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Inês Maio Gonçalves

Laparoscopy in Abdominal
Trauma: are we making the
most out of it?

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Laparoscopy in Abdominal Trauma: are we
making the most out of it?

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Assinatura: Inês Maio Gonçalves

Nome: INÊS MAIO GONÇALVES

Endereço electrónico: med06023@med.up.pt **Telefone ou Telemóvel:** 914988841

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Dedicatória

Quero deixar uma palavra de apreço ao meu orientador, que foi incansável nos esforços para que este trabalho fosse bem-sucedido, aos meus familiares, em especial à minha mãe (que acompanhou o processo de escrita mais de perto), que me incentivaram e aconselharam sabiamente e aos meus colegas e amigos, que estiveram sempre do meu lado desde o início da minha jornada na FMUP e que foram essenciais para este passo final.

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Título do Projeto: Laparoscopy in Abdominal Trauma: are we making the most out of it?

Resumo:

Aim: To review to which extent laparoscopy can be used in the trauma setting.

Introduction: Minimally invasive surgery has become an increasingly interesting technique for surgeons of all areas, but one cannot overlook the specificities of trauma when considering introducing a new technique. To which patients is laparoscopy best suited?

Methods: The key words “Abdominal Trauma” and “Laparoscopy” were introduced in the Medline database and all relevant full texts were reviewed.

Conclusion: Laparoscopy cannot be applied to the majority of trauma patients, but it can still offer advantages in selected cases, such as patients suspected of having a diaphragmatic or small bowel lesion.

Palavras-chave: Abdominal trauma; Laparoscopy; Blunt trauma; Penetrating trauma; Diaphragmatic Injury; Small Bowel Injury

Laparoscopy in Abdominal Trauma: are we making the most out of it?

Inês Maio¹, António Taveira Gomes²

1 –Faculty of Medicine, University of Porto; 2 - Department of Surgery, Faculty of Medicine, University of Porto

Corresponding author:

Inês Maio, Faculty of Medicine, University of Porto.

Alameda Prof Hernâni Monteiro 4200 - 319 Porto PORTUGAL.

E-mail: med06023@med.up.pt

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Abstract

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Introduction

Minimally invasive surgery has become an increasingly interesting technique for surgeons of all areas and trauma was no exception (1). In spite of the enthusiasm that may arise from being able to treat a patient without causing further injury, one cannot overlook the specificities of trauma when considering introducing a new technique. Hemodynamically unstable patients and the possibility of overlooking undetectable injuries (2) are major concerns and possible obstacles to laparoscopy (3).

In a similar fashion, we can't forget the characteristics of laparoscopy, as a minimally invasive technique, when considering applying it to a group of patients. A long training curve and great variability in laparoscopic skills between surgeons(4), and even the effect of different techniques (5) (2) mustn't be disregarded.

So, is laparoscopy enough to diagnose and/or treat injured patients? We believe that there isn't a single answer to this question.

We've selected four topics to discuss: blunt, penetrating, diaphragmatic and small bowel trauma and we will summarize the current perspective on these topics regarding laparoscopy in abdominal trauma.

Methods

This review was accomplished by introducing the key words “Abdominal Trauma” and “Laparoscopy” in the Medline database. All abstracts were reviewed and those concerning studies in animals and pediatric-only works were excluded. We also excluded case reports and less significant studies with redundant results.

Articles from the references of relevant works were retrieved, whenever available, by searching them at Pubmed or by directly contacting the author.

All full-texts that couldn't be accessed by these methods were excluded from this review.

Blunt Trauma

Blunt trauma accounts for 80-90% of the trauma in most civilian centers(6). According to some authors the role of laparoscopy in blunt abdominal trauma is controversial, limited and inconclusive.(7)

Since most blunt trauma-associated deaths occur due to unrecognized injuries(6), it would be very beneficial if we could use laparoscopy to diagnose those injuries.

In Goettler's(3) opinion, laparoscopy is indicated in blunt trauma to diagnose diaphragmatic rupture and evaluate free fluid. Free fluid is a relevant finding in auxiliary tests, since it can mean free enteric contents, urine, resuscitative fluid or blood. Goettler states the ability of laparoscopy to examine the peritoneum, added to the possibility of sampling the fluid, is what makes this technique superior to diagnostic peritoneal lavage.

