Innovative: International Multi-disciplinary Journal of Applied Technology
(ISSN 2995-486X) VOLUME 02 ISSUE 07, 2024

Lithotripsy by Holmium Laser (Endoscope) in the Major Operating Room of Al-Sadr Hospital / Najaf

Khadija Hamed Abd Alhussien
University of Kufa College of Sciences Departement of Medical physics

Mustafa Tarrad Obaid Muhammad
University of Fallujah College of Applied Sciences Department of Medical Physics

Ali Shaker Mahmoud Ahmed
Al-Karkh University of Science College of Science Department of Medical Physics

Najlaa Mohammed Kzar Mokhef
University of Baghdad College of scinces women Department of Medical physics

Mohammed Baqer Osama Abdul Zaid Karim
University of Fallujah Faculty of Applied Science Department of Medical Physics

Abstract:

laser is a device that projects a highly concentrated narrow beam of light which is amplified using stimulated radiation. Lasers have three properties: coherency, collimation and monochromatic properties. These three properties of lasers produce a small focus point of intense power. This paper is a basic introduction to laser physics, especially that relevant to accelerator science. It presents the essential physics of a laser, some of the different types of laser system available, the propagation of laser beams, and the key diagnostics that are used for lasers.

laser, a device that stimulates atoms or molecules to emit light at particular wavelengths and amplifies that light, typically producing a very narrow beam of radiation. The emission generally covers an extremely limited range of visible, infrared, or ultraviolet wavelengths. Many different types of lasers have been developed, with highly varied characteristics. Laser is an acronym for “light amplification by the stimulated emission of radiation. "In the following papers, the types, characteristics and uses of lasers will be explained with the difference between light and laser with photos and research samples.

Keywords: *Lasers. Pulse Amplification. light, radiation. frequency. photon. Energy. Power. Kidneys. Stones. Patient.*

Introduction

Laser lithotripsy is a surgical method to remove a kidney, ureteral, or bladder stone. Which causes sharp pain when moving because of its pointed heads, in addition to that, it may be a cause of urinary tract infection and wounding of the inner wall of the ureter[1]. Often the patient has a choice between ***ESWL*** and ureteroscopy ***URS***. ESWL will be more commonly employed for stones in the kidney and ureteroscopy more often used for ureteral stones. Patients will often prefer ESWL as it is less invasive in that typically no scopes are inserted into the patient's bladder[2].

There are many options for urologists to treat ureteral stones that range from ***8 mm to 15*** mm, including ESWL and ureteroscopy holmium laser lithotripsy[3]. and the procedure usually lasts between ***30 minutes and 2 hours***. Kidney stones are often painful and can take several weeks to fully pass through the body's system. A person should see a doctor if their stones become particularly painful or if they experience other worrying symptoms. There are several potential treatment options for kidney stones. Drug therapies focus on both alleviating pain and discomfort and allowing the stone to pass more easily. However, kidney stones that are too large to pass naturally may require surgical removal[4].

What is the name of the laser used?

holmium laser Compared to extracorporeal shock wave lithotripsy, holmium laser lithotripsy has been shown to have higher success rates and decreased chance of (a complication of extracorporeal shockwave lithotripsy in which fragments of the stones block the ureter)[5].

What is holmium laser lithotripsy?

Holmium laser lithotripsy uses lasers to break stones that are located in the urinary tract. This could include stones in the bladder, kidneys, ureters (tubes that carry urine from the kidneys to the bladder) or urethra (the tube through which urine leaves the body from the bladder). A flexible laser fiber is inserted through a scope (camera) placed in the urinary tract via the urethra to break up the stones. The stone fragments are then removed with a small basket or other instruments. The procedure is done without any incisions (cuts)[6].

How is laser stone crushing done?

The urologist inserts the cystoscope either directly into the patient's urethra or with a metal wire guide and continues up the urinary tract to locate the stone in the ureter or kidney. When the stone is located, a thin fiber optic device is inserted into the operating channel of the endoscope and advanced until it is in contact with the stone[7].

Reasons for laser lithotripsy

Kidney stones can become trapped anywhere in the urinary tract, including the kidney and the ureter. The ***ureter*** is a tube that carries urine from the kidneys to the bladder. If a stone gets stuck in the ureter it can cause a blockage and the back-up of urine into the kidney. They can also be quite painful and can become infected. Laser lithotripsy is used to break apart the kidney stone so that it can pass through the ureter. The pieces will either be removed by the surgeon using a special basket or left in place where they will move from the ureter to the bladder, then out of the body with the urine[8]. Laser lithotripsy may be chosen if other non-surgical treatments have failed or if kidney stones are:

- Too large to pass
- Irregular in shape
- Causing bleeding or damage to surrounding tissue
- Dangerous and rapid cases due to the non-passage of urine

