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The Need and Indications for Developing an Approach and Technique for Performing Laparoscopic Gynecological Surgeries at Zero Intra-Abdominal Pressure Without the Use of a Laparolift Under Spinal Anesthesia Only

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Abstract:

Background. Traditional gynecological laparoscopy performed under CO_2 pneumoperitoneum and general anesthesia provides a predictable operative space, but is associated with cardiorespiratory changes due to Trendelenburg and significant drug load, limiting the applicability of this method in high-risk patients and in resource-constrained regional hospitals. Gasless laparoscopy is considered an alternative; however, it is more often performed with a laparolift, which increases technological dependence, complicates organization, and may limit the versatility of pelvic exposure in certain clinical situations. Aim of the study. To substantiate the need and clinical indications for developing an approach and technique for performing laparoscopic gynecological surgeries at zero intra-abdominal pressure without the use of a laparolift under spinal anesthesia only, and to formulate requirements for the safety and reproducibility of the future algorithm. Materials and Methods. A

problem-based analytical review of the literature was conducted, including a qualitative synthesis of data on the physiological effects of CO_2 pneumoperitoneum and positioning, low-pressure strategies, neuraxial anesthesia in laparoscopy, gasless approaches, and the early recovery profile (pain, PONV). A patent information analysis of the state of the art was performed, including an international search of the PATENTSCOPE (WIPO) and Espacenet (EPO) databases, to identify technical solutions related to creating a CO_2-free operating space and dependence on lifting systems. Results. According to the literature, two "incomplete" models predominate: a gasless approach with a laparolift and neuraxial anesthesia with preserved CO_2 pneumoperitoneum. Laparolift, despite eliminating the CO_2 factor, creates a new "bottleneck" in scaling: dependence on specialized equipment, a prolonged preparatory phase, and variability in pelvic exposure in some patients. The combination of zero intra-abdominal pressure, elimination of a laparolift, and true spinal anesthesia represents a clinical and technological niche that potentially reduces CO_2- and GA-associated load and improves the early recovery profile (including PONV). A key condition for the clinical feasibility of this approach is preliminary standardization: positioning strategy, "adequate exposure" criteria, conversion protocol, and a uniform set of safety and efficacy endpoints. Conclusion. The "0 mmHg" approach. The concept of "laparoscopy without a laparolift under spinal anesthesia only" has sound clinical and organizational justifications and requires further development of a reproducible approach and a safety algorithm, followed by clinical evaluation.

Keywords : gynecological laparoscopy; gasless laparoscopy; zero intra-abdominal pressure; laparolift; spinal anesthesia; Trendelenburg; safety; conversion; PONV; regional hospitals.

Introduction

Laparoscopy in gynecology has long been a "quiet standard": less surgical trauma, faster recovery, shorter hospital stay, and better quality of life. However, this standard has a price—it lies not in the incisions, but in physiology. The classical model of laparoscopy relies on a combination of CO_2 pneumoperitoneum and general anesthesia, which means controlled ventilation, drug loading, and inevitable cardiorespiratory shifts, which are amplified in the Trendelenburg position [1], [2].

Even with impeccable anesthetic management, increased intra-abdominal pressure and Trendelenburg alter venous return, pre- and afterload, cardiac output, and arterial pressure variability. At the same time, pulmonary compliance decreases, airway pressure increases, and CO_2 resorption maintains the risk of hypercapnia and the need for more stringent ventilation parameters. This is particularly important in gynecology, as pelvic floor positioning often requires significant table tilt, and the duration of the procedure often extends beyond short procedures.

The clinical "cost" of this model is particularly evident in the early postoperative period. After general anesthesia and laparoscopy, nausea, vomiting, the need for opioid analgesia, shoulder pain syndrome, and delayed ambulation persist. According to current guidelines and clinical reviews, the incidence of postoperative nausea and vomiting reaches approximately 30% in the general population and can approach 80% in high-risk patients, transforming PONV from an "unpleasant symptom" into a factor affecting safety, cost, and satisfaction with treatment [3], [4].

This is where medicine and care organizations converge. The World Health Organization consistently emphasizes that surgical safety is not a luxury.

