Major vascular injury during laparoscopy

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ABSTRACT: Major vascular injury during laparoscopy is most deadly complication of laparoscopy. This report is review major vascular injuries based on surgeon’s relation and literature. The incidence of MVI is 0.04–0.1%. Extremely important is to learn proper technique of insufflation. According to patient’s physique surgeon should consider best technique of insufflation, take caution against slim people, and induct implements with proper angle. We should avoid excessive force during trocar and Veres’s needle insertion, we also should avoid redundant movement after Verres needle is inserted in abdomen cavity. Elevation of the anterior abdominal wall at the time of Veres or primary trocar insertion is routinely recommended. Major vascular injury is seriously underestimated problem of laparoscopic operations.

KEYWORDS: complications, insufflation, laparoscopy, major vascular injury

INTRODUCTION

Laparoscopic surgery currently comprises the standard of conduct in many disease entities. This method is not free of complications. The majority of them is connected to peritoneal insufflation. The most common complications are subcutaneous emphysema and injury of abdominal wall blood vessels.

It poses greater risk, but damage to the gastrointestinal tract is much less frequent during introduction of further instruments. The most dangerous complication following insufflation is major vascular injury. The percentage of complications after minimally invasive surgery has remained unchanged for many years. Introduction of single-use trocars and new amenities has not significantly changed the rate of complications. There are various methods of peritoneal insufflation, of which the closed method is the most commonly used.

MATERIAL AND METHODS

This article comprises a case analysis of major vascular injury during insufflation, prepared on the basis of reports from surgeons who have performed a procedure where complications of this type occurred. Descriptions of major vessel injury available during the creation of pneumoperitoneum in the literature over the years 1985 – 2014 were analyzed. The analysis of 5 cases is based on the direct report of surgeons who were present during the procedure in which a major blood vessel was damaged, and 46 cases on the basis of articles available in the world literature.

Data was collected using scientific search engines PubMed, link. springer.com, scholar.google, articles present in the Main Library of the Medical University of Warsaw. The most frequently searched phrases are: major vascular injury in laparoscopic surgery, trocar/Veress injury during laparoscopy, aortic injury during laparoscopy, vascular injuries during laparoscopy. 387 articles were analyzed and 341 were rejected. Most often, the work was disqualified because damage to major vessels occurred during the surgery itself, or because the description of the insufflation method was insufficient.

RESULTS

Fifty-one cases of major vascular injury during the creation of pneumoperitoneum were subject to analysis. There were 47 complications (92%) in clinics. The most frequent major vessel injury occurred during laparoscopic cholecystectomy – 22 cases (43%). The second procedure in terms of the frequency of occurrence of mvi. (major vessel injury) is diagnostic laparoscopy in gynecology departments – 7 cases (14%). An indication for this type of surgery was suspicion of endometriosis. The operator’s experience was analyzed. In 38 out of 51 cases, there is no data regarding the subject’s competence. In 10 cases (77%) the operator was a specialist and in 3 (23%) the doctor during specialist training. Thirty-eight cases (74%) of major vascular injury concerned women. The median age is 30 years. In addition, an analysis of the impact of body weight on major vessel injury during abdominal insufflation was conducted. Precise data was available only in 13 cases and the body type was determined in 27 cases. Fifteen patients presented a correct body type (which is 56% of available data), 9 were underweight (33%) and 3 (11%) were overweight. In 10 cases, there is no data on the mode of operation. Thirty-eight patients (75%) had elective surgery, while 3 (5.8%) patients were operated in urgent mode.

In 12 patients (24%) there were difficulties in overcoming the body’s layers during introduction of the instrument. In the vast majority, in 33 cases (65%) there is no data regarding the area of introduction of an instrument, which damaged the major vessel. In 10 cases, they were introduced under the navel. In 35 cases (69%) the vessel was pierced with an inserted trocar. In 4 cases, damage occurred with the Veress needle, and in 3 upon too deep skin incision. In 27 patients (53%) there is no data on the used trocar. In 10 cases a reusable trocar was used, in 9 a single-use trocar with a safety mechanism, in 3 the Hasson Trocar. Fig. 1. presents a detailed share of individual instruments in recorded cases of major vascular injury. In 42 cases (82%), there were no information as to whether or not the body layers were elevated. In 2 cases, the doctor elevated the patient’s skin, in the next 3 muscle fascia, and in remaining 4, instruments were introduced without elevating of the abdominal wall. In 38 cases, only the arterial vessel was damaged, and in 8 cases only the venous vessel. Five cases included perforation of venous and arterial vessels. Most often, in 23 cases
(45%) the aorta was damaged, followed by the right common iliac artery – 10 (20%) and left common iliac artery – 7 (14%), and left common iliac vein – 6 (12%). Damage listed is presented in the figure below. In 10 cases (20%) only the anterior wall of the vessel was damaged, and in 5 (10%) the vessel was punctured through, in the remaining 36 cases (70%) there was no data on this subject. In 47 cases, the complication was diagnosed intraoperatively, in in 3, mvi was diagnosed after initial surgery. One case included only damage to the anterior wall diagnosed intraoperatively; damage to the posterior part was diagnosed during post-operative care. Decreased blood pressure and rapid acceleration of heart rate are the most frequently described first symptoms. In 11 cases a damaged blood vessel was provided by a vascular surgeon, in 8, by the operative team. In 40 cases (78%) the patient survived the complication, in 5 (10%) the patient died, in 6 situations there was no data on this subject.