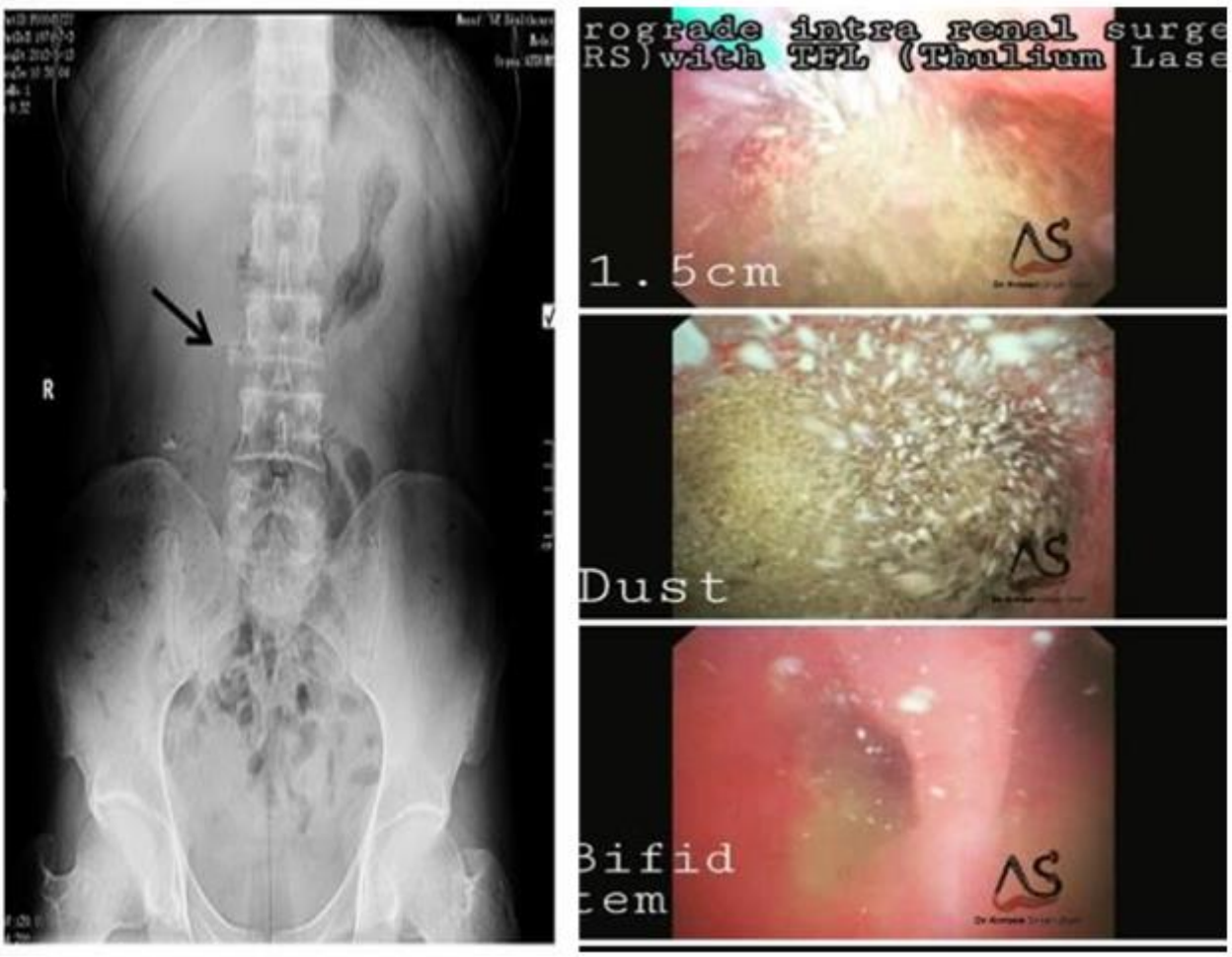


Figure3-1 / the pictures show the location of the gravel and its fragmentation

Preparing for a session of laser lithotripsy

- Subjecting the patient to specific examinations and tests in order to determine the location of the stones, their number, and their size in order to determine the location of the stones; Where this is done by taking ***x-rays*** after injecting the patient with a specific dye into his vein, so that this dye is transmitted to the kidneys, ureters and bladder through the bloodstream to reveal the stones and their location, which enables the doctor to see them on the image in the form of dark spots[9].
- The patient informs his doctor of all types of medications, supplements, and prescriptions that he uses, as some of them have a negative effect on patients undergoing laser lithotripsy; Some of them may be stopped for a certain period of time before the session, which may reach 7 days or more due to their effects. Some may cause interactions with the anesthetic medications used during the procedure, while other types of medications may increase the risk of bleeding[10].
- Avoiding personal efforts or stopping any kind of medication without consulting a doctor. On the other hand, there are some medications that the doctor prescribes to be taken after the session for a certain period. The doctor will also recommend continuing to take some medications without making any modification to the mechanism
- The patient should stop smoking several days before undergoing the laser lithotripsy session, in order to reduce blood clotting problems that may occur. Fasting between 8-12 hours before receiving general anesthesia
- The patient asked for help from a family member or someone close to him, as the patient will not be able to drive for several hours after the session due to the effect of the anesthetic and the drowsiness it causes, which forces the person to seek the assistance of another person to transport him to his home after the session[11].

Lithotripsy methods

Fragmentation can be performed by several means: ***ultrasonic lithotripsy, EHL, laser lithotripsy, and ballistic lithotripsy.***

1. Ultrasonic lithotripsy consists of the transmission of high-frequency vibrations along a rigid metal probe from the source to the stone and Fragmentation occurs
2. ***EHL*** is associated with a high risk of damage to the ureteral mucosa and a high incidence of perforation, particularly when the calculus is embedded in the ureteral mucosa. EHL should be avoided for ureter lithotripsy.
3. Laser lithotripsy is particularly well adapted to pediatric ureter lithotripsy because of the limited size (250 to 320 μm) and the flexibility of the optic fibers used to deliver the energy. Two different laser sources are currently used for lithotripsy: the pulsed-dye laser and the holmium: yttrium-aluminum garnet (YAG) laser. The pulsed-dye laser generates an acoustic shock wave that acts like a hammer to fragment the stone. There is no risk for the adjacent soft tissue, but everyone present in the room must wear protective glasses because accidental eye exposure to the laser beam can create irreversible damage to the retina. The holmium:YAG laser is also a pulsed laser that acts via a thermal effect. It is particularly effective on cystine stones and produces smaller fragments than pulsed-dye lasers do.153,154 There is no risk of ocular lesion in case of an accidental exposure. Because of the thermal effect, however, there is a risk of thermal injury to adjacent walls[12].

How long does passing a kidney stone take? What does it depend on?

1) Size

The size of a kidney stone plays a role in how quickly it will pass through a person's body. In general, smaller stones pass faster and with less pain. Around 80% of kidney stones that are smaller than 4 millimeters (mm) will pass on their own in about 31 days. Approximately 60% of kidney stones that are 4– 6 mm will pass on their own in about 45 days. Around 20% of kidney stones that are larger than 6 mm will pass on their own in about 12 months. However, when stones are this large, it is best to seek immediate surgical removal[13].

2) Location

Of the kidney stone also plays a role in whether or not a person will be able to pass it naturally. Some stones form in the kidney itself, while others may form in the ureter. Kidney stones that form in the upper part of the ureter are close to the kidney. Those that form in the lower part are close to the bladder. According to research outlined in a 2014 review Trusted Source, 48% of stones that form close to the kidney pass without intervention[14].

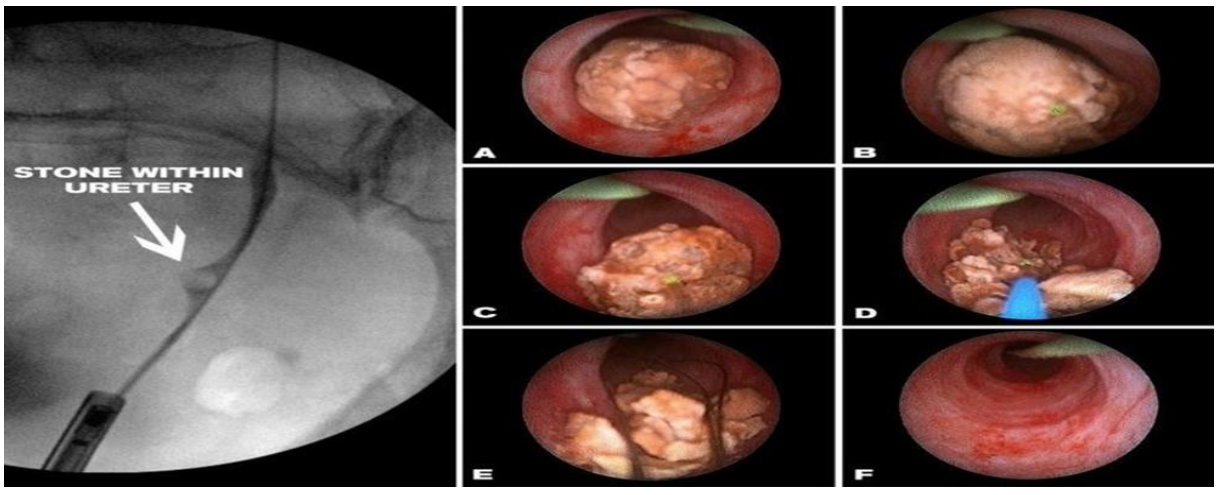


Figure3-2 / the method of Procedure the operation

Lithotripsy steps

1. The doctor uses a ***ureteroscope***, which is a small, lighted tube that he passes through the urethra and bladder to the ureter and kidneys, enabling him to reach the site of the stones.

