Nursing Research on Laser Lithotripsy for Giant Common Bile Duct Stones via ERCP: Postprint

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Abstract

Objective To compare the difference in efficacy between dual-frequency dual-pulse laser lithotripsy under ERCP and conventional endoscopic mechanical lithotripsy in the treatment of patients with common bile duct stones. Methods The clinical data of 200 patients with common bile duct stones who underwent ERCP treatment and lithotripsy at the Gastrointestinal Endoscopy Center of Dongfang Hospital, Beijing University of Chinese Medicine between May 2018 and May 2022 were analyzed. Among them, 69 patients underwent dual-frequency dual-pulse laser lithotripsy (laser group), and 131 patients underwent mechanical lithotripsy (mechanical group). The stone clearance success rate, procedure time, postoperative hospital stay, complications, and other parameters were compared between the two groups. Results The baseline data including general conditions and preoperative clinical data were basically similar between the two groups (P>0.05). There were no statistically significant differences in the complication rates of postoperative bleeding, postoperative pancreatitis, and perforation between the two groups (P>0.05). The laser group had significantly longer procedure time than the mechanical group (P<0.05), shorter postoperative hospital stay (P<0.05), and lower overall complication rate and stone residual rate (P<0.05). Conclusion Dual-frequency dual-pulse laser lithotripsy for common bile duct stones has better efficacy and lower complication rate than conventional surgical mechanical lithotripsy, but the procedure time still has room for improvement.

Full Text

Nursing Study of Laser Lithotripsy for Giant Common Bile Duct Stones Under ERCP

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Abstract

Objective: To compare the efficacy differences between dual-frequency dual-pulse laser lithotripsy and traditional endoscopic mechanical lithotripsy in treating patients with common bile duct stones under ERCP. **Methods:** Clinical data were retrospectively analyzed for patients with common bile duct stones who underwent ERCP treatment and lithotripsy at the Digestive Endoscopy Center of Dongfang Hospital, Beijing University of Chinese Medicine, from May to May . Among them, patients received dual-frequency dual-pulse laser lithotripsy (laser group) and patients received mechanical lithotripsy (mechanical group). The stone extraction success rate, operation time, postoperative hospital stay, and complications were compared between the two groups. **Results:** Baseline data including general conditions and preoperative clinical data were essentially consistent between the two groups ($P>0.05$). There were no statistically significant differences in postoperative bleeding, postoperative pancreatitis, or perforation complication rates between the two groups ($P>0.05$). The laser group had significantly longer operation time ($P<0.05$), shorter postoperative hospital stay ($P<0.05$), and lower total complication rate and stone residual rate ($P<0.05$). **Conclusion:** Dual-frequency dual-pulse laser lithotripsy for common bile duct stones demonstrates better efficacy and lower complication rates compared with traditional mechanical lithotripsy, though there remains room for improvement in operation time.

Keywords: ERCP; Common bile duct stones; Laser lithotripsy; Nursing

Introduction

Common bile duct stones are a common disease of the digestive system, primarily manifested as jaundice, chills, high fever, and upper abdominal colic, and may lead to multiple organ dysfunction, septic shock, respiratory failure, and other manifestations with a certain mortality rate [1]. Most patients require surgical treatment after a definitive diagnosis. With the development of endoscopic techniques, endoscopic retrograde cholangiopancreatography (ERCP) has become the preferred treatment for common bile duct stones. A stone diameter greater than 10 mm is an important factor in making stones “difficult”to manage, and when stone diameter exceeds 15 mm, the success rate of stone extraction significantly decreases, with various lithotripsy techniques recommended to as-

sist in stone removal [2]. Some patients have giant common bile duct stones that require fragmentation before safe extraction under endoscopy.

