OPPORTUNITIES OF USING ORAL INTRALUMINAL LASER LITHOTRIPSY FOR A LARGE CALCULUS OF THE COMMON BILE DUCT (CLINICAL REPORT)

Ivanov Y.V.[1,2], Sazonov D.V.[1], Smirnov A.V.[1], Mamoshin A.V.[3,4], Baranov A.V.[5], Panchenkov D.N.[2,5]

[1]Federal Scientific and Clinical Center of Specialized Types of Medical Care and Medical Technologies of the FMBA of Russia, Moscow, Russia
[2]Moscow State University of Medicine and Dentistry named after A.I. A.I. Evdokimov" of the Ministry of Health of Russia, Moscow, Russia
[3]Oryol Regional Clinical Hospital, Oryol, Russia
[4]Orel State University named after I.S. Turgenev, Oryol, Russia
[5]Skobelkin State Scientific Center of Laser Medicine FMBA, Moscow, Russia

Abstract

There is a clinical report of successful oral intraluminal laser lithotripsy with subsequent lithoextraction of a large concretion of the common bile duct in a patient with choledocholithiasis and mechanical jaundice. For the intraluminar lithotripsy a tulium laser "Urolaz" was used with energy modes 0,025-0,05-0,1 J, up to a maximum of 0.5 J. The average power is 6-10 W. Laser exposure was carried out by pulses in an aqueous medium in order to prevent carbonation of the light guide and smoke. The effect of exposure to the concretion was manifested in its fragmentation and the formation of small particles without damage of the mucous membrane of the common bile duct. The total duration of the intervention was 45 minutes. The method is effective and safe, thus it avoids the need of endoscopic papillosphincterotomy and violation of the anatomical integrity and physiological function of the Oddi sphincter.

Key words: choledocholithiasis, papillosphincterotomy, fragmentation of concretion, endoscopic laser lithotripsy, common bile duct.

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Contacts: Ivanov Y.V., e-mail: ivanovkb83@yandex.ru

ВОЗМОЖНОСТИ ПРИМЕНЕНИЯ ПЕРОРАЛЬНОЙ ВНУТРИПРОСВЕТНОЙ ЛАЗЕРНОЙ ЛИТОТРИПСИИ ПРИ КРУПНОМ КОНКРЕМЕНТЕ ОБЩЕГО ЖЕЛЧНОГО ПРОТОКА (КЛИНИЧЕСКОЕ НАБЛЮДЕНИЕ)

Ю.В. Иванов[1,2], Д.В. Сазонов[1], А.В. Смирнов[1], А.В. Мамошин[3,4], А.В. Баранов[5], Д.Н. Панченков[2,5]

[1]«Федеральный научно-клинический центр специализированных видов медицинской помощи и медицинских технологий ФМБА России», Москва, Россия
[2]«Московский государственный медико-стоматологический университет им. А.И. Евдокимова» Минздрава России, Москва, Россия
[3]Орловской области «Орловская областная клиническая больница, Москва, Россия
[4]«Орловский государственный университет имени И.С. Тургенева», Орел, Россия
[5]«Государственный научный центр лазерной медицины им. О.К. Скобелкина ФМБА России», Москва, Россия

Резюме

Представлено клиническое наблюдение успешного выполнения пероральной внутрипросветной лазерной литотрипсии с последующей литоэкстракцией крупного конкремента общего желчного протока у пациентки с холедохолитиазом и механической желтухой. Для проведения внутрипротоковой литотрипсии использовали тулиевый лазер «Уролаз» в следующих режимах: энергия – 0,025-0,05-0,1 Дж, максимум до 0,5 Дж. Средняя мощность 6-10 Вт. Лазерное воздействие проводили импульсами в водной среде с целью профилактики карбонизации волокна световода и задымления. Эффект воздействия на конкремент проявлялся в его фрагментации и образовании мелких частиц без повреждения слизистой оболочки общего желчного протока. Общая продолжительность вмешательства составила 45 мин. Метод является эффективным и безопасным, позволяет избежать необходимости выполнения эндоскопической папиллосфинктеротомии и нарушения анатомической целостности и физиологической функции сфинктера Одди.

