

VILNIUS UNIVERSITY

ANDRIUS GAIŽAUSKAS

**THE COMPARATIVE STUDY OF EFFECTIVENESS AND RISK  
FACTORS OF URETEROSCOPY AND EXTRACORPOREAL SHOCK  
WAVE LITHOTRIPSY IN THE UPPER PART OF URETER**

Summary of Doctoral Dissertation

Biomedical sciences, Medicine (06B)

Vilnius, 2015

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VILNIAUS UNIVERSITETAS

ANDRIUS GAIŽAUSKAS

**URETEROSKOPIJOS IR EKSTRAKORPORINĖS LITOTRIPSIJOS  
EFEKTYVUMO BEI RIZIKOS VEIKSNIŲ PALYGINAMASIS  
TYRIMAS ŠALINANT AKMENIS IŠ VIRŠUTINIO ŠLAPIMTAKIO  
TREČDALIO**

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## 1. ABBREVIATIONS, CONCEPTS AND TERMS

ACHI – Australian Classification of Health Interventions

ASA – American Society of Anaesthesiologists physical status classification

AUA – American Urology Association

BMI – body mass index

Ch – (*Charriere gauge*) Unit which expresses the external diameter in mm where: CH N° = ext. diameter in mm. It is equal to 1/3 millimetre (in English-speaking countries it is called *French gauge (Fr)*)

CNS – central nervous system

CROES – The Clinical Research Office of the Endourological society is an official organ within of the Endourological Society responsible for a global organizing, structuring and favouring a global network of endourological research. The CROES was founded during the World Congress on Endourology meeting 2008 in Shanghai and has been operational for more than four years now. The CROES council is composed of a Chairperson and 6 international members (2 American, 2 European and 2 Asian). The operational activities will be located in the office of the chairperson of CROES, whereas headquarters of CROES is located in New York (Endourological Society office)

DRG – diagnosis – related group

EAU – European Association of Urology

EQ – efficiency quotient

ESWL – extracorporeal lithotripsy sometimes also called extracorporeal shock wave lithotripsy

fURS – flexible ureteroscopy

HU – Hounsfield units

“Impacted ureter stone“. This term does not have a strict definition. This collocation describes a stone which has not changed its position in the ureter for at least two months. This definition is used in such cases when, while performing ureteroscopy, it is impossible to move the guidewire or a ureter catheter next to the stone or contrast in the ureter below the stone is invisible on excretory urograms. There is a strong presumption to call cases an “impacted ureter stone“ case when, while performing the ureteroscopy ureter wall,

which has been affected by an inflammation and a turgid mucous where the stone is stuck,  
can be seen

KUB – kidney, ureter, bladder

MET – medical expulsive therapy

ND – no data

PCN – percutaneous nephrostomy

PCNL – percutaneous nephrolithotripsy

PUJ – pyeloureteric junction

SFR – stone free rate

URS – ureteroscopy



## 2. INTRODUCTION

Most commonly used stone removal methods are extracorporeal shock wave lithotripsy and ureteroscopy, and ureterolithotomy in rare cases. According to the literature, actively performing stone removal from the ureter a satisfactory treatment result is achieved when the stone is completely removed from the ureter. However, treatment results vary, depending in which part of the ureter the stone is stuck in. If the stone is being removed from the distal part of the ureter, treatment effect, when performing ureteroscopy is from 93 to 97 per cent and there is only a very small chance of complications. Stone removal from the upper part of the ureter is related to the higher risk for complications. This happens because of the anatomical peculiarities of the ureter and the size of the stone and its position, so the effect of the treatment of this ureter section is lower. The **research problem** of this dissertation is to identify the risk factors which could allow to predict the effectiveness of the ureteroscopic treatment when removing stone from the upper part of the ureter.

### 2.1. Relevance of the study

According to the data provided in the literature, an absolute stone removal can be stated in various periods of time following the treatment: instantly after the operation, one month after the operation, or three months after the operation. It makes the evaluation of treatment effectiveness more complicated.

Also, the term of a stone free status is not precisely defined. Some authors diagnose a stone free status when there are no more signs of the removed stone crystals or small fragments, others call cases stone free when the crystals left are smaller than 1 mm and there are no possibilities to remove them because of their diminutive size. Some literary resources mention that a “stone free“ condition is stated when the stone fragments left in the ureters are not larger than 4 mm. Such promiscuity in treatment conclusions prevents from accurate judgement of the effectiveness of one or another treatment method, so, when a stone relapse is discussed, it is unclear if a new stone has formed in the ureter or it is only an increased fragment of the stone which had not been removed completely before.

All the aspects mentioned before are important when a treatment tactics is being discussed with the patients: the length of the treatment, how likely it is to reach a stone free condition, and what risk for complications remains. In some cases, how much it is

going to cost too. That is why it is very important to identify the risk factors which would help to predict a possibility for successful treatment and possible complications.

Endourological method of stone removal has significantly improved in the two last decades. Nowadays, a wide range of lithotripsy and removal methods is used. The installation of technical novelties into the operational practice helps to achieve positive treatment results and reduce the possibility of complications. If a stone is in the distal and middle part of the ureter, the ureteroscopy is chosen. When removing stones from the upper part of the ureter, it is still recommended to choose extracorporeal lithotripsy.

The aim of the study is to prove that ureteroscopy is a safe treatment procedure which causes a small amount of complications. When performing ureteroscopy in the upper part of the ureter a highly satisfactory result is achieved by completely removing the stone from the ureter if the operation is done in the medical institutions that possess all the equipment needed. So, URS could be the first option treatment choice for removing stones from the upper part of the ureter.

When precisely choosing the treatment method after evaluating the size and position of the stone, a fast and complete removal of the stone is achieved and it is followed by a short hospitalization period. Considering the risk factors, the patient is informed about the possible risks of some complications.

Another aim of the study is to compare the efficiency quotient when two different treatment methods are chosen (ureteroscopy and extracorporeal shock wave lithotripsy) when a stone is detected in the upper part of the ureter and to identify how many additional procedures may be needed to reach a complete stone free condition in the ureter.

## **2.2. Aim of the study**

To evaluate the importance of the preoperative risk rates which allow to predict the result of the treatment and the possible complications, and to compare the effectiveness of ureteroscopy and extracorporeal lithotripsy application.

## **2.3. Objectives**

1. To evaluate the effect of treatment and the frequency of complications when removing stones from the upper part of the ureter when ureteroscopy with a laser lithotripsy is performed.

2. To identify the factors that may cause operational and postoperative complications.
3. To compare the efficiency quotient of ureteroscopy and extracorporeal lithotripsy when the stone is being removed from the upper part of the ureter.
4. To evaluate ureteroscopy and shock wave lithotripsy economical effect.

#### **2.4. Scientific novelty**

Till now, in Lithuania, only a few retrospective and prospective comparative studies comparing the effectiveness of various treatment approaches for removing stones from the ureter have been done. No study that would analyse ureteroscopic stone removal results only from the upper part of the ureter has been conducted so far. In the researches that have been made up to date the treatment effectiveness has never been evaluated by calculating the efficiency quotient of the methods used. The articles that had been published so far do not discuss the risk factors that may influence the treatment results. No economic calculations that would indicate which way of treatment is financially cheaper after introducing service coding system according to ACHI classification in Lithuania had been done.

#### **2.5. Practical significance**

Study results obtained allow to predict the effectiveness of the treatment according to its duration, possible amount of the additional procedures and complication risks when removing stones from the upper part of the ureter.

#### **2.6. Principal statements for defence**

1. Ureteroscopy with laser lithotripsy is an effective and fast way of treatment to completely remove the stone from the upper part of the ureter.
2. When performing ureteroscopy the size of the stone does not influence the final treatment result.
3. The position of the stone in the upper part of the ureter at the level of the 3rd lumbar vertebrae is related to a high possibility for the migration of the stone to the kidney.
4. Patient's gender, age, ASA degree, the fact whether the stone is in the left or in the right ureter have no influence on the complication risks.

5. An “impacted ureter stone“ is a prognostic cause for the ureter stricture in the stone location.
6. Nowadays ureteroscopy for upper part ureter stones is loss-making procedure in Lithuanian hospitals.

### **3. METHODOLOGY**

#### **3.1. Randomization. Planned prospective study**

Patients who were diagnosed with a stone in the upper part of the ureter and who fulfilled selection criteria were introduced with the study and invited to take part in it. They also received answers to all the questions they had. A patient randomization was performed using a generated accidental number sequence. Though, because of the repetitive breakdowns of the lithotripter *Dornier DoLi S*, randomization had to be cancelled. The data about the patients was collected prospectively only about the patients who had ureteroscopy performed on them. For the sake of comparison the second (ESWL) patient group was kept. Data about this group was collected retrospectively.

