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Posted Date: 6 May 2024

doi: 10.20944/preprints202405.0269.v1

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Article

Gynecological Laparoscopic Surgeries under Spinal Anesthesia: Benefits and Challenges

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Abstract: Objective: This prospective study investigated the feasibility performing laparoscopic pelvic surgery in spinal anesthesia and analyzed their intraoperative side effects like pain and nausea and vomitus of 915 patients. **Methods**: Implementation and performance of laparoscopic surgery under local anesthesia of 915 patients out of a total of 3212, who underwent laparoscopic pelvic surgery in spinal anesthesia, were analyzed in relation to BMI (Body Mass Index), obesity, pain during surgery and amount of intraperitoneal mmHg CO2 gas pressure and surgical complications. **Results:** BMI > 30, intraabdominal adhesions, increased duration of the operation, bleeding and increased intraperitoneal CO2 pressure were statistically significant as the main causes of pain during laparoscopic surgery in spinal anesthesia. Underweight patients, on the other hand, had less pain when intra-abdominal pressure increased compared to those of normal weight. The appearance of pain, nausea and vomitus occurred in 10,3% and was easy to manage and treat. It did not affect the surgeon's work and the course of the operation. **Conclusion**: In view of these observations, we are proposing spinal anesthesia for laparoscopic surgery as the first choice in those patients, who have no contraindications. In our knowledge this clinical study constitutes the largest clinical observations and dataset that applies spinal anesthesia in laparoscopic pelvic surgery.

Trial registration: ISRCTN38987, on 10 December 2019.

Keywords: spinal anesthesia; laparoscopic surgeries; gynecology; mini-invasive operations

1. Introduction

In global practice, general anesthesia is considered as a common method to conduct laparoscopic abdominal surgeries. Spinal anesthesia is assumed as a next alternative when the patient has contraindications to total anesthesia. The authors raise the experience of applying spinal anesthesia as the first choice for laparoscopy surgery, clinically proving that it is the best option for anesthesia. Over 3212 laparoscopic gynecology surgeries were conducted in Urgench (Uzbekistan) with spinal anesthesia to observe the benefits and challenges of this minimal-invasive operation.

In 2020, there was over 40,000 birth deliveries in the Khorezm region (which has a 1.77 million population) and 8,795 patients had cesarean section. The majority (98.1%) of patients had epidural (spinal) anesthesia [1]. Regional anesthesia (RA) is a common practice in the Khorezm region of Uzbekistan and anesthesiologists widely used this method with outstanding outcome. Regional

 doi:10.20944/preprints202405.0269.v1

anesthesia for cesarean sections compared to general anesthesia (GA) provides less maternal mortality, possibility to use less drugs, more direct practice of childbirth [2,3], and the opportunity to diminish blood loss while ensuring outstanding postoperative pain control [4].

Table 1. Birth delivery parameters in Khorezm region, Uzbekistan.

Annual Birth Rate	Cesarean Section	Regional Anesthesia	Intubation
40 896	8795 (21.5%)	8634 (98.1%) (peridural)	161 (1.9 %)

Source: Khorezm Healthcare department, 2022.

For laparoscopic surgery however, peridural anesthesia is insufficient. Relaxation of abdominal muscles by spinal anesthesia, enabling the insufflation of the peritoneal cavity sufficiently, has to be performed. In order to make gynecological organs, covered by intestines, visible, Trendelenburg position is needed [5]. However, inducing spinal anesthesia in Trendelenburg position by inexperienced personnel can be dangerous, because anesthesia like bupivacaine reaching the thoracic spinal canal can block the correct functioning of respiratory organs and by this arrest spontaneous breathing. The other reason, why general anesthesia is still preferred for laparoscopy in gynecology, is the use of a sufficiently high intraabdominal pressure of CO2 gas to blow the abdominal cavity in order to achieve a good endoscopic view and by this avoiding the risk of unwanted surgical side effects. On the one side loco-regional anesthesia may cause discomfort and pain to the patient, on the other side most of the surgeons are not used to act in low CO2 pressure, which is a condition, in which most patients feel comfortable.

To carry out spinal anesthesia in Trendelenburg position, it is important to have physical knowledge of anesthesia medicine in hyperbaric solution [6] and to have trained personnel [7]. Such anesthetics include 0,5% hyperbaric solution of Bupivacaine Hydrochloride (Longocain Heavy). When a hyperbaric solution is injected in the cerebrospinal fluid, it sinks and drops below the puncture site causing anesthesia in the corresponding segment [8–10]. If the puncture is done in L2-L3 and the patient is in the supine position, the hyperbaric solution with anesthesia like Bupivacaine flows from the apex of the lumbar lordosis in both directions. When the patient is in a lateral recumbent position, the anesthesia effect will be on the corresponding side [8,9]. This means also, when the body is tilted to a Trendelenburg position, the anesthetic medicine spreads unhindered in cranial direction to the thoracic segments and to the nerves innervating the respiratory organs [10,11]. However, performing the puncture in a sitting position and leaving the patient in this position for a while [12], a classic “saddle” anesthetic block develops [5,13]. By applying it correctly, anesthesia in hyperbaric solution is fixed at the correct side enabling laparoscopic surgery without effecting the respiratory organ.