Ключевые слова: холедохолитиаз, папиллосфинктеротомия, фрагментация конкремента, эндоскопическая лазерная литотрипсия, общий желчный проток.

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Контакты: Иванов Ю.В., e-mail: ivanovkb83@yandex.ru

Introduction

One of the most common complications of cholelithiasis is choledocholithiasis - the presence of stones in the common bile duct. In 10-25% of patients with cholelithiasis, concretion is detected not only in the gallbladder, but also in the common bile duct [1, 2]. The longer the medical history of cholelithiasis, the greater the risk of choledocholithiasis. The presence of stones in the common bile duct against the background of existing cholecystolithiasis or without it, previous cholecystectomy can cause obstructive jaundice or cholangitis, which in itself is an unfavorable factor in the course of the disease. Detected concretion in the common bile duct is subject to mandatory removal, regardless of its presence or absence in the gallbladder due to the risk of developing severe complications: obstructive jaundice, cholangitis, acute gallstone pancreatitis [3].

The clinical picture of choledocholithiasis is quite variable and depends on many factors: the size and number of concretion, the level and degree of blockade of the common bile duct, the topographic anatomy and structure of the terminal section of the common bile duct and the ampulla of the major duodenal papilla (MDP), comorbidities of the organs of the pancreaticoduodenal zone.

In clinical practice, the following manifestations of choledocholithiasis can be found: a) latent, characterized by the absence of a clinical picture of the disease and is detected only during examination of the patient; b) with complete blockade of the common bile duct up to the MDP ampulla, manifested by progressive obstructive jaundice with or without cholangitis; c) with complete blockade of the common bile duct at the level of the MDP ampulla, accompanied by progressive obstructive jaundice and acute pancreatitis; d) with valvular (moving) concretion and stenotic papillitis, periodic unsystematic outbreaks of obstructive jaundice and cholangitis are characteristic; e) choledocho-intestinal fistula with a clinical picture of cholangitis [2].

All existing methods for removing stones from the common bile duct can be conditionally divided into five large groups: 1) upfront surgery (laparotomy, short-scar incision); 2) laparoscopic operations; 3) percutaneous-transhepatic (antegrade) minimally invasive interventions; 4) endoscopic (retrograde) surgical aids; 5) hybrid operations combining several methods of lithoextraction. The use of one or another method of lithoextraction depends primarily on the technical equipment of the hospital, the qualifications of doctors, the characteristics of the clinical picture and the course of the disease.

It has been established that in modern conditions the best way to resolve choledocholithiasis is the endoscopic method, and the "gold standard" of the technique is recognized as endoscopic retrograde cholangiopancreatography (ERCP) and lithoextraction with or without preliminary endoscopic papillotomy/papillosphincterotomy (EPST) [4].

Endoscopic lithoextraction is performed using the Dormia endoscopic grasping basket, which is presented on the medical market with a wide range of reusable and disposable instruments of various shapes, sizes and rigidity. It should be noted that the necessary conditions for the successful removal of a concretion from the common bile duct are a sufficient diameter of the terminal section of the common bile duct and MDP, as well as the possibility of inserting a Dormia basket for a concretion for its full opening and reliable grasping. With small concretion, no more than 1 cm, the procedure for performing ERCP,

EPST and lithoextraction, with sufficient experience of the endoscopist and a typical topographic and anatomical structure of the MDP, usually does not cause technical difficulties and in 92-96% of cases can effectively eliminate choledocholithiasis [4]. The greatest difficulties arise with large and massive stones in the common bile duct. In most cases, unsuccessful attempts to extract large stones from the common bile duct end in a switch to another method of lithoextraction (upfront or laparoscopic surgery). In some cases, the endoscopic method of lithoextraction can lead to a number of specific complications: bleeding after EPST, post-manipulation acute pancreatitis, strangulation of the Dormia basket in the terminal choledochus or MDP, perforation of the common bile duct wall, perforation of the duodenal wall.