2. The scope enters the urinary tract through the urethra, the tube that carries urine out of the body. The scope continues to pass through the urethra, bladder, and into the ureter or kidney (if necessary) to access the stone. Once the doctor sees the stone, a fiber will be sent through the scope to the stone. The fiber can create a laser beam to break up the stone. Small pieces may be removed using a basket that is passed through the scope. Small sand-like pieces may remain and will be gradually passed through the urine[15].
3. The doctor connects the stones to a specific device in the event that the stones are of a small size, so that they can then be removed from the ureter completely. In cases where the ureter is narrow or if the stones are of a large size, here the doctor resorts to using a laser to break the stones into smaller pieces. which enables them to pass through the ureter on their own, but large kidney stones that are broken up into small particles can be removed using the device designated[16].
4. Some kidney stones or large stones may require making a small incision in the back so that a hollow tube is inserted through it into the kidney, and after the stones are broken up with a laser, they are removed and removed from the body through this same tube. The ureteral stent is placed [small plastic tube placed inside the ureter to help urine (pee) pass from a kidney into the bladder. A child may need a ureteral stent: after surgery to keep the urine pathway open. if the ureter is narrow or blocked. to make way for a kidney stone to pass]. The passage of time, and in some cases the stent may be placed two or three weeks before undergoing the lithotripsy session, and this is in cases where the ureter is too narrow to prevent the ability to insert the speculum, as the vaginal stent allows the expansion of the ureter in this case to facilitate the insertion of the speculum during Lithotripsy session[17].

Types of kidney stones

a) calcium oxalate stones

b) calcium phosphate stone

c) struvite stones

d) uric acid stones

e) cystine stones]12[

A. Calcium stones

One 2016 article Trusted Source states that calcium stones are the most common type of kidney stones. Calcium stones contain calcium oxalate, calcium phosphate, or a combination of the two. Calcium oxalate stones consist of calcium oxalate dihydrate (COD), and calcium oxalate monohydrate (COM). A kidney stone made out of calcium oxalate with COD crystals will have jagged edges. However, a kidney stone formed out of calcium oxalate with COM crystals, which is more common, will have a smooth surface. Another crystal, brushite, forms little rosettes of very thin, sharp crystals.

B. Uric acid stones

According to a 2018 article, uric acid stones account for 3–10%Trusted Source of kidney stones. Uric acid stones are usually pebble-like in appearance. Some of these stones may be hard on the outside, but softer on the inside as they consist of different types of uric acid and calcium oxalate monohydrate.

C. Struvite stones

Struvite stones are the next most common type of kidney stones, with 7–8%Trusted Source of people worldwide having them. These stones are larger than others.

D. Cystine stones

Cystine stones are the result of cystinuria, which is a condition that can pass down through families. Kidneys produce cystine, a type of amino acid, and in people with cystinuria, this amino acid leaks through the kidneys and into the urine. Cystine stones are compact, partially opaque, and are amber[18].

Classification and treatment of stones

- Drinking water from (1.8 to 3.6 liters) per day will keep the urine light and may prevent the formation of additional stones or remove some very small stones before they accumulate while eating enough fluids to produce clear or semi-transparent urine.
- Moderation in eating foods that contain calcium
- Reducing the intake of food salt and proteins, including meat, smoking and soft drinks.
- Lots of fruits and vegetables, especially lemons and oranges
- Pain relievers Removing a small stone can cause some discomfort. To reduce the associated mild pain, your doctor may prescribe a pain reliever such as ibuprofen (Advil, Motrin IB, others) or naproxen sodium (Aleve).

Large stones and stones accompanied by symptoms due to their large size. Kidney stones that are too large to pass on their own, cause bleeding, damage to the kidneys, or persistent urinary tract infections may require more intensive treatment. Actions may include:

1. An extracorporeal shock wave (ultrasound) lithotripsy procedure uses powerful vibrations to break up the stone into small crumbs that can be passed in the urine. This procedure takes about ***45 to 60 minutes*** and can cause moderate pain, so you may be given sedation or light sedation so you don't feel pain. ESWL can cause blood in the urine, bruising in the back or abdomen, bleeding around the kidneys and other nearby organs, and discomfort as the stone fragments pass through the urinary tract.
2. Surgery to remove very large stones from the kidneys. A procedure called percutaneous nephrolithotomy involves surgically removing kidney stones using telescopes and small instruments inserted through a small opening in your back. You will receive general anesthesia during the surgery and will stay in the hospital for ***1 to 2 days*** until you recover. Your doctor may recommend this surgery if extracorporeal shock wave lithotripsy hasn't been successful.
3. Use an endoscope to remove stones. To remove a smaller stone in the ureter or kidney, your doctor may pass a thin, lighted tube (ureteroscope) with a camera through your urethra and bladder and into the ureter. Once the stone is located, special tools can be used to pick up the stone or break it up into pieces that pass out of the body with urine. Your doctor may then place a small tube (stent) in your ureter to reduce swelling and promote healing. You may need general or local anesthesia during this procedure.
4. Parathyroid surgery. Some calcium phosphate stones are caused by an overactive parathyroid gland, which is located on the four corners of the parathyroid gland, just below the Adam's apple. When these glands produce too much parathyroid hormone (***hyperparathyroidism***), your calcium levels can rise and kidney stones may form as a result. Sometimes hyperparathyroidism occurs when a small, benign tumor forms in one of the parathyroid glands or when you develop another condition that causes these glands to produce more parathyroid hormone. Removing the growths from the gland stops the formation of kidney stones. Or your doctor may recommend treatment for a condition that causes your parathyroid gland to produce too much hormone[13,19].

Reasons for the formation of stones

1. Eat red meat, duck meat and sardines
2. An increase in salt intake
3. Eat some foods a lot, such as eggs, legumes, mushrooms, cauliflower, fried foods, soft drinks, tea, coffee, spinach, chips, peanuts and chocolate.
4. Eat sugar in large quantities
5. A significant increase in the percentage of calcium in the body
6. The reasons mentioned above cause obesity, and therefore obesity is one of the reasons for the formation of stones
7. Some diseases, including thyroid diseases

8. Not taking the necessary fluids that the body needs.

What should I expect after holmium laser lithotripsy?

Because the stone is directly visualized during stone treatment, the stone fragmentation and clearance rate is very high. Ureteroscopy is performed through the urethra and no incision is required. The majority of patients have enough room to pass the ureteroscope safely to the stone. In rare cases, the ureter is too narrow to safely pass the ureteroscope. When this occurs, a ureteral stent is placed and the surgery must be performed after the ureter has time to relax, usually ***10-14 days*** later. Ureteral stents are left after most, but not all, ureteroscopy surgeries for kidney stones. Ureteral stents are soft plastic tubes that help the urine to pass even if the ureter has become inflamed. In some cases, it is not possible to remove all the stones in a single treatment. When this occurs, a second surgery may be needed. Most patients will notice some pain and blood in the urine after the operation for a few days. Stent symptoms will persist until the stents are removed. Most patients can expect to return to full activity one week after surgery[20].

Some complications

1. Pain.
2. Blood in urine.
3. Trouble urinating or other urination symptoms.
4. Injury to the ureters

Figure3-4 / Kidney stones under a microscope

Risks of stone fragmentation process

Ureteroscopy is a safe procedure, usually performed in an outpatient surgical center setting. Risks include of course pain, infection and bleeding. Very rare risks included ureteral perforation or injury, or subsequent scarring called structuring. The main thing for patients to be concerned about after any stone procedure would be fevers. Fevers after a stone procedure could trigger bacteremia (bacteria in the blood stream) and even sepsis:

1. Simple kidney perforation - these perforations generally heal without additional external treatment.
2. A minor wound in other abdominal organs such as the bladder or intestines. 3 -Damage to normal kidney function, despite its importance and effectiveness.
3. Some stones stuck in the ureter, when some parts of them are broken, others return to the kidneys, which causes pain and greater difficulty for the doctor and the patient.
4. There may be a need to push the stones that were removed towards the kidneys, and this happens by means of a small device called the urethral probe so that the surgeon can remove it and remove it[21].

