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Evaluation of the Initiation Effect of QLB Combined with General Anesthesia in the "Painless Mode" during Gynecological Laparoscopic Surgery

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Abstract: *Objective*: To evaluate the painless mechanism of the quadratus lumborum block at the level of the arcuate ligament (denoted as QLB) combined with general anesthesia during gynecological laparoscopic surgery. *Methods*: Forty patients undergoing gynecological laparoscopic surgery were selected and evenly divided by ball-drawing. The combined group received QLB combined with general anesthesia, while the reference group received only general anesthesia. The initiation effects of the painless mode were compared between the two groups. *Results*: The analgesic indicators in the combined group were significantly superior. Except for before 10 minutes of anesthesia (i.e., T0), the hemodynamics in the combined group were more favorable. At different postoperative time points, the pain scores of the combined group were lower in both resting and active states, with $P < 0.05$ between the groups. *Conclusion*: QLB combined with general anesthesia can significantly improve the analgesic effect, stabilize hemodynamics, alleviate postoperative pain, and enhance anesthesia safety in patients undergoing gynecological laparoscopic surgery.

Keywords: Gynecological laparoscopy; QLB; General anesthesia; Painless mode; Initiation effect

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1. Introduction

Gynecological diseases encompass a wide variety of conditions, many of which require surgical treatment. Laparoscopic surgery is a novel surgical approach for gynecological diseases, offering distinct advantages in terms of minimally invasive procedures, painless procedures throughout the surgery, and shortened postoperative recovery time [1]. However, laparoscopic surgery can affect the patient's respiratory and circulatory systems, leading to hemodynamic fluctuations. Therefore, it is crucial to select an appropriate anesthesia method. QLB demonstrates high feasibility for anesthesia during laparoscopic surgery, with a wide range of blockage, a high success rate of anesthesia, and the ability to alleviate visceral pain and discomfort. Moreover, the precision of this anesthesia method is high when performed under ultrasound guidance, minimizing the specific dosage of anesthetic drugs and thus offering favorable safety benefits. When combined with general anesthesia, it can enhance the analgesic effect through a synergistic mechanism, thereby fully leveraging the advantages of minimally invasive surgery [2]. Combined anesthesia can reduce the irritation of laparoscopic surgery on the patient's body under the premise of achieving a "painless mode," thereby improving surgical outcomes. It can also alleviate postoperative pain, enabling patients to navigate the perioperative period. Based on this, this study enrolled 40 patients undergoing gynecological laparoscopic surgery to analyze the implementation effects of QLB combined with general anesthesia.

2. Materials and methods

2.1. General information

Forty patients who underwent gynecological laparoscopic surgery between October 2024 and April 2025 were selected and evenly divided by ball-drawing. The specific information for each group is as follows (**Table 1**).

Table 1. Comparison of information content between groups [mean ± SD, n/%]

Group	Number of Cases	Age (years old)	ASA Grade		Operation Time(min)
			Grade I	Grade II	
Combined Group	20	44.65 ± 4.84	11	9	133.56 ± 17.95
Reference Group	20	45.01 ± 4.70	12	8	132.09 ± 18.40
t/χ^2	-	0.239	0.102		0.256
P	-	0.813	0.749		0.800

