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Analysis of the Application Effect of Laparoscopy Combined with Choledochoscopy in the Treatment of Difficult Cholelithiasis

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Abstract: *Objective*: To analyze the therapeutic effect of laparoscopy combined with choledochoscopy in the treatment of difficult cholelithiasis. *Methods*: A total of 60 patients with difficult cholelithiasis admitted for treatment from January 2022 to December 2024 were selected and evenly divided into two groups using a random number table. The combined group received laparoscopy combined with choledochoscopy treatment, while the single group received laparoscopy treatment alone. The total treatment efficacy, perioperative indicators, angiotensin (Ang) levels, quality of life scores, and complication rates were compared between the two groups. *Results:* The total treatment efficacy in the combined group was higher than that in the single group; except for operative time, the perioperative indicators in the combined group were superior to those in the single group; the Ang levels after treatment in the combined group were lower than those in the single group, and the quality of life scores were higher ($P < 0.05$). The complication rate in the combined group was lower than that in the single group ($P < 0.05$). *Conclusion:* Laparoscopy combined with choedochoscopy can enhance the treatment effectiveness for patients with difficult cholelithiasis, improve perioperative indicators, regulate their Ang levels, elevate quality of life, and demonstrate high surgical safety.

Keywords: Laparoscopy; Choledochoscopy; Difficult gallstones; Perioperative indicators; Complication rate

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1. Introduction

Difficult gallstones are a type of gallstone disease characterized by rapid onset, rapid progression, and significant difficulty in stone extraction, presenting symptoms such as pain in the right shoulder or upper right abdomen, and prone to causing adverse events such as cholecystitis or gallbladder cancer [1]. The primary treatment methods for this condition include oral medication or surgical intervention. The former mainly involves anti-inflammatory and cholagogic tablets or stone-dissolving drugs, which can alleviate symptoms but offer limited curative potential. Surgical treatment primarily employs laparoscopy, utilizing fiber-optic endoscopy to accurately locate the surgical area, comprehensively explore the abdominal cavity, and systematically perform procedures such as cholecystectomy

and stone extraction. While laparoscopic monotherapy offers a relatively short operative time, it is prone to leaving residual stones, thus presenting certain limitations [2]. Choledochoscopy, with its high imaging quality, can expand the surgical field of view during laparoscopy, efficiently remove small-volume stones, and, when combined with laparoscopy, achieves a high surgical success rate. Based on this, this study selected 60 patients with difficult gallstones to evaluate the overall efficacy of laparoscopic combined with choledochoscopic treatment.

2. Materials and methods

2.1. General information

A total of 60 patients with difficult gallstones admitted for treatment from January 2022 to December 2024 were selected and evenly divided into two groups using a random number table. The combined group consisted of 30 patients, including 18 males and 12 females, aged between 28 and 74 years old, with an average age of (43.15 ± 4.18) years old; the disease duration ranged from 1 to 8 months, with an average duration of (3.58 ± 0.74) months. The single group also had 30 patients, including 17 males and 13 females, aged between 26 and 71 years old, with an average age of (43.22 ± 4.34) years old; the disease duration ranged from 1 to 7 months, with an average duration of (3.40 ± 0.68) months. There were no significant differences in the data between the two groups ($P > 0.05$).

Inclusion criteria: Diagnosis of gallstones based on imaging techniques such as ultrasound or CT; meeting the indications for laparoscopic and choledochoscopic treatment; having complete basic patient information; possessing normal cognitive function; being informed about and consenting to the study. Exclusion criteria: Presence of surgical contraindications; having a history of biliary surgery; intrahepatic bile duct stones; cardiorenal and hepatic dysfunction; suffering from mental illnesses; withdrawing from the study midway.