The Trendelenburg position has also advantages. Among other factors it improves venous return and harmonizes blood pressure [5,14]. There are several key factors that discourage the use of laparoscopic surgery under spinal anesthesia. Firstly, the surgical and anesthesiology teams may lack the necessary expertise to perform both anesthesia and surgery in Trendelenburg position, which is required for gynecology during laparoscopic procedures. Additionally, the unfamiliar and potentially challenging environment of the operating theater can contribute to patient anxiety, mainly due to a lack of confidence, if the patient is not well prepared by the medical team. While the occurrence of nausea, vomiting, and discomfort during the surgical intervention is a possible inconvenience, it can be effectively managed with proper care. Notably, the conscious state of the patients under spinal anesthesia eliminates the risk of aspiration into the lungs in case of vomiting. It is the responsibility of the anesthetist and surgeon to provide clear explanations and reassurance to address any concerns related to nausea and vomiting. Importantly, opting for laparoscopic surgery under spinal anesthesia offers distinct advantages, such as accelerated postoperative recovery, reduced incidence of postoperative nausea and vomiting, and decreased requirement for analgesic medications. The intensity of pain and discomfort is directly related to the pressure of pneumoperitoneum [5]. It can be managed by reducing intra-abdominal pressure.

 doi:10.20944/preprints202405.0269.v1

According to several retrospective research studies on clinical databases, endoscopic surgeries performed under neuraxial anesthesia, such as spinal anesthesia, have been associated with reduced patient mortality and major morbidity, including pulmonary complications and transfusion requirements, compared to classical surgeries performed under general anesthesia [4,11]. The same was also described for laparoscopic surgeries [15]. To note that in difficult times such as the COVID pandemic, there was not enough anesthetic material, drugs and personnel available for surgical procedures under general anesthesia, which can be prevented or at least reduced with more interventions in spinal and epidural anesthesia [16]. Another advantage of regional anesthesia technique has been shown to reduce the length of hospital stay, which is important in time of catastrophes [17]. One of the advantages of local regional anesthesia (LRA) is better postoperative pain control, which has been linked to spinal drug injection in the LRA group [5,17]. Patients who receive general anesthesia often experience initial pain upon regaining consciousness postoperatively. Comparisons between the benefits of spinal anesthesia and general anesthesia for postoperative pain control showed statistical significance at subsequent testing periods, such as 8, 12, 24, and 48 hours after surgery [17]. Patients who received spinal anesthesia did not require intravenous opioid administration, and they achieved a quick return of intestinal motility and independent ambulation. It allowed also to shorten the period of urinary catheterization and to decrease the infection risk. Avoiding extended bed rest, which can result in paralytic ileus, muscle soreness, and weariness, also encourages better postoperative pain management.

Intra- and post-operative advantages of spinal anesthesia combined with LRA were observed, including significantly lower pain scores in the postoperative period compared to general anesthesia [17]. A statistically significant difference of 6 points in visual analog scale pain scoring (VAS), a validated subjective measurement of acute and chronic pain, was recorded one hour after surgery, as reported in a study [17]. Our study and these findings support to increase and better define the use of spinal anesthesia and LRA for laparoscopic surgeries in the future.

2. Materials and Methods

2.1. Study Group

A total of 3212 women participated in the prospective study and had laparoscopic surgery of the pelvis using spinal anesthesia in Urgench city of Uzbekistan from January 9, 2019 to January 31, 2024 [5,18]. Following parameters were recorded for each patient: Indication for surgery, BMI (Body Mass Index), parity, the presence of adhesive disease, volume and duration of the intervention, pain before, during and after surgery, localization of pain, amount of intraperitoneal mmHg CO2 gas pressure and quantity of blood loss during the intervention and etc. Pain was recorded by questioning the patients and was scored from 1-10: mild 1-4, moderate 5-6, severe 7-8 and very strong 9-10. 915 of these interventions were analyzed statistically. Patients ranged in age from 25 to 50 years. The consent from each patient was asked prior to the operation. A quality questionnaire with a pain score was performed before, during and after surgery. Data of 915 patients operated until March 6, 2021 in spinal anesthesia were entered into the database and analyzed.

2.2. Technique of Spinal Anesthesia

To perform spinal anesthesia in Trendelenburg position, it is important to have physical knowledge of anesthesia medicine in hyperbaric solution and to have trained personnel. Such anesthetics include 0.5% hyperbaric solution of Bupivacaine Hydrochloride (Longocain Heavy). When a hyperbaric solution is injected in the cerebrospinal fluid, it sinks and drops below the puncture site causing anesthesia in the corresponding segment. If the puncture is done in L2-L3 and the patient is in the supine position, the hyperbaric solution with anesthesia like Bupivacaine flows from the apex of the lumbar lordosis in both directions. When the patient is in a lateral recumbent position, the anesthesia effect will be on the corresponding side. This means also, when the body is tilted to a Trendelenburg position, the anesthetic medicine spreads unhindered in cranial direction to the thoracic segments and to the nerves innervating the breathing organs. On the other hand,

 doi:10.20944/preprints202405.0269.v1

performing the puncture in a sitting position and leaving the patient in this position for a while, a classic "saddle" anesthetic block develops.

For anesthesia of the abdomen the anesthetic is injected into the spinal canal of L2-L3, the patient is in sedentary position. Immediately after the patient is slowly positioned in a Trendelenburg position of minus15 degrees. This way the anesthetic moves gently in the cranial direction. At this time special care is required, since too strong flow of the anesthetic in the direction of the thoracic segments of the spinal canal can cause blockage of breathing and apnea. By holding the patient in a slight Trendelenburg position, anesthesia moves in direction of the xiphoid. After placement of the spinal anesthesia, the patient is moved from Trendelenburg to horizontal position. Than the level of anesthesia on the abdomen is evaluated by touching the skin (Algometry). The level between the abdomen and the thorax should not be exceeded. When the anesthetist detects anesthesia effects above the umbilicus or beginning of bradycardia is observed, the patient is given a slightly anti-Trendelenburg position, so that the anesthetic moves back in caudal direction until the anesthetic is fixed. This lasts a few minutes. By this procedure respiratory arrest is prevented with certainty. Immediately after the placement of the spinal anesthesia, oxygen is required routinely for all patients, because of the danger of cerebral hypoxia as cause of the hypotension. It is very important to follow the monitoring of blood pressure, pulse and oxygen at this moment. An epigastric sonde was placed.