The Current Standard and Its Limits

Laparoscopy in gynecology has become the preferred approach for most benign diseases of the adnexa and pelvis, demonstrating less invasiveness and faster recovery compared to laparotomy [5], [6], [7], [8], [9], [10], [11]. These advantages are also retained in special populations, including patients with benign adnexal lesions during pregnancy, provided selection criteria and appropriate surgical management are met [12], [13], [14], [15], [16]. However, the standard laparoscopy model almost always includes two "physiological levers"—CO_2 pneumoperitoneum and general anesthesia. These levers ensure a stable operating space and controlled ventilation, but they also create the workload that becomes limiting when the patient enters the operating room less than "ideal"—living—with comorbidities, reduced respiratory reserve, obesity, cardiovascular pathology, or pregnancy [17], [18]. The clinically significant hemodynamic and respiratory effects of CO_2 pneumoperitoneum and the Trendelenburg position have long been described and confirmed in various surgical contexts: changes in venous return, arterial pressure variability, and myocardial load are observed. In terms of respiratory effects, pulmonary compliance decreases, airway pressure increases, and conditions for hypercapnia are created due to CO_2 resorption [18]. Even with good monitoring, this means an increased number of corrections, a growing drug burden, and expanded demands on the anesthesiology service. In large centers, this is perceived as "routine," but in regional healthcare systems, it is precisely this routine that often becomes a barrier to accessibility.

Methodology

The methodology of this study is based on a structured problem oriented analytical review combined

with patent landscape analysis to justify the development of a zero intra abdominal pressure laparoscopic approach without laparolift under spinal anesthesia. A comprehensive literature search was conducted using major international medical databases, prioritizing high quality evidence such as systematic reviews, randomized clinical trials, and clinical guidelines, including those from the World Health Organization. The selection criteria focused on studies addressing physiological effects of CO_2 pneumoperitoneum, Trendelenburg positioning, neuraxial anesthesia, gasless laparoscopy, and early postoperative recovery outcomes such as pain and postoperative nausea and vomiting. A qualitative synthesis approach was applied to critically compare existing models, including conventional laparoscopy, low pressure CO_2 techniques, and gasless approaches with laparolift, identifying their clinical limitations and technological dependencies. In parallel, a patent analysis was performed using international databases to evaluate current technical solutions for creating a CO_2 free operative field and to assess innovation gaps. The collected data were interpreted through an integrated clinical and organizational framework, emphasizing safety, reproducibility, and scalability. Special attention was given to defining key parameters for future algorithm development, including exposure criteria, positioning strategies, and conversion protocols, ensuring that conclusions are both evidence based and practically applicable.

Results and Discussion

Here, it is appropriate to emphasize a fundamental framework: modern surgery views safety as a reproducible process, not as the individual talent of a team. According to the logic of the WHO and global surgery, any technology that aspires to scalability must reduce the number of critical dependencies and make the outcome predictable with a reasonable level of resources [19], [20], [21]. Therefore, the question of finding a laparoscopic model that maintains minimal invasiveness while reducing the physiological and organizational "entry costs" is not a highly specialized one: it is a question of quality and accessibility of care.

Early postoperative recovery is a separate issue. For gynecological laparoscopy, it is important not only to "perform the operation" but also to quickly return the patient to activity: pain, nausea and vomiting, shoulder pain syndrome, opioid requirements, and length of hospitalization shape the actual clinical and economic picture [22]. Current consensus approaches to PONV prevention emphasize that this is not a minor discomfort, but a factor that directly impacts quality, resources, and satisfaction with treatment. Reducing the overall anesthetic burden and the need for opioid analgesia are considered one way to improve this profile [23].

Partial Solutions: Low CO_2 Pressure and Neuraxial Anesthesia with Maintained Pneumoperitoneum

Reducing intra-abdominal pressure to low values and switching to neuraxial anesthesia with maintained CO_2 pneumoperitoneum logically appears as a "compromise." In the literature, they are described as ways to reduce the severity of the adverse effects of the standard model and improve postoperative recovery [24]. However, in essence, these are steps within the same paradigm: the gas remains, and therefore the physiological "pressure + CO_2 resorption" axis remains, albeit in a more attenuated form; at the same time, dependence on gas infrastructure and consumables remains.

Neuraxial anesthesia in laparoscopy does indeed demonstrate promising clinical advantages, particularly in terms of a more "gentle" recovery and a reduced drug burden. Data have accumulated in related surgical fields on the potential reduction in pulmonary complications and a range of outcomes with the use of regional/neuraxial approaches instead of general anesthesia in certain patient groups [25], [26], [27], [28]. These data cannot be mechanically extrapolated to gynecology, but they reinforce the line of thought: reducing the proportion of general anesthesia, where feasible and safe, is a strategy that deserves clinical standardization.