In addition to the described technique of intraductal mechanical lithotripsy, balloon dilatation of the area of preliminary EPST followed by lithoextraction or extracorporeal shockwave lithotripsy followed by endoscopic removal of concretion fragments is used in clinical practice with varying degrees of success. The effectiveness of these treatment methods of choledocholithiasis is noticeably inferior to the method of ERCP, EPST and mechanical lithoextraction. Extracorporeal shockwave lithotripsy, due to its low efficiency and high risk of acute cholecystitis, is not considered by most surgeons as an independent method of treating choledocholithiasis.

In recent years, a number of foreign authors recommend using electrohydraulic or laser lithotripsy for large concretion in the common bile duct [5, 6]. The technique of oral transpapillary cholangioscopy and subsequent intraductal laser lithotripsy makes it possible to break stones into small pieces in the common bile duct without damaging its walls, and then remove them using the Dormia basket.

Given the few foreign publications and single reports in the Russian-language medical literature on the implementation of endoscopic laser lithotripsy for choledocholithiasis, we considered it possible to present our own clinical observation.

Clinical observation

Patient A., 56 years old, was hospitalized in the Department of Surgery of the Federal State Budgetary Institution Federal Clinical Research Centre of Russia's Federal Medical-Biological Agency on July 15, 2021 on an emergency basis with a referral diagnosis: obstructive jaundice. From the medical history it is known that in 2017 she underwent laparoscopic cholecystectomy for cholelithiasis, chronic calculous cholecystitis. During the last 6 months before hospitalization, she suffered from periodic pulling pains in the right hypochondrium after eating, which were relieved by antispasmodic drugs. From July 03, 2021, she noticed scleral and skin icteric, from July 08, 2021 - dark urine and discolored feces. Due to the increasing jaundice and the deterioration of the general condition, the patient was referred for hospitalization in a hospital for examination and treatment.

On admission, the general condition of moderate severity. Skin with a pronounced icteric tinge and traces of scratching, there is no clinical picture of cholangitis and acute gallstone pancreatitis. Arterial pressure 130/75 mmHg, pulse 78 beats/min. The abdomen is not swollen, soft, moderately painful in the right hypochondrium and mesogastrium, there are no symptoms of peritoneal irritation. Peristalsis is auscultated, palpation revealed no neoplasms in the abdominal cavity, no ascites. Urination is not disturbed, the urine is dark brown in color, with rectal examination there are traces of light feces.

Blood tests dated July 15, 2021 for hepatitis B and C are negative. Biochemical blood test dated July 15, 2021: total protein 70 g/l, urea 4.7 mmol/l, creatinine 96 μmol/l, total bilirubin 420 μmol/l (direct 378 μmol/l, indirect 49 μmol/l), pancreatic blood amylase 26 U/l, glucose 3.92 mmol/l, AST 390 U/l, ALT 320 U/l, ALP 460 U/l, C-reactive protein 1.6 mg/l. Clinical analysis of urine dated July 15, 2021: dark brown color, relative density 1.39 g/ml, pH 6.5, urobilinoids 2.8 μmol/l, bilirubin 18.5 μmol/l. Indicators of the general blood test, hemostasiograms within normal values.

The patient underwent the necessary instrumental studies. ECG dated July 15, 2021: sinus rhythm, heart rate 76 beats/min, ECA sharply deviated to the left, blockade of the anterior branch of the left branch of the His bundle. X-ray of the chest organs dated July 15, 2021: no pathology. Conclusion from the Ultrasound of the abdominal cavity and retroperitoneal space dated July 15, 2021: choledocholithiasis (a single concretion 20 mm in the terminal section of the common bile duct), signs of biliary hypertension (dilation of the intrahepatic bile ducts up to 5-7 mm, common bile duct up to 21 mm).