#### **3.2. Study process**

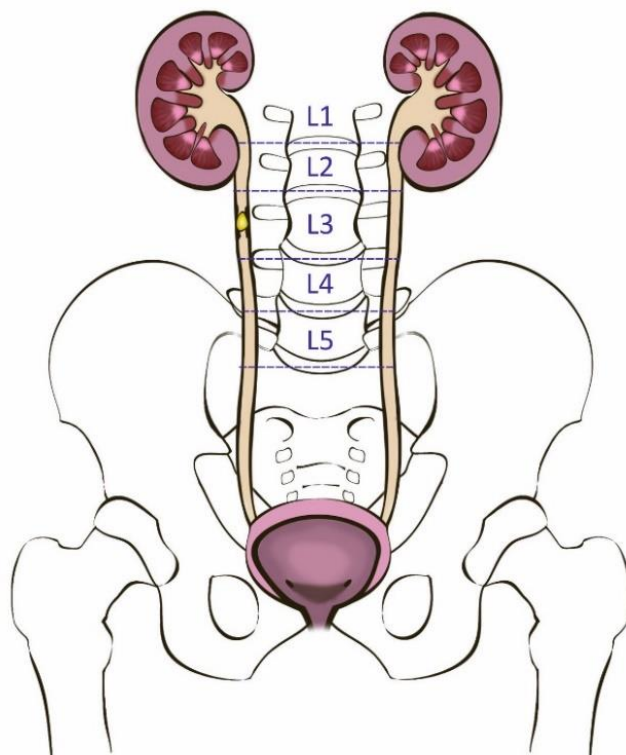
- 3.2.1. After a patient agrees to take part in the study, all the data needed is collected (age, height, weight, body mass index, the rate of creatinine and urea in the blood), ASA class is indicated, a general urine examination and computed tomography, which helps to estimate the size of the stone, its density, and localization in the upper part of the ureter, are done.
- 3.2.2. One of the two stone removal methods is applied: ureteroscopy with laser lithotripsy or extracorporeal shock wave lithotripsy. If the procedure is unsuccessful (the stone is not removed or does not break), the same treatment is repeated later.
- 3.2.3. After the performed treatment patient's condition is assessed, complications that might have occurred registered, and analgesics provided.
- 3.2.4. Two weeks later, by performing sonoscopy and KUB it is evaluated if the stone had been removed from the ureter. If, during the treatment the ureter had been stented, the stent is removed.
- 3.2.5. A month later, it is again evaluated if the stone stayed in the ureter by performing sonoscopy and KUB.
- 3.2.6. Three months later a final assessment of the treatment is delivered if the stone removal in the first month of treatment was unsuccessful.

### 3.3. Definition of the patients studied

These were the patients over 18 years old, who were diagnosed with the stone in the upper part of the ureter and who were treated in Republican Vilnius University hospital and Vilnius University hospital “Santariskiu klinikos“. All the patients which fulfilled the inclusion criteria were invited to take part in the study. All the patients studied signed the informed consent and informed consent agreement form.

### 3.4. Inclusion criteria:

- 3.4.1. Patient's age suitable for the study: the patient should be over 18 years old.
- 3.4.2. Written patient's agreement to take part in the study by signing the informed consent and informed consent agreement form.
- 3.4.3. The diagnosis of one contrastive stone in the upper part of the ureter below the PUJ (it can be seen in the synoptical urogram). The localization of the stone in the upper third of the ureter is defined depending on the fact at which lumbar vertebrae level it is (Figure 1).



*M. Vitkauskienė*

**Figure 1.** The localization of the stone in the upper part of the ureter according to the lumbar vertebrae level.

3.4.4. Radiologically evaluated stone size is 5-20 mm when measuring the largest dimension.

### **3.5. Rejection criteria:**

3.5.1. The age which is not suitable for the study: the patient is younger than 18 years old.

3.5.2. Patient's refusal to take part in the study by not signing the informed consent and informed consent agreement forms.

3.5.3. The patient is suffering from a mental illness.

3.5.4. The patient is pregnant.

3.5.5. Anatomical anomalies of the ureter (e.g. double ureter, ureter strictures, or solitary kidney).

3.5.6. The presence of other localization stones in the same ureter (e.g. trail of residual stone fragments in the ureter, also called "*steinstrasse*").

3.5.7. Uncontrollable hypertension.

3.5.8. Uncontrollable coagulopathy.

3.5.9. The clinic of obstructive pyelonephritis or clinically displayed ureter infection (positive urine culture, patient's fever when the temperature is higher than 38°C).

3.5.10. Any other therapeutic condition which is a contraindication for the endotracheal anaesthesia.

**3.6. Treatment methods.** Two different methods were applied for the stone removal from the upper part of the ureter: ureteroscopy and extracorporeal shock wave lithotripsy.

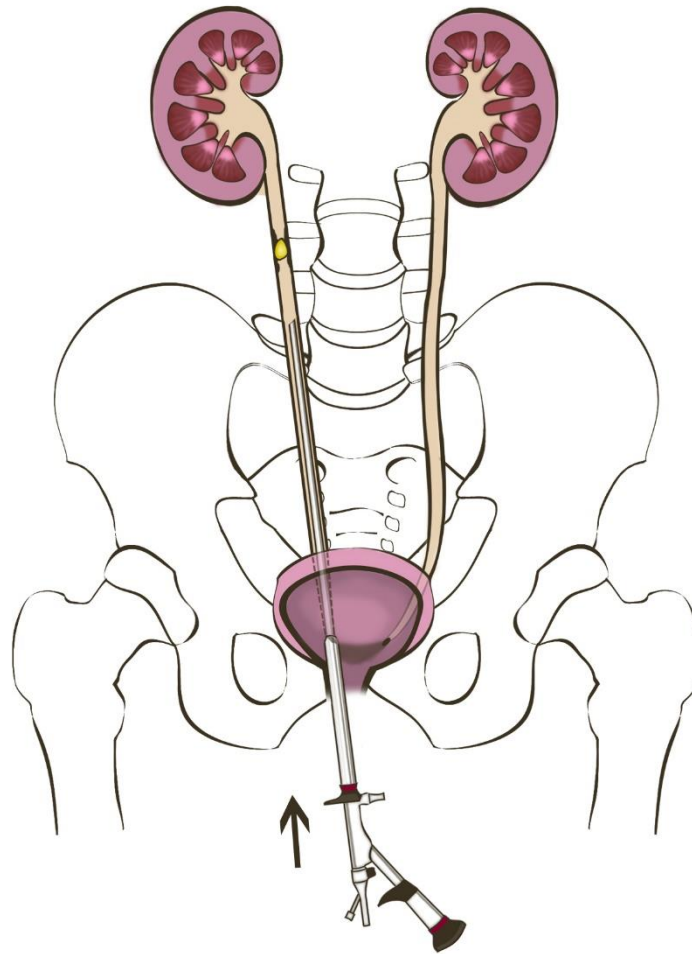
**3.6.1. Ureteroscopy.** The operation is performed by using general anaesthesia when the patient is lying in cystoscopy position. During the introductory narcosis a prophylactic antibiotic therapy is performed to the patient by drip-feeding gentamycine leach (5mg/kg for patient's body mass). To cause the diuresis 20 mg more lasix solution is drip-fed too. The operational field is prepared antiseptically and a synoptical cystoscopy is performed. After examining the bladder and not diagnosing any pathologies or anatomical alterations which might influence the treatment tactics and operation process, to the ureter which contains a stone in its upper part, 5 *Ch* ureter catheter is inserted with

a guidewire which is characterized by having extremely good hydrophilic qualities and having a very soft and elastic distal tip, in this way helping to avoid possible ureter perforations by pushing the guidewire in the ureter towards the collecting system of the kidney. Through the ureter catheter which is in the ureter, the contrastive substance (76% urografin solution) is injected. To obtain the X-ray view a mobile device C-arm is used. The ureter is assessed on X-ray (its opening and flexures), the position of the stone in the ureter is specified. Later, by observing the view in the X-ray monitor, the hydrophilic guidewire is pushed towards the stone, reeved by the stone and moved to the collecting system of the kidney. On the guidewire to the collecting system the ureter catheter is installed. This manipulation is performed by trying not to push the stone from the ureter to the kidney pelvis. When the manipulation is successful, the soft guidewire is removed and through the ureter catheter the “zebra“ guidewire, which is more solid in comparison to the soft guidewire and straightens the ureter more effectively, is installed. Ureter catheter and cystoscope are removed. Active ureter extension methods (balloon dilatation or silicone dilators) were not used. Next to the “zebra“ guidewire 9,8 Ch semirigid ureteroscopy is inserted, which gradually, when the visibility is good and radiological observation is performed, pushes towards the stone. (Figures 2 and 3).