To prevent complications due to SA, the authors paid serious attention to comorbid diseases of patients, contraindications of SA, discussed with other specialists' relative contraindications of SA. By using a special technique and by preoperative monitoring and intraoperative vigilance there is a very low risk of SA for patients. Rarely, if a problem with SA might happen, intubation material and devices for general anesthesia must be available for immediate use.

In the case there is tachycardia and low blood pressure Atropine is administered. The cause of nausea and vomitus is low blood pressure and high intraabdominal pressure. Nausea and vomitus often occur at the beginning of surgery and can be prevented by Atropine acting as cholemimetic and blocking the secretion of the gastrointestinal tract and secretion of saliva. Nausea and vomitus, associated and induced by hypotension, is prevented by perfusion of physiological solution and by administration of the sympathomimetic and vasopressor phenylephrine (Mesaton) to increase blood pressure. The use of measures for the prevention and treatment of hypotension, as well as for the prevention of spinal blockade, included the administration of an infusion of crystalloids and/or colloids, wrapping the lower limbs with compression stockings or bandages, the introduction of an optimal dose of local anesthetic, a special technique of bending the body for the spinal injection and the administration of inotropes and vasopressors.

In case nausea and vomitus happen the operation table with the patient is returned to the horizontal position, the head of the patient is turned to the side and the patient is giving the opportunity to vomit. A maximum of 5 minutes is enough in order to continue surgery in Trendelenburg position. There is no danger, because the patient is conscious. After that she is removed to Trendelenburg position in order to continue the operation. Usually there is a single event of vomitus during the operation. The vomit is secretion of the gastrointestinal tract, which has accumulated in the lumen of the stomach and intestines already before the administration of Atropine. At this point Atropine prevents only nausea and vomitus. This is the reason why mostly nausea and vomitus happen in the beginning of surgery. The reason why it happens only one time, is because Atropine is hindering during the operation the production of more saliva and gastric secretion.

During and after surgery high intraabdominal pressure can be present, because of the irritation of the peritoneum in the region of the diaphragm, where there is no anesthesia. This occurs mainly for large and long surgeries which are associated with pain induced by adhesions and bleeding.

2.3. Special Technique of Laparoscopic Surgery under Spinal Anesthesia

Patient position depends on the location to be operated – Trendelenburg position for the pelvic organs in gynecological procedures. Inducing spinal anesthesia by inexperienced personnel can be dangerous, because bupivacaine and other anesthesia in the spinal canal can block breathing. By

 doi:10.20944/preprints202405.0269.v1

using the described technique below and by monitoring and vigilance there is very low risk for the patient. In rare cases it may nevertheless happen, intubation material and devices for general anesthesia must be available for immediate use. Among our 3212 patients with laparoscopic surgery in spinal anesthesia, there was not one case with respiratory arrest. Before moving the patient to the Trendelenburg position the patient is held for 10 minutes in the horizontal position to fix anesthetic medicine in the spinal canal. Once the medicine is fixed there is no risk anymore that anesthesia of the breathing organs will occur by moving the patient in the Trendelenburg position. The advantage of Trendelenburg is that it improves venous return and harmonizes blood pressure.

Intraumbilical incision was performed and at both sides of the incision the skin was elevated with clamps. A Veress needle was introduced intraperitoneally to enable CO2 insufflation with low pressure. A 10 mm Trocar was inserted in the umbilical area and 2 to 3 five mm trocars were inserted in the lower abdomen. Even in patients after cesarean section, the same procedure was performed. To evacuate excised tissue the lateral incision of the 5 mm trocar was extended, if necessary.

The intensity of pain and discomfort is directly related to the pressure of pneumoperitoneum. It can be managed by reducing intra-abdominal pressure. In our experience of 915 patients a good compromise is 8 mmHg or lower, sometimes 10 mmHg is also well endured. In the beginning the surgeon has to take time to adapt to work with such low pressures. Such adaptation however, is going fast, if the surgeon is motivated. And this goes along without respiration problems of the patient by doing such a surgery with a pneumoperitoneum of 8 mmHg and in Trendelenburg of 30-45°. To have a good laparoscopic visibility and not to be disturbed by intestines some precautions are important: 1. a good preoperative preparation of the bowel, 2. Trendelenburg of 30-45°, 3. manipulation of the uterus by a vaginal or laparoscopic device.

All laparoscopic operations were performed under spinal anesthesia.

Before moving the patient to the Trendelenburg position the patient is held for 10 minutes in the horizontal position to fix anesthetic medicine in the spinal canal [5,18]. Once the medicine is fixed there is no risk anymore that anesthesia of the breathing organs will occur by moving the patient in the Trendelenburg position. To study the factors influencing the occurrence of pain, an analysis was carried out depending on the abdominal status, the duration of the operation, the volume of blood loss, the presence of nausea and vomiting during the operation, and volume of intra-abdominal pressure during the operation.

2.4. Describing as a Statistical Model

Factors influencing the occurrence of pain were further analyzed using a statistical model known as ‘analysis of covariance’ or ANCOVA for short. This is a method that allows the determination of the relationship between two variables, here occurrence of pain and obesity, while controlling for a third variable, the amount of CO2 gas used to relieve pain. The third variable is commonly referred to as a ‘covariate’. The methodology was first used in the 1930’s in agricultural application, but since then it has widely been used in many other fields. Analysis of covariance is known to increase the statistical power of the significance test [19,20].

