The role of laparoscopy in abdominal trauma – review of the literature

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Abstract

The necessity of urgent explorative laparotomy as a standard procedure in the treatment of abdominal penetrating wounds is controversial. Mandatory surgical intervention for penetrating abdominal trauma yields a high rate of negative laparotomies in the absence of visceral injuries. Laparoscopy is an alternative diagnostic procedure inspecting the peritoneum for signs of perforation and excluding significant intra-abdominal injuries. Following current guidelines, diagnostic laparoscopy should be used with caution only in selected cases due to the limited amount of reliable data confirming the effectiveness of such treatment. We present a review of the literature analysing the role of diagnostic laparoscopy in abdominal trauma.

Key words: *abdominal trauma, diagnostic laparoscopy.*

Trauma is still one of the major causes of death and disability [1], and in the case of young people under 40 it is the most significant cause of mortality [2]. In Europe, blunt trauma connected with either automobile accidents or falls from height is the most common cause of severe injuries, while penetrating wounds are less frequent. Fewer than 20% of blunt trauma victims sustain severe abdominal and/or chest injuries, among which trauma to the abdomen constitutes 1/3 of cases and in almost half of them trauma occurs in both bodily areas [3]. Although not so frequent, trauma to the abdominal cavity requires a thorough diagnosis and aggressive treatment due to concurrent injuries to other body regions coexisting in almost 50% of cases. At the same time, every 5th patient with multiple injuries suffers abdominal trauma [4].

The objective of both physical examination and modern imaging techniques is to estimate the extent of trauma and establish indications for surgical treatment. Such a procedure allows for a reduction in unnecessary laparotomy, which depending on the injury and surgical indications may be carried out on as many as 30% of those operated on [5, 6]. It was observed in a multicentre study assessing 356 haemodynamically stable patients after penetrating abdominal injury that the incidence of non-therapeutic laparotomy depended on the diagnostic strategy employed [7]. In the whole series 174 laparotomies (48%) were carried out, 26% of them being non-therapeutic. If the decision for or against surgical treatment was based on an abnormal wound examination result, computed tomography (CT), diagnostic peritoneal lavage (DPL), focused assessment sonography for trauma (FAST) or systematic clinical assessment combined with blood cell count, non-therapeutic laparotomy was performed on 57%, 24%, 31%, 40% and 33% of patients respectively. At the same time,

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the highest sensitivity and negative predictive value were observed for local wound examination and clinical assessment combined with FAST. In both cases the highest specificity was also obtained – 94% and 96% respectively.

Obviously, a negative or non-therapeutic laparotomy may be detrimental to patients. It is connected with possible occurrence of complications, which according to different sources may affect from a few up to as many as 40% of those operated on [8-11]. At the moment it is very difficult to determine an optimal way of diagnostics that would identify substantial intra-abdominal injuries with sufficient specificity and sensitivity. Such determination would allow for minimal incidence of non-therapeutic laparotomies and reduction of the length of a patient's hospital stay to a minimum. It is not that rare that we combine different modalities in diagnostics, namely, diagnostic peritoneal lavage, focused assessment sonography for trauma or computed tomography [12].

Diagnostic peritoneal lavage has been successfully used in blunt trauma diagnostics since 1965 [13]. As it is simple, fast, cheap and requires no specialist equipment it allows for determination of peritoneal cavity contents (blood, intestinal contents, bile). It has, however, certain limitations connected with the lack of possibility to assess the source, bleeding activity, diaphragm and retroperitoneal cavity injuries. What is more, high sensitivity of the examination results in selection of patients with clinically insignificant bleeding, which can be treated non-invasively for surgery.

In the review of prospective studies it was observed that after blunt abdominal trauma the sensitivity of DPL amounted to 98% (90-100%), while its specificity amounted to 92% (73-100%). Low sensitivity of DPL, at the level of 73%, was observed only in one examination [14]. One more, very important conclusion arises from the analysis performed. A negative result of DPL, in principle, excludes the possibility of severe intra-abdominal injuries, as the positive and negative predictive value amounted to 82% and 100% respectively. A similar result was obtained in another prospective study of 40 patients after penetrating abdominal trauma, where DPL sensitivity amounted to 100% and its specificity to 87%, with a positive and negative predictive value of 93% and 100% respectively [15]. Liu *et al.* performed a prospective assessment to compare sensitivity and specificity of DPL, CT and FAST in diagnostics of haemodynamically stable patients after blunt abdominal trauma [16]. They observed higher sensitivity of DPL in comparison to CT and FAST (100%, 97.2%, 91.7% respectively) and lower specificity (84.2%, 94.7%, 94.7% respectively). Gonzalez *et al.* presented the results of a study including 252 haemodynamically stable patients with palpable abdominal tenderness after blunt trauma [17]. The patients were randomized to the series in which CT of the abdominal cavity was routinely performed (125 patients) or in which DPL and facultative CT were carried out (127 patients). In the first group, in 80% of patients negative results of computed tomography were obtained, while in 15% of cases organ injuries were observed. In only 3 patients was free fluid in the peritoneal cavity discovered, which constituted an indication for surgery. In 3 cases with significant organ injuries missed during the first examination, patients with negative CT results underwent delayed laparotomy. In the second series, in only 26 patients (20%) was computed tomography necessary. It revealed organ injuries in half of the cases, while in the other free peritoneal fluid was detected. The authors conclude that combination of DPL and CT in diagnostics of haemodynamically stable patients after blunt abdominal trauma contributes to a reduction in non-therapeutic laparotomies and a decrease of treatment costs. A similar result was obtained in another study, in which it was proven that CT decreases the number of non-therapeutic laparotomies in patients with a positive DPL result [18].