**Figure 2.** 9,8 Ch semirigid ureteroscopy.





*M. Vitkauskiene*

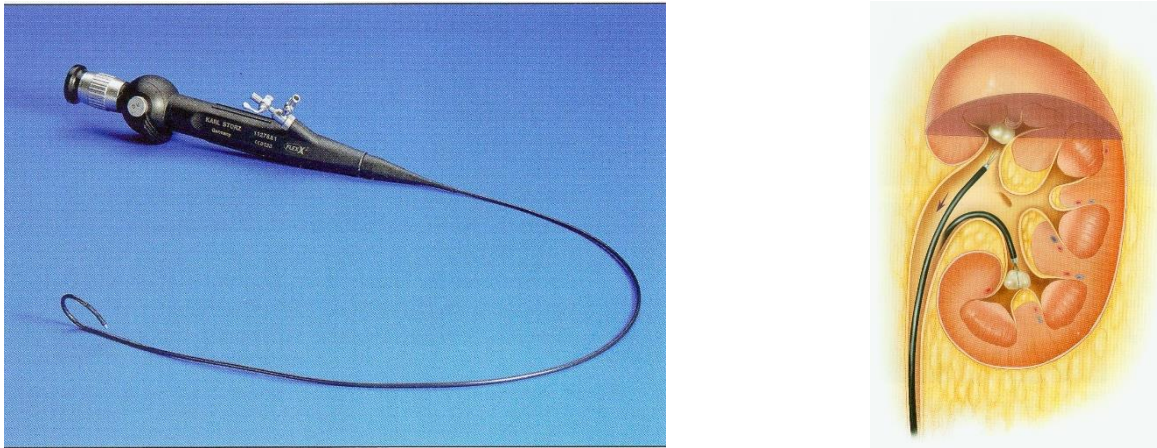
**Figure 3.** The push of the ureteroscope towards the stone located in the upper part of the ureter.

If, during the operational stage it was diagnosed that the ureter is very narrow and the optical instrument which is being pushed towards the stone may cause complications, in such cases the ureteroscope was removed and a 7 Ch Double-J stent was inserted. The operation was repeated later. After pushing the ureteroscope towards the stone, to prevent its migration special baskets which withhold the stone were used.

The disintegration of the stone up to the tiny details was performed by using *Lumenis versa puls Holmium laser* using 5-10-20 W power. Unit of power was not standardized and was chosen taking into consideration the circumstances of the procedure. During the operation, using pincers or baskets, all the fragments of the broken stone were removed. After repeatedly examining the entire ureter and making sure that there are no more stones left, optical instruments were removed. For two week period to all the patients on the guidewire the ureter was being stented with a 28 cm length 7 Ch Double-J stent.

After finishing the operation an 18 Ch Foley catheter was left in the bladder for 12-24 hours.

If, during the ureteroscopy the stone still migrated to the collecting system of the kidney, the semi rigid ureteroscope was removed from the ureter. A dual 12 Ch ureter catheter was inserted on the guidewire, a second guidewire was inserted into the ureter and on one of the guidewires into the ureter 10/12 Ch „access sheath“ was inserted, through which towards the kidney pelvis a flexible ureterorenoscope was inserted. (Figure 4).



**Figure 4.** Flexible ureterorenoscope and its capacity of reaching the stones in the kidney.

When the stone was found in the collecting system of the kidney it was disintegrated with the laser and the fragments were removed by using the basket.

Operations were performed by two urologists who had an experience of more than a hundred ureteroscopies of the upper part of the ureter.

During the operation and the post-operative period a prophylactic antibiotic therapy was applied to the patient (Gentamycin 5 mg/kg/24 hours). The bladder catheter was removed on the first day after the operation. After making sure that there were no serious post-operative complications (fever, severe pain, urine retention) the patient was discharged from the hospital for the ambulatory treatment with a recommendation to use uroseptics (Nitrofurantoin 0,1 g x 2) and analgesics (Diclofenac 0,1 g) in case of pain.

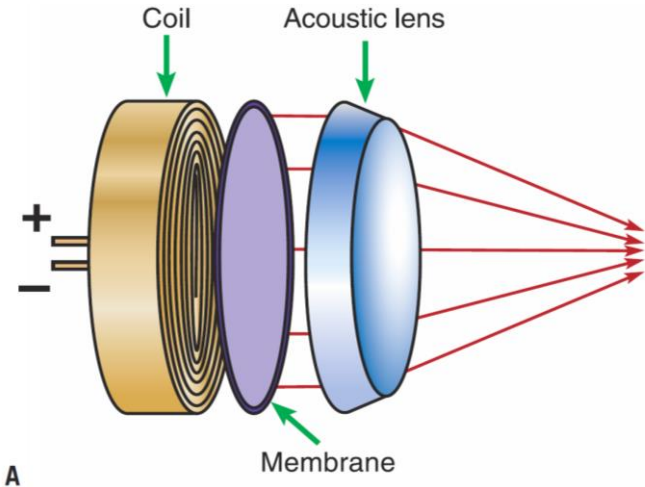
**3.6.2.Extracorporeal shock wave lithotripsy.** This treatment is performed without using general anaesthesia. Before the planned procedure premedication with nonsteroidal anti-inflammatory drugs is performed on the patients. During the lithotripsy session the operator has an opportunity to change the intensity and frequency of the shock

waves, considering the patient's condition. Lithotripsy in the ureter was performed with an electromagnetic *Dornier DoLi S* lithotripter (Figure 5).



**Figure 5.** *Dornier MedTech DoLi S* extracorporeal lithotripter [<http://www.alakamedical.com/>]

In the therapeutical head of the instrument there is an electric coil which, affected by electric voltage instantly charged and discharged creates a magnetic field. The magnetic field striking against the metal panel (membrane) turns into a flat high voltage supersonic wave (shock wave). This wave through an acoustic lens can be focused in a required distance from the therapeutical head towards the stone (Figure 6).



**Figure 6.** Acoustic wave generation and focusing device in the electromagnetic lithotripter.

The patient who is prepared for the procedure is laid on their back. The therapeutical head of the lithotripter is contacted to the patient's lumbar region from the back. The shock wave is focused to the stone with an X-ray device. During the procedure it is stricken to the stone 3000-3500 times in the rate of 100-110 pulses per minute. The intensity of the hits is adjusted considering how the patient is capable of tolerating pain. If there are no serious complications (fever, severe pain) the patient is discharged from the hospital on the next day.

**3.6.3. Ambulatory observation.** For the ureteroscopic patient group another visit is arranged two weeks after the operation to remove the stent. This procedure is performed in ambulatory or day in-patient department conditions and the patient is sent to ambulatory treatment.

Repeated visits are arranged in 1 month and 3 months after treatment to assess patient's condition by performing kidney sonoscopy and KUB. During the urogram it is examined if there are no more residual fragments left in the ureter, on sonoscopy - there is no hydronephrosis, which may have been caused by the stricture of the ureter or residual fragments.

### **3.7. Economic calculations**

In Lithuania a DRG medical service coding system is used, according to which medical institutions are paid for provided treatment services (operations). According to compulsory health insurance fund data given in 2014 September, it can be counted how much money is paid to the medical institutions from the compulsory health insurance fund. Provided service is evaluated in points, which are multiplied by the coefficient which is different to each Lithuanian medical institution and varies from 0,71 to 0,93, so, after calculating the value of the service provided, only a total of points for the patient treated is provided.

### **3.8. Statistical analysis**

Statistical analysis is done by *SPSS (Statistical Package for Social Sciences) Statistics 17.0* and *Excel 2013 (Microsoft Office 2013)*. When writing about the groups of the patients studied absolute and percent values of the categorical variables are provided, whereas averages and standard deviations of interval variables are provided. To distribute interval variables with normal distribution between two independent samples a Student's

t-test was used, meanwhile between two dependent samples paired Student's t-test was used. The difference of categorical variables between two samples was evaluated with Chi-square test. The difference between two samples was reckoned to be statistically significant when  $p < 0,05$ . To indicate the connections between the variables Spearman's correlation coefficient was calculated.