Note that in our analysis, ‘occurrence of pain’ called the response variable is dichotomous in nature. That is a patient either experiences pain or is free of pain. Generalization to cases where there is a degree of pain i.e., the response variable is ordinal is possible. Therefore, the statistical model regressing the occurrence of pain on the explanatory variables ‘amount of utilized CO2 gas’ and ‘obesity’ is based on the so-called logistic regression [21]. The model assumes that the odds of having pain to being free of pain on the logarithmic scale, called the logit, is a linear function of the explanatory variables.

3. Results

All patients who underwent surgery depending on the presence of pain were divided into 2 groups. The first group - women who did not feel pain during the operation ac-cording to the VAS scale (the degree of pain intensity according to VAS:

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(1) No pain – 0;
(2) Weak - up to 40%;
(3) Moderate - 40–70%;
(4) Severe - more than 70%;
(5) Unbearable - 100%. [34,35].

Table 2. Basal characteristics of patients comparing patients without pain to patients with pain during surgery.

		Group-1 No pain – n-847	**Group 2 Little\Middle Pain n-68**	**P Value***
1	Age of operation –years	29.3±6.49	30.2±6.29	0.2571 a
2	Body mass index – kg\m2	24.1±3.72	25.4±5.12	0.07664 a
3	Obesity BMI >30	63 7,44%	13 19,12%	0.003 b
4	COMORBID DISEASES			
5	Anemia	713-84%	60 88%	0.6093 b
6	Adhesions	18 2.1%	6 8.8%	0.0062 b
7	Hepatitis B	11 2.2%	2 2.9%	0.2508 b
8	Hepatitis C	19 2.2 %	3 4.4%	0.2204 b
9	Parity	440 52%	32 47 %	0.3726 b

* a – Mann Whitney test; b – Fisher's Exact Test.

Consequently, 847 (92.5%) of patients out of 915 women varied in this range - The second group consisted of women who had mild or moderate pain during surgery 68 (7.5%) patients. To study the factors influencing the occurrence of pain, an analysis was carried out depending on age, body mass index, obesity, parity and concomitant diseases. A significant difference between the groups was found in the one with patients who had adhesive disease and who underwent dissection of adhesions during surgery. In the first group, women with adhesive disease accounted for 18 (2.1%) and in the second group 6 (8.8%). In addition, a statistically significant difference between the groups defined as individuals with body mass index exceeding 30 - body mass index - >30. In the first group, obese women accounted for 63 - 7.44% and in the second group 13 - 19.12%, respectively. When analyzing other factors influencing the onset of pain, no statistically significant factors were found between the groups.

Table 3. Characteristics causing increased pain.

			First group			Second group			p-value
			n=847	P (%)	**m (±)**	n=68	P (%)	**m (±)**	
1	Abdominal status	I	4	0,47	0,236	3	4,41	2,49	
		II	241	28,45	1,55	7	10,29	3,69	
		III	578	68,24	1,60	55	80,88	4,77	
		IV	24	2,83	0,57	3	4,41	2,49	p<0,001
2	Lengths of operation	>30	99	11,6	1,10	4	5,88	2,85	
		31-60	648	76,51	1,46	38	55,88	6,02	
		< 60	100	11,81	1,11	26	38,24	5,89	p<0,001
3	Bleeding	0-50	801	94,57	0,78	61	89,71	3,69	
		> 50	46	5,43	0,78	7	10,29	3,69	p<0,001
4	BMI	>25	531	62,69	1,66	35	51,47	6,06	
		25-30	253	29,87	1,57	20	29,41	5,53	
		>30	63	7,44	0,90	13	19,12	4,77	p=0.003
5	Hg	0-4	150	17,71	1,31	4	5,88	2,85	

 doi:10.20944/preprints202405.0269.v1

	5-8	697	82,29	1,31	64	94,12	2,85	p=0.013

The results of statistical analysis showed that such indicators as - 4th degree [35] of abdominal status; the duration of the operation is more than 60 minutes. In addition, blood loss over 50 ml; body mass index over 30 and intra-abdominal pressure over 5 mm are statistically significant indicators that play a fundamental role in the development of moderate or mild pain during surgery ($p \leq 0.05$; $p \leq 0.001$).

Of the 915 patients who underwent spinal anesthesia, 27 women experienced side effects such as headache in the frontal and occipital region of severe and moderate severity, as well as nausea and vomiting. Of the 27 women, these side effects were severe in 13 women, and moderate in the remaining 14 patients. Thirteen patients who exhibited severe symptoms of headache, nausea, and vomiting underwent manipulation-plumbing. In addition, an additional group of 14 patients with moderate headache received drug correction, which encompassed the following approaches:

- the use of intravenous infusion solutions in the amount of 1 liter,
- 8 mg of Dexamethasone solution,
- thereafter use of subcutaneous application of a solution of caffeine sodium benzoate 200 mg-1 ml every 8 hours.
- oral administration of Paracetamol tablets 500 mg every 8 hours.

The dynamics of changes in the patient's condition was assessed after 24 hours of drug therapy.

Conversion to intubation anesthesia was performed in 1 case (0.11%). The indication for surgical intervention of this patient was symptomatic uterine fibroids, vesico- and rectocele and stress urine incontinence. Laparoscopic hysterectomy was performed under spinal anesthesia. After 2.5 hours, anesthesia began to wake up and intubation anesthesia was installed. Among 915 patients with SA, 31 (5,3%) needed at the same time sedation and 17 (2,9%) intravenous narcotic analgesics. None of the 915 patients needed to be converted to GA with intubation, because of nausea and vomitus.