**DISCUSSION**

Laparoscopic surgery is currently the standard for treatment of specific diseases and is routinely performed in medical treatment facilities. With a constantly increasing number of minimally invasive procedures, surgeons are increasingly dealing with various types of complications.

It is estimated that more often, there occurs damage to the gastrointestinal tract (most often it affects perforation of the small intestine – 0.06% – 0.4%) than major vascular injury during insufflation. Available literature indicates the frequency of major vascular injury in the range from 0.04% to 0.1%. The work by Ch. Chapron et al. based on the largest number of cases of major vascular injury collected from many centers reports that the frequency is 0.02% [4], Most cases of mvi. have been recorded in the countries of North America – Canada and the USA, with only 3 such cases described in the Polish literature. Ninety-four percent of the presented cases come from clinical centers. Various sources repeatedly stress that the frequency of such complications remains underestimated. It remains a question of how often such complications occur in smaller hospitals.

As far as the world literature is concerned, opinions regarding the influence of the operator’s experience on occurrence of major vascular injury during insufflation are divided. Carillo and Dixon [5] believe that experience is a key risk factor. In the 5 cases which they analyzed, the operator was a surgeon who had performed less than 20 laparoscopic operations. Chaumpault believed that experience is important but not crucial to the occurrence of such complications [6]. In his work, L.E. claims that the injury is independent of the learning curve, as half of the cases of major vascular injury concerned operations performed by experienced physicians [7]. All cases of major vascular injury were reported by doctors with extensive experience. Admittedly, it is generally accepted that the incidence of surgical complications is inversely proportional to the operator’s experience, but drawing unambiguous conclusions that this rule also applies to mvi. has not been sufficiently documented.

Excision of the gallbladder using a minimally invasive method constitutes a model example of laparoscopic surgery, during which young doctors acquire their first experience in minimally invasive surgery. In 22 (43%) of all cases presented in the work, major vascular injury occurred during laparoscopic cholecystectomy. It is the most common laparoscopic surgery performed by residents, upon which young doctors’ experience with minimally invasive surgery bases. It is during cholecystectomy that they learn to create peritoneal emphysema and introduce trocars to the abdominal cavity. Often, the technique once learned from older colleagues does not change for many years. It is not always correct and safe for the patient, and performed repeatedly, can eventually lead to the potentially most serious complication in laparoscopy, i.e., major vascular injury. The combination of inexperience and an incorrect technique constitutes a key risk factor, which is why residents of treatment units should learn the correct method of insufflation of the peritoneal cavity from the very beginning.

There are some risk factors for mji. depending on the patient to whom the operator should consciously adapt. Already during the initial medical examination, he should adopt a specific strategy for the creation of pneumoperitoneum. The patient’s weight is of particular significance. WW. Hurd et al. analyzed the position of the navel relative to the aortic bifurcation depending on the patient’s body structure. The authors concluded that the aortic bifurcations located on average at the height of the 4th lumbar vertebra, and its position remains unchanged. The navel, on the other hand, moves in relation to the fork, along with the increase in body weight. In the frontal plane, in slim patients, the navel is offset from the aortic bifurcation by only 0.4 cm, in the case of overweight patients the distance increases on average to 2.4 cm, and in obese persons to 2.9 cm. Mutual anatomical relations are presented in the following figure.

Considering the above study, many authors (including Nehzat9, G. Vilos10 S Krishnakumar and P. Tamble [11]) recommend introducing of instruments in a specific way. In slim persons, at a 45-degree downward angle. This will avoid the bifurcation of major vessels from the top. In obese persons, it is possible to safely insert instruments at a 90-degree angle, the navel is displaced distally to the bifurcation by 2.9 cm, therefore there is no need to bypass major vessels. Overweight persons are in an intermediate situation. It is recommended to maintain an angle between 45 and 90 degrees when inserting instruments. Persons with low body weight and normal structure are potentially more vulnerable than obese persons.