2.2. Methods

Laparoscopic treatment for the single-treatment group: Prior to surgery, patients were instructed to fast and abstain from drinking for more than 6 hours, undergo skin preparation, and then, after general anesthesia, maintain a supine position with the head elevated and feet lowered, and the body tilted approximately 25° to the left. A 1 cm observation port was made below the umbilicus, and 1 cm and 0.5 cm working ports were made below the xiphoid process and below the right costal margin, respectively. A carbon dioxide pneumoperitoneum was established with a pressure of 12 mmHg, and a laparoscope and corresponding therapeutic instruments were inserted to comprehensively explore the abdominal cavity. The fundus of the gallbladder was grasped with grasping forceps and turned upward to expose the gallbladder triangle. The cystic artery and cystic duct were separated using an electrocautery hook, and a locking clip was applied near the common bile duct side, 0.5 cm from the common bile duct, and a titanium clip was applied near the gallbladder side. The cystic duct was then cut. The cystic artery was closed with a locking clip and cauterized and severed with electrocoagulation. The gallbladder was separated using an electrocautery hook for complete dissection and then resected. Active bleeding points were observed, and electrocoagulation hemostasis could be performed if necessary. Residual stones or bile in the abdominal cavity were cleared. The resected specimen was removed through the umbilical incision, the laparoscope and instruments were withdrawn, the carbon dioxide was evacuated, and the incision was sutured.

Combined laparoscopic and choledochoscopic treatment for the combined-treatment group: Preoperative preparation and anesthesia methods were the same as above. The patient was maintained in a supine position, and a 1 cm incision was made at the umbilicus. A 10 mm Trocar was inserted, and carbon dioxide gas was

injected to establish an artificial pneumoperitoneum with a pressure of 12 mmHg. Observation was conducted using the laparoscope, and a 0.5 cm incision was made below the right costal margin, into which a 5 mm Trocar was inserted; a 1 cm incision was made below the xiphoid process, into which a 10 mm Trocar was inserted. Keep the patient in a left oblique position with the head elevated and feet lowered, and examine the liver region and the gastroduodenal region. For patients with an excessively thick or tense gallbladder wall, incision and decompression are performed. The cystic triangle region is dissected to clarify the relationship between the three ducts and the ampulla, separate the ducts, insert a choledochoscope, evaluate the position of the cystic duct, determine the number, location, and size of stones, and remove them. The cystic artery is clamped with a lock clip, and the residual end of the cystic duct is also clamped. If the cystic duct is thick, it is ligated with a suture; if the residual end is short, it is sutured. The gallbladder tissue is stripped using a combination of anterograde and retrograde methods. Remove stones and resected tissues, and suture the incision.

2.3. Observation indicators

(1) Perioperative indicators: Observe indicators such as operation time, intraoperative blood loss, postoperative recovery time of gastrointestinal function, postoperative pain score at 7 days (using the Visual Analog Scale, with scores ranging from 0 to 10, where higher scores indicate greater pain intensity), and length of hospital stay.

(2) Ang levels: Fasting venous blood samples are collected at the same time periods, centrifuged for 10 minutes at a speed of 3000 r/min, and the supernatant is extracted. The levels of AngI, AngII, and Ang1-7 are evaluated using the enzyme-linked immunosorbent assay method [3].

(3) Quality of Life Score: The Generic Quality of Life Inventory (GQOLI) [4] was selected for evaluation, encompassing social function, psychological function, and physical function, each scored out of 100 points. Quality of life is positively correlated with the score.

(4) Complication Rate: The incidence rates of complications such as abdominal abscess, incision infection, bile leakage, intestinal adhesion, pulmonary infection, and bile duct injury were observed.

2.4. Efficacy evaluation criteria

Cure is defined as the disappearance of physical signs, normalization of blood test results, negative laboratory test results, and absence of residual stones on ultrasound. Significant efficacy is characterized by marked improvement in physical signs, generally normal blood test results, mostly negative laboratory test results, and no residual stones on ultrasound. Preliminary efficacy is indicated by improvement in physical signs, blood test results, and laboratory test results, with a small amount of residual stones visible on ultrasound. No efficacy is determined when there is no improvement in physical signs, blood test results, and laboratory test results, with a large amount of residual stones visible on ultrasound.

2.5. Statistical analysis

Data were analyzed using SPSS 26.0 statistical software. Count data were expressed as (n/%) and compared using the chi-square (χ^2) test. Measurement data were tested for normal distribution using the Kolmogorov-Smirnov (K-S) test and expressed as mean ± standard deviation (SD). Comparisons between groups were made using the independent samples t-test, while comparisons within groups were made using the paired t-test. A P-value less than 0.05 was considered statistically significant.

