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Risk Factors and Prevention Measures for Specific Shoulder Pain in Laparoscopic Surgery

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Abstract

Introduction: Shoulder pain is a specific discomfort associated with laparoscopic procedures. Its pathophysiology remains poorly understood and hypothetical. Several factors have been suggested as potential triggers for this pain. The aim of our study is to assess post-laparoscopic surgery shoulder pain and investigate the risk factors for its occurrence and methods of prevention.

Materials and Methods: This is a descriptive and prospective study involving 337 patients who underwent laparoscopic surgery for acute non-traumatic abdominal emergencies between February 2018 and October 2021.

Results: Among the 337 operated patients, 190 were females (56.4%), with a mean age of 38 years ± 15 years. Shoulder pain was present in 73 patients (21.6%). Its intensity was low in the majority of cases. The average duration of pain was 1.99 ± 1.09 days. The operative time threshold at which pain began to appear was 34.5 minutes. Pain was less intense in patients who underwent drainage at the end of the procedure (p-value = 0.026 on postoperative day 1). Moreover, there was no correlation between the duration of postoperative shoulder pain and drainage (P= 0.482).

Conclusion: The insufflation of CO2 to create pneumoperitoneum and the tensioning of the nerves in the abdominal wall were the factors responsible for shoulder pain in our study. Drainage at the end of the procedure reduced the intensity of the pain but did not prevent its occurrence.

Keywords: CO_2; Laparoscopy; Postoperative Pain; Shoulder Pain

Introduction

In laparoscopic surgery, there are fewer skin incisions and less parietal trauma, resulting in fewer sections of cutaneous nerves and thus less postoperative pain compared to conventional surgery [1]. However, a criticism of laparoscopic approach is the presence of postoperative shoulder pain, with an incidence estimated between 35% and 80% [1-3]. It is a pain of moderate intensity and short duration, but in some cases, it persists for more than 72 hours [4,5], and its intensity is sometimes greater than that of the surgical sites [2]. This pain unique to the laparoscopic approach is still poorly understood [6,7]. Thus, the pathophysiology of this pain, the factors implicated in its occurrence, and the means of its prevention remain hypothetical. Several factors have been cited as the origin of this pain, such as CO_2 used for pneumoperitoneum creation [8], abdominal distension resulting from pneumoperitoneum creation [7], and the low temperature (below body temperature) of the insufflated gas [7]. The objective of our study is to evaluate post-laparoscopic

surgery shoulder pain and to study the risk factors for its occurrence, and the means of its prevention.

Material and Methods

Conducted at the university department of general surgery of Ain Taya Hospital (CHU Alger EST, Algeria), our descriptive and prospective study included 337 patients undergoing laparoscopic surgery for acute non-traumatic abdominal emergencies between February 2018 and October 2021. We included in this study all adult patients aged 15 years and older presenting only acute non-traumatic abdominal surgical emergencies. We excluded from this study traumatic emergencies, patients classified as ASA IV, and patients in hypovolemic or septic shock.

Postoperative pain was assessed at postoperative day 0 (POD0) and postoperative day 1 (POD1) using the visual analog scale (VAS) and categorized into four modalities:

No pain = VAS 0,

Mild pain = (VAS 0 - 3),

Moderate pain = (VAS 4 - 6),

Severe pain = (VAS > 6).

In our study, first-line analgesics such as paracetamol were used as the initial treatment. The majority of our patients were discharged on POD1; therefore, pain intensity assessment was conducted at both POD0 and POD1. The evaluation of postoperative pain duration was performed during follow-up consultations.

Results

Out of the 337 operated patients, 190 were females (56.4%) and 147 were males (43.6%). The mean age was 38 years ± 15 years, with a range from 15 to 82 years. The body mass index (BMI) was above 25 in 179 patients (53.11%). Comorbidities were present in 109 patients (32.3%), and abdominal scarring was observed in 90 patients (26.7%). According to the American Society of Anesthesiologists (ASA) classification, our patients were categorized as ASA I in 74.8% (252 patients), ASA II in 22% (74 patients), and ASA III in 3.3% (11 patients). Pregnant women represented 4.2% (8 patients) of our sample, with a mean gestational age of 15 weeks ± 7.29 weeks, ranging from 7 to 29 weeks. The pathologies operated on in our study are summarized in Table 1.

