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Pain after laparoscopy

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Abstract
Background: In the context of the much-heralded advantages of laparoscopic surgery, it can be easy to overlook postlaparoscopy pain as a serious problem, yet as many as 80% of patients will require opioid analgesia. It generally is accepted that pain after laparoscopy is multifactorial, and the surgeon is in a unique position to influence many of the putative causes by relatively minor changes in technique.
Methods: This article reviews the relevant literature concerning the topic of pain after laparoscopy.
Results: The following factors, in varying degrees, have been implicated in postlaparoscopy pain: distension-induced neuropraxia of the phrenic nerves, acid intraperitoneal milieu during the operation, residual intra-abdominal gas after laparoscopy, humidity of the insufflated gas, volume of the insufflated gas, wound size, presence of drains, anesthetic drugs and their postoperation effects, and sociocultural and individual factors.
Conclusions: On the basis of the factors implicated in postlaparoscopy pain, the following recommendations can be made in an attempt to reduce such pain: emphathically consider each patients' unique sociocultural and individual pain experience; inject port sites with local anesthesia at the start of the operation; keep intra-abdominal pressure during pneumoperitoneum below 15 mmHg, avoiding pressure peaks and prolonged insufflation; use humidified gas at body temperature if available; use nonsteroidal anti-inflammatory drugs at the time of induction; attempt to evacuate all intraperitoneal gas at the end of the operation; and use drains only when required, rather than as a routine.

Key words: Laparoscopy — Pain — Review

Clinical significance of postlaparoscopy pain

Laparoscopy is a credible alternative to open surgery for a range of procedures in various surgical specialities. For many, but not all, of these procedures, laparoscopic surgery has displayed advantages over open surgery including lower morbidity and mortality, smaller incisions, reduced length of hospital stay, faster recovery, and earlier return to normal activities and work [3, 4, 5, 16, 20, 28, 36].

From the patient's perspective, reduced postoperation pain is one of the greatest advantages of laparoscopic compared with open surgery [3, 4, 5, 9, 10, 16, 22, 23, 28, 34]. However, pain is not completely abolished after laparoscopy. Patients frequently describe subdiaphragmatic and shoulder tip pain [19, 26, 29, 34] in addition to the discomfort of port-site incisions. Some authors report that 80% of patients require opioid analgesia after laparoscopic surgery [21].

There are several reasons why there is still room for surgeons to improve management of postlaparoscopy pain. First, better pain control would magnify the other advantages of laparoscopy in terms of earlier discharge and recovery time. Second, surgeons may enjoy the satisfaction of less postoperation pain than they experienced formerly with open surgery, and of not needing to identify pain as an issue requiring further attention. Third, it commonly is believed that reduced postoperation pain after laparoscopy emanates from the smaller size of the incisions. However, there is evidence to suggest that the dominant source of pain and discomfort after laparoscopy is from the peritoneum rather than the skin or abdominal wall [17]. Finally, the surgeon's perception of postlaparoscopy pain may be masked by the current tendency for the patient to be discharged after a short hospital admission.

The etiology of postlaparoscopy pain is multifactorial, and treatment of any one factor in isolation may not achieve the desired result. However, the surgeon is in a unique position to influence many of the putative causes by relatively minor changes in technique, with a corresponding additive improvement in outcome. A concise knowledge of the multifactorial etiology of postlaparoscopy pain and how the impact of each contributing factor might be nullified will assist in this process.

Etiology and treatment of postlaparoscopy pain

Factors associated with gaseous pneumoperitoneum

Neuropraxia of the phrenic nerves during gas insufflation. To allow sufficient access space for operation maneuvers,

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most surgeons still initiate a pneumoperitoneum during laparoscopic procedures. To avoid complications of the abdominal compartment syndrome, insufflation pressure usually is kept below 15 mmHg, which still allows sufficient exposure [2, 6, 9].

It has been suggested that distension of the diaphragm and the resultant phrenic nerve neuropraxia possibly contribute to postoperation pain, which may include the related C4 dermatome [7, 19, 29]. A 20% stretch of the nerve results in complete occlusion of the endoneural vessels and total ischemia of the nerve [35]. Yet in a prospective randomized study, insufflation pressures higher than 18 mmHg did not show a significant difference in pain and analgesic consumption compared with pressures as low as 9 mmHg [29].

It is likely that pressure peaks have a greater noxious influence on the phrenic nerves than the plateau pressure of the pneumoperitoneum. It is believed that the more time the nerve has to adapt to the stretch, the less likely it is that distension injury will occur. Tissue damage by combustion is an additional mechanism that reportedly damages the phrenic nerves [38].