In his review of the literature concerning blunt trauma, Nicolau(7) considered to be the best indications for laparoscopy: 1 - diagnosis of bleeding or complete hemostasis in case of solid viscus injury, especially when managed non-operatively; 2 - possible diaphragmatic injuries; 3 - possible hollow organ injury and/or mesenteric injuries particularly in multiple trauma patients with irrelevant clinical exam and indirect CT signs 4 - Unfavorable progress of patients managed non-operatively with inconclusive imaging results.

In conclusion, this author believes that laparoscopy is still needed in blunt trauma and this technique can avoid many unnecessary laparotomies and missed injuries.

Malhotra and associates(6) consider that laparoscopy presents too many technical limitations and only consider it as a future option for blunt trauma when smaller scopes and gasless techniques are available.

It is our opinion that laparoscopy can be a useful technique whenever other diagnostic methods cannot exclude diaphragmatic or small bowel injury. However, this shouldn't delay the use of laparotomy whenever the patient is critically ill.

Penetrating Trauma

When facing a hemodinamically stable penetrating trauma patient there are few questions that we need to answer: 1 - Is the peritoneum violated? 2 - Are there intra-abdominal injuries? 3 - If so, do those injuries require a surgical repair?(8)

In the past years, laparoscopy has been used in an attempt to answer those questions. Some view it solely as a means to define if there was peritoneum violation(4), but there are others attempting surgical repairs using this technique(9-11).

Leppäniemi(12) and associates conducted a study with 102 patients in order to find out if laparoscopy was superior to laparotomy in ruling out injury in patients with documented peritoneal violation – which they assigned to group A. They also wanted to know if laparoscopy offered a better approach than non-operatively expectant management in patients with stab wounds and equivocal peritoneal penetration – Group B.

In this study, the rationale for laparoscopy was to use it both as a screening and therapeutic tool. Given this, laparotomy wasn't mandatory for every patient and the criteria for conversion were major hemoperitoneum, organ injuries not amenable to laparoscopic repair and inadequate visualization of potentially organs or sources of bleeding(12).

The authors did not find any statistically significant differences when they analyzed mortality, morbidity, length of hospital stay, hospital costs and length of sick leave in patients managed laparoscopically, when compared to those submitted to laparotomy.

This notion that laparoscopy is as costly as laparotomy is contrary to what Marks and associates concluded in their work(13). This paper analyzed 131 hemodinamically stable patients with penetrating trauma to the flank. The inclusion criteria were similar to those in Leppäniemi's study: patients with stab wounds to the abdomen or flank with presumptive

abdominal penetration (based on omental evisceration, positive diagnostic peritoneal lavage or positive wound exploration) and had an additional group of 81 patients with tangential gunshot wounds without obvious peritoneal penetration.

Marks achieved a similar negative laparoscopy rate when compared to Leppäniemi (11% in both works), but a much lower negative/non-therapeutic laparotomy rate (19.1% versus 65%).

The main difference between the two studies lies in the length of hospital stay: whether in Leppäniemi's study there was no statistically significant difference between the two groups, Marks reported a three times longer hospital stay for the laparotomy group.

Still, the most interesting data that we can extract from Leppäniemi's work (12) comes from the analysis of group B.

In this study they observed a statistically significant shorter hospital length of stay and length of sick leave, as well as fewer costs for the non-operatively managed group when compared to the laparoscopy group. Morbidity, mortality and severity of injury were similar for both groups of patients.

Leppäniemi and associates concluded in their work that, even though laparoscopy was a useful in avoiding unnecessary laparotomies, it did not considerably lower the morbidity, mortality and hospital stay inherent to trauma.(12)

Considering all the data, the authors concluded that the benefits of finding occult diaphragmatic lacerations precociously, which they considered to be the main advantage of laparoscopy when compared to non-operatively management, have to be weighed against the risks and the costs of laparoscopy. This technique was then considered to be beneficial in asymptomatic patients with stab wounds to the left lower chest or upper abdomen.

It should be noted, however, that no long-term follow-up was granted for all the patients and that many diaphragmatic lesions may have a delayed presentation(14), as it is discussed further in this article.

It is known that 30-50% of all stab wounds do not even perforate the peritoneum and another 20-40% cases with perforated peritoneum do not involve visceral injuries requiring surgical interventions (8).

In light of this fact, Weinberg and associates (15) conducted a study with 15 hemodynamically stable patients where they used “awake” laparoscopy as a screening method to detect peritoneal penetration after tangential gunshot wounds or violation of the anterior fascia in local wound exploration for stab injuries.