## 4. STUDY RESULTS

### 4.1. Preoperative data.

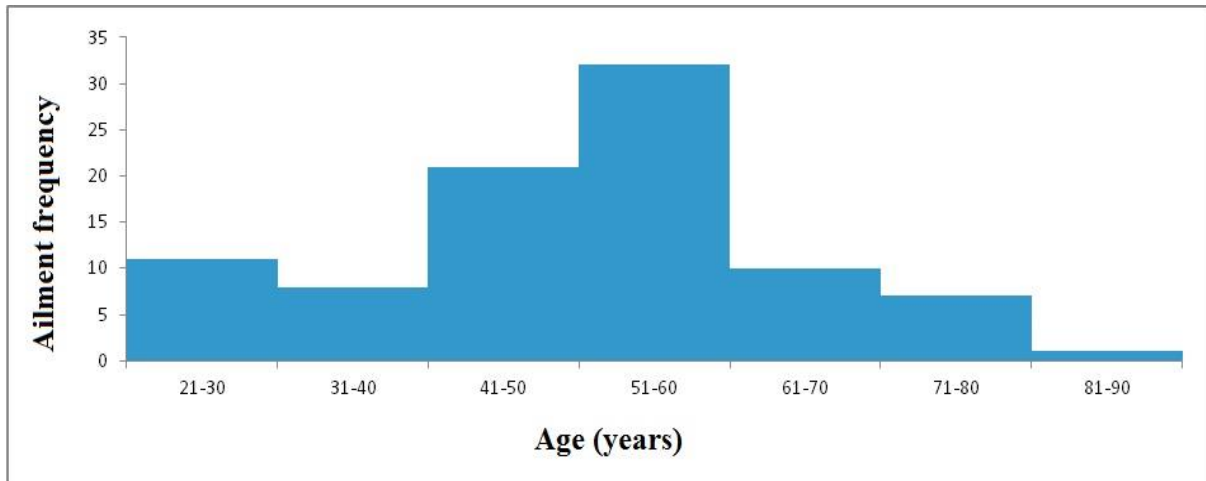
From July 2011 to April 1, 2014 90 patients took part in the study. Forty patients had ureteroscopy performed on them, fifty had the treatment started by performing extracorporeal lithotripsy. All in all 61 (67%) men and 29 (32,2%) women were studied, who were  $50 \pm 13$  years old. Preoperative data about the patients studied is provided in table 1.

**Table 1.** Preoperative data about the patients studied

Patients	URS	ESWL	<i>p</i> value
Age (year)	$50 \pm 15$ (min – 22; max – 77)	$49,8 \pm 11,7$ (min – 25; max - 81)	0,71
Men	25 (62,5 %)	36 (72 %)	0,34
Women	15 (37,5 %)	14 (28 %)	
Right side	17 (42,5 %)	23 (46 %)	0,74
Left side	23 (57,5 %)	27 (54 %)	
BMI	$27,3 \pm 4,7$	$29,5 \pm 5,5$	0,049
Urgent hospitalization	28 (66,6 %)	27 (54 %)	0,12
Scheduled hospitalization	14 (33,3 %)	23 (46 %)	
The size of the stone in largest dimension (mm)	$8,7 \pm 3,0$	$9,5 \pm 2,4$	0,20

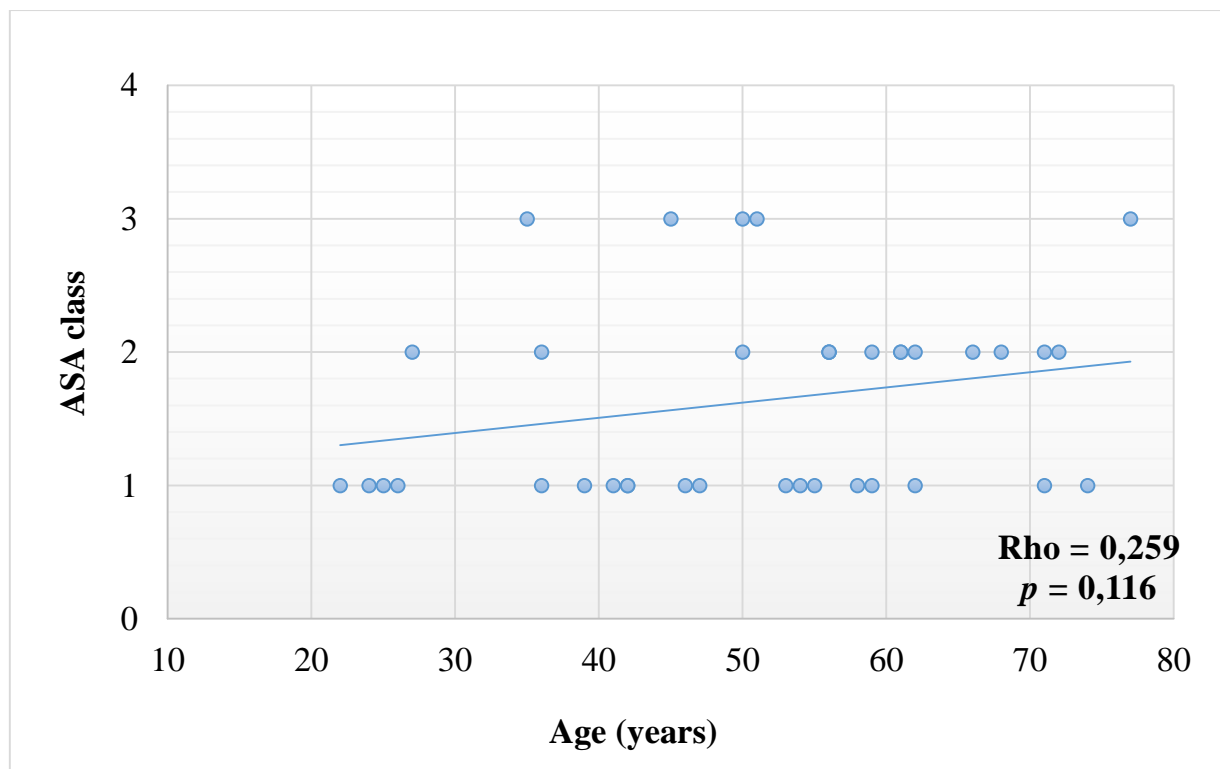
The size of the stone in area (mm <sup>2</sup> )	43,8 ± 29,4	47,9 ± 22,9	0,47
Hounsfield's units (HU)	1218 ± 231	ND	ND
Impacted ureter stone	11 (27,5 %)	ND	ND
Stone location - L2	5 (12,5 %)	10 (20 %)	0,342
Stone location – L3	15 (37,5 %)	28 (56 %)	0,081
Stone location – L4	14 (35 %)	12 (24 %)	0,253
Stone location – L5	6 (15 %)	0 (0%)	0,005
ASA class: 1	19 (47,5 %)	ND	ND
ASA class: 2	16 (40%)	ND	ND
ASA class: 3	5 (12,5%)	ND	ND

The distribution of the ailment rate of both groups of the patients by size is illustrated in the diagram (Figure 7), from which it can be seen that people from 41 to 60 years old most often had stone in the upper third of ureter. These patients are all of employable age.