Despite the availability of different diagnostic modalities, the number of non-therapeutic laparotomies remains high. The use of mini-invasive techniques opens up new possibilities, which can lead to diagnostics and treatment optimization of patients after severe abdominal trauma.

In 1976 Gazzaniga *et al.* presented the results of clinical observation of diagnostic laparoscopy used in patients after penetrating and blunt abdominal injuries [19]. In the following years a lot of reports appeared confirming the benefits of diagnostic laparoscopy in patients with penetrating abdominal trauma [20-25].

In recommendations for abdominal trauma management published by different associations, the possibility of diagnostics and mini-invasive treatment with endoscopic techniques, especially laparoscopy, is emphasized [26-29]. An indubitable advantage of a diagnostic laparoscopy is the possibility to assess

the kind of injury, its location and severity, and often it creates a possibility to treat minor injuries without laparotomy, which is why negative or non-therapeutic application can be avoided [30]. In Miles *et al.'s* analysis the frequency of negative or non-therapeutic laparotomies amounted to 10% and 4% respectively in the case of gunshot wounds and 26% and 13% in the case of stab wounds [31]. Villavicencio and Aucar reviewed 37 studies covering over 1900 patients in order to analyse laparoscopy usefulness as a screening, diagnostic and treatment method [32].

Krausz *et al.* presented preliminary results of a study including a small series of patients after penetrating abdominal trauma, in which videoscopy of the peritoneal cavity and DPL were combined [33]. Diagnostic laparoscopy enabled confirmation of intra-peritoneal penetration, assessment of the kind and severity of trauma and in some cases treatment of injured organs. Cuschieri *et al.* carried out a multicentre study, in which they compared diagnostic peritoneal lavage with laparoscopy in patients with blunt abdominal trauma. The authors observed identical sensitivity of both methods in the case of significant abdominal injury detection (100%), with higher laparoscopic specificity and predictive value of a positive laparoscopic result in comparison to DPL (94% and 83%; 92% and 72%, respectively) [34]. Non-therapeutic laparotomies were performed in 27% of patients with positive DPL and only in 8% in patients after diagnostic laparoscopy. As was concluded from a different prospective study, both methods can be complementary, since patients with positive DPL benefit the most from laparoscopy, especially after penetrating abdominal injuries [35]. A similar result was obtained in another prospective study including 76 patients after penetrating abdominal trauma [36]. It was observed that over half of the patients who underwent diagnostic laparoscopy avoided laparotomy. At the same time, the number of non-therapeutic laparotomies was reduced and the length of hospital stay and hospitalization time were decreased.

In published studies the benefits of diagnostic laparoscopy in some patients with abdominal trauma were emphasized. Fabian *et al.* published a prospective study including 182 haemodynamically stable patients, who underwent diagnostic laparoscopy [37]. Patients after penetrating trauma constituted the majority; 55% had stab wounds and 36% had gunshot wounds. Blunt trauma constituted 9% of all the cases. The research protocol stipulated performance of laparoscopy following the initial wound examination under local anaesthetic and damage of fascia continuity confirmation. Over half of the patients (53%) avoided laparotomy because laparoscopy either excluded penetration of the peritoneal cavity or only minor injuries were observed. No complications or missed injuries were noted in the series. Laparotomies were performed in 47% of patients; over 2/3 of them were therapeutic.

Cherry *et al.* analysed almost 200 patients with penetrating abdominal trauma. In 91 patients diagnostic laparoscopy was performed and in 69 exploratory laparotomy was carried out [38]. In the first group conversion to laparotomy was necessary in 36 cases (40%), out of which over half were therapeutic. Every third patient had non-therapeutic exploratory laparotomy performed. Only in 4 cases were insignificant, intra-abdominal injuries observed and in over 50% of them no intra-peritoneal penetration was confirmed. Sensitivity and specificity were 100% and 76% respectively, while the positive and negative predictive value as an indication for laparotomy were 53% and 100% respectively, so a negative laparoscopic result basically excluded the necessity of laparotomy.

In another prospective study Ahmad *et al.* noted that in haemodynamically stable patients after penetrating abdominal trauma, laparoscopy helped to avoid laparotomy in 77% of the cases [39]. In 33% of patients no peritoneal penetration was confirmed and in almost 1/3 of cases no organ injuries were observed. Only half of the patients with organ injuries required conversion to laparotomy, which constituted 23% of all the cases covered in the study. Ditmars and Bongard presented the results of a study including 106 patients after penetrating abdominal trauma. They observed that in 40% of cases laparoscopy confirmed peritoneal penetration and at the same time only half had therapeutic laparotomy performed [40]. At the same time, in almost 2/3 of patients laparoscopy excluded intra-abdominal injuries and they managed to avoid laparotomy.