On July 16, 2021, under intravenous anesthesia, the patient underwent gastroduodenoscopy (duodenoscope JF-Q150, Olympus), cannulation of the common bile duct. In order to minimize the risk of wirsungography and postoperative pancreatitis, preliminary contrasting of the ductal systems from the mouth of the duodenal duodenum was not performed and was guided by the position of the radiopaque conductor during fluoroscopy. After confirming the location of the conductor in the common bile duct, 5 mm long papillotomy was performed, up to the level of the 1st transverse fold, balloon dilatation of the mouth of the common bile duct with QBD-10x3 balloons (Wilson-Cook) up to 10 mm. With repeated attempts to extract the concretion, it is not possible due to the impossibility of holding the lithoextractor above the concretion and its incomplete coverage by the Dormia basket. It was decided to perform oral cholangioscopy, laser intraductal crushing of the calculus, followed by its lithoextraction.

After replacing the duodenoscope with an ultrathin Olympus GIF-N180 gastroscope with an outer diameter of 4.9 mm, the latter was passed into the duodenum, then into the terminal section of the common bile duct. Due to the high elasticity of this device model, a 0.035"/0.89 mm nitinol conductor wire was used to create rigidity, which was inserted into the instrumental channel of the endoscope.

After the stage of cholangioscopy and visualization of the concretion, the conductor was removed from the lumen of the endoscope, the common bile duct was filled with physiological sodium chloride solution without pressure, followed by its aspiration (Fig. 1). This maneuver in some cases allows "bringing down" the concretion directly to the tip of the endoscope located in the common bile duct.

For laser lithotripsy, a laser optical fiber 200 μm and 400 μm thick was used, which was initially passed into a Teflon catheter 1.5 m long, 1.5 mm in diameter, intended for use with instrumental channels of endoscopes up to 2.0 mm. The catheter had an additional port for fluid supply. The use of such a design makes it possible to protect the instrumental channel of the endoscope from damage by the optical laser fiber, as well as the fiber itself from creases, and makes the position of the laser fiber in the lumen of the bile ducts more manageable.

After passing the catheter through the instrumental channel of the endoscope, liquid was supplied into the lumen of the common bile duct, the optical fiber was removed 5 mm from the lumen of the Teflon catheter and brought directly to the concretion.

To perform intraductal lithotripsy, a Urolaz thulium laser was used in the following modes: energy setting - 0.025-0.05-0.1 J, up to a maximum of 0.5 J. Average power 6-10 watts. It should be noted that the higher the average power, the greater the effect of crushing and heating of the liquid. The higher the energy in the pulse, the greater the crushing effect, but at the same time, the risk of damage to the wall of the common bile duct increases when the laser pulse directly hits it.

Laser exposure was carried out by pulses in an aqueous medium in order to prevent carbonization of the fiber of the light guide and smoke. The effect on the concretion was manifested in its fragmentation and the formation of small particles (Fig. 2). At the same time, there was no damage to the mucous membrane of the common bile duct, despite the sliding of the optical laser fiber from the concretion.