They’ve described a method for “awake” laparoscopy, performed in the Emergency Department, under the effect of local anesthesia and sedation. They’ve achieved proper conditions for inspection of the peritoneal cavity by using low-pressure pneumoperitoneum (7-10mmHg) and a light source. If violation of the peritoneum was detected, the patient would then be submitted to laparotomy.

When compared to a cohort of patients submitted to conventional laparoscopy in the operating room, the authors found no significant differences in the sensitivity and specificity of “awake” laparoscopy, concluding that this is a safe and cheaper method to screen peritoneal penetration, even if only 8% of the patients were found suitable to apply this technique(15). This low percentage may lead us to selection bias, since the patients deemed to be appropriate to use this method (vigil, cooperative, non-intoxicated and willing to consent to this invasive technique) are usually less likely to be seriously injured.

Cherkasov and co-workers(2) conducted a study with 2695 patients in order to evaluate the utility of laparoscopy in hemodinamically unstable trauma victims, since this is the indication for 20% of all the trauma surgeries.

Although laparoscopy is popular for the evaluation of hemodinamically stable patients with abdominal trauma, it remains questionable whether it will be widely used in hemodinamically unstable patients(2).

The authors estimated that 50% of the laparotomies performed in the control group (managed according to conventional trauma guidelines) could be prevented by performing laparoscopy and that this technique avoided 73.3% of the needless laparotomies in the study group. They've also appointed a lower mortality rate in the laparoscopy group (8.9%) when compared to the control group (13.6%). Based on their data, they've calculated a specificity of 88% and an accuracy of 91% for laparoscopy.

The authors did not provide a statistical analysis to compare the rates of complications, lengths of hospital stay and surgery durations, making it difficult to draw conclusions from this study. Not comparing the hemodinamically stable group with the unstable patients, makes it impossible to be certain that laparoscopy is a safe choice for the unstable victims.

The authors are convinced that these good results were due to a low-pressure carbon dioxide insufflation technique (9-12mmHg) applied to all patients submitted to laparoscopy, due to intrinsic characteristics of the technique (as being less traumatic and providing a magnified view) and to the vast experience in laparoscopy of the surgeons involved in the study and, therefore, they may not be universally applicable.

Cherry and associates (4) developed a research with 161 hemodinamically stable patients with anterior abdominal wounds. In this study, they have retrospectively analyzed the accuracy of laparoscopy in correctly identifying the patients that needed to be converted to a laparotomy.

Using laparoscopy just as a screening method for peritoneal penetration instead of applying it as a potentially therapeutic technique, the authors established that the use of this technique would cause a 58.3% reduction in non-therapeutic laparotomies.

They've calculated a sensitivity of 100%, a specificity of 76%, a positive predictive value of 53% and a negative predictive value of 100% for laparoscopy to detect intra-abdominal lesions.

It should also be noted that the authors used laparoscopy regardless the result of local wound exploration and, even if the methods mandated that a laparoscopy positive for peritoneal penetration should be converted, there were two cases in which the surgeons did not proceed to laparotomy.

In another note, the authors state that their laparoscopy and control groups are not equivalent regarding their Injury severity scores.

The authors finish by concluding that diagnostic laparoscopy may not be necessary if the clinicians invest in other methods, such as imaging techniques, to detect abdominal injury(4). We find this conclusion difficult to draw, due to the protocol inaccuracies already pointed, but, all aspects considered, this study may show as that underutilization of laparoscopy just as a screening method may not be worthwhile.

Simon and his team (11) presented a different approach, in which they reviewed 9286 abdominal, thoracic and back trauma cases over 5 years (44 laparoscopies) in order to determine the impact of laparoscopy on negative laparotomy rates. Of these 44 patients, only one was submitted to a non-therapeutic laparotomy and 7 were completely managed by laparoscopy, 4 of which received a surgical repair.

In short, the authors found laparoscopy to be a safe (no missed injuries), reliable method that had a positive impact in patients' length of hospital stay (4 days in laparotomy group versus 2.2 in laparoscopy group) and negative laparotomy rates (this procedure was avoided in 22

patients) and believe that the introduction of an “aggressive” laparoscopy protocol made a difference in their institution(11).

The authors suggest that patients with anterior abdominal trauma should probably be managed expectantly and excluded from future applications of laparoscopy, as they regard this as an excessively invasive method for a patient with a 50 to 55% chance of not needing a laparotomy(11). The main proposed indication for laparoscopy is multiple sites of penetration or isolated flank and thoracoabdominal injuries(11).