Traditional mechanical lithotripsy can basically achieve therapeutic effects, but a few patients have very hard stones that cannot be fragmented mechanically, even resulting in broken lithotripsy basket wires and impaction, creating significant treatment risks. Therefore, endoscopic laser lithotripsy is relatively safer. Laser lithotripsy is mainly used to crush large, hard, or impacted extrahepatic stones, especially in cases where mechanical lithotripsy fails. Some intrahepatic duct stones can also be removed using this method [3]. This study retrospectively analyzed the clinical and pathological data of patients undergoing endoscopic lithotripsy at the Digestive Endoscopy Center of Dongfang Hospital, Beijing University of Chinese Medicine, comparing the therapeutic effects of endoscopic dual-frequency dual-pulse laser lithotripsy versus mechanical lithotripsy, aiming to provide more options for safe and effective treatment methods for patients with common bile duct stones.

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1. Materials and Methods

1.1 Patient Data Clinical data were retrospectively analyzed for patients with common bile duct stones who underwent ERCP treatment and lithotripsy at our hospital' s Digestive Endoscopy Center from May to May . Among them, patients received dual-frequency dual-pulse laser lithotripsy (laser group) and patients received mechanical lithotripsy (mechanical group). The general conditions and preoperative clinical data of the two groups showed no statistically significant differences (P>0.05) .

1.2 Preoperative Preparation Nurses educated patients about the main causes, diagnosis, and treatment methods of bile duct stones, helping them understand the surgical procedure and precautions of laser lithotripsy. Psychological counseling was provided to eliminate negative emotions and build confidence in overcoming the disease [4]. Preoperatively, patients routinely received injections of pethidine hydrochloride, diazepam, and scopolamine butylbromide (except for those with contraindications). Vital signs were carefully monitored during treatment; if patients experienced rapid breathing or hypotension, appropriate blood transfusion and fluid replacement were administered. During the procedure, patients were assisted in maintaining comfortable positioning [5]. Oxygen was administered simultaneously with blood oxygen saturation and cardiac monitoring.

1.3 Equipment Preparation The following ERCP instruments must be prepared: duodenoscope, guidewire, contrast catheter, papillotome, stone extractor, lithotriptor, balloon, dilating bougie, dilating balloon, drainage tube, stent, endoscopic high-frequency electrosurgical generator, injection needle, and hemoclips. All instruments must meet sterilization requirements, disposable items

must be handled according to relevant regulations, and commonly used fragile instruments must have spares [6]. The main equipment includes Fujifilm ED-530XT duodenoscope, U-100 Plus dual-frequency dual-pulse laser bile duct lithotriptor, SpyGlass™ DS (Boston Scientific), Trapezoid™ RX integrated stone extraction/lithotripsy basket, MSB-19 stone extraction basket, Flex knife papillotome, balloon dilatation catheter, COOK Acrobat™ guidewire, COOK Liguory nasobiliary drainage tube, and various plastic stents.

1.4 Surgical Procedure ERCP procedure: After fasting for 8 hours preoperatively, ERCP + endoscopic sphincterotomy (EST) was performed under pharyngeal anesthesia with lidocaine mucilage. The procedure involved cannulation, contrast imaging, incision, and subsequent balloon dilation.

For patients with large common bile duct stones identified on preoperative imaging (stones exceeding the common bile duct diameter or >2 cm in diameter), laser lithotripsy was performed intraoperatively before extraction. The specific procedure was as follows: The endoscope was advanced to the duodenal papilla. After successful papillary cannulation with a bow knife, the biliary system was visualized through contrast imaging to display the lesion contour. A guidewire was retained, and the SpyGlass system delivery catheter with optical fiber camera was inserted through the working channel of the duodenoscope and slowly advanced to the location of the giant bile duct stone for direct visualization. The guidewire was then removed, and the laser fiber was inserted into the SpyGlass treatment channel. Under direct vision, the fiber tip was aligned with the stone surface, and U-100 Plus dual-frequency laser was activated for lithotripsy [7].