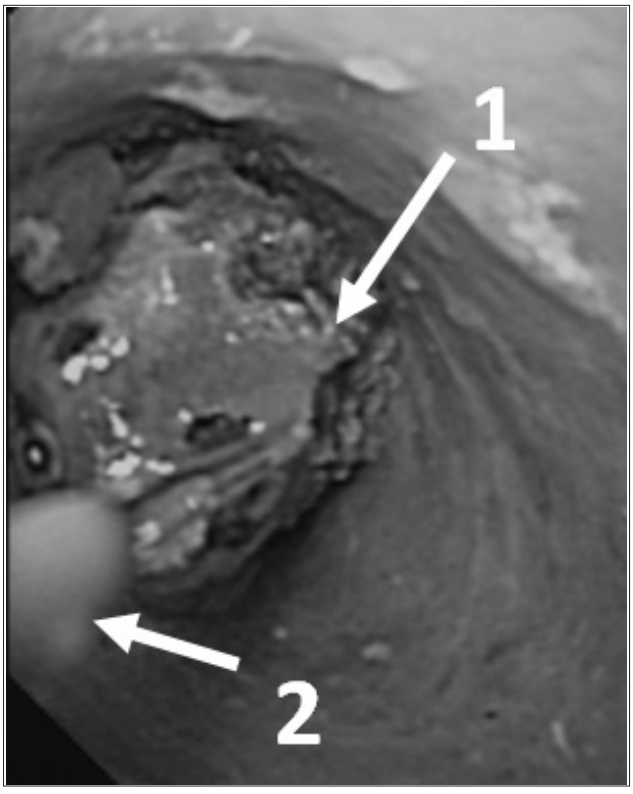

Рис. 1. Этап холангиоскопии и визуализации конкремента в общем желчном протоке: 1 – концевая часть лазерного оптического волокна; 2 – конкремент.
Fig. 1. Cholangioscopy and visualization of the concretion in the common bile duct: 1 – the end part of the laser optic fiber; 2 – concretion.

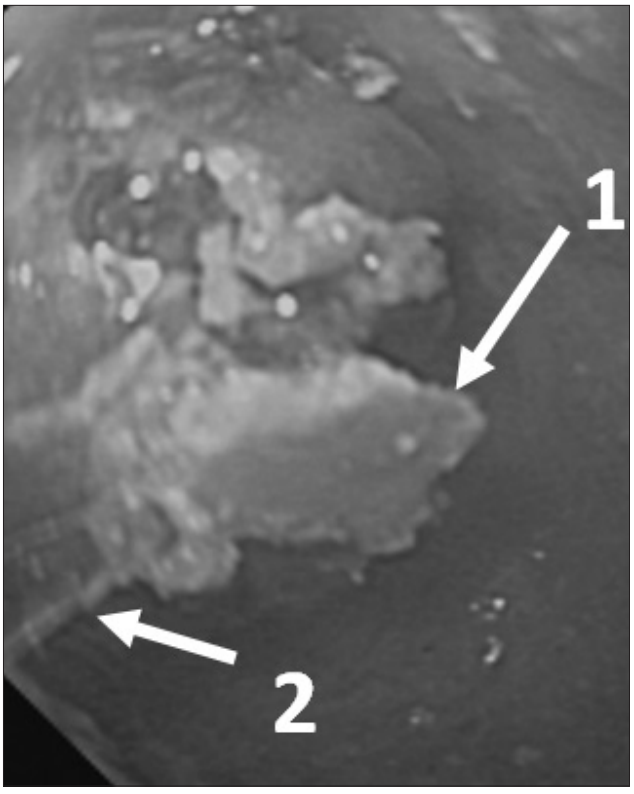

Рис. 2. Этап лазерной литотрипсии:
1 – концевая часть лазерного оптического волокна;
2 – фрагмент конкремента.
Fig. 2. Stage of laser lithotripsy:
1 – end part of the laser optical fiber;
2 – a fragment of a calculus.

The surgical intervention ended with the washing out and extraction of fragments of the concretion with the Dormia basket. The total duration of the intervention was 45 minutes.

The course of the postoperative period is smooth, without complications. The patient was discharged with recommendations from the hospital on July 22, 2021 in a satisfactory condition under the supervision of a surgeon at the place of residence. Total bilirubin on the day of discharge 62 μmol/l (direct 41 μmol/l, indirect 21 μmol/l), AST 80 U/l, ALT 65 U/l, alkaline phosphatase 180 U/l.

Discussion

In recent years abroad, when it is impossible to perform mechanical lithotripsy and lithoextraction from the common bile duct in choledocholithiasis, methods of endoscopic laser or electrohydraulic destruction of large concretion have been used, followed by sanitation of the duct and extraction of fragments with a Dormia basket. The efficiency of laser lithotripsy is slightly higher than electrohydraulic one: 99% and 96.7%, respectively [5, 6].