In addition to patient-dependent factors, impact on the occurrence of mvi. is also seen in technical aspects of insufflation. Raising of the body layers while inserting the Veress needle reduces risk of major vascular injury. In 42 (82%) cases, no information was provided on whether and how the abdominal wall was raised, which may suggest...
that operators did not in fact raise it. The work of Japanese doctors Aiko Sakamoto et al. compares the distance of the front surface of the lumbar spine to the abdominal wall depending on how the body layers are elevated. In case of elevating the skin with the hands and compressing the torso on both sides of the body, the distance was 9 cm. If case of elevating the navel using Kocher’s forceps, the distance increased to 13 cm. They did not compare the elevating of the muscle fascia itself, while the skin is closest to the fascia in the area of the navel, practically adhering to it. The authors also compared how the distance of distance between the outer and the inner wall of the abdomen, depending on how the layers were elevated. When elevating the skin with the hands, it was 5 cm, lateral pressure on the body layers – 4 cm, elevating the navel with Kocher’s forceps – 2 cm. 12 A. Modrzejewski, whose experience reaches over 10,000 laparoscopic cholecystectomies, recommends elevating the muscle fascia, considering that it is a key factor preventing damage to the vessels and internal organs [13].

On the basis of the quoted works, it may be concluded that elevating the muscle fascia or the site where it closely adheres to the skin, and therefore the navel, constitute methods that provide greater safety during insufflation than elevating the skin itself with the hands or Backhaus’s forceps, not to mention squeezing the torso laterally. The above study by A. Sakamoto shows that elevating the fascia or navel significantly increases the distance between the torso wall and the abdominal organs, while shortening the distance that must be covered by the Veress needle or the trocar. Pulling up the skin alone to a lesser extent increases the distance between the internal organs and the abdominal wall, and additionally increases the distance that must be overcome by the set of instruments. Failure to elevate the layers creates an unnecessary additional risk factor.

When introducing the Veress needle into the peritoneal cavity, several rules must be followed. Unnecessary movements should be avoided following its introduction. If the Veress needle is inserted into a large vessel, maneuvering it from side to side may lead to a 1-cm wide tear while spot damage corresponds to the diameter of the needle (1.6 mm) [14]. The operator-dependent risk factor is the number of attempts to insert a Veress needle for insufflation. In his article, Vilos George emphasized that with more attempts to place the Veress needle in the peritoneal cavity, the risk of complications increases (at the first trial between 0.8% and 16.3%, for two trials between 16.3% and 37.5% for three trials between 44.4% and 64%, with more than three trials risk of complications oscillates between 84.6% and 100%).

With a larger number of attempts for Veress needle insertion, the likelihood of pneumoperitoneum creation decreases (in the first sample between 85.5% and 86.9%, for the second sample the probability is between 8.5% and 11.6%, for the third sample between 2.6% and 3.0%, for more attempts it is the range of 0.3% to 1.6%) [15]. Upon 3 failures for introduction of the Veress needle, an alternative method of insufflation to be considered is Hasson’s minilaparotomy or using Palmer’s point (located 3 cm below the costal arch in the left midclavicular line) as the site of insufflation.

Trocar is a tool with the greatest potential for major vascular damage. Thirty-five cases analyzed in the presented work (67%) were formed this way. The analysis of Fig. 1 presenting the share of particular instruments in the discussed cases of mji. may indicate that the safety mechanisms used in single-use trocars do not significantly increase the safety of insufflation. Most safety mechanisms are activated using increased strength when inserting trocars, and this in turn constitutes a separate risk factor for major vascular injury. For this reason, in September 1996, the American Food and Drug Administration FDA decided to change its name from “safe trocar” to “trocar with safety shield”. Results presented in the paper show that in every fourth patient, there were difficulties in overcoming layers of the skin with the instrument. In his work, Yuzpe states that in cases where the operator had the impression that it was difficult to overcome the fascia and had to use
more force during introduction of instruments, there was a twice as large incidence of complications.16 This is due to the fact that with greater pressure on the layers, there is risk that the instrument might get stuck in the abdominal wall in an uncontrolled manner and cause damage to the internal organs or blood vessels below. When introducing trocars, it is important to remember about using a rotational motion, which allows for use of much less force to overcome the resistance of the body layers.

In 10 situations the anterior wall was damaged, and in 5 cases there was perforation of a major blood vessel. Such a situation worsens the prognosis and the complication is more difficult to treat. In 40 cases (78%), the patient lived through the complication, for 6 there was no data, and 5 (10%) patients died. Major vascular injury during insufflation is a rare laparoscopic complication. In an era where the number of minimally invasive operations increases from year to year, it is dangerously marginalized. The frequency as well as mortality of this complication remains underestimated.

**CONCLUSIONS**

1. Low weight constitutes an important risk factor for major vascular injury.

2. MVI during insufflation can happen to both to a highly qualified operator as well as a physician during a specialized training. Experience does not comprise a key risk factor for the complications discussed above.

3. During creation of the pneumoperitoneum in the navel, it is necessary to elevate the navel or muscle fascia; elevating the skin alone reduces risk of complications to a lesser extent.

4. A trocar is a tool that usually causes damage to the major blood vessels. It should be introduced gradually by rotary motion, while avoiding excessive pressure. Using a trocar with a safety mechanism can also cause major vascular injury.

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The authors declare that they have no competing interests.

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Cite this article as: Pasnik B., Modrzejewski A.: Major vascular injury during laparoscopy; Pol Przegl Chir 2019: 91 (4): 36-40