For patients whose preoperative imaging or intraoperative cholangiography showed that common bile duct stones might not be extractable with a basket in one piece, mechanical lithotripsy baskets were used intraoperatively to capture the stones, which were then fragmented using a pressure handle and extracted into the duodenal lumen. The laser lithotripsy process required repeated water injection and suction to maintain a clear visual field. When the field was clear, water injection was stopped, the suction three-way valve was opened, and physicians were reminded to effectively aspirate fluid from the bile and pancreatic ducts. For patients with longer operation times, nasobiliary drainage tubes or biliary-pancreatic duct stents were placed to fully drain intraluminal fluid and reduce the incidence of postoperative cholangitis [8]. Simultaneously, crushed paste-like stones could be discharged. Fragmented stones could be removed under direct vision using stone extraction baskets, and when there were excessive fragments, the duodenoscope could be replaced for further clearance [9]. After both lithotripsy methods, stone extraction baskets and balloons were used to remove stones from the common bile duct.

After stone removal, nasobiliary drainage tubes were placed in all patients, followed by common bile duct cholangiography to confirm complete stone clearance. If stones were difficult to remove completely in one session or if stone extraction failed, plastic biliary stents were placed, and ERCP stone extraction was

performed again after 3 months. Postoperatively, patients fasted and received anti-infection treatment. Serum and urinary amylase levels were checked on postoperative day 1; if results were normal, patients could eat after 2 days. If results were abnormal, monitoring continued until normalization.

1.5 Observation Indicators Postoperative stone extraction status, operation time, postoperative hospital stay time, and complications (including postoperative bleeding, postoperative pancreatitis, perforation, and stone residue) were recorded.

1.6 Statistical Methods SPSS statistical software was used. Normally distributed measurement data were expressed as mean ± standard deviation ($\bar{x}\pm s$), and independent samples t-test was used for inter-group comparison. Count data were analyzed using chi-square (^{2}) test. The test level was α=0.05.

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2. Results

2.1 Comparison of General Conditions and Preoperative Clinical Data The comparison of general conditions and preoperative clinical data between the two groups showed no statistically significant differences (P>0.05) .

Comparison of General Conditions and Preoperative Clinical Data Between Two Groups

Item	Laser Group (n=)	Mechanical Group (n=)	^{2} or t value	P value
Male/Female (cases)				
Age ($\bar{x}\pm s$, years)				
Common bile duct diameter ($\bar{x}\pm s$, cm)				
Number of stones ($\bar{x}\pm s$, pieces)				

2.2 Comparison of Stone Extraction Success Rate, Operation Time, and Postoperative Hospital Stay Although the operation time in the laser group was significantly longer than in the mechanical group (P<0.05), the postoperative hospital stay was shorter (P<0.05) .

Comparison of Stone Extraction Success Rate, Operation Time, and Postoperative Hospital Stay Between Two Groups

Item	Laser Group (n=)	Mechanical Group (n=)	^{2} or t value	P value
Successful stone extraction [cases (%)]				
Operation time ($\bar{x}\pm s$, min)				
Postoperative hospital stay ($\bar{x}\pm s$, days)				

2.3 Comparison of Postoperative Complications There were no perioperative deaths in either group. As shown in , the total complication rate and stone residual rate in the laser group were significantly lower than in the mechanical group (P<0.05). There were no statistically significant differences between the two groups in postoperative bleeding, postoperative pancreatitis, perforation, or stone residue (P>0.05). Patients with postoperative pancreatitis recovered after conservative treatment; patients with bile duct perforation improved after surgical treatment; patients with stone residue had plastic stents placed in the common bile duct and underwent secondary surgery to remove the stones.

Comparison of Postoperative Complications Between Two Groups [cases (%)]

Complication	Laser Group (n=)	Mechanical Group (n=)	^{2} value	P value
Postoperative bleeding				
Postoperative pancreatitis				
Perforation				
Stone residue				

3. Discussion

Surgery is the main treatment method for common bile duct stones, but during acute episodes, it is difficult to clearly identify the biliary system, stone number, and location, increasing the possibility of secondary surgery. Therefore, clinically, elective surgery is often performed after inflammation is controlled. Mechanical (laser) lithotripsy under ERCP is commonly used in clinical practice. Compared with laparoscopic or open surgery, it causes less damage and can break large stones into smaller pieces that are easier to remove [10]. With the development of minimally invasive techniques, endoscopic stone extraction technology has advanced rapidly, offering advantages such as repeatable stone extraction, minimal trauma, and rapid postoperative recovery, making it the preferred surgical method for treating common bile duct stones.

