature which predispose to IAH occurrence following surgical repair of incisional hernias.

Materials and Method

We used for our research the Web of Science, Scopus and PubMed research platforms and we used the following search formula: ("Intra-abdominal hypertension" OR "intra-abdominal pressure" OR "abdominal compartment syndrome") AND "risk factors" AND "incisional hernia". The results were filtered according to the following criteria: language (English), publish year (>2000) and access (in extenso).

Results and Discussions

A very important parameter for understanding the pathophysiological mechanism of IAH is abdominal compliance (AC) expressed as the

ration between the variation of intra-abdominal volume (IAV) and of the IAP. AC designates the abdominal expansion capacity and it is determined by the elasticity of the expandable limits of the abdominal cavity which are the abdominal wall and the diaphragm. Specifically, in a patient with normal AC, a 2L basal IAV increase will generate a small change in the same direction of IAP by about 5 mmHg. In the case of a patient with low AC, the same variation of IAV produces an increase in IAP by 15 mmHg (10). Thus, all circumstances in which AC is altered will lead to a higher risk of IAH/ACS.

In this context, we chose to classify the risk factors for IAP increase in the following categories: (1) those related body habitus and anthropometry; (2) those associated with the presence of comorbidities; (3) those related to the defect of the abdominal wall; (4) those associated with the surgical management.

Anthropometric and Demographic Risk Factors

Remodeling capacity of the shape of the abdominal cavity depends on certain factors such as height, weight, body mass index (BMI), age, sex and fat distribution (*Table 1*). For patients with android obesity and significant visceral adiposity, the abdominal cavity has a spherical shape and a low expansion capacity. For those with gynoid obesity, adipose tissue is better represented subcutaneously, the abdominal perimeter is elliptical and the AC is increased (10). It is worth mentioning the observation of a study (14)

showing that the mean BMI of patients who developed postoperative IAH was 42 kg/m² versus 35,8 kg/m² in those who did not have this complication. The same correlation was valid for patients with ACS. They had an average BMI of 43 kg/m², compared to an average BMI of 36.5 kg/m² of those without ACS. In young patients, the elastic recoil of the abdominal wall is increased and it influences negatively the AC (12).

Risk Factors Associated with the Presence of Comorbidities

Comorbidities can play an important role in the development of IAH even if the most advantageous surgical technique is used for preventing an increase in the intra-abdominal pressure. Thus, two cases in which ACS occurred following surgical treatment using components separation techniques of giant incisional hernias have been reported (16,17). This procedure has the advantage of allowing a tension free closure of large abdominal defects after increasing the IAV. However, despite using this technique, authors claim that comorbidities such as smoker status, asthma, obstructive sleep apnea contributed to the development of IAH in those two cases.

In another study (6), from 50 patients treated surgically for incisional hernias with a mean diameter of 14 ± 5.8 cm, 92% were diagnosed postoperative with IAH and 16% with ACS. It is also worth mentioning that the average BMI in this group was 34.6 ± 6.7 kg/m² and that half of the patients had a significant history of obstructive sleep apnea (32%), chronic obstructive pulmonary disease (18%) or cirrhosis (2%).

In the context of insufficient literature data related to risk factors strictly associated with hernia repair, it would be fair to admit that some of the general factors that predispose to IAH/ACS should also be taken into consideration (*Table 2*). Those factors are often responsible for primary or secondary IAH/ACS, but could also predispose to IAH/ACS as postoperative complications by altering the AC.

Table 1. Anthropometric and demographic risk factors

Risk factor	References
Android obesity	(6)
Waist-to-hip ratio >1	(10)
Increased visceral fat	(11)
Short stature	(12)
Male sex	(12), (13)
Young age	(12)
Obesity (weight, BMI)	(6), (14), (15)

Table 2. Factors associated with the presence of comorbidities. [Any change in the intraabdominal volume leads to a modification in the same direction of the IAP. Thoracic cavity pressure influence and can be influenced by the IAP (10)]

Risk factor	References
Bowels and/or stomach filled with fluid	(12)
Splenomegaly	(18)
Hepatomegaly	(18)
Fluid overload	(19-22)
Tense ascites	(12,22)
Sepsis, burns, trauma and bleeding	(18,23)
Pseudocyst, abscess, abdominal fluid collections	(21,24)
Interstitial and anasarca edema (skin, abdominal wall)	(23)
Rectus sheath hematoma	(12)
Abdominal wall bleeding	(23)
Muscle contraction (pain)	(12)
Abdominal/thoracic burn eschars (circular)	(23)
Pneumoperitoneum	(12)
Mechanical ventilation (positive pressure)	(21,22, 25)
Use of accessory muscles	(12)
Use of positive end-expiratory pressure (PEEP)	(12,15)
Tension pneumothorax	(12,21)
Chronic obstructive pulmonary disease; Asthma	(16,17,26)
Basal pleuropneumonia	(12,25)

Risk Factors Related to the Defect of the Abdominal Wall

Multiple attempts of closing a defect can lead to fibrosis and tissue damage with a decrease in remodeling and adaptation to IAP variations capacity of the abdominal wall (10, 14) (Table 3).