2.2. Methods

Patients were required to fast for more than 6 hours and abstain from drinking for more than 4 hours before surgery, and their body temperature, blood pressure, and other vital signs were measured. In the combined group, QLB anesthesia was administered. The patients were placed in a prone position, and under precise ultrasound guidance, the quadratus lumborum muscle at the level of the arcuate ligament (bilateral) was marked. At the first lumbar vertebra on the dorsal spine, specifically between the diaphragm at the apex of the transverse process and the adjacent quadratus lumborum muscle, and at the lower edge of the twelfth rib (bilateral), ropivacaine was injected, with a dose of 20 mL (0.375%) on each side. The reference group did not receive QLB anesthesia. The anesthesia induction methods were consistent between the two groups, involving intravenous administration of 0.02 mg/kg midazolam, 1.5 to 2.0 mg/kg propofol, 0.5 μg/kg sufentanil, and 0.2 mg/kg cisatracurium. Subsequently, tracheal intubation was performed, and anesthesia was maintained by pumping propofol (at a dose of 4 to 12 mg/kg per hour) + remifentanil (at a dose of 0.05 to 0.20 μg/kg per hour). Cisatracurium was administered intermittently to maintain muscle relaxation, with the bispectral index (BIS) maintained between 40 and 60, and fluctuations in blood pressure and heart rate were kept within 30% of the baseline values. The ventilator's tidal volume (VT) parameter was set at 500 ml, maintaining the end-tidal carbon dioxide partial pressure (PETCO2) between 35 and 45 mmHg, with an inspiratory-to-expiratory ratio of 1:2 and a respiratory rate of 8 to 12 breaths per minute. After surgery, a subcutaneous analgesic pump was implanted in the patient's left upper limb, mixing sufentanil (100 μg) and lidocaine (10 mL, 2%) with physiological saline to prepare a 100 mL solution. Each injection was 2 ml at a rate of 2 ml/h, with a lockout time of 15 minutes for the analgesic pump.

2.3. Observation indicators

(1) Analgesic indicators: The consumption of remifentanil and propofol was recorded.
(2) Hemodynamics: The mean arterial pressure (MAP) and heart rate (HR) were measured at T0 (before anesthesia), T1 (1 minute after tracheal intubation), T2 (5 minutes after pneumoperitoneum establishment), and T3 (at the end of surgery).
(3) Pain scores: From 2 to 48 hours postoperatively, a visual analog scale (VAS) ranging from 0 to 10 points was used to assess pain levels under resting and active conditions, with higher scores indicating greater pain intensity.

2.4. Statistical analysis

Data were processed using SPSS 28.0 software. Continuous variables were compared using t-tests, and categorical variables were compared using chi-square tests. Statistical significance was considered when the *P*-value was less than 0.05.

3. Results

3.1. Comparison of analgesic indicators between groups

The analgesic indicators in the combined group were significantly superior, with $P < 0.05$ between the groups (**Table 2**).

Table 2. Comparison of analgesic indicators between groups [mean ± SD, χ^2]

Group	Number of Cases	Remifentanil dosage (mg)	Propofol dosage (mg)	Number of analgesic pump presses within 48h postoperatively	Rescue analgesia rate (%)
Combination Group	20	0.75 ± 0.23	336.85 ± 19.74	1.02 ± 0.39	1 (5.0)
Reference Group	20	1.21 ± 0.35	401.56 ± 20.83	2.05 ± 0.47	6 (30.0)
t/χ^2 value	-	4.912	10.084	7.542	4.329
P value	-	<0.001	<0.001	<0.001	0.038

3.2. Comparison of hemodynamics among groups

Except for T0, the hemodynamic parameters in the combined group were consistently lower at other time points, with a statistically significant difference between groups ($P < 0.05$) (**Table 3**).

Table 3. Comparison of hemodynamics among groups [mean ± SD]

Group	Number of Cases	MAP (mmHg)				HR (beats/min)			
		T0	T1	T2	T3	T0	T1	T2	T3
Combination Group	20	75.68 ± 5.62	77.86 ± 6.81	79.86 ± 5.28	78.44 ± 4.67	84.19 ± 6.25	84.12 ± 5.61	83.59 ± 4.15	77.98 ± 4.13
Reference Group	20	75.71 ± 5.53	82.52 ± 6.45	84.06 ± 5.34	82.02 ± 4.53	81.24 ± 6.22	88.04 ± 5.63	87.18 ± 4.50	81.02 ± 4.10

Group	Number of Cases	MAP (mmHg)				HR (beats/min)			
		T0	T1	T2	T3	T0	T1	T2	T3
t	-	0.017	2.222	2.501	2.461	1.496	2.206	2.623	2.336
P	-	0.987	0.032	0.017	0.019	0.143	0.034	0.012	0.025

3.3. Comparison of pain scores among groups

At different postoperative time points, under both resting and active conditions, the combined group exhibited lower pain scores, with a statistically significant difference between groups ($P < 0.05$) (**Table 4**).