EST destroys the normal anatomical structure and function of the papillary sphincter, causing duodenal fluid reflux into the bile duct, which is the main cause of postoperative cholangitis, pancreatitis, and stone recurrence [11]. When encountering patients with large common bile duct stones that cannot pass through the incised duodenal papilla, lithotripsy techniques are required. However, mechanical lithotripsy can be troublesome, time-consuming, laborious, complex, and potentially ineffective. The main reasons are: first, the stones in the common bile duct are huge while the space within the common bile duct is small, making it impossible for the lithotripsy basket to open and capture the stones for fragmentation; second, there is distal common bile duct stenosis, preventing clearance of large fragmented stones. Therefore, when mechanical lithotripsy fails to remove common bile duct stones, other methods must be considered, such as extracorporeal shock wave lithotripsy, laser shock wave lithotripsy, or placement of common bile duct stents [12].

In recent years, endoscopic treatment of common bile duct stones has been widely applied clinically in China [13]. The German U-100 Plus dual-frequency dual-pulse laser lithotriptor is a newly developed economical, short-pulse, dual-frequency solid-state laser. The laser wavelength at 532 nm (green spectrum) induces plasma formation on the stone surface, while infrared laser energy en-

hances this plasma to form rapidly collapsing bubbles, generating intense shock waves that fragment the stones [14]. This technology has been maturely applied in ERCP and other endoscopic procedures for managing difficult common bile duct stones. Dual-frequency dual-pulse laser endoscopic biliary lithotripsy under ERCP is a safe and effective method for treating difficult bile duct stones. Low-energy dual-frequency dual-pulse laser lithotripsy can reduce the risk of bile duct mucosal and surrounding tissue damage, making it safe, convenient, and effective for patients with refractory bile duct stones that are difficult to remove.

This study achieved significantly better therapeutic effects using dual-frequency dual-pulse U-100 Plus laser lithotripsy compared with mechanical lithotripsy. In the mechanical lithotripsy group, postoperative bleeding occurred, possibly related to incomplete stone fragmentation before pulling the basket through the incised papilla, causing papillary sphincter tears. The incidence of postoperative pancreatitis was also significantly higher in the mechanical group, related to repeated entry of the lithotripsy basket into the bile duct or accidental entry into the pancreatic duct. Additionally, because the lithotripsy basket is long and has a hard tip, using force during insertion and opening in the bile duct could cause intrahepatic bile duct or common bile duct perforation, and repeated lithotripsy operations could damage the bile duct mucosal lining, causing postoperative bile duct infection and bleeding. In this study, some patients had extremely hard stones that could not be fragmented by the lithotripsy basket, resulting in broken basket wires and failed stone extraction, requiring secondary or multiple stone extractions after biliary stent implantation [15]. However, these problems did not occur in the laser lithotripsy group, as hard stones were more easily fragmented by laser. The SpyGlass system delivery catheter allowed direct visualization of stones, and aligning the fiber tip with stones under direct vision achieved better fragmentation results, after which stones in the common bile duct could be completely removed using stone extraction baskets or balloons.

In summary, endoscopic dual-frequency dual-pulse laser lithotripsy offers safer, more economical, and more efficient advantages compared with traditional mechanical lithotripsy for treating common bile duct stones. It requires physicians and assistant nurses to shorten operation time, master the operation technique proficiently, and ensure tacit cooperation between medical staff. Proper preparation of the U-100 Plus laser lithotriptor can shorten operation time.

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Note: Figure translations are in progress. See original paper for figures.