**Figure 7.** The proportion between patient's age and ailment

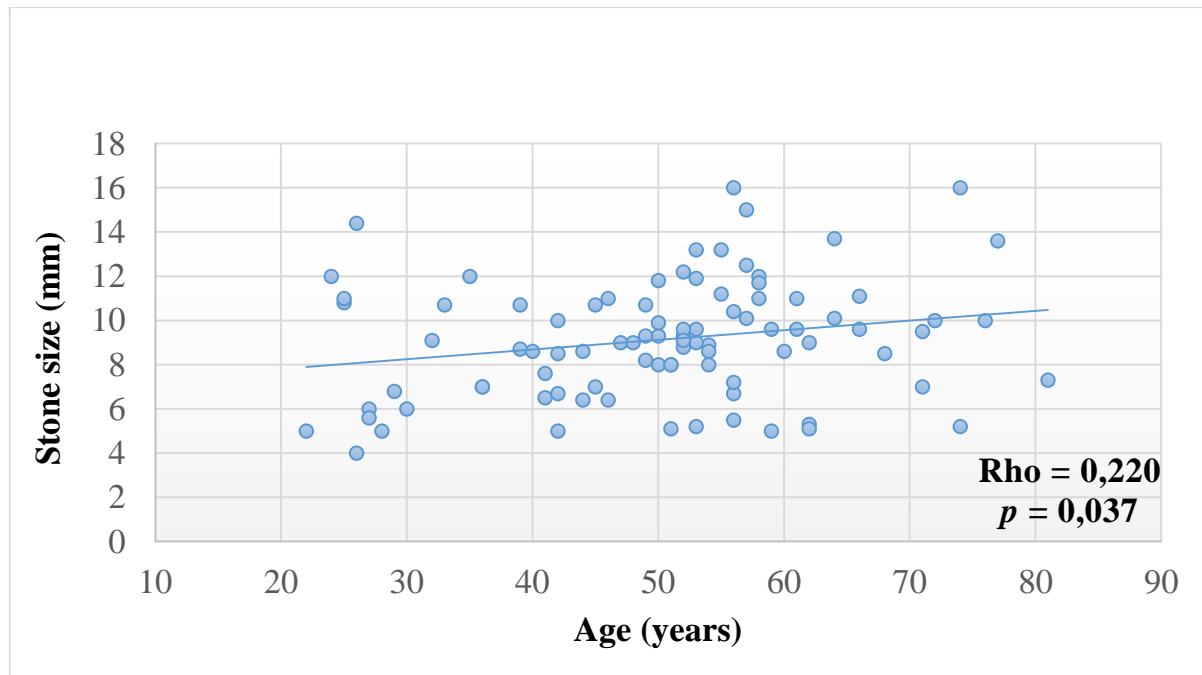
When evaluating the physical condition of patients who had an ureteroscopy in ASA class it was indicated that there was no correlation between patients' age and ASA degree. (Figure 8).



**Figure 8.** The dependence of patients' preoperative condition on their age



In both patient groups studied there is a correlation between their age and the size of the stones. (Figure 9).



**Figure 9.** The dependence of the stone size on the patient’s age

In the male group stones were larger than in the female group, although the difference is not statistically significant. The area of the stones was calculated using this formula:

$$Area (mm^2) = \pi \times \frac{length (mm)}{2} \times \frac{width (mm)}{2} = 0.785 \times length (mm) \times width (mm)$$

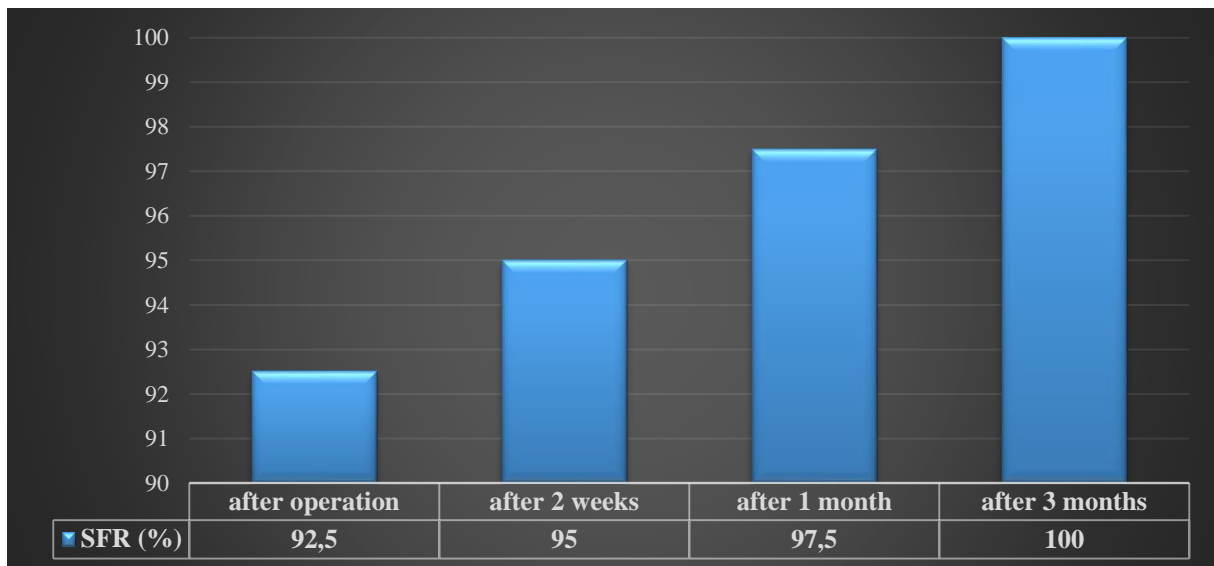
The comparison of the stone sizes is illustrated in *table 2*:

**Table 2.** The comparison of the stone parameters according to the gender

The parameters of the stones	Males	Females	p value
The biggest dimension of the stone (mm)	9,3±2,9	8,8±2,1	0,44
The area of the stone (mm <sup>2</sup> )	49,0±28,8	39,9±17,3	0,067

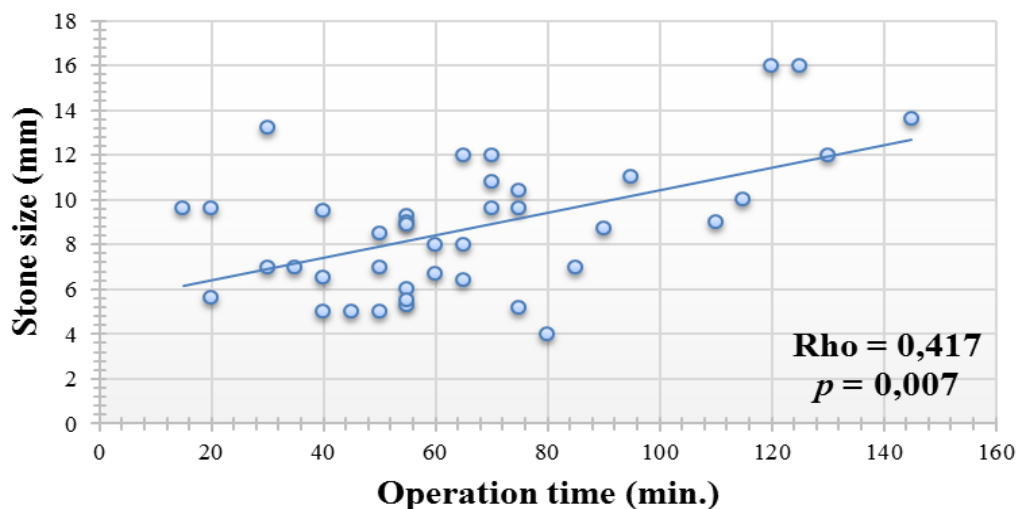
## 4.2. Treatment results after the ureteroscopy

92,5% of the patients studied who had ureteroscopy, had the stone removed completely during the first procedure. In the cases of two patients the stone was not reached and lithotripsy could not be performed. The result of completely removed stones is illustrated in the diagram (Figure 10).



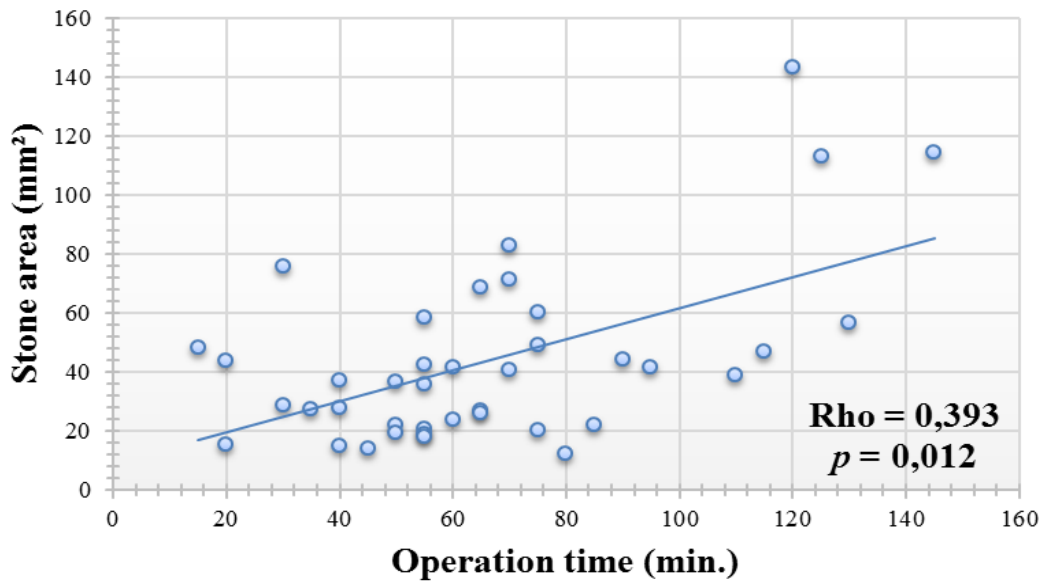
**Figure 10.** The result of completely removed stone after the ureteroscopy

When performing ureteroscopy with laser lithotripsy the duration of the operation was  $64,5 \pm 31,3$  minutes. The dependence of the duration of the operation on the size of the stone is illustrated in the graph (Figure 11).