Table 4. Comparison of pain scores among groups [mean ± SD, points]

Group	Number of Cases	Rest				Activity			
		Post-op 2h	Post-op 12h	Post-op 24h	Post-op 48h	Post-op 2h	Post-op 12h	Post-op 24h	Post-op 48h
Combination Group	20	2.35 ± 0.42	2.04 ± 0.34	1.55 ± 0.41	0.44 ± 0.15	2.89 ± 0.56	2.35 ± 0.45	2.05 ± 0.47	1.15 ± 0.36
Reference Group	20	4.07 ± 0.44	3.49 ± 0.38	3.36 ± 0.47	1.13 ± 0.21	5.91 ± 0.63	5.18 ± 0.49	4.41 ± 0.52	1.82 ± 0.42
t	-	12.646	12.717	12.978	11.957	16.023	19.024	15.058	5.417
P	-	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001

4. Discussion

Gynecological laparoscopic surgery is a frequently performed surgical procedure that involves making a small incision of 0.5 to 1.5 cm in the abdomen to insert laparoscopic instruments for targeted surgical treatment [3,4]. The success of this procedure is closely related to the anesthetic effect, necessitating a rational selection of anesthesia protocols to ensure painlessness while enhancing the safety of anesthetic drug dosages, thereby reducing postoperative adverse reactions.

General anesthesia is a commonly used anesthetic method for gynecological laparoscopic surgery, capable of inhibiting the hypothalamic projection system and the limbic system of the cerebral cortex, providing effective analgesia. However, general anesthesia cannot block the central nervous conduction caused by traumatic procedures, lacking a significant inhibitory mechanism on the neural conduction process. This continues to interfere with the patient's sympathetic-adrenal medullary system, increasing the overall release of catecholamines, affecting the patient's circulatory system, and thereby reducing the anesthetic effect [5].

Quadratus lumborum block (QLB) is a novel anesthetic block technique that can be combined with general anesthesia, offering high feasibility for abdominal surgery anesthesia. QLB reduces the dosage of anesthetic drugs during general anesthesia and alleviates postoperative pain, leading to faster postoperative recovery. Performing QLB under ultrasound guidance allows the anesthetic to directly reach the anterior aspect of the quadratus lumborum muscle in the lateral region of the arcuate ligament. This enables efficient action on the lower thoracic paravertebral space, thereby achieving excellent intraoperative and postoperative analgesic effects. This anesthetic technique prevents the continuous transmission of stressful stimuli to the patient's central nervous system, enhancing anesthetic safety. Moreover, QLB combined with general anesthesia provides a wide range of block planes, is easy to perform, and has a long duration of anesthetic action, ensuring the smooth progress of laparoscopic surgery.

The results showed that the analgesic indicators in the combined group were significantly superior, with a statistically significant difference between groups ($P < 0.05$). The reason for this is that QLB, combined with general anesthesia, can rapidly exert an anesthetic effect and provide extensive blockage, thereby enhancing the effectiveness of general anesthetic drugs and reducing their maintenance dosage. Simultaneously, it prevents the continuous resistance of the cerebral cortex to general anesthetic drugs, resulting in a lower rate of rescue analgesia in patients. QLB combined with general anesthesia allows local anesthetics to act on regions such as the paravertebral space, regulating the neural innervation function of the T7-L1 segments and alleviating incisional pain in the abdominal wall muscles. It also acts on the sympathetic nerves of the T5-6 segments, providing a strong blocking effect on the sympathetic chain, thereby reducing visceral traction pain during surgery. Combined anesthesia blocks the transmission of nociceptive stimuli to the cerebral cortex or spinal nerves, preventing central sensitization and reducing the required dosage of general anesthetic drugs such as propofol during surgery. QLB has a preemptive analgesic effect, preventing significant fluctuations in vital signs during surgery, thus maintaining BIS values without the need for additional propofol and reducing its dosage [6]. During QLB anesthesia, ropivacaine is selected as the anesthetic drug, with a blocking effect lasting approximately 24 hours, providing a long-lasting blocking effect and strong coverage during the acute postoperative pain phase, reducing the frequency of analgesic pump use. Combined anesthesia prevents the continuous transmission of peripheral pain signals, thereby downregulating the pain memory effect and stably exerting the analgesic pump's effect without the need for frequent pressing.