Among our 915 patients with laparoscopic surgery in spinal anesthesia, there was not even one case with respiratory arrest. Duration of laparoscopic surgeries using spinal anesthesia ranged between a minimum of 20 minutes and a maximum of 175 minutes while the average was 47 minutes among 915 patients. The antalgic effect of spinal anesthesia (Bupivacaine Hydrochloride) lasted between 120 minutes to 240 minutes, including the postoperative time.

Two separate ANCOVA were performed to assess the effect of the CO2 gas on enduring pain with the weight as the covariate. In the first analysis, the effect was considered for obese patients versus patients with normal weight. It was found that every term of the model was statistically significant ($p < .01$) and that the amount of CO2 gas was the so-called effect modifier for experiencing pain. Thus, higher amount of CO2 gas in obese patients indicated higher chance of experiencing pain. For example, if the amount of CO2 gas was 8 units, then the odds ratio, that is the chance of experiencing pain to the chance of being pain free was 1.6. This means that an obese patient is 60% more likely to experience pain during the surgery than a patient with a normal weight. The chance of experiencing pain in obese patients rapidly increased with higher amount of CO2 gas and for 10 units of CO2 gas, an obese patient was more than 6 times, that is more than 600%, more likely to experience pain than a patient with a normal weight.

The second analysis, pertained to consideration of the effect of CO2 in controlling pain in underweight patients versus patients with normal weight. In this case, it was found that although not every term in the model was statistically significant, the interaction between the two variables was statistically significant at the 10% level ($p = 0.08$). Moreover, in this case, it was found that the break-even value for the CO2 gas was about 5.6 units. This means that if the amount of the CO2 gas was higher than 5.6 units, then a patient with healthy weight was less likely to experience pain. On the other hand, if the amount of CO2 was less than 5.6 units, then a patient with normal weight was more likely to experience pain. For example, if the amount of CO2 was 5 units, a patient with normal weight was 35% more likely to experience pain (odds ratio was 1.35), while for an amount of 7 units

 doi:10.20944/preprints202405.0269.v1

of the gas, a patient with a normal weight was about 48% less likely to feel pain during surgery (odds ratio was 0.52). Table 4 gives the calculated odds ratio for varying values of CO2 for both analyses.

Table 4. Effect of Weight in the Amount of CO2 Pressure on Pain.

CO2	*OR (Obese v Nonobese)*	OR (Healthy Weight v Underweight)
4	*0.097881276*	2.161062502
5	*0.195538107*	1.349858808
6	*0.390627835*	0.84315877
7	*0.780359943*	0.526660053
8	*1.558930486*	0.328966289
9	*3.114286273*	0.205481351
10	*6.221431345*	0.128349278

Table 5 presents data on intraoperative side effects experienced by a total of 915 patients. Each row in the table corresponds to a specific side effect, and the columns provide information on the number of patients who experienced each side effect and the percentage of patients it represents.

Table 5. Incidence of intraoperative side effects.

	Intraoperative Side Effects	Number of Patients Symptoms from 915	%
1	Pain	22	2%
2	Nausea	48	5,2%
3	Nausea and vomitus	13	1,4%
4	Pain nausea and vomitus	11	1,2%

The first side effect listed in the table is "Pain." Out of the 915 patients, 22 patients reported experiencing pain during the operation. This corresponds to a percentage of 2% of the total patient population. The second side effect is "Nausea." Among the 915 patients, 48 patients reported experiencing nausea. This accounts for 5.2% of the total patient population. The third side effect is "Nausea and Vomitus" (vomiting). This refers to patients who experienced both nausea and vomiting during the procedure. Out of the 915 patients, 13 patients reported this combination of symptoms, which represents 1.4% of the total patient population. The final side effect listed in the table is "Pain, Nausea, and Vomitus." This refers to patients who reported experiencing pain, nausea, and vomiting simultaneously during the operation. Among the 915 patients, 11 patients reported this combination of symptoms, accounting for 1.2% of the total patient population.

In summary, the table provides quantitative data on the occurrence of different intraoperative side effects, including pain, nausea, nausea and vomiting, and pain along with nausea and vomiting. The numbers and percentages allow for a scientific analysis of the prevalence of these side effects within the observed patient population.

3. Discussion:

In the meantime, more than 3212 laparoscopic surgeries in Trendelenburg position were performed in Urgench in collaboration with the clinical team of Switzerland [5,18]. It is in our knowledge the biggest numbers performed worldwide in gynecology. Intubation and intravenous anesthesia for such operations became history in Urgench, Uzbekistan, just like cesarean sections did. After a learning phase and becoming used to perform laparoscopic surgery in spinal anesthesia and Trendelenburg position, the anesthetists nor the surgeons, nor the patients are any more interested to perform such surgeries in GA with intubation. In Urgench spinal and peridural anesthesia for laparoscopic surgeries became the new standard of care as it is for cesarean section.

 doi:10.20944/preprints202405.0269.v1

The relationship between patient weight and pain during surgery can be complex and multifactorial. It is important to consider various factors that may contribute to this relationship, such as body composition, tolerance to pain, and individual physiological differences [9,11,13,14]. The results presented highlight the potential influence of patient weight on the experience of pain during surgery when CO2 is used. It suggests that overweight patients may have a higher chance of experiencing pain when the applied amount of CO2 exceeds a certain threshold. Regarding overweight patients, it is plausible that the increased amount of CO2 applied during surgery may result in a higher chance of pain exceeding a certain threshold. The excess weight and adipose tissue in overweight individuals can lead to increased intra-abdominal pressure, which may contribute to discomfort or pain during the insufflation of CO2. Additionally, the distribution of adipose tissue may affect the spread and dispersion of CO2, potentially leading to variations in pain perception [22–24]. Scheib et al. reviewed relevant studies of the existing literature on the relationship between patient weight, CO2 application, and pain during surgery [25]. The impact of patient weight on pain perception during laparoscopic surgery was examined. The authors described that overweight patients experienced higher levels of pain compared to normal-weight patients when the CO2 pressure exceeded a certain threshold. This finding was attributed to the increased intra-abdominal pressure resulting from excess adipose tissue in overweight individuals.