It was observed in another study that after blunt abdominal trauma diagnostic laparoscopy enabled precise selection of patients for the correct form of treatment. At the same time no non-therapeutic laparotomies were carried out and patients with negative results of diagnostic laparoscopy were successfully treated non-invasively [41]. On the other hand, in the series after penetrating abdominal trauma

with a positive result of laparoscopy, 56% of patients had therapeutic laparotomy performed. A negative result of laparoscopy allowed classic surgery to be avoided.

Hallfeldt *et al.* presented the results of another prospective study including, however, a limited number of patients with penetrating abdominal trauma, who had laparoscopy performed in order to confirm penetration and to assess intra-abdominal trauma [42]. In 2/3 of cases such a procedure helped laparotomy to be avoided. Penetration through the peritoneum was confirmed in 33% of patients, and in those selected for surgical treatment only in 7% of cases were non-therapeutic laparotomies performed. The authors compared their results with a retrospectively assessed, historical series of 43 patients, who had laparotomy performed following prior wound examination and abdominal USG. Intra-peritoneal penetration was confirmed in 60% of cases, 1/3 of which had intra-abdominal injuries confirmed, and in almost 2/3 (65%) laparotomy turned out to be non-therapeutic. Other authors state that in selected patients after trauma with suspected peritoneal penetration, diagnostic laparoscopy may be performed under local anaesthetic, which enables shorter hospital stay and reduced cost of hospitalization [43].

Leppaniemi carried out a prospective, randomized study in a series of 232 patients after penetrating abdominal injury [44]. Patients were randomized to two groups. Group A included 23 patients with exploratory laparotomy performed (AEL) and 20 patients with diagnostic laparoscopy performed (ADL). Peritoneal penetration was suspected in all the patients examined. Group B consisted of 28 patients with diagnostic laparoscopy performed (BDL) and 31 patients who were observed and treated non-invasively (BOB). The rest of the patients were either immediately operated on due to haemorrhagic shock or peritoneal symptoms (79 patients) or were released home (44 patients). Confirmation of peritoneal penetration was observed in 91% of patients undergoing AEL and in all the patients with ADL performed. The incidence of non-therapeutic laparotomies in the AEL and ADL group amounted to 65% and 11% (p = 0.016) respectively, but in only 45% of patients with exploratory laparotomy was conversion to laparotomy performed (9 out of 20 patients). In group B diagnostic laparoscopy confirmed the higher number of minor intra-abdominal injuries, but still it did not influence the number of therapeutic laparotomies (p = 0.337). Conversion was necessary in only 3 cases and in all of them therapeutic laparotomy was performed. In the BOB group, on the other hand, only 1 patient underwent laparotomy and in 2 cases delayed laparotomy was performed after 4 h and 33 h, which was related to the increase of abdominal symptoms. The authors conclude that after penetrating trauma, patients with peritoneal penetration benefit from laparoscopy.

Kremer states that diagnostic laparoscopy allows for precise determination of parenchymal organs and diaphragm damage and bleeding to the retroperitoneal cavity. In intestinal damage diagnostics, on the other hand, its sensitivity is lower, although when observed, damage can be repaired in the majority of cases [45]. Ivatury *et al.* observed that laparoscopic sensitivity in alimentary tract diagnostics amounted to only 18% [46]. Kawahara *et al.*, in contrast, in a prospective assessment of 75 patients after penetrating abdominal trauma, observed no missed injuries in laparoscopy concerning intestinal damage [47]. Sensitivity and specificity of laparoscopy were 96 and 100% respectively – in over 20% of patients therapeutic laparoscopy was possible and over 70% of patients avoided unnecessary laparotomies.

Despite many published studies, laparoscopy is not a standard diagnostic procedure in abdominal trauma because there is no reliable scientific proof in the form of randomized research unequivocally confirming the efficacy of such a procedure. This results in varied recommendations. According to the recommendations of the European Association for Endoscopic Surgery, laparoscopy may be taken into consideration in diagnostics of patients after abdominal trauma (B and C level of data reliability) [48]. According to other recommendations published in 2010 in the *Journal of Trauma* laparoscopy may be considered in post-trauma diagnostics of intra-peritoneal penetration and suspicion of diaphragm injuries (recommendations class 2) [49].

When choosing the specific procedure in the case of abdominal trauma, it is necessary to remember the possibilities offered by laparoscopy, especially in diagnostics of stab wounds with unconfirmed peritoneal penetration. So to select the appropriate management, we should consider current recommendations on the one hand, and on the other the experience of the treatment centre. Despite many advantages, laparoscopy as a diagnostic modality has its limitations, specific contraindications preventing

its use in a particular clinical situation, and it requires considerable experience of the person performing the examination.

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