Except for T0, the hemodynamic parameters in the combined group were consistently lower at other time points, with a statistically significant difference between groups ($P < 0.05$). At the T1 time point, tracheal intubation produces significant traumatic stimulation to the body, continuously activating the sympathetic nerves in the tracheal region and increasing vagal nerve excitability, leading to an elevation in MAP levels and an accelerated heart rate. The blocking effect of QLB on the thoracolumbar segments reduces the body's tissue pain sensitivity, thereby decreasing the stress response to tracheal intubation. Administering sufentanil before tracheal intubation exerts a synergistic effect, alleviating the intubation response and, in combination with QLB anesthesia, stabilizing the patient's intraoperative hemodynamics. Moreover, maintaining anesthesia with propofol reduces the cardiovascular response caused by tracheal intubation, dilating blood vessels and stabilizing blood pressure values. At the T2 time point, creating a pneumoperitoneum produces strong stimulation to tissues such as the uterus or peritoneum, exciting the sympathetic nerves and causing visceral pain. QLB, combined with general anesthesia, acts on the sympathetic chain, relieving visceral traction pain and reducing the adverse effects of pneumoperitoneum on peritoneal tissues. Pneumoperitoneum increases the patient's intra-abdominal pressure, activating mechanical receptors in the abdominal wall region. QLB combined with general anesthesia inhibits abdominal wall nerve sensitivity, thereby reducing abdominal wall pressure and preventing excessive hemodynamic fluctuations. Furthermore, pneumoperitoneum elevates hormone levels such as norepinephrine in the body. Combined anesthesia inhibits catecholamine release, preventing the continuous transmission of nociceptive signals, thereby stabilizing hormone levels in the body and avoiding significant hemodynamic fluctuations. At the T3 time point, ropivacaine continues to exert its analgesic mechanism, allowing the patient to awaken smoothly.

Additionally, the controllable dosage of anesthetic drugs in combined anesthesia reduces drug accumulation, preventing rebound tachycardia and other conditions.

The pain scores at different postoperative time points in the combined group were consistently lower, with a statistically significant difference between groups ($P < 0.05$). The reason for this is that ultrasound-guided anesthesia allows the anesthetic to precisely reach specific regions, fully exerting a paravertebral-like blocking effect and achieving excellent analgesic results. Moreover, the anesthetic can slowly and continuously exert its analgesic effect, reducing postoperative pain. Combined anesthesia employs QLB, general anesthesia, and an analgesic pump, providing high synergistic effects, prolonging postoperative analgesia time, and doubly blocking the peripheral and central nervous systems, thereby exhibiting strong analgesic effectiveness.

5. Conclusion

In conclusion, adopting QLB combined with general anesthesia during gynecological laparoscopic surgery yields excellent results, reducing the dosage of anesthetic drugs, decreasing the frequency of analgesic pump presses, stabilizing perioperative hemodynamics, and alleviating postoperative pain, offering high anesthetic safety benefits. However, before anesthesia, it is essential to assess the patient's individual circumstances, such as medication history and surgical history, to exclude contraindications to combined anesthesia. Simultaneously, educate patients on anesthesia cooperation methods to ensure they have a high level of understanding of anesthetic knowledge and can efficiently cooperate with the anesthesia process as instructed by the doctor. To enhance anesthetic effectiveness, closely monitor the patient's vital signs during surgery, promptly identify adverse anesthetic events, and provide targeted treatment to prevent severe adverse reactions.

Disclosure statement

The author declares no conflict of interest.

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