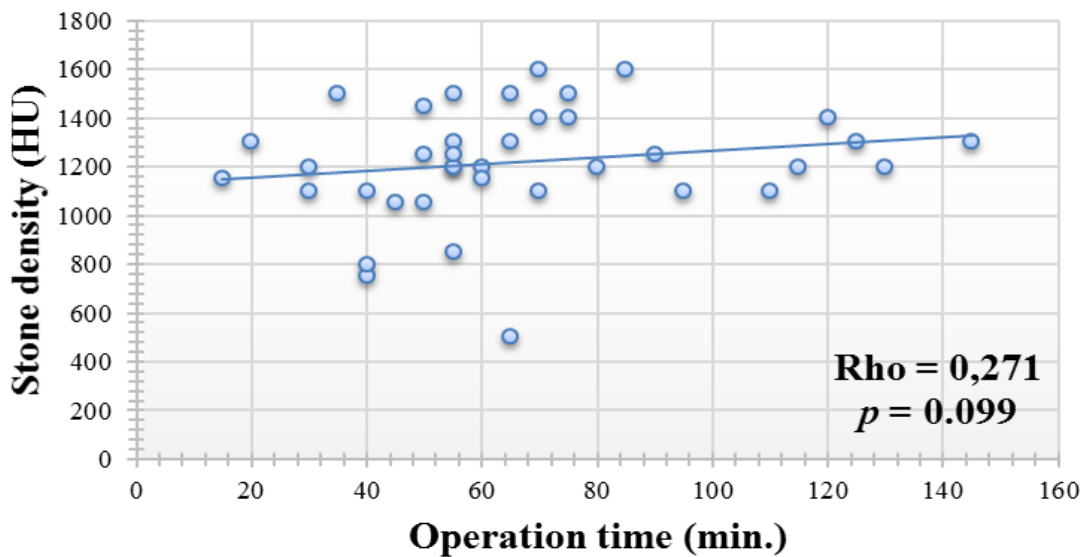
**Figure 11.** The duration of the operation depending on the size of the stone

The same dependence was indicated between the duration of the operation and the area of the stone (Figure 12).



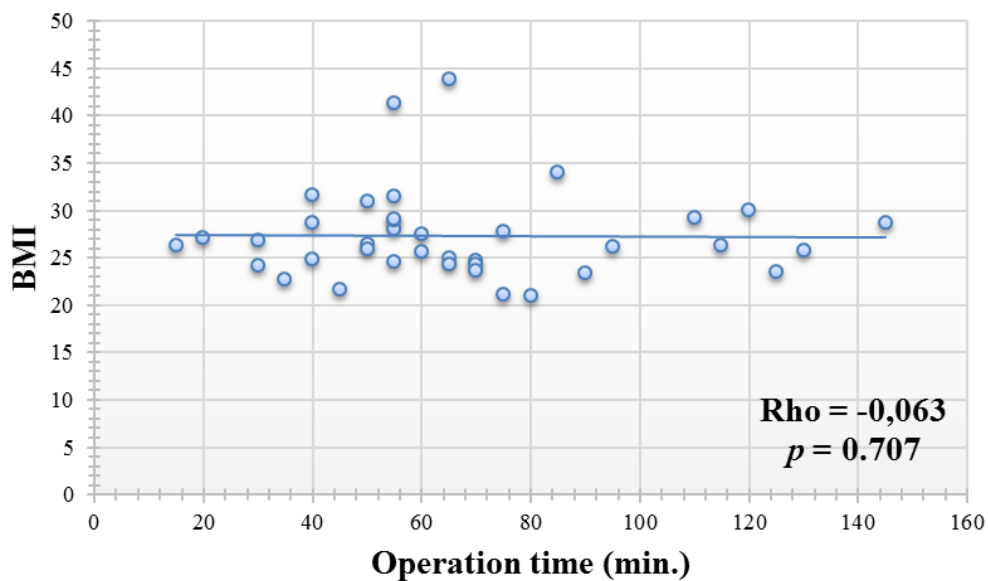
**Figure 12.** The duration of the operation depending on the area of the stone

When performing ureteroscopy with laser lithotripsy the duration of the operations does not depend on the density of the stone (Figure 13).



**Figure 13.** The relation between the duration of the operation and the density of the stone

Patient's body mass index is not a prognostic factor of the duration of the operation (Figure 14).



**Figure 14.** The duration of the operation depending on the body mass index

### 4.3. Failures during the operations

When performing ureteroscopy some difficulties occurred, which prevented from breaking the stone instantly and removing it from the upper part of the ureter using semi rigid 9,8 Ch ureteroscope. The reasons for the failures are summarized in table 3.

**Table 3.** The reasons for ureteroscopy failures and the ways of solving them

The reason for the failure	Amount	Solution
<b>The stone migrated to the kidney</b>	9 (22,5 %)	Flexible pyeloscopy was performed, the stone was removed from the kidney
<b>The stone was not reached:</b>		
Because of a narrow ureter	1 (2,5%)	The ureter stented, URS repeated 5 days later
Because of a big oedema of mucous around the stone	1 (2,5%)	The ureter stented, URS repeated 3 weeks later

For the tall male because of the insufficient length of the semi rigid ureteroscope	1 (2,5%)	Flexible ureteropyeloscopy performed
-------------------------------------------------------------------------------------	----------	--------------------------------------

It should be noted that 7 (77,8 %) stones out of all 9 stones which migrated back to the kidney were at the level of the 3<sup>rd</sup> lumbar vertebrae ( $p = 0,005$ ). One stone was at L4 lumbar vertebrae (11,1 %) ( $p = 0,09$ ), and one more - L5 (11,1 %) ( $p = 0,09$ ).

For three patients the treatment of the stone was unsuccessful because of different reasons. Since one female patient's ureter was narrow, the pushing of the ureteroscope was complicated: it was impossible to push the optical instrument above the level of iliac arteries, a strong resistance of the tissues was also felt. That is why it was decided to finish the operation without removing the stone, whereas the ureter was stented. Five days later the ureter dilated passively because of the stent and the operation was repeated and the stone was successfully removed from ureter. It was possible to reach the stone in other patient's ureter, but an intramural ureter stone was diagnosed with a big oedema of mucous on the wall of the ureter. The stone was hardly visible and the contact lithotripsy with a laser not applicable, so the operation was finished, the ureter was stented and the patient had an anti-inflammatory treatment for three weeks. Three weeks later the ureteroscopy was performed repeatedly and the stone was successfully removed from the ureter. For the third male patient who was 188 cm tall it was not possible to reach the stone in the ureter, because the semi rigid ureteroscope was too short (45 cm). That is why during the same operation an access sheath and an ureteropyeloscope were inserted into the ureter. The stone was disintegrated and removed.

In nine cases, when the stone which was in the ureter migrated back to the kidney, the ureteropyeloscopy and the disintegration of the stone with a laser in the kidney were performed, and the fragments removed, later the ureter was stented. Eight patients to whom the stone migrated from the ureter back to the kidney were treated in the in-patient department as a matter of urgency and only in one patient's case the stone migrated back to the kidney when a scheduled operation was performed. The calculated  $p\ value = 0.11$  showed, that the fact that patients were moved to the in-patient department as a matter of urgency is not a prognostic factor causing the migration of the stone.

#### 4.4. Complications of ureteroscopies

After performing 42 ureteroscopies for forty patients studied, seven patients had complications. The frequency of various complications was 16,7%. Different patients had seven complications: five men and two women ( $p = 0,59$ ). In five cases in the left ureter and in two cases in the right ureter ( $p = 0,41$ ). The nature of the complications and their frequency are illustrated in table 4.

**Table 4.** The frequency of the complications of the ureteroscopies

The nature of the complication	Amount (%)
Perforation	3 (7,1)
The irritation of the stent	1 (2,4)
Stricture	3 (7.1)
Fever	0
Sepsis	0
Deaths	0

The differentiation of the complications studied according to modified Clavien complication scale is illustrated in table 5.