Why is holmium laser lithotripsy done?

It's an alternative to a procedure called extracorporeal shockwave lithotripsy. In that procedure, sound waves from outside the body are used to break up the stones. Holmium laser lithotripsy has been shown to be effective no matter the size, location and/or hardness of stone. These factors limit the shockwave lithotripsy's effectiveness[22].

Result

In this chapter, we will explain the result of that research after finding the results and examining scenes for patients with laser lithotripsy. Kidney stones usually do not cause symptoms until they move inside the kidney or pass through one of the ureters, so the patient begins to feel several symptoms, the most important of which are pink or red urine or a foul smell in the urine with nausea and frequent urination with a feeling of pain, whether it is during urination or in the back.

The patient performs several examinations and analyzes, including blood analysis and x-rays, and in some cases, he needs a machine. After that, the specialist doctor transfers the patient to a hospital specialized in kidneys to determine by which methods the stones are broken up. The general methods are by with medication, sound waves, or laser lithotripsy (**endoscope**), it depends on the size and location of the stones, as mentioned in the second chapter of the research. After determining the resort to laser lithotripsy, the patient is transferred to the major operating room after bringing a complete file containing the medical examinations, the patient's name and age….. (Medical report).

Figure 4-1 /Examination of a female using x-rays

After conducting pre-operative examinations, the patient is transferred to the operating theater and a urinary catheter is used (a thin and flexible tube

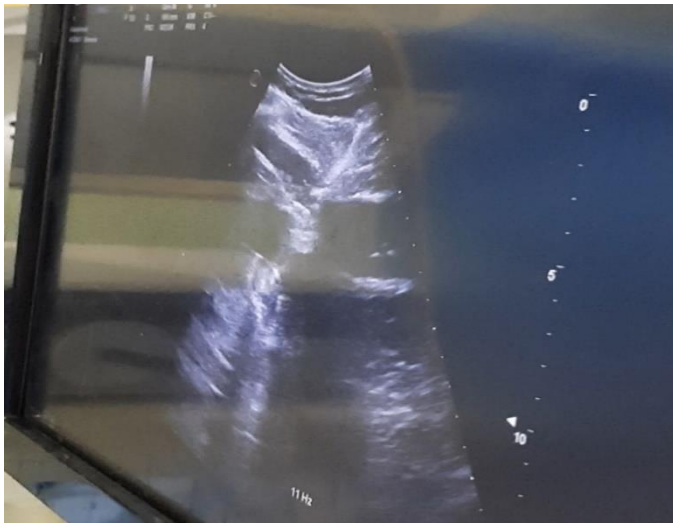
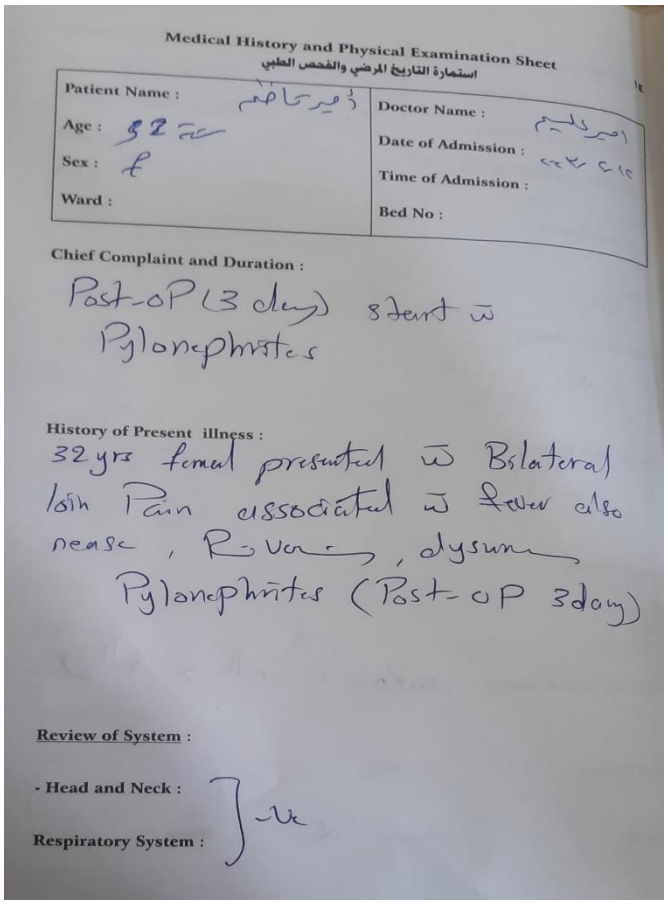


figure4-2/ Examination of an elderly man with many stones using ultrasound in the operating room to ensure that there are no remnants of stones kidneys.

that is installed in your bladder to drain your urine. The catheter is installed inside the bladder with a balloon filled with water). Not forgetting the anesthesia, pressure, sugar and other devices.

After that, sterilize the medical tools used for the operation, see the doctor for medical examinations, and know the location of the stone in any kidney or ureter.

Figure 4-2/ Medical report for a young man, about 30 years old.



Medical History and Physical Examination Sheet

استمارة التاريخ المرضي والفحص الطبي

Patient Name :

Age :

Sex :

Ward :

Doctor Name :

Date of Admission :

Time of Admission :

Bed No :

Chief Complaint and Duration :

Post-oP (3 day) stent w Pylonephrites

History of Present illness :