For the first time, the use of laser technologies began more than 23 years ago in urology for urolithiasis, and then in maxillofacial surgery for sialolithiasis. The mechanism of destruction of concretion by free-running pulses of these lasers is based on the effect of explosive vaporization of concretion, which leads to its uncontrolled fracture into small fragments [7, 8].

For a long time, the main option for intraductal laser lithotripsy was the use of a holmium laser. In 2013–2015 the first publications began to appear on the possibilities of a new type of laser, the operation of which is based on ions of the rare earth metal thulium (No. 69), which, like holmium (No. 67), belongs to the lanthanides [9-12]. However, thulium lasers have a higher degree of absorption of their radiation by water compared to holmium ones. In the domestic medical literature, there are only a few data on the use of laser technologies for choledocholithiasis, so many issues of their technical implementation, indications and contraindications, the choice of optimal operating modes for safe exposure to the bile ducts still require further study [3, 9].

Our first clinical experience with oral intraluminal laser lithotripsy of a large common bile duct concretion using a thulium fiber laser was a complete success. In total, the clinic successfully performed 3 similar surgical interventions for choledocholithiasis (1 clinical case presented above, and 2 observations for acute calculous cholecystitis complicated by choledocholithiasis and cholangitis).

Endoscopic laser lithotripsy of common bile duct concretion followed by lithoextraction allows, if conventional ERCP, EPST and lithoextraction are not possible, to not resort to upfront (laparotomic) surgery or laparoscopic choledochotomy and removal of concretion, which can be technically difficult and not always feasible surgical intervention.

In addition to the undeniable advantages, the method of traditional ERCP, EPST and lithoextraction has its drawbacks. So, to extract large stones from the common bile duct, their preliminary mechanical fragmentation and EPST are necessary. Performing EPST at the height of obstructive jaundice, disorders of the blood coagulation system (high INR, taking anticoagulant drugs, etc.) significantly increases the risk of bleeding and poses a certain threat to the patient's life. There are frequent cases of infringement of the Dormia basket with a captured large concretion in the intrapancreatic part of the common bile duct, which leads to the need to perform an already open surgical intervention to remove the instrument with the concretion. It is not always possible to bring the Dormia basket above the place of obstruction of the common bile duct with a concretion and its capture, and excessive and rough manipulations with the lithoextractor can lead to perforation of the duct wall. Large concretion with a dense structure cannot always be fragmented using the Dormia basket or other lithoextractors.

Another very important fact: EPST, in addition to the risk of bleeding, perforation of the posterior wall of the duodenum leads to the inevitable dysfunction of the sphincter of Oddi, and in some cases to cholangitis.

Oral intraluminal laser lithotripsy makes it possible to fragment a large concretion, even of a dense structure, in a short time frame, while there is no need to perform EPST with all the ensuing risks of its complications. To extract fragments of the concretion from the common bile duct, it is sufficient to perform only papillotomy without destroying the sphincter apparatus of the MDP or balloon dilatation. The risk of complications such as bleeding, perforation of the posterior wall of the duodenum or common bile duct, post-manipulation pancreatitis with endoscopic laser lithotripsy is significantly lower than with traditional ERCP, EPST and lithoextraction. We did not observe these complications when performing oral intraluminal laser lithotripsy.

Conclusion

Thus, endoscopic laser lithotripsy followed by lithoextraction is an effective and safe minimally invasive treatment for choledocholithiasis with large or strangulated concretion in the common bile duct, avoiding the need to perform EPST and disrupting the anatomical integrity and physiological function of the

sphincter of Oddi. A full visual revision of the common bile duct is possible before and after sanitation, the lithotripsy process is carried out under visual control in real time. It is possible to avoid unwanted damage to the wall of the common bile duct and reduce the duration of the intervention due to the targeted bringing of the end of the laser light guide to the surface of the concretion, reduce the risk of complications specific to ERCP and EPST. This technique can be considered as the main method of treating choledocholithiasis, with the ineffectiveness of traditional ERCP, EPST and lithoextraction.

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