Lin and associates(10) analyzed 86 patients injured with stab wounds to the abdomen. Laparoscopy is reported to have decreased the non-therapeutic laparotomy rate from 57.9% in the laparotomy-managed group (group A) to 0% in the laparoscopy-managed group (group B). Group B also had shorter hospital stays, shorter operation times and 94.1% of these patients could be successfully treated with laparoscopic surgical repair.

In light of this data, and knowing that the negative laparotomy rates cannot be minimized at expense of a delay in the diagnosis and treatment of injury(16), we believe that laparoscopy offers a diagnostic and therapeutic alternative that can be very beneficial in penetrating trauma victims.

Diaphragmatic Injury

One of the best indications for laparoscopy in trauma is thoracoabdominal trauma (5), since the diagnosis of diaphragmatic injury is difficult (in physical examination and radiologic studies, signs are frequently absent) and undetected lesions can present later with life-threatening diaphragmatic herniations(14).

It is estimated that 7-26% of the thoracoabdominal injuries have concomitant diaphragmatic lesions(14).

Powell and associates(14)conducted a study with 108 penetrating trauma victims to evaluate laparoscopy's sensitivity and specificity to detect diaphragmatic injury. 20% of the patients had unidentified diaphragmatic injuries that were diagnosed with laparoscopy. Notably, in this study, 68% of the patients with diaphragmatic injury presented with a normal Chest radiography.

It should be highlighted that, in this work, laparoscopy wasn't used to repair the diaphragmatic lesions and the authors didn't compare the laparoscopy group with a control group managed non-operatively, neither have performed CT imaging in their patients before submitting them to surgery. We must also emphasize that only hemodinamically stable patients with no other indication for laparotomy were included in the study.

These observations are pertinent because, given these characteristics, Powell's study can't answer a key question: how is laparoscopy better than CT scanning in diagnosing diaphragmatic injury?

Yucel and associates (17) tried a different approach to the left thoracoabdominal trauma, using laparoscopy to diagnose and treat their 36 hemodinamically stable patients. 36.1% of the

cases had injuries to the diaphragm, and 69.2% of the injuries could be repaired through laparoscopy.

The authors also state that the presence of hemopneumothorax is not a good indicator of diaphragmatic injury (present in 41.7% of patients with hemopneumothorax and in 33.3% of the patients without).

Much like Powell's study, Yucel's doesn't offer a comparison for the accuracy of detecting diaphragm injury between laparoscopy and CT imaging (even if we know that this method won't be diagnostic unless there is herniation).

Friese and associates (18) assessed the sensitivity and specificity of laparoscopy by performing both this method and a laparotomy or thoracoscopy in all of their 34 patients. They've only come upon one missed injury in a patient with a hemoperitoneum.

The authors performed CT scans in two patients and, notably, the positive findings in this test (hemothorax, pneumothorax) did not correlate with the presence of diaphragmatic lesion.

It appears to be safe to conclude from this data that laparoscopy is good at diagnosing diaphragmatic injury when compared to laparotomy, in hemodynamically stable patients. It is not, however, clear if we should opt for this technique instead of conducting a non-operative trial based on negative CT or MR scans, as it is estimated that 10 to 15 laparoscopies need to be performed to detect one occult diaphragmatic lesion(12).

It doesn't leave us much doubt, either, that laparoscopy should be attempted if 1 – there is not enough data to safely exclude a diaphragmatic lesion 2 – in an hemodynamically stable patient 3 – victim of thoracoabdominal trauma, and the surgical team has enough experience in this technique.

Small Bowel Injury

The high number of missed occult small bowel injuries associated with laparoscopy in trauma is a major reason why some surgeons still preclude it today(2).

Three key papers: Sitnikov, 2009 (19), Mathonnet, 2002 (20) and Kawahara, 2009 (5) have discussed this issue and debated possible methods to reduce the reported 41-77% missed injuries rate (5).

Kawahara (5)and associates sustain that a methodical inspection technique and a careful selection of patients is of paramount importance, with stable patients with tangential penetrating anterior abdominal wounds yielding the best results. They've primarily used this technique as a way to rule out injuries that required surgery (even if some repairs were attempted with success). They've achieved a potential reduction in 73% in laparotomies with a 1.33% (1 out of 75 patients in the study) missed injury rate.