3. Results

3.1. Comparison of overall effectiveness rates between the two groups

The overall effectiveness rate in the combined group was higher than that in the single-treatment group ($P < 0.05$) (**Table 1**).

Table 1. Comparison of overall effectiveness rates between the two groups (*n*/%)

Group	n	Disease Cure	Marked Efficacy	Moderate Efficacy	No Efficacy	Overall Effective Rate
Combination Group	30	18 (60.00)	9 (30.00)	3 (10.00)	0	100.00 (30/30)
Single Agent Group	30	17 (56.67)	7 (23.33)	2 (6.67)	4 (13.33)	86.67 (26/30)
χ^2						4.286
P						0.038

3.2. Comparison of perioperative indicators between the two groups

Except for surgical duration, the perioperative indicators in the combined group were superior to those in the single-treatment group ($P < 0.05$) (**Table 2**).

Table 2. Comparison of perioperative indicators between the two groups (mean ± SD)

Group	n	Operative Time (min)	Intraoperative Blood Loss (mL)	Time to Gastrointestinal Function Recovery (h)	Pain Score at Postoperative Day 7	Length of Hospital Stay (days)
Combination Group	30	48.95 ± 6.48	45.39 ± 5.95	16.37 ± 1.77	2.20 ± 0.58	6.71 ± 0.51
Single Agent Group	30	47.11 ± 6.32	55.71 ± 5.82	17.82 ± 1.56	3.86 ± 0.67	7.09 ± 0.63
t		1.113	6.791	3.366	10.260	2.568
P		0.270	0.000	0.001	0.000	0.013

3.3. Comparison of quality of life scores between the two groups

One day before surgery, there was no significant difference in quality of life scores between the two groups ($P > 0.05$). Seven days after surgery, the quality of life score in the combined group was higher than that in the single-treatment group ($P < 0.05$) (**Table 3**).

Table 3. Comparison of quality of life scores between the two groups (mean ± SD, points)

Group	n	Social Functioning		Psychological Functioning		Physical Functioning	
		Preoperative	Postoperative	Preoperative	Postoperative	Preoperative	Postoperative
Combination Group	30	81.56 ± 4.91	92.11 ± 3.58	80.07 ± 3.54	93.57 ± 3.45	82.45 ± 3.66	92.85 ± 3.14
Single Agent Group	30	81.63 ± 4.95	87.02 ± 3.14	80.10 ± 3.56	90.01 ± 3.41	82.19 ± 3.62	88.02 ± 3.10
t		0.055	5.855	0.033	4.020	0.277	5.996
P		0.956	0.000	0.974	0.000	0.783	0.000

3.4. Comparison of Ang levels between the two groups

One day before surgery, there was no significant difference in Ang levels between the two groups ($P > 0.05$). Seven days after surgery, the Ang level in the combined group was lower than that in the single-treatment group ($P < 0.05$) (**Table 4**).

Table 4. Comparison of Ang levels between the two groups (mean ± SD)

Group	n	Ang I (ng/mL)		Ang II (ng/L)		Ang-(1-7) (ng/L)	
		Preoperative	Postoperative	Preoperative	Postoperative	Preoperative	Postoperative
Combination Group	30	7.51 ± 1.74	10.33 ± 1.89	37.29 ± 5.11	54.28 ± 4.15	310.75 ± 28.41	411.53 ± 32.48
Single Agent Group	30	7.53 ± 1.76	14.52 ± 1.94	37.31 ± 5.08	66.12 ± 4.18	311.02 ± 28.39	520.19 ± 38.76
t		0.044	8.473	0.015	11.010	0.037	11.769
P		0.965	0.000	0.988	0.000	0.971	0.000

3.5. Comparison of complication rates between the two groups

The complication rate in the combined group was lower than that in the single-treatment group ($P < 0.05$) (**Table 5**).