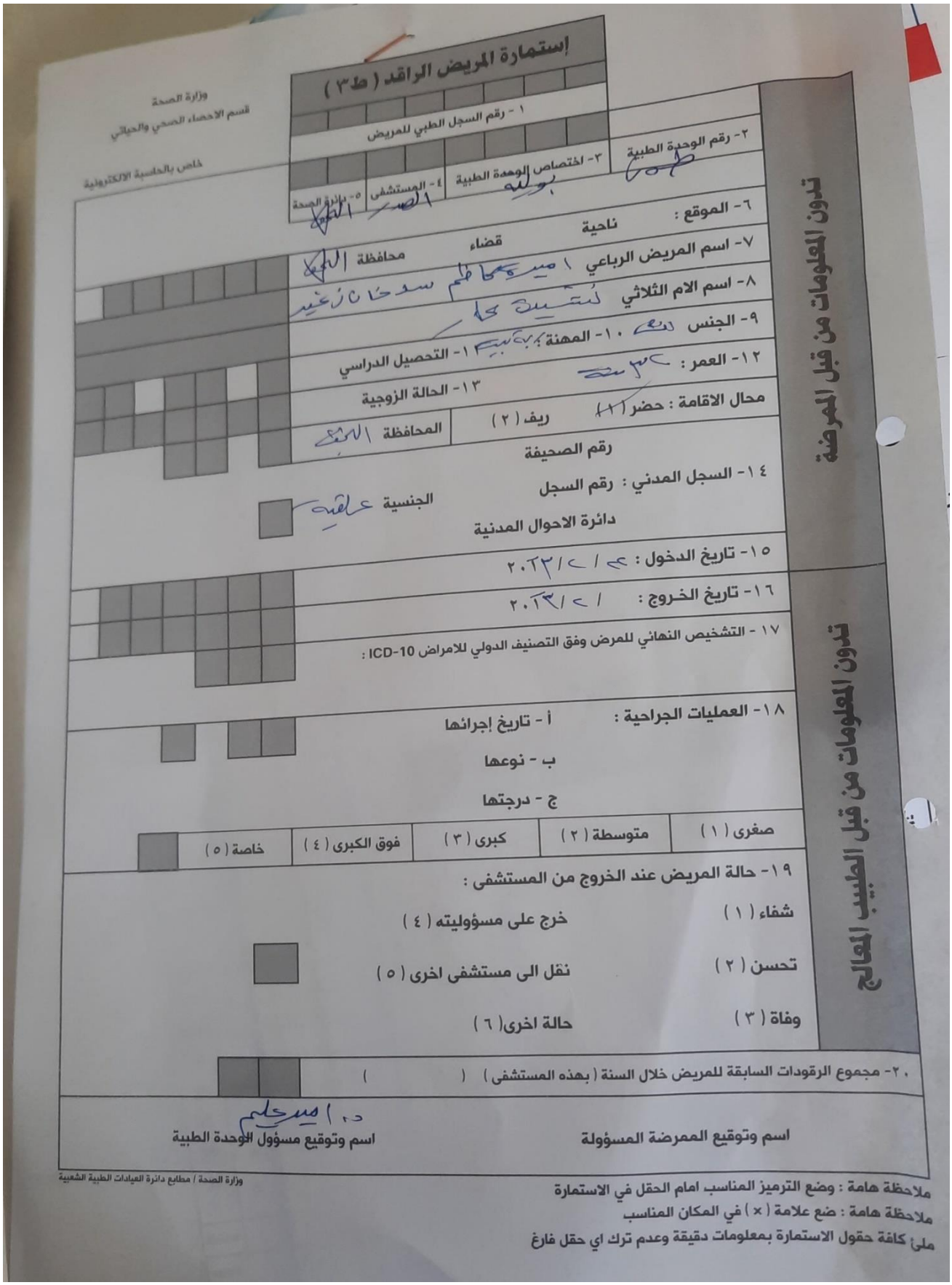
32 yrs female presented w Bilateral loin Pain associated w fever also nease , R-vom , dysum Pylonephrites (Post-oP 3day)

Review of System :

- Head and Neck :

Respiratory System :

After that, sterilize the medical tools used for the operation, see the doctor for medical examinations, and know the location of the stone in any kidney or ureter.



Medical History and Physical Examination Sheet

استمارة التاريخ المرضي والفحص الطبي

Patient Name : ذهيرتاهم	**Doctor Name :** اميرليم
Age : 32 سنة	**Date of Admission :**
Sex : f	**Time of Admission :**
Ward :	**Bed No :**

Chief Complaint and Duration :

Post-oP (3 day) start ب
Pylonephrites

History of Present illness :

32 yrs femal presented ب Bilateral
loin Pain associated ب fever also
nease, R-vom, dysum
Pylonephrites (Post-oP 3day)

Review of System :

- Head and Neck :

Respiratory System : } -ve

Medical History and Physical Examination Sheet (Cont...)

Physical Examination

General Examination :

Height : cm **Weight :** Kg **Temperature :** C

Pulse : / min. **Resp. Rate :** / min **B.p :** mm.Hg

Head :

Nose :

Ears :

Neck :

Thorax :

Breasts :

Lungs :

Heart :

Abdomen :

Liver :

Spleen :

Kidneys :

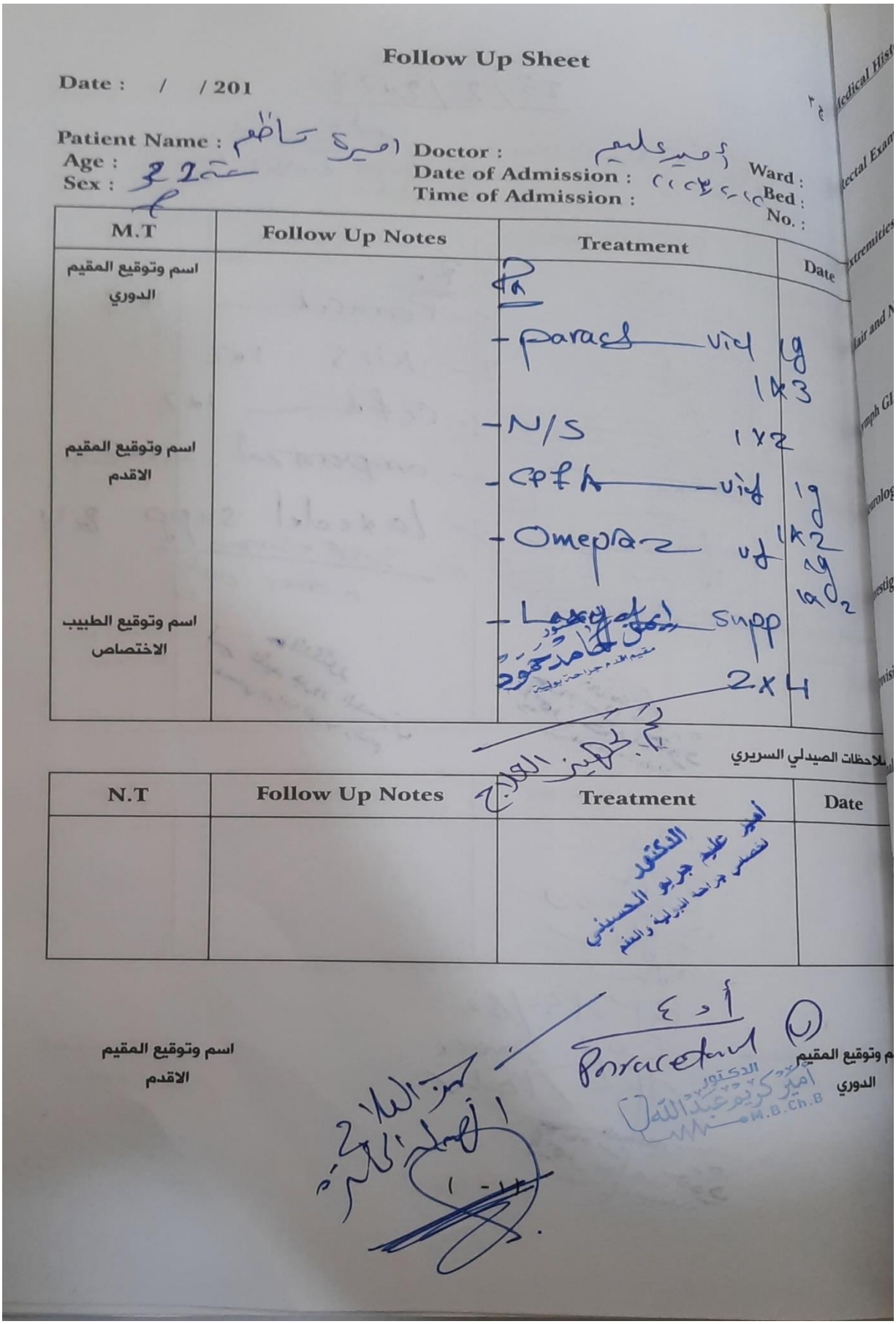
Inguinal Region :