**Table 5.** The complications of the ureteroscopies according to modified Clavien classification scale

The degree of the complication	Amount
I°	3
II°	0
IIIa°	1
IIIb° „,d“	3
IVa°	0
IVb°	0
V	0

During three operations after removing stones from the ureter and injecting contrastive substance on X-ray the extravasation of the contrast behind the ureter to the soft tissues could be seen. Such finding was approached as perforation, even if the defect of the ureter wall was not visible. Almost after all ureteroscopies ureter was stented, so other additional manipulations because of the perforation of the ureter were not performed.

In one patient's case after a successful operation during the first few postoperative days stent irritation symptoms occurred (severe pain in the lower part of the abdomen, dysuria, persistent pains despite analgesics and spasmolytics prescribed), so on the second postoperative day the stent was removed and the patient recovered.

For three patients during the late postoperative period (1 and 3 months later) when performing control echoscopies ureterohydronephrosis were diagnosed. Three months later, when performing intravenous urograms or retrograde pyelography ureter strictures were diagnosed to them. One patient had a stricture of the middle part of the ureter diagnosed at the level of iliac vessels, which probably occurred because of the ureteroscopy. This patient had an ureteroscopy, the stricture was dilated and the ureter was stented. Later, after removing stent when performing control echoscopies, hydronephrosis did not occur and the patient recovered. Two patients had strictures diagnosed in the same area where the stone was situated. During the retrograde pyelography ureters that were completely overgrown because of the stricture were diagnosed, so the endoscopic dilatation of the strictures of the ureter was not doable. The patients were operated by performing ureter resection and forming anastomosis "end to end". Both patients had "impacted ureter stones" removed ( $p = 0,02$ ), so it is thought that the reason for the stricture was the inflammation in the area where the stone was situated, which led to developing scar tissue.

There were no fever, sepsis, or death cases in the group of the patients studied. No complications related to ASA class were recorded. Out of seven patients who had complications the first ASA class was diagnosed to four of them and the second ASA class was diagnosed to three patients.

After calculating by *chi square test* and evaluating the relation between the age of the patients studied and the frequency of complications, it can be stated that age is not a risk factor for complications (table 6).

**Table 6.** The frequency of complications according to the age groups

Age group	Amount	<i>p</i> value
21-30	1	0,95
41-50	2	0,53
51-60	2	0,81
71-80	2	0,27

#### 4.5. Efficiency quotient of ureteroscopy

When removing stones from the upper part of the ureter the efficiency quotient of ureteroscopy (EQ) was calculated using this formula:

$$EQ = \frac{\text{Complete stone removal (\%)}}{100 + \text{repeated operations (\%)} + \text{additional procedures (\%)}}$$

or

$$EQ = \frac{\text{Completely removed stones}}{\text{primary operations} + \text{repeated operations} + \text{additional procedures}}$$

When calculating in a different period after operation the effectiveness coefficient was calculated:

$$EQ(\text{after operation}) = \frac{92,5\%}{100 + 0\% + 25\% + 95\%} = \frac{92,5\%}{220\%} = 0,42$$

$$EQ(\text{after 2 weeks}) = \frac{95\%}{100 + 2,5\% + 25\% + 97,5\%} = \frac{95\%}{225\%} = 0,43$$

$$EQ(\text{after 1 month}) = \frac{97,5\%}{100 + 5\% + 25\% + 100\%} = \frac{97,5\%}{230\%} = 0,42$$

$$EQ(\text{after 3 months}) = \frac{100\%}{100 + 5\% + 25\% + 100\%} = \frac{100\%}{230\%} = 0,43$$



Or

$$EQ(\text{after operation}) = \frac{37 \text{ stones removed}}{40 \text{ URS} + 10 \text{ fURS} + 38 \text{ stent removals}} = \frac{92,5\%}{220\%} = 0,42$$

$$EQ(\text{after 2 weeks}) = \frac{38 \text{ stones removed}}{40 \text{ URS} + 10 \text{ fURS} + 1 \text{ URS} + 39 \text{ stent removals}} = \frac{95\%}{225\%} = 0,43$$

$$EQ(\text{after 1 month}) = \frac{39 \text{ stones removed}}{40 \text{ URS} + 10 \text{ fURS} + 2 \text{ URS} + 40 \text{ stent removals}} = \frac{97,5\%}{230\%} = 0,42$$

$$EQ(\text{after 3 months}) = \frac{40 \text{ stones removed}}{40 \text{ URS} + 10 \text{ fURS} + 2 \text{ URS} + 40 \text{ stent removals}} = \frac{100\%}{230\%} = 0,43$$

#### 4.6. Results of extracorporeal shock wave lithotripsy

The results of successful treatment of 92 extracorporeal lithotripsy for 50 patients are given in table 7.

**Table 7.** Results of extracorporeal shock wave lithotripsy

ESWL	Patients treated	Stone free rate
After first ESWL session	50	10 (20%)
After second ESWL session	28	14 (28%)
After third ESWL session	12	15 (30%)
After fourth ESWL session	2	15 (30%)

It should be noted that fourteen patients who had ESWL when the stone did not break after the second session, repeated ESWLs were not successful neither after the third, nor after the fourth lithotripsy session.

Patients who had unsuccessful ESWLs, had other stone removal methods performed on them (table 8).

**Table 8.** Additional intervention treatment procedures

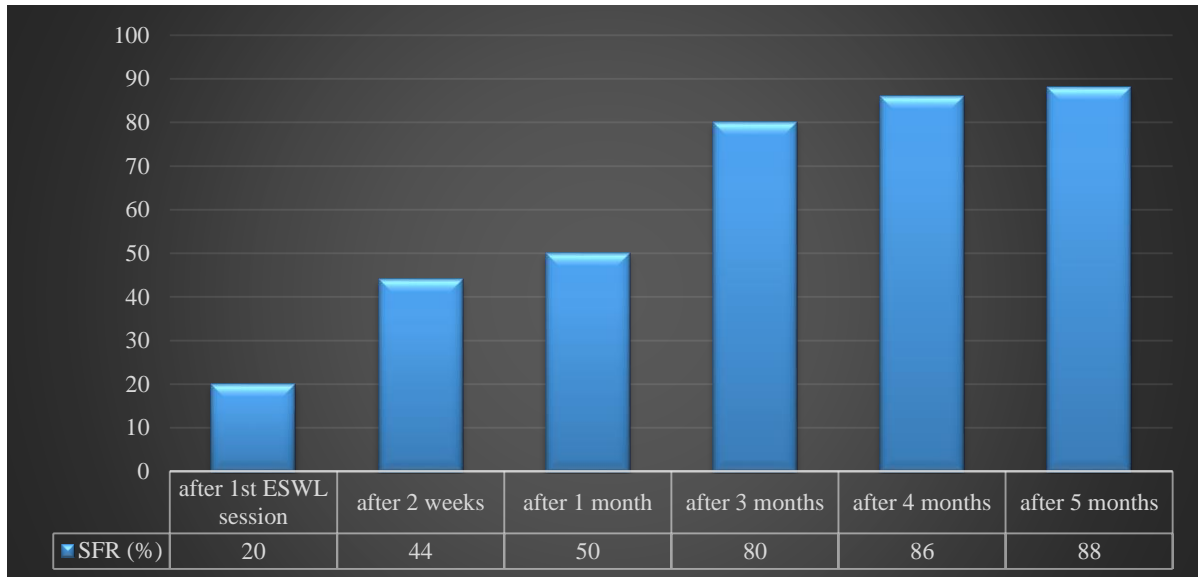
Operation	Number of patients
Ureteroscopy	35
Repeated ureteroscopy	4
Flexible ureteropyeloscopy	4
Percutaneous nephrolithotripsy	1
Stenting	52
Percutaneous nephrostomy	1

So, in the extracorporeal lithotripsy group all in all 185 treatment procedures were performed.

Overall stone removal result when performing extracorporeal lithotripsy in such cases when it was not effective and other treatment methods were used is given in table 9 and in the diagram (Figure 11).