The use of subdiaphragmatically administered local anesthetics, especially those with long-acting effects such as bupivacaine, are recommended in several studies [27, 39]. Although the risk of local anesthetic toxicity exists, with appropriate dosage precautions, this method has been shown as quite safe [17].

The type of insufflated gas and intra-abdominal pH. The phrenic nerves may be damaged by the acid milieu created by the dissolution of CO_2 if this gas is used for insufflation. The intraperitoneal pH when CO_2 gas is insufflated has been measured at 6.0 immediately postoperatively. On the first postoperation day, the pH rises to 6.4–6.7, and on the second postoperation day to 6.8–6.9. Thereafter it normalizes to above 7.0 [29]. Similar values were found when argon gas was substituted [29]. In the past, N_2O was thought to be less irritative [32], but its side effects and explosive nature have placed major limitations on its use. Potential neural injury to the phrenic nerves by the acid milieu may be minimized by shorter duration exposure to implicated gases.

Residual intra-abdominal gas. Several reports have indicated that residual intra-abdominal gas after laparoscopy causes pain [2, 12]. Carbon dioxide dissolution, intra-abdominal acidosis, and the consequent peritoneal irritation occur for a longer period if the gas is not evacuated at the end of a laparoscopic procedure. Residual gas also may result in a loss of peritoneal surface tension and support to abdominal viscera, thus contributing to postoperation pain [2].

A gas-draining catheter has been used for the first 6 postoperation hours, allowing visceral peristaltic and voluntary abdominal muscle activity to expel residual gas [2]. Patients with a gas drain *in situ* were reported to have significantly less pain after the operation than a control group without such a drain.

The irritative effect of wound drains could potentially negate any advantage conferred by expulsion of residual gas by this mechanism. A separate study reported significantly less postoperation pain when residual gas was actively aspirated at the completion of laparoscopic cholecystectomy without the use of a drain than when no active aspiration was undertaken [12]. It therefore is suggested that intraperitoneal gas by actively evacuated at the end of the laparoscopic procedure by instrumental suction under direct vision.

Temperature of gas. The effect of gas temperature on postoperation pain after gynecologic laparoscopic procedures has been investigated in a prospective randomized study of standard insufflation gas (20°C) versus gas at body temperature. This study found that pain reduction was significantly greater for those patients in whom warmed gas was used, especially with respect to diaphragmatic and shoulder-tip pain, with a lasting effect of 3 days [29].

In another prospective randomized study of 103 patients, significant pain reduction was observed in patients receiving body-temperature insufflation gas (CO_2) compared with those in whom standard gas was insufflated [19].

However, rigorously controlled animal studies have determined that the physiologic impact of warm gas insufflation is minimal [6]. These studies have experimentally confirmed the theoretical principles of thermodynamics indicating that considerably more heat expenditure from the patient is needed to evaporate body water to humidify the initially dry CO_2 stream than is required to heat the initially cool CO_2 gas to body temperature. In these energy calculations, the component attributable to heating the insufflated CO_2 to physiologic levels can be ignored because of the extremely low specific heat of the gas. Because it takes so little energy to heat gas insufflated at room temperature, it almost instantaneously reaches body temperature in the abdomen. It is therefore hard to formulate a credible hypothesis to explain how this phenomenon could influence postoperation pain.

Humidity of gas. Recently, a prospective randomized controlled trial was conducted at the Queen Elizabeth Hospital, Adelaide, to investigate the outcome when humidified CO_2 gas was insufflated during laparoscopic cholecystectomy instead of the standard dry gas [24]. This study demonstrated significantly reduced postoperation pain in patients who underwent humidified gas insufflation, among whom significantly less mean time elapsed before their return to normal activities. The humidified insufflation group showed a trend of less postoperation analgesic consumption, along with a shorter hospital stay and earlier return to work, although these latter three results were not statistically significant.

The exact relation between dry gas and postoperation pain is not yet determined, but other animal studies have observed that dry gas insufflation is implicated in ultrastructural damage to exposed membranes, an effect that was not seen with the use of humidified gas [25]. We believe that this may be a mechanism mediating postoperation pain. Furthermore, it is well established that interleukin-6 (IL-6) released during abdominal surgery is a sensitive marker of

tissue damage induced by mechanical or thermal injury [4, 8, 11, 14, 40]. The injury provoked by insufflation of dry gas might be one reason why there are no overall significantly different trauma response levels between open and laparoscopic surgery [3, 11, 14, 15, 18, 20, 22, 41].