Genitalia :

O/E 22/2/2023

- Con
- orund
- clear chest
- soft abd
- SPO_2 98%
  PR 96
  BP 120/80
- afb
- UOP 1600 cc dark color

الدكتور الكردي
M.B.Ch.B



Follow Up Sheet

Date : / / 201

Patient Name : اميرة تاظم
Age : 22 سنة
Sex : f

Doctor : أ.م.د عليم
Date of Admission :
Time of Admission :

Ward :
Bed :
No. :

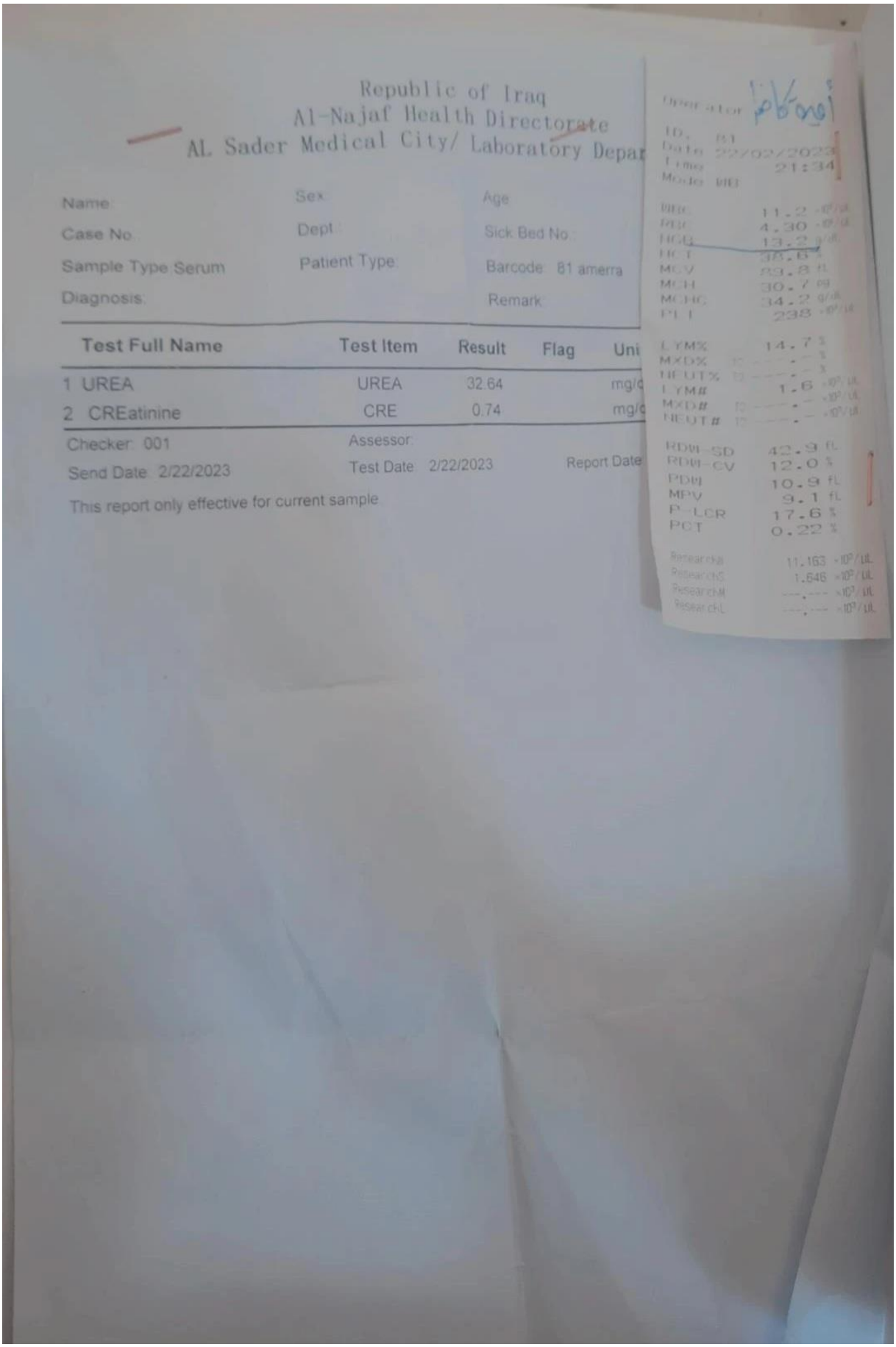
M.T	Follow Up Notes	Treatment	Date
اسم وتوقيع المقيم الدوري		Rx - Paracf vial 1g 1x3 - N/S 1x2 - Cpfx vial 1g 1x2 - Omepraz vial 40mg 1x2 - Lasix supp 2x4	
اسم وتوقيع المقيم الاقدم			
اسم وتوقيع الطبيب الاختصاص			

ملاحظات الصيدلي السريري

N.T	Follow Up Notes	Treatment	Date

اسم وتوقيع المقيم الاقدم

اسم وتوقيع المقيم الدوري



Republic of Iraq
Al-Najaf Health Directorate
AL Sader Medical City/ Laboratory Depar

Name:
Sex:
Age:
Case No:
Dept:
Sick Bed No:
Sample Type:Serum
Patient Type:
Barcode: 81 amerra
Diagnosis:
Remark:

Test Full Name	Test Item	Result	Flag	Uni
1 UREA	UREA	32.64		mg/d
2 CREatinine	CRE	0.74		mg/d

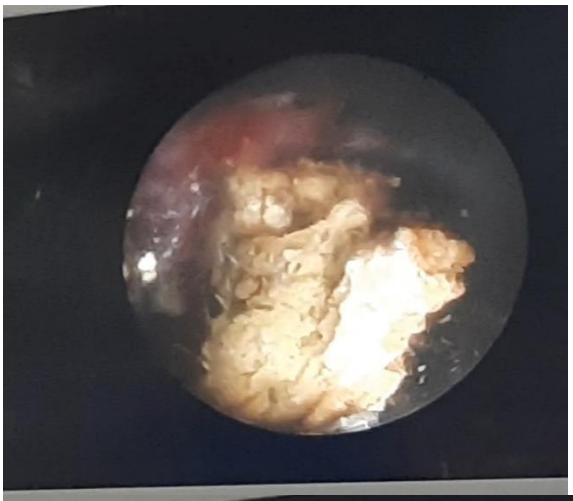
Checker: 001
Assessor:
Send Date: 2/22/2023
Test Date: 2/22/2023
Report Date:
This report only effective for current sample

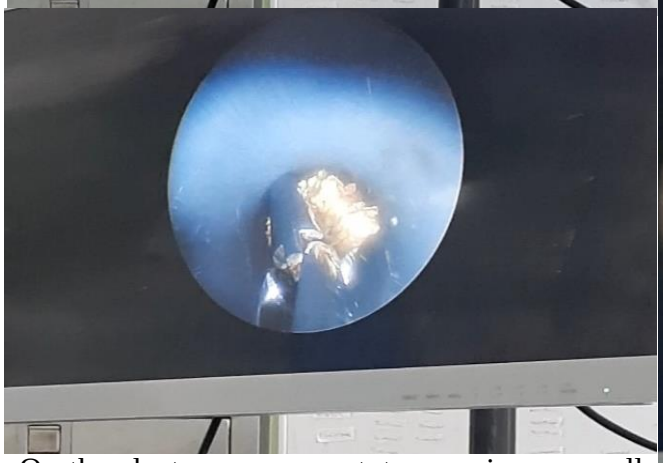
Operator:
ID: 81
Date: 22/02/2023
Time: 21:34
Mode: WB