Table 5. Comparison of complication rates between the two groups (*n*/%)

Group	n	Intra-abdominal Abscess	Incisional Infection	Bile Leak	Intestinal Adhesion	Pulmonary Infection	Bile Duct Injury	Overall Complication Rate
Combination Group	30	0 (0.00)	1 (3.33)	0	0	0	0	3.33 (1/30)
Single Agent Group	30	1 (3.33)	1 (3.33)	1 (3.33)	1 (3.33)	1 (3.33)	1 (3.33)	20.00 (6/30)
χ^2								4.043
P								0.044

4. Discussion

The pathogenic factors of gallstones are complex, encompassing long-term skipping breakfast, genetic factors, low physical activity, or cirrhosis, among others. The pathological basis includes increased bile concentration and an imbalance in the ratio of bile acids to cholesterol in the bile, which hinders the smooth excretion of bile and leads to stone formation. The symptoms of this disease are influenced by the location of the stones, the degree of inflammatory response, and the size of the stones, with pain in the upper right abdomen and right shoulder being the primary manifestations. Difficult gallstones refer to a type of gallstone characterized by a complex pathological environment or anatomical structure where the stones are located, large stone size, high risk associated with endoscopic or surgical treatment, and a higher incidence of postoperative complications. These stones may induce symptoms such as indigestion and belching, necessitating early surgical intervention.

Laparoscopic surgery is a commonly used procedure for difficult gallstones. It involves a laparoscope equipped with a miniature camera and is composed of a CO2 pneumoperitoneum system, a video recording system, an electrocautery system, and surgical instruments. During the operation, an artificial pneumoperitoneum can be created under the guidance of a laparoscope, followed by trocar puncture and cholecystotomy, ensuring

a high degree of surgical precision. However, laparoscopic surgery may not efficiently remove stones that are concealed or small in size, presenting certain surgical limitations. Cholangioscopy, a new type of optical endoscope, consists of an optical image transmission system, an objective lens system, and an eyepiece system, and includes flexible and rigid cholangioscopes, among other specifications. It can expand the surgical field of view and ensure a safe and reliable treatment process [5]. The combination of these two techniques can fully leverage their respective advantages and improve the stone clearance effect, resulting in remarkable therapeutic outcomes.

The results showed that the overall effective rate of the combined group was higher than that of the single-technique group, and apart from operative time, the perioperative indicators of the combined group were superior to those of the single-technique group ($P < 0.05$). The reasons for this are as follows: laparoscopy combined with cholangioscopy can magnify the surgical field, accurately locate impacted stones within the ducts, and determine the number of stones, thereby preventing stone omission and enhancing surgical efficacy. Stone removal under direct cholangioscopic visualization can increase the stone clearance rate and effectively prevent disease recurrence [6].

Additionally, the combined surgery is highly applicable to special conditions such as thickened gallbladder walls and increased tension, enabling the clarification of the relationships among the three ducts and the ampulla, preventing bile duct injury, and accurately separating adhesive tissues to ensure surgical precision. More importantly, the combined surgery is minimally invasive, which can reduce surgical trauma and thus promote postoperative recovery [7,8]. The level of Ang in the combined group was lower than that in the single-procedure group 7 days after surgery, the quality of life score was higher, and the complication rate was lower ($P < 0.05$). The reason is that the combined surgery can prevent massive activation of the Ang system and improve patients' tolerance to surgical treatment. Moreover, the magnifying effect of the combined surgery can enhance the accuracy during cholecystectomy and stone removal, reducing stimulation of the renin-angiotensin-aldosterone system (RAS). Consequently, it can improve Ang levels and reduce the risk of postoperative complications [9,10]. Based on the aforementioned surgical treatment, patients recover faster postoperatively, experience mild stress responses, and can resume normal life as soon as possible, thereby enjoying a higher quality of life.

5. Conclusion

In summary, laparoscopic combined with choledochoscopic treatment for patients with difficult gallstones demonstrates a high overall effectiveness rate, accelerates postoperative recovery, protects the patients' Ang system, significantly improves their future quality of life, and is associated with fewer postoperative complications.

Disclosure statement

The author declares no conflict of interest.

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