Depending on the size of the defect, the incisional hernias can be small (< 5 cm), medium (5-10 cm), large (>10 cm) and giant (>10 cm and accompanied by loss of domain) (27). Loss of domain designates the case in which the ratio between the volume of the

hernia sac and the volume of the abdominal cavity is ≥ 0.5 (28). Patients with giant hernias have a significant risk of postoperative IAH/ACS.

Palumbo et al (4) found a correlation between the size of the parietal defect, the IAP value 24 hours after its repair and the forced expiratory volume in the first second (FEV-1). Thus, in the postoperative evolution of 2 patients with 20 cm and 19 cm parietal defects, increasing in IAP by 9 mmHg and 8 mmHg respectively have been recorded, accompanied by a decreasing in FEV-1 by 300 ml and 200 ml. Although detailed studies involving a greater number of patients with a variety of incisional hernias are required, the authors suggest that variation in opposite directions of FEV-1 and IAP values can be used in early diagnosis of ACS.

In order to prevent this type of complications, Yao et al (5) correlated the ratio between the volume of the hernia sac and the volume of abdominal cavity (obtained by 3D CT reconstruction) with the risk of postoperative development of ACS. The highest ratio found in 10 patients studied was 7.82% and no case of ACS was reported. It is also worth mentioning that BMI values were in the range of 22-28 kg/m² and that defect diameters were less than 9 cm. In another study, a 20% ratio was associated with postoperative IAH/ACS (6). The ratio between the volume of the hernia sac and the volume of the abdominal cavity which may predispose to ACS has not yet been established in literature. Investigating these features provides valuable information on the management of patients with important abdominal wall defects, but requires more detailed studies on a significant number of cases.

Risk Factors Associated with the Surgical Management

The dimensions, the material and the intra-abdominal position of the prosthesis are equally important for prevention of IAH (Table 4). Regarding the prosthesis type, one study suggests that composite mesh can be

Table 3. Risk factors related to the defect of the abdominal wall

Risk factor	References
Diameter of the defect	(5)
Loss of domain	(29)
Ratio between the volume of the hernia sac and the volume of abdominal cavity	(5,6)
History of postoperative recurrence	(10,14,30)

Table 4. Risk factors associated with the surgical management

Risk factors	Reference
Mesh dimension	(16)
Mesh type	(16)
Surgical technique	(4,6,26)
Surgery length	(14)

successfully used in this context, (4) while other authors are in favor of using biological prosthesis made from non-cross-linked acellular collagen matrix derived from porcine dermis (31,32). If this types of prosthesis are not available, one study recommends the use of an absorbable synthetic mesh (33). On the other hand, the use of prosthesis may limit postoperative the expansion of the abdominal cavity (16). Another variable that can influence patient evolution is the surgical technique chosen to repair the defect. Research has shown superior results of the intraperitoneal approach, fixation of the prosthesis with a spiral fixation device and use of the component separation (4) or transversus abdominis muscle release techniques (6). A recent study on 175 patients shows that prolonged surgeries have an increased risk of IAH/ACS because of the abundant hydric resuscitation [$>5L$ of fluid resuscitation over 24 h, especially when crystalloid solutions are used (34)] that can lead to intestinal and abdominal wall edema (14).

Conclusion

This review assembles the risk factors that can predispose to IAH/ACS following incisional hernias surgical repair. Some of these factors are not supported by strong evidence from large, detailed trials, but more by case reports or small series of cases, so some observations may be subjective. Still, we chose to bring into attention those aspects because ACS/IAH can be easily overlooked, especially in the context of elective surgeries. Moreover, we chose to categorize the risk factors in order to emphasize that some of them should make a doctor adapt the preoperative care as well as the surgical

plan and the surgical act itself. We believe that the limited number of studies on the subject of this article can be explained by several situations. Thus, for the majority of patients undergoing ventral hernia surgical repair, IAH is either underdiagnosed or it resolves without creating management difficulties. Also at this moment, some risk factors are hard to quantify (for example, calculating the abdominal volume by CT) and the number of patients who develop ACS in the context of hernia surgery associated with each individual risk factor is small in order to obtain statistically significant results.

The risk factors we found for these complications are related to the habitus and anthropometry, the presence of comorbidities, the characteristics of the hernia and the surgical act. Among the most important risk factors we mention: elevated BMI, COPD, large incisional hernias with loss of domain, surgical technique used, prolonged surgeries and repeated attempts to close the defect. Recent studies on larger number of patients demonstrate that IAH/ACS are real and serious complications. Awareness of the predisposing factors could be useful in predicting the occurrence of such complications after surgical cure of incisional hernia. Quantifying and standardizing these factors require more detailed studies.

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Authors' Contributions

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