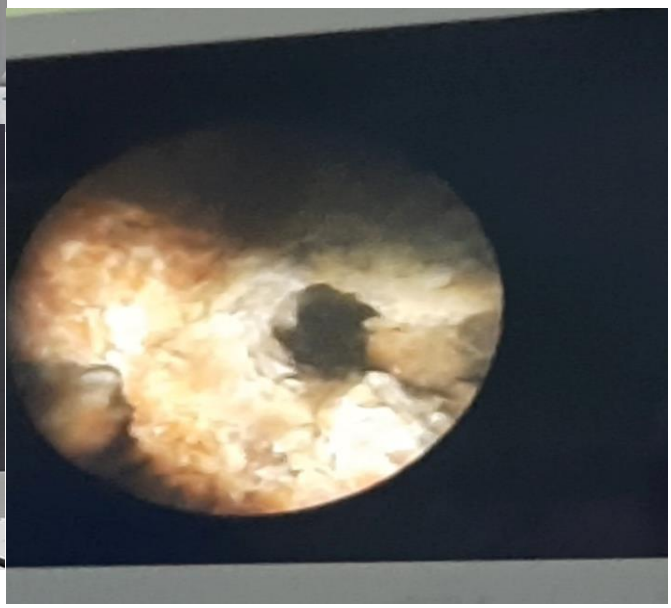
WBC	11.2
RBC	4.30
HGB	13.2
HCT	38.6
MCV	89.8 fL
MCH	30.7 pg
MCHC	34.2 g/dL
PLT	238
LYM%	14.7 %
MXD%	- %
NEUT%	- %
LYM#	1.6
MXD#	-
NEUT#	-
RDW-SD	42.9 fL
RDW-CV	12.0 %
PDW	10.9 fL
MPV	9.1 fL
P-LCR	17.6 %
PCT	0.22 %
Research#	11.163
ResearchS	1.646
ResearchM	--.---
ResearchL	--.---

Gravel is broken up in the same way, depending on the location, for example, Kidney stones in the ureter or bladder, the doctor may need to insert an endoscope from the urinary system of the disease, as in the pictures, and the endoscope passes to the bladder or to the bladder, then the ureter, depending on the location of the kidney stones, and the kidney stones are broken up.

If the stones are of a small size, they are gradually expelled during the urine, or taken out by the doctor during their direct fragmentation.

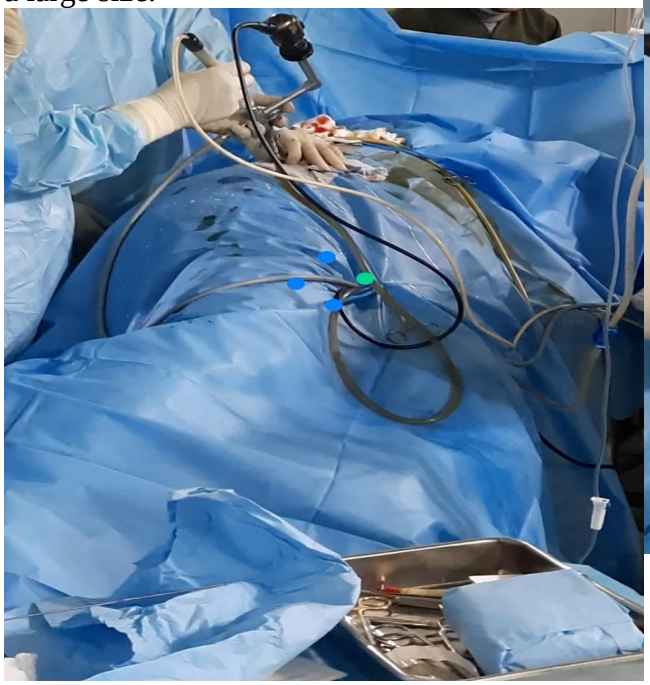


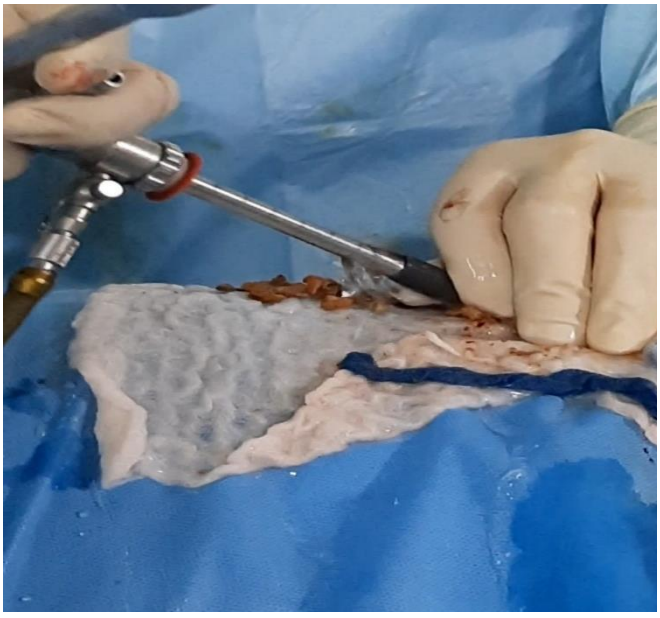


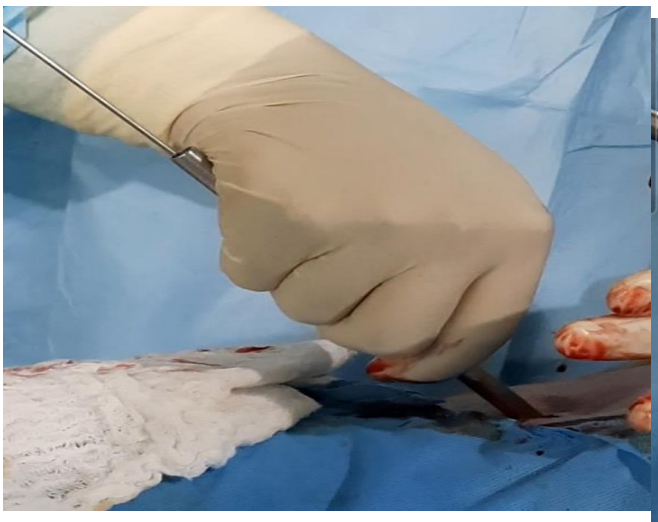


Or the doctor may resort to opening a small incision in the back if the stones are in the kidneys or in the kidneys and ureters and are of

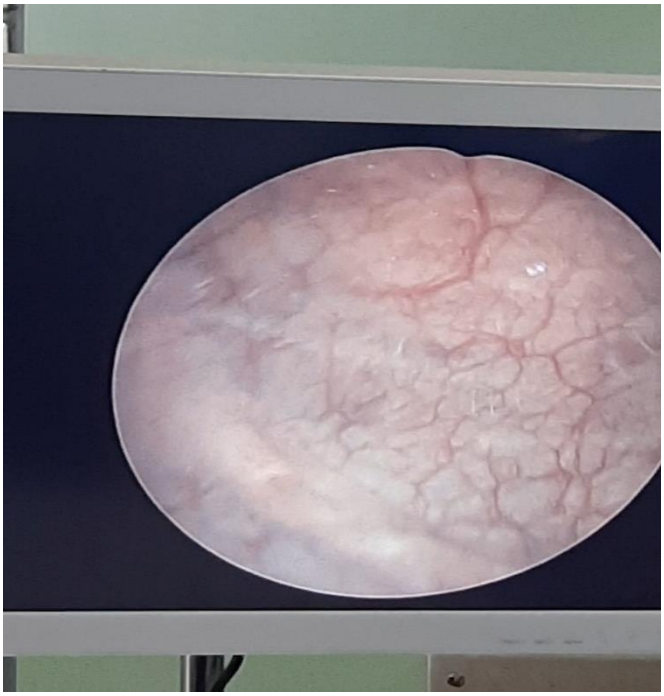
a large size.