It is noteworthy that the effects of dry gas on postoperation pain will become more significant as the duration of gas insufflation increases [29] and can be ameliorated by simply incorporating a humidification chamber as part of the insufflator tubing line (Cook Medical Technologies, Qld, Australia).

Gasless laparoscopy. Perhaps the most intriguing opportunity to resolve the pain that results from gas insufflation is in the use of gasless laparoscopy. The use of retractor systems such as the Nathanson retractor (Cook Medical Technologies, Queensland, Australia) permits laparoscopic exposure without the creation of a pneumoperitoneum.

Another major advantage of gasless laparoscopy is that it abolishes the requirement for elevated intra-abdominal pressure, and by doing so, diminishes the risk of thromboembolic and cardiopulmonary complications associated with the abdominal compartment syndrome. The disadvantages are that some of these devices require additional small incisions that may potentiate pain from abdominal wall and peritoneal trauma. The net effect on postlaparoscopy pain remains to be elucidated. Device assembly can sometimes be complicated, and the operation exposure is somewhat different than that provided by CO_2 insufflation.

Gasless laparoscopy may offer an advantage if pneumoperitoneum is contraindicated for cardiopulmonary reasons. If only standard gas insufflation is available, concomitant gasless laparoscopy may reduce insufflation-induced pain, but at the risk of some additional trauma.

Operation factors

Wound pain. The number and size of the incisions used vary between different procedures and also between different centers. When laparoscopy is used to facilitate major resectional surgery (splenectomy, colectomy), larger incisions may be necessary to deliver major specimens, and wound pain may become clinically relevant.

Local anesthesia, preferably administered into the incision of access before the wound is created, is recommended by many authors, with significant pain reduction in both open [14, 41] and laparoscopic procedures [26]. Not all studies have shown a significant difference however [1, 7, 13]. For laparoscopic procedures, only small amounts of local anesthesia will be required, minimal side effects are anticipated, and the use of local anesthesia is recommended.

Wound drainage. Wound drains after laparoscopic surgery usually are sited on the lateral aspect of the abdomen, traversing muscle layers. The umbilical incision is less commonly used due to a greater incidence of pain, infection, and potential incisional herniation at this site if the defect is not formally closed. Active movements of the patient and respiratory excursion can provoke or increase pain caused by wound drains. It is recommended that the necessity for wound drainage be carefully individualized, rather than regarded as a routine consideration.

Anesthetic factors

The use of nonsteroidal anti-inflammatory drugs after induction of anesthesia is recommended during laparoscopic procedures [7]. Their direct analgesic effect is not sufficient for their use as single agents, but they have a useful opioid-sparing and anti-inflammatory effect, especially when combined with paracetemol. In several studies, ibuprofen was found to be a useful alternative to fentanyl for providing postoperation analgesia in outpatient surgery, significantly reducing postoperation pain and nausea compared with fentanyl [30, 33].

Sociocultural and individual factors

The sociocultural environment affects hospital stay and recovery time. This variable, encountered on almost a daily basis by most surgeons, was effectively demonstrated in a study comparing the course after laparoscopic cholecystectomy in French and American patients. Postoperation discomfort had resolved within 2 weeks in 73% of the French and in 93% of the Americans. A higher percentage of Americans returned to work in a given period than did the French patients [37]. It is accepted that despite the best practices, a multitude of factors including previous pain experiences and individual thresholds will influence individual postoperation pain perception and recovery time.

Conclusions

On the basis of the available literature, several recommendations can be made in an attempt to minimize pain after laparoscopic surgery. First, the surgeon should take a moment to consider the sociocultural and individual factors likely to have an impact on the pain experience for each patient, and to discuss the likely outcome as part of the informed consent process. In the operating room, it is recommended that port-site wounds be injected with local anesthesia before any wound is created. Thereafter, the intra-abdominal pressure during insufflation should be kept below 15 mmHg and unnecessary pressure peaks and prolonged insufflation avoided. The use of humidified gas is a simple but effective measure if available. If humidified gas is not available, gasless laparoscopy may reduce insufflation-induced pain, but at the risk of additional trauma caused by additional incisions and mechanical traction. While the patient is under anesthesia, a nonsteroidal anti-inflammatory agent should be administered. At the end of the operation, the surgeon should try to evacuate the intraperitoneal gas under direct vision. Finally, wound drainage should be carefully individualized and not routinely used.

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