Preoperative Diagnosis			Peroperative Diagnosis		
Pathologies	N	%	Pathologies	N	%
Acute appendicitis (simple and complicated)	177	52,6	Acute appendicitis (simple and complicated)	178	53
Acute lithiasic cholecystitis	88	25,9	Acute lithiasic cholecystitis	88	25,9
Ovarian cyst torsion	24	04,5	Ovarian cyst torsion	27	07,5
Ectopic pregnancy	23	06,9	Ectopic pregnancy	23	06,9
Péritonites par perforation d'ulcère	10	3	Peritonitis due to peptic ulcer perforation	9	2,7
			Ileal perforation	1	0,3
Occlusions intestinales aigues sur brides	8	2,4	Acute intestinal obstruction due to adhesions	7	2,1
			Obstruction due to stromal tumor	1	0,3
Acute nonspecific abdominal pain	7	2,1	Acute appendicitis	3	0,89
			Ruptured right ovarian cyst	1	0,3
			Retrocecal internal hernia	1	0,3
			No specific etiology	2	0,6

Table 1: Operated Pathologies.

The mean operative time across all pathologies was 52.09 minutes ± 24.14 minutes (range: 14 to 178 minutes). The overall anesthesia duration (surgical intervention time) was 75.35 minutes ± 25.17 minutes (range: 29 to 203 minutes). The mean overall hospitalization duration was 1.5 days (range: 1 day to 8.5 days), with a mean postoperative hospitalization duration of 1 day (range: 1 day to 7.5 days).

The postoperative morbidity rate was 6.2% (n = 21 patients). Shoulder pain specific to laparoscopic approach was found in 73 patients (21.6%). Postoperative pain in our patients was predominantly mild, with 73% (n = 246 patients) reporting mild pain at postoperative Day 0 (POD0) and 68.5% (n = 231 patients) at PO D1. The pain evolved progressively, with 73% of patients reporting mild pain at

POD0 compared to 68.5% at POD1. Additionally, there was a decrease in the percentage of patients reporting moderate and severe pain from POD0 to POD1.

The mean duration of postoperative pain was 1.99 days ± 1.09 days, ranging from 0 to 6 days. The threshold operative time for the onset of pain was 34.5 minutes (calculated using the Youden test). Correlation analysis between the occurrence and duration of postoperative shoulder pain and various parameters such as sex, age, BMI, ASA stage, timing of surgical interventions, location of the operated organ (above or below the mesocolon), operative time, and drainage, using chi-square test, Fisher's exact test, or Spearman's Rho test, showed no significant relationship between these parameters and the occurrence of shoulder pain Table 2.

Postoperative pain	Parameters	P
Survenue de la douleur scapulaire	Age	0,333
	Gender	0,469
	Body Mass Index	0,501
	ASA Status	0,910
	Timing of Surgical Procedures	0,157
	Operated Pathology	0,287
	Location of Operated Target Organ	0,511
	Operative Time	0,616
	Drainage	0,199
	Day of Resumption of Intestinal Transit	0,760

Table 2: Risk Factors for the Occurrence of Postoperative Shoulder Pain.

Similarly, correlation analysis between the intensity of postoperative shoulder pain and various parameters using chi-square test, Fisher's exact test, or Spearman's Rho test, revealed a significant relationship between the intensity of shoulder pain at POD1 and drainage (p-value = 0.026 at POD1) Table 3. However, there was no correlation between the duration of postoperative shoulder pain and drainage (P = 0.482, Fisher's exact test).

Postoperative pain	Parameters	*P* at D0	*P* at D1
Survenue de la douleur scapulaire	Âge	0,425	0,419
	Sexe	0,944	0,785
	Body Mass Index	0,501	430
	ASA Status	0,910	720
	Operated Pathology	0,540	0,234
	Location of Operated Target Organ	0,456	0,132
	Operative Time	0,056	0,053
	Drainage	0,157	0,026
	Day of Resumption of Intestinal Transit	0,760	0,333

Table 3: Factors correlated with the intensity of shoulder pain at postoperative day 0 and day 1.