In contrast, a study [26] focused on underweight individuals and their response to CO2 insufflation during laparoscopy. The results indicated that underweight patients were less likely to experience pain as the amount of CO2 pressure increased. The researchers hypothesized that the lower amount of adipose tissue in underweight individuals allowed for more even distribution of CO2 pressure, reducing the likelihood of pain exceeding a certain threshold. In another study however, [5] found no significant association between patient weight and pain during laparoscopic surgery, and suggested that factors other than weight, such as individual pain thresholds and surgical technique, may have a more substantial impact on pain perception. Our results confirm that underweight individuals are less prone to pain with increasing CO2 pressure.

It is important also to note that individual variations exist within each weight category, and other factors, such as overall health status and previous surgical experiences, can also influence pain perception during surgery [5]. Additionally, the discussion focuses solely on the influence of CO2 pressure on pain and does not consider other aspects that may contribute to pain during surgery, such as surgical technique or individual pain thresholds. Further studies are required to better define indications and contraindications of laparoscopic surgeries in loco-regional anesthesia.

In our experience of 915 patients a good compromise is 8 mmHg or lower, sometimes 10 mmHg is also well endured. At the beginning, surgeon has to take time to adapt to work with such low pressures. Such adaptation, however, can be rather quick, if the surgeon is motivated and this goes along without respiration problems of the patient by doing such a surgery with a pneumoperitoneum of 8 mmHg and in Trendelenburg of 30-45°. To have a good laparoscopic visibility and not to be disturbed by intestines some precautions are important: first, a good preoperative preparation of the bowel, second, Trendelenburg of 30-45° and third, manipulation of the uterus by a vaginal or laparoscopic device.

By using the described technique below and by monitoring and vigilance there is very low risk for the patient. In rare cases, however, complications may occur. Therefore, on material and devices for general anesthesia must be available for immediate use.

Loco-regional anesthesia for laparoscopic surgery in Trendelenburg is not only feasible, but should be discussed as being used in many cases as the first choice due the advantages it brings for the patients, for the feasibility and for the need of special material used in general anesthesia. A special case is with obese patients, who have more pain with higher CO2 pressure, which is needed for the visibility of the abdominal organs by the surgeon. To consider is also that obese patients may be associated more often with cardiovascular related problems. In these cases, careful consideration has to be taken which kind of anesthesia to choose. In rare pathologic cases general anesthesia with intubation should stay as a first choice. Pain is usually is combined with high intraabdominal pressure, and also occurs at the end of the operations, especially during long and extensive surgeries.

 doi:10.20944/preprints202405.0269.v1

Locoregional anesthesia could become the first choice of anesthesia for the new surgical vaginal approach called the vNOTE (vaginal Natural Orifice Transluminal Endoscopic surgery) technique, which combines laparoscopic instrumentation and skills exclusively by the vaginal route for surgery of the uterus and adnexa [27]. It is an important advantage by performing this surgery in spinal or peridural anesthesia, since abdominal trocars are not used and therefore anesthesia doesn't need to be effective in the abdominal area. Another advantage is that the vNOTE approach doesn't need a second surgical assistant moving the uterus, since the main surgeon is moving himself the uterus with his vaginal endoscopic instruments. It has also to be mentioned that the endoscopic vaginal procedure is using low CO2 intraabdominal pressure (8mmHg) with lower risk of side effects.

Intraoperative nausea and vomiting can be minimized through effective implementation of perioperative strategies [5,18]. Based on our accumulated expertise, the intravenous administration of specific compounds such as Dexmedetomidine from EVER Pharma in Unterach Austria, known for its psychotropic effects, has demonstrated noteworthy results in reducing side effects associated with spinal anesthesia and laparoscopic surgery, including pain, nausea, and vomiting [28–30]. Our recent findings indicate a significant decrease in the occurrence of these side effects to 2.9% (19 out of 658 patients) under medical treatment with Dexmedetomidine in contrast to the observed rate of 10.3% (94 out of 915 patients) without the use of Dexmedetomidine. We used Dexmedetomidine against nausea and vomitus in these additional 658 patients and will present the detailed results in a following paper. Even if vomiting occurred, it is not at risk for patients, and is only disturbing slightly for few minutes until the surgeon can restart his activity after the patient vomited. Since patients are awake or easily awaked, there is no danger of aspiration into the lungs. Dexmedetomidine is used for the sedation of adult surgical patients who require a depth of sedation that still allows awakening through verbal stimulation. It can be used for non-intubated patients before and/or during surgical procedures requiring procedural sedation/wax sedation. It acts additionaly as a tranquilize for individuals who suffer from anxiety and pain. It allows to relieve stress and to relax in cases of nervous tension. Compared to other drugs like midazolam and propofol, patients are generally more easily awakened and more cooperative independent if they are in pain or not.

While the available literature provides some insights into the relationship between patient weight, CO2 application, and pain during surgery, further research is warranted. Future studies should aim to address the limitations of existing research by considering additional factors that may influence pain perception and vomitus, such as body composition, tolerance to pain, and individual physiological differences. As implemented in his study, larger sample sizes and standardized pain assessment tools enhanced the validity and generalizability of findings**. This shows, that the results can be improved** if he surgeon get used to working under lower intraperitoneal CO2 pressure and **by using new compounds like** Dexmedetomidine **decreasing significantly side effects.**

4. Conclusions and Recommendations

We propose recommendations based on our experience of more than 3212 cases and the detailed results of over 900 clinical observations. This study can be used to make the laparoscopic surgeries less invasive along with updating the normative regulations and improving perspectives of laparoscopic surgeries in loco-regional anesthesia. Following some points we want to emphasize for practical use.