Mathonnet and associates (20)focused their work in small bowel perforations in the context of blunt trauma. The aim of their work is to compare the sensitivity and specificity to detect small bowel injury of laparoscopy when opposed to CT scan and to analyze the advantages inherent to a precocious diagnosis.

They've achieved optimal results (100% of sensitivity and specificity for laparoscopy, compared to the 83.3% and 22.2% for the CT; n=42) and a larger number of conservative approaches (87% bowel repairs were possible in the laparoscopy group versus 18% in the delayed surgery group, in which resections were necessary in 82% of the cases, much higher than the 13% of resections in the laparoscopy group).

Caution must be exercised when drawing conclusions from this study, though, because it is not clear why and what kind of patients were assigned to each study group.

Sitnikov et al. (19) propose a careful method to inspect the bowel and achieved an estimated 0% (n=819) missed injury rate and avoided unnecessary laparotomies in 74.9% of the patients.

Choi and associates (9) have used a combination of laparoscopy and minilaparotomy to inspect the small bowel in both blunt and penetrating traumas and have achieved a 0% (n=78) missed injuries rate. The authors argue that this extraordinary missed injury rate is due to a very thorough method for laparoscopic bowel inspection that they describe in the paper.

Worth mentioning too is Gorecki's small study (n=3)(21) in which the authors use yet another technique for inspection of the bowel and achieved optimal results without the aid of the minilaparotomy.

Given this data it is our opinion that laparoscopy should be attempted to rule out small bowel injuries if the surgical team is experienced in laparoscopic techniques and willing to adopt a systematic approach to the inspection of the small bowel. This attitude offers an advantage when compared to the non-operative approach because laparoscopy allows early detection and repair of injuries that may cause delayed morbidity and mortality (5).

Discussion and Conclusions

After reviewing the literature in this subject, there is no doubt for us that laparoscopy can and should be applied whenever there is significant doubt if the patient might have a diaphragmatic(14) or a small bowel lesion(5), given that an appropriate technique is applied.

In other situations, there is still much to be debated regarding this technique: should we use it as a screening method in the ER, as proposed by Weinberg(15) or as potentially therapeutic method, such as did Lin and collaborators(10)? We are further inclined to Lin's perspective, but studies comparing the level of skill of the surgeons performing trauma laparoscopies and their respective outcomes, as well as an insight into how much training is enough before being prepared to perform trauma laparoscopy, are needed in order to give a better understanding of this subject.

Cherkasov (2) also posed an interesting question regarding the hemodynamically unstable patients that, we believe, wasn't fully answered in their study. It seems natural that as surgeons grow comfortable with this new technique and are able to clearly define its applications, they advance to use it in more complex cases, such as these, but this matter needs to be further analyzed in future works.

It is also clear for us that careful selection of the population is vital(12) and, to our best knowledge, laparoscopy cannot be applied to the majority of trauma patients, but it can still offer advantages in selected cases.

Conflict of Interest

We certify that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript.

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Anexo

International Journal of Surgery – Regras de publicação

Uniform Requirements

These guidelines generally follow the 'Uniform Requirements for Manuscripts Submitted to Biomedical Journals, published by the International Committee of Medical Journal Editors (ICMJE). The complete document appears at <http://www.icmje.org>.

Authorship

All authors should have made substantial contributions to all of the following: (1) the conception and design of the study, or acquisition of data, or analysis and interpretation of data, (2) drafting the article or revising it critically for important intellectual content, (3) final approval of the version to be submitted.

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Acknowledgements

All contributors who do not meet the criteria for authorship as defined above should be listed in an acknowledgements section. Examples of those who might be acknowledged include a person who provided purely technical help, writing assistance, or a department chair who provided only general support. Authors should disclose whether they had any writing assistance and identify the entity that paid for this assistance.

Conflict of Interest

At the end of the text, under a subheading 'Conflict of interest statement', all authors must disclose any financial and personal relationships with other people or organisations that could inappropriately influence (bias) their work. Examples of potential conflicts of interest include employment, consultancies, stock ownership, honoraria, paid expert testimony, patent applications/registrations, and grants or other funding.

Role of the Funding Source

All sources of funding should be declared as an acknowledgement at the end of the text. Authors should declare the role of study sponsors, if any, in the study design, in the collection, analysis and interpretation of data; in the writing of the manuscript; and in the decision to submit the manuscript for publication. If the study sponsors had no such involvement, the authors should so state.

Randomised Controlled Trials

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