Discussion

Criticism often arises regarding laparoscopic procedures due to the incidence of postoperative shoulder pain, estimated to range from 35% to 80% [1-3]. This pain typically presents as moderate in intensity and short in duration, though in certain cases, it can persist beyond 72 hours and surpass the intensity of incisional pain [4,5]. In our study, laparoscopy-specific shoulder pain was observed in 73 patients (21.6%). Predominantly, it was of low intensity (VAS = 0-3) in most patients (73% at POD0 and 68.5% at POD1) [6]. This pain exhibited a regressive pattern, with a mean duration of 1.99 days (range: 0 to 6 days) [6]. These findings corroborate existing literature, where shoulder pain is often described as

moderate and typically resolves within seven postoperative days, barring exceptional cases. The etiology of laparoscopy-specific shoulder pain remains elusive. Various factors have been postulated to elucidate its origin, including peritoneal cavity distension by insufflated CO_2 and tension on nerves and blood vessels, culminating in the release of inflammatory mediators and neuropraxia of the phrenic nerve due to CO_2's acidic effect [2,4,7,9].

The alleged algogenic role of CO_2 in precipitating post-laparoscopic shoulder pain is frequently discussed, possibly mediated by local acidosis [8]. Notably, a significant correlation exists between postoperative pain and residual carbon dioxide volume in the peritoneal cavity following parietal closure [2,4,10]. Studies have suggested that active aspiration of residual CO_2, as opposed to passive evacuation, substantially mitigates post-laparoscopy pain [11,12]. Our study unveiled a significant association between shoulder pain intensity at POD1 and the placement of a drain at the procedure's conclusion (p-value = 0.026 at POD1 per chi-square test) [6]. Shoulder pain intensity diminished at POD1 in patients with drainage, attributed to residual CO_2 evacuation through the drain. Nonetheless, drainage neither prevents the onset of this pain nor curtails its duration. For some authors, it has been demonstrated that drainage does not reduce postoperative shoulder pain [13].

Inflammatory phenomena surrounding the drains could potentially induce pain, negating any advantage conferred by the expulsion of residual gases through the drain [7]. Thus, it is suggested that intraperitoneal gas be actively evacuated at the end of the laparoscopic procedure by instrumental aspiration under direct vision without the use of drains [7]. Some authors even advocate for placing the patient in a Trendelenburg position at 30° with a pulmonary recruitment maneuver consisting of five manual lung inflations. This maneuver helps push the diaphragm upward, facilitating the evacuation of residual gas from the subphrenic space [1]. Some authors suggest that post-laparoscopy pain is partly due to abdominal distension during pneumoperitoneum creation. This distension leads to stretching of the phrenic nerves and the anterior abdominal wall [7]. A nerve extension of 20% results in complete occlusion of endoneural vessels and total nerve ischemia [7,14]. This observation was noted in our study; indeed, our results showed that pain onset occurs intraoperatively once the phrenic nerves are irritated by CO_2 (from the threshold of 34.5 minutes according to the Youden test). Once the phrenic nerves are irritated and pain is triggered, even complete evacuation of residual CO_2 through a drain will not completely eliminate postoperative pain, as evidenced by the absence of a relationship between drainage and the duration of postoperative shoulder pain. For other authors, the nerve has time to adapt to stretching, making it less likely for distension injury to occur. It is rather the intraoperative pressure spikes >15 cm/Hg that have a greater nociceptive influence on the phrenic nerves than the pneumoperitoneum plateau pressure [7]. Finally, a last category of authors suggests that the low temperature (below body temperature) of insufflated gas may be responsible for the pain. Two studies compared pain in two groups of patients. The first group was insufflated with gas at a low temperature (20°C), and the second group was insufflated with gas at physiological temperature (37°C). The results of these studies showed that patients in the second group insufflated with warm gas had less postoperative shoulder pain [7,15,16]. However, rigorously controlled studies on animals have determined that the impact of insufflation of warm gas on postoperative shoulder pain is minimal [7,17].

Conclusion

Our study demonstrated that CO_2 used to create pneumoperitoneum and the tensioning of nerves in the abdominal wall resulting from abdominal distension are two main factors involved in the genesis of shoulder pain. Our study also showed that the volume of residual gas is directly related to the intensity of the pain. Moreover, the use of a drain at the end of the procedure would not prevent the occurrence of this pain, but would reduce its intensity. Thus, CO_2 desufflation at the end of the procedure or the placement of a drain would reduce the intensity of postoperative pain.

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