However, two key issues remain with laparoscopy under neuraxial anesthesia with preserved CO_2 pneumoperitoneum. The first is the continued need to create the surgical space with pressure, which in some patients contributes to discomfort and physiological changes, especially in the presence of pronounced Trendelenburg. The second is methodological: in many publications, neuraxial anesthesia is accompanied by variable sedation, which complicates comparability and makes the

protocol less “pure” in terms of reproducibility and interpretation of effects. As a result, “neuraxial anesthesia + CO_2” remains an important, but not definitive, answer to the question of the physiological and resourcefulness of neuraxial anesthesia.

Indications and Limitations as the Basis for Safe Development

This review considers indications not as a list of diagnoses, but as a clinical logic: where the potential benefit of zero pressure and avoiding general anesthesia will be greatest and where the risks of technical difficulties will be manageable.

The most justified areas for development appear to be situations where:

1. Cardiorespiratory load must be minimized (comorbidity, reduced reserve);
2. Rapid and "clean" recovery with a reduction in ponv and opioid requirements is important;
3. There are organizational limitations regarding gas infrastructure and anesthesia provision, typical for regional hospitals.

At the same time, limitations should be formulated as clearly as the indications. Literature on gasless approaches shows that the quality of pelvic exposure can become a critical factor in obese patients and those with severe adhesions [25], [26], [27]. Therefore, the development of access techniques and conditions for performing 0 mmHg should initially be based on clear applicability limits and a conversion protocol as a safety feature, not as a "sign of failure."

Requirements for a Future Safety and Conversion Algorithm

Since this article is of a review and substantiation nature, the key outcome is the formulation of requirements for the algorithm to be developed and clinically evaluated. These requirements can be represented as five mandatory pillars.

1. Positioning strategy and its tolerability. With CO_2 reduction or elimination, the role of positioning increases, and therefore positioning tactics should be standardized in advance and tested for tolerability, rather than remaining an "operating room art".
2. Criteria for adequate exposure. For zero pressure, clinically applicable criteria for "sufficient visualization and working space" must be defined in advance, which will allow for standardized decisions rather than debates during surgery [27].
3. Conversion protocol. Conversion should be considered as part of a safety strategy: predefined conditions and a sequence of actions in the event of insufficient exposure or signs of safety degradation. Reviews emphasize that it is precisely controlled conversion that determines the practical value of the approach, not a "no gas at all costs" declaration.
4. Standardization of anesthetic management. The principle of "solely spinal anesthesia" is emphasized as a pure model that allows for the evaluation of effects without confounding. A uniform monitoring standard and clear correction rules are necessary, which improves reproducibility and reduces outcome variability.
5. A uniform set of endpoints for clinical evaluation. Since the goal of development is not to demonstrate technical feasibility but to implement a safe technology, the evaluation should include: intraoperative physiology, quality of exposure and ease of performing key steps, complication and conversion rates, early recovery indicators (pain, PONV, shoulder syndrome, mobilization, length of hospital stay), as well as clinical and economic parameters.

Conclusion

Based on the analysis of literature and patent information, a key conclusion was reached: existing approaches either conserve CO_2 when switching to neuraxial anesthesia or abandon CO_2 at the expense of dependence on laparoscopic anesthesia. Gynecology, with its need for stable pelvic exposure and high value for early recovery, particularly benefits from a model that minimizes both physiological burden and technological dependence. Therefore, the concept of "zero intra-abdominal pressure without laparoscopic lift under spinal anesthesia only" is not simply a potential innovation, but a response to the practical limitations of the standard model and the scalability barriers of existing gasless solutions.

Traditional laparoscopy Standard pressure CO_2; general anesthesia with mechanical ventilation Stable exposure, wide applicability, proven technique Maximum physiological and resource load (CO_2 + pressure + Trendelenburg + GA), relevant for risk groups and regions Control model; sets the problem to be addressed
Low CO_2 pressure Low CO_2 pressure; neuraxial anesthesia (variable sedation) Partial reduction of exercise effects; potentially better recovery profile with reduced GA/opioid ratio CO_2 maintained (gas resorption/dependence); exposure may be less stable; protocols are heterogeneous "Transitional" strategy:

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