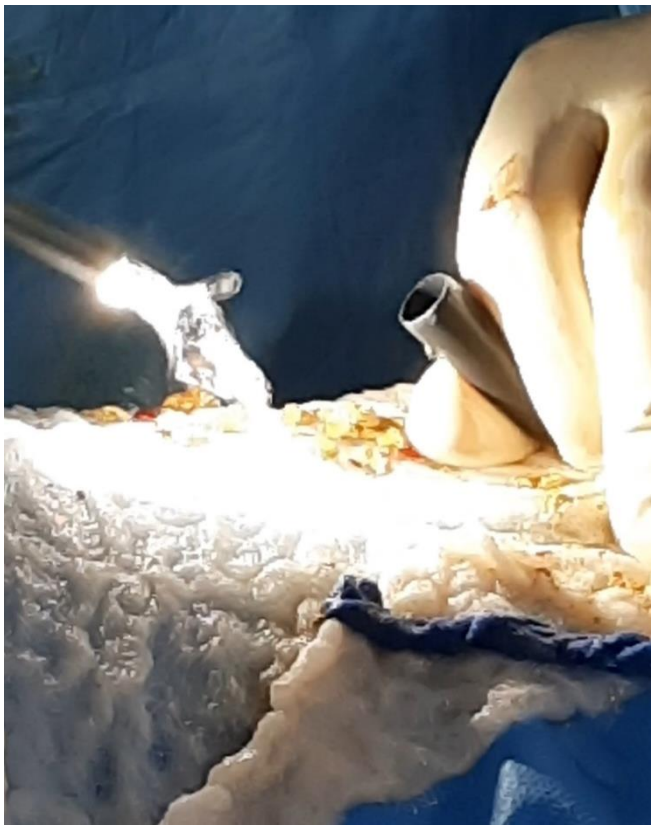






Upon completion of the operation, an examination is made to ensure that the urinary system is free of stones Some stones are given to the patient and others are given to the kidney stone analysis laboratory





Reference

1. N.M. Fried, Recent advances in infrared laser lithotripsy, Biomed. Opt. Express. 9 (2018) 4552–4568.
2. S. Garg, A.K. Mandal, S.K. Singh, A. Naveen, M. Ravimohan, M. Aggarwal, U.K. Mete, K. Santosh, Ureteroscopic laser lithotripsy versus ballistic lithotripsy for treatment of ureteric stones: a prospective comparative study, Urol. Int. 82 (2009) 341–345.
3. A.A. Obaid, F.M. Ali, A.A.A. Alwan, Comparison of Ureteroscopic Holmium Laser lithotripsy and ESWL in Treatment of Ureteric Stones, in: J. Phys. Conf. Ser., IOP Publishing, 2019: p. 22026.
4. S.R. Khan, M.S. Pearle, W.G. Robertson, G. Gambaro, B.K. Canales, S. Doizi, O. Traxer, H.-G. Tiselius, Kidney stones, Nat. Rev. Dis. Prim. 2 (2016) 1–23.
5. H.H.M. Farag, M.A. Hendawy, M.S. Hussein, Holmium YAG Laser Ureterolithotripsy versus Extracorporeal Shock Wave Lithotripsy in Management of Proximal Ureteric Stones; Prospective Randomized Study, Egypt. J. Hosp. Med. 76 (2019) 3807–3815.
6. A.H. Aldoukhi, W.W. Roberts, T.L. Hall, K.R. Ghani, Holmium laser lithotripsy in the new stone age: dust or bust?, Front. Surg. 4 (2017) 57.
7. R.B. Sabnis, A.P. Ganpule, S.K. Patwardhan, Practical urology (instruments, pathology, radiology): a comprehensive Guide, Jaypee Brothers Medical Publishers, 2021.
8. Z. Moinuddin, R. Dhanda, Anatomy of the kidney and ureter, Anaesth. Intensive Care Med. 16 (2015) 247–252.
9. E.X. Keller, V. De Coninck, O. Traxer, A. Shvero, N. Kleinmann, S.G. Hubosky, S. Doizi, T.J. Hardacker, D.H. Bagley, M. Sonzogni-Cella, Stones, in: Adv. Ureteroscopy A Pract. Guid. to Treat. Difficult Probl., Springer, 2021: pp. 105–154.
10. K.J. Flynn, B.A. Erickson, P.J. Guidos, J. Simmering, P. Polgreen, C.R. Tracy, Longitudinal assessment of post-ureteroscopic laser lithotripsy pain and opioid consumption using text messaging: tailoring pain management to the patient, Urol. Pract. 6 (2019) 369–376.
11. P.T. Camp, Increased efficiency within time of flight LiDAR systems through the inclusion of Mid-IR components, (2024).
12. E.G. Cuenca, A Comparison of the Thulium Fiber Laser Versus Holmium: YAG Laser Lithotripsy of Upper Urinary Tract Calculi: Preliminary Results of a Randomized Prospective Clinical Trial, (2023).
13. A.M. Fard, M.M. Fard, Evaluation of office stones in kidney patients and how to form and treat them, Eurasian J Sci Tech. 2 (2021) 384–398.
14. T. Alelign, B. Petros, Kidney stone disease: an update on current concepts, Adv. Urol. 2018 (2018) 3068365.
15. M. Hora, O. Dolejšová, Urology for Medical Students, Charles University in Prague, Karolinum Press, 2021.
16. D. Rodríguez, D.E. Sacco, Minimally invasive surgical treatment for kidney stone disease, Adv. Chronic Kidney Dis. 22 (2015) 266–272.

17. J.E. Lingeman, J.A. McAteer, E. Gnessin, A.P. Evan, Shock wave lithotripsy: advances in technology and technique, Nat. Rev. Urol. 6 (2009) 660–670.
18. R.E. Pacheco, Cystine urolithiasis in ferrets, Vet Clin North Am Exot Anim Pr. 23 (2020) 309–319.
19. W.G. Robertson, Dietary recommendations and treatment of patients with recurrent idiopathic calcium stone disease, Urolithiasis. 44 (2016) 9–26.
20. T. Song, B. Liao, S. Zheng, Q. Wei, Meta-analysis of postoperatively stenting or not in patients underwent ureteroscopic lithotripsy, Urol. Res. 40 (2012) 67–77.
21. R. Bhanot, P. Jones, B. Somani, Minimally invasive surgery for the treatment of ureteric stones–state-of-the-art review, Res. Reports Urol. (2021) 227–236.
22. N. Petrides, S. Ismail, F. Anjum, S. Sriprasad, How to maximize the efficacy of shockwave lithotripsy, Turkish J. Urol. 46 (2020) S19.