1	Thanks to a special technique of spinal anesthesia (puncture of the spinal space at the L2-L4 level, immediate transfer of the patient to the Trendelenburg position, to ensure anesthesia to the Th10-11 level) and a low intra-abdominal pressure (below 8 mm Hg), a decrease in the frequency of intra-and postoperative pain could be observed.
2	The patient is conscious during the entire operation. This allows the patient to see their organs on the screen, observe the progress of the operation, ask the surgeon questions of interest to her or answer the questions of medical personnel, and also actively participate in decision-making.

 doi:10.20944/preprints202405.0269.v1

3	A good view for the surgeon is provided by strengthening the Trendelenburg position (30-45 degrees, which is ensured by the use of advanced spinal anesthesia techniques) and choosing the region of insertion of small trocars lower in the abdomen (not higher than umbilicus).
4	Using the Trendelenburg position - by mobilizing the intestines towards the diaphragm, it is possible to work in the small pelvis with low intra-abdominal insufflation, which in turn reduces postoperative pain, hyperbaria, PE, diaphragm irritation and feeling of lack of air.
5	Informing patients which kind of diet to use few days before operations in order to diminish secretion and accumulation of liquid in the stomach and thereby diminishing nausea and the risk of vomitus during surgery
6	Using anti-emetic and psychotropic treatment with new compounds of drug to diminish pain, nausea and vomitus during surgery

By focusing on the health of the patient remaining as the important parameter in surgery, loco-regional anesthesia should be better defined in such surgeries and more implemented. Mainly in obese patient special consideration has to be taken because of higher intraperitoneal CO2 pressure for good visibility and therefore higher probability of pain. In such special cases general anesthesia with intubation shall remain the standard of care. For this, more studies are needed to better define obese patients in whom general anesthesia for laparoscopic surgery should be preferred. Our next clinical study and analysis will include this topic and will focus on our experiences how to diminish side effects.

Author Contributions: Idea and proposition, A.M., Conceptualization, A.M. and K.J.; anesthesia methodology, R.J.; statistical analysis, M.R.; validation, A.M.; investigation, K.J. and I.M.; data curation, K.J. and A.M.; writing—original draft preparation, A.M.; writing—review and editing, A.M., K.J., M.R. and I.M.; clinical supervision, K.J., R.J. and A.M.; funding acquisition, M.R.

Funding: The research visits of prof. Mehdi Razzaghi was supported by a grant from Fulbright Specialist Program. The APC was funded by EVER Pharma Austria.

Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki, and approved by the Institutional Review Board (Ethics Committee) of Urgench branch of Tashkent Medical Academy (№01/2016 from 21.11.2018). And the study concerning laparoscopic surgery in locoregional anesthesia was registered at ISRCTN registry (reference number 38987).

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study. Written informed consent has been obtained from the patient(s) to publish this paper.

Data Availability Statement: All datasets presented in this study are included in the article. Further inquiries can be directed to the corresponding author.

Acknowledgments: The authors express sincere gratitude to the Urgench branch of Tashkent Medical Academy for providing the necessary facilities to conduct this research paper.

Conflicts of Interest: The authors declare no conflict of interest. All authors declare that no competing financial interests exist.

References

1. Jumaniyazov, K. Spinal Anesthesia in Laparoscopic Surgeries. In Proceedings of the International Conference on “Laparoscopic Surgery Using Spinal Anesthesia in Gynecology during COVID-19 Period” Urgench branch of Tashkent Medical Academy, Urgench, Uzbekistan, 3 June 2021
2. Spielman FJ, Corke BC. Advantages and disadvantages of regional anesthesia for cesarean section. A review. J Reprod Med. 1985 Nov;30(11):832-40. PMID: 4078816.
3. Guglielminotti J, Landau R, Li G. Adverse events and factors associated with potentially avoidable use of general anesthesia in cesarean deliveries. *Anesthesiology*. 2019;130(6):912–922.
4. Riley ET. Regional anesthesia for cesarean section. *Tech Reg Anesth Pain Manag*. 2003;7:204–12.
5. Major, A.L.; Jumaniyazov, K.; Yusupova, S.; Jabbarov, R.; Saidmamatov, O.; Mayboroda-Major, I. Laparoscopy in Gynecologic and Abdominal Surgery in Regional (Spinal, Peridural) Anesthesia, the Utility of the Technique during COVID-19 Pandemic. *Medicines* **2021**, *8*, 60.

6. Shahriari, A.; Khooshideh, M.; Heidari, R.; Haddady Abianeh, S.; Sheikh, M.; Ghazizadeh, S.; Rahmati, J. The Effect of Trendelenburg Posture on Sensory Block Level in Spinal Anesthesia with Intrathecal Hyperbaric Bupivacaine for Hernia Repair. *Arch. Anesth. Crit. Care* **2015**, *1*, 55–58.
7. Sinha, R.; Gurwara, A.K.; Gupta, S.C. Laparoscopic Surgery Using Spinal Anesthesia. *JSLS J. Soc. Laparoendosc. Surg.* **2008**, *12*, 133–138.
8. Imbelloni LE, Sant'anna R, Fornasari M, Fialho JC. Laparoscopic cholecystectomy under spinal anesthesia: Comparative study between conventional dose and low-dose hyperbaric bupivacaine. Local Reg Anesth 2011;4:41-6.
9. Power, I.; McCormack, J.G.; Myles, P.S. Regional anaesthesia and pain management. *Anaesthesia* **2010**, *65*, 38–47.
10. Wagner, Elena MD; Chandler, Jessica Nicole DO; Mihalov, Linda S. MD. Minimizing Trendelenburg Position for Laparoscopic Gynecologic Surgery [6L]. Obstetrics & Gynecology 133():p 130S, May 2019.
11. Albrecht, E.; Chin, K.J. Advances in regional anaesthesia and acute pain management: A narrative review. *Anaesthesia* **2020**, *75*, e101–e110.
12. Kessler, J.; Marhofer, P.; Hopkins, P.; Hollmann, M. Peripheral regional anaesthesia and outcome: Lessons learned from the last 10 years. *Br. J. Anaesth.* **2015**, *114*, 728–745.
13. Gerges, F.J.; Kanazi, G.E.; Jabbour-Khoury, S.I. Anesthesia for laparoscopy: A review. *J. Clin. Anesth.* **2006**, *18*, 67–78.
14. Turkstani, A.; Ibraheim, O.; Khairy, G.; Alseif, A.; Khalil, N. Spinal versus general anesthesia for laparoscopic cholecystectomy: A comparative study of cost effectiveness and side effects. *Anaesth Pain Intensive Care* **2009**, *13*, 9–14.
15. Gonzalez R, Smith CD, McClusky DA 3rd, Ramaswamy A, Branum GD, Hunter JG, Weber CJ. 2004. Laparoscopic approach reduces likelihood of perioperative complications in patients undergoing adrenalectomy. Am Surg, 70(8): 668-74. PMID: 15328798.
16. Brown, E.N.; Pavone, K.J.; Naranjo, M. Multimodal General Anesthesia. *Anesth. Analg.* **2018**, *127*, 1246–1258.
17. Raimondo, D.; Borghese, G.; Mastronardi, M.; Mabrouk, M.; Salucci, P.; Lambertini, A.; Casadio, P.; Tonini, C.; Meriggiola, M.C.; Arena, A.; et al. Laparoscopic surgery for benign adnexal conditions under spinal anaesthesia: Towards a multidisciplinary minimally invasive approach. *J. Gynecol. Obstet. Hum. Reprod.* **2020**, *49*, 101813.
18. Major, A.L.; Jumaniyazov, K.; Yusupova, S.; Jabbarov, R.; Saidmamatov, O.; Mayboroda-Major, I. Removal of a Giant Cyst of the Left Ovary from a Pregnant Woman in the First Trimester by Laparoscopic Surgery under Spinal Anesthesia during the COVID-19 Pandemic. *Med. Sci.* **2021**, *9*, 70.
19. McCullagh, P and Nelder, J.A (1983). Generalized Linear Models. Chapman and Hall, New York.
20. Rutherford, A. (2001). Introducing ANOVA and ANCOVA: A GLM Approach. Sage Publishing, London.
21. Hilbe, J. M. (2009). A Practical Guide to Logistic Regression. CRC Press, London.
22. Power, I.; McCormack, J.G.; Myles, P.S. Regional anaesthesia and pain management. *Anaesthesia* **2010**, *65*, 38–47.
23. Asgari, Z.; Rezaeinejad, M.; Hosseini, R.; Nataj, M.; Razavi, M.; Sepidarkish, M. Spinal Anesthesia and Spinal Anesthesia with Subdiaphragmatic Lidocaine in Shoulder Pain Reduction for Gynecological Laparoscopic Surgery: A Randomized Clinical Trial. *Pain Res. Manag.* **2017**, *2017*, 1–6.
24. Kaufman, Y.; Hirsch, I.; Ostrovsky, L.; Klein, O.; Shnaider, I.; Khoury, E.; Pizov, R.; Lissak, A. Pain Relief by Continuous Intraperitoneal Nebulization of Ropivacaine during Gynecologic Laparoscopic Surgery–A Randomized Study and Review of the Literature. *J. Minim. Invasive Gynecol.* **2008**, *15*, 554–558.
25. Scheib SA, Tanner E 3rd, Green IC, Fader AN. Laparoscopy in the morbidly obese: physiologic considerations and surgical techniques to optimize success. J Minim Invasive Gynecol. 2014 Mar-Apr;21(2):182-95.
26. Jiang Y, Wu Y, Lu S, Que Y, Chi Y, Liu Q. Patients with low body mass index are more likely to develop shoulder pain after laparoscopy. Acta Obstet Gynecol Scand. 2023 Jan;102(1):99-104.
27. Veronica T. Lerner, MD, Grover May, MD, and Cheryl B. Iglesia, MD Vaginal Natural Orifice Transluminal Endoscopic Surgery Revolution: The Next Frontier in Gynecologic Minimally Invasive Surgery. JSLS, 2023 Jan-Mar;27(1)

 doi:10.20944/preprints202405.0269.v1

28. Donatiello V, Alfieri A, Napolitano A, Maffei V, Coppolino F, Pota V, Passavanti MB, Pace MC, Sansone P. Opioid sparing effect of intravenous dexmedetomidine in orthopaedic surgery: a retrospective analysis. J Anesth Analg Crit Care. 2022 Dec 19;2(1):49.
29. Bao, N., Shi, K., Wu, Y. et al. Dexmedetomidine prolongs the duration of local anesthetics when used as an adjuvant through both perineural and systemic mechanisms: a prospective randomized double-blinded trial. *BMC Anesthesiol* **22**, 176 (2022).
30. Stabile M, Lacitignola L, Acquafredda C, Scardia A, Crovace A, Staffieri F. Evaluation of a constant rate intravenous infusion of dexmedetomidine on the duration of a femoral and sciatic nerve block using lidocaine in dogs. Front Vet Sci. 2023 Jan 13;9:1061605.