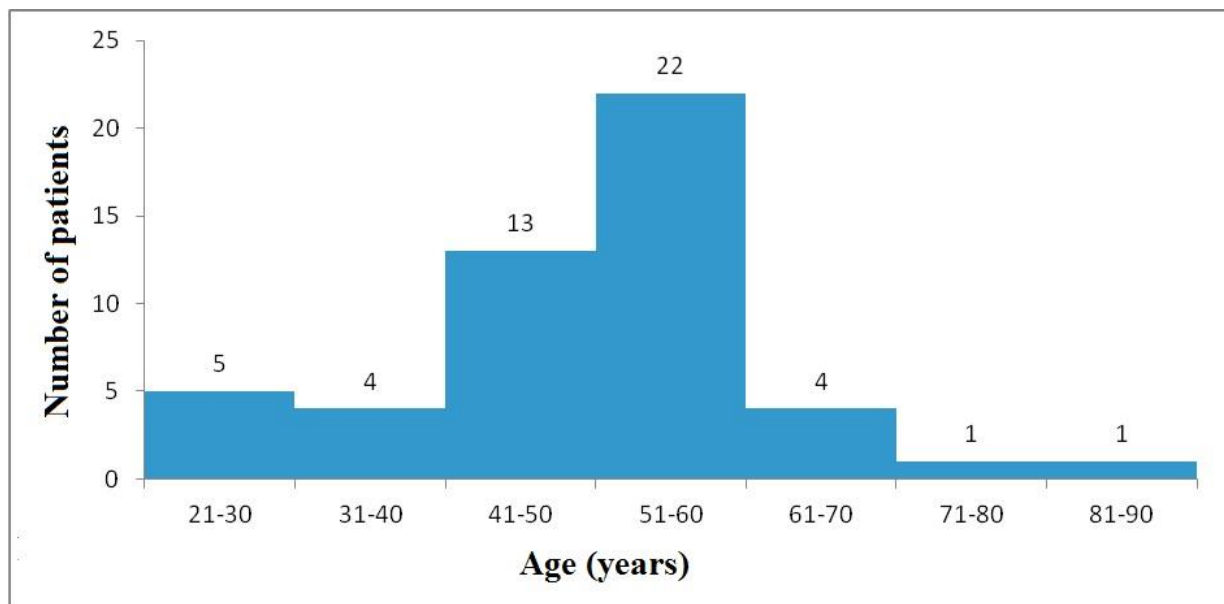
**Table 9.** Results of extracorporeal lithotripsy according to the length of treatment

Length of treatment	Number of patients treated	SFR (%)
After first ESWL session	10	20
After 2 weeks	22	44
After 1 month	25	50
After 3 months	40	80
After 4 months	43	86
After 5 months	44	88



**Figure 11.** Results of extracorporeal shock wave lithotripsy according to the length of treatment

When evaluating the speed of stone removal a questions occurs, whether the patient's treatment does not take too long to get the stone removed from the ureter. In this group of patients studied 88 % patients treated were up to 60 year-old (Figure 12). These are all patients of employable age and during the treatment they could not be one hundred per cent employable. Only 50 % of patients were treated completely after 1 month.



**Figure 12.** The distribution of patients according to their age in extracorporeal lithotripsy group

#### 4.7. Complications of extracorporeal lithotripsy

Complications in the group of patients whose treatment started by using extracorporeal lithotripsy are given in table 10. Overall number of complications makes up 10%, but these complications occurred after ureteroscopies performed when extracorporeal lithotripsies were unsuccessful.

**Table 10.** Complications in ESWL group

The nature of complication	Amount (%)
<b>Pyelonephritis</b>	1 (2%)
<b>Sepsis</b>	1 (2%)
<b>Perforation</b>	2 (4%)
<b>Asystole</b>	1 (2%)
<b>Death</b>	0

#### 4.8. Efficiency quotient of extracorporeal shock wave lithotripsy

ESWL EQ was calculated using the same formula as calculating URS EQ:

$$EQ(\text{after the procedure}) = \frac{10 \text{ stones removed}}{50 \text{ ESWL} + 14 \text{ stenting} + 1 \text{ PCN}} = \frac{10}{65} = 0,15$$

$$EQ(\text{after 2 weeks}) = \frac{22 \text{ stones removed}}{50 \text{ ESWL} + 23 \text{ ESWL} + 1 \text{ fURS} + 12 \text{ URS} + 27 \text{ stenting} + 1 \text{ PCN}} = \frac{22}{114} = 0,19$$

$$EQ(\text{after 1 month}) = \frac{25 \text{ stones removed}}{50 \text{ ESWL} + 25 \text{ ESWL} + 2 \text{ fURS} + 18 \text{ URS} + 33 \text{ stenting} + 1 \text{ PCN}} = \frac{25}{129} = 0,19$$

$$EQ(\text{after 3 months}) = \frac{40 \text{ stones removed}}{50 \text{ ESWL} + 42 \text{ ESWL} + 2 \text{ fURS} + 33 \text{ URS} + 48 \text{ stent} + 1 \text{ PCN} + 1 \text{ PCNL}} = \frac{40}{177} = 0,23$$

$$EQ(\text{after 4 months}) = \frac{43 \text{ stones removed}}{50 \text{ ESWL} + 42 \text{ ESWL} + 4 \text{ fURS} + 35 \text{ URS} + 52 \text{ stent} + 1 \text{ PCN} + 1 \text{ PCNL}} = \frac{43}{185} = 0,23$$

$$EQ(\text{after 5 months}) = \frac{44 \text{ stones removed}}{50 \text{ ESWL} + 42 \text{ ESWL} + 4 \text{ fURS} + 35 \text{ URS} + 52 \text{ stent} + 1 \text{ PCN} + 1 \text{ PCNL}} = \frac{44}{185} = 0,24$$

Patients who had ureteroscopy were treated in the hospital longer. However, postoperative hospital were not different in both groups studied (table 11).

**Table 11.** Hospital stay

Hospital stay	URS (days)	ESWL (days)	<i>p</i> value
Overall	5,0 ± 2,0	3,2 ± 2,8	< 0,05
Postoperative	2,4 ± 1,0	2,2 ± 2,3	0,56

#### 4.9. Economical effectiveness of ureteroscopy and extracorporeal lithotripsy

In Lithuania a DRG medical service coding system has been used for two years already, according to which medical institutions are paid for provided treatment services (operations). According to compulsory health insurance fund data given in 2014 September, it can be counted how much money is paid to the medical institutions from the compulsory health insurance fund. In the group studied, in which the patients had a stone removed from the upper part of the ureter by performing ureteroscopy, the sum of points calculated is given in table 12.

**Table 12.** The number of procedures and the points paid in the ureteroscopy group

Operation	Number of operations	Points for treatment
Ureteroscopy and flexible ureteropyeloscopy with lithotripsy (± stenting)	40	1331
Repeated ureteroscopy with lithotripsy (± stenting)	2	1331
Stent removal	38	151

In this group for the treatment of one patient approximately 1541 points were paid from the compulsory health insurance fund.

In another group of patients studied, where to remove the stone from the upper part of the ureter extracorporeal shock wave lithotripsy was started to be used, the payment in points from the compulsory health insurance fund for the procedures performed is given in table 13.

**Table 13.** The number of procedures and the points paid in ESWL group

Operation name	Number of operations	Points for operation
Initial ESWL	50	1539
Repeated ESWLs	42	1539
Ureteroscopy + lithotripsy ( $\pm$ stenting)	35	1331
Ureteropyeloscopy + lithotripsy ( $\pm$ stenting)	4	1331
Stent removal	33	151
Percutaneous nephrolithotripsy	1	3243

In this group for the treatment of one patient approximately 4034 points were paid from the compulsory health insurance fund.

## **5. SUMMATION OF RESULTS**

Ureteroscopy and extracorporeal lithotripsy are two main methods which are recommended to perform when removing stones from the ureter. Other operations (laparoscopic or open ureterolithotomy, antegrade ureteroscopy) are used only in such case, when ESWL and URS were unsuccessful.

According to literary resources, the effectiveness of both treatment methods may reach 80-90 %, but in literature this index is given in different postoperative periods and the treatment result itself is evaluated differently. In the articles published the content of the definition of a stone free rate (SFR) is approached differently. Some studies provide positive treatment result when the residual fragments of the stone are smaller than 4 mm, so it is difficult to evaluate the real success result in time and quality aspect.

To acquire an objective evaluation, during the study done treatment results were registered at different periods after the lithotripsy, while treatment is evaluated as successful only when the fragments of the stone that can be seen during the operation are smaller than 1 mm when examining on X-ray, any residual fragments are not found neither in the kidney, nor in the ureter. It may be considered that a definition of a stone free rate means that there are no residual fragments, which could be removed by using the basket and pincers, left in the ureter.

All the aspects mentioned here are important when discussing treatment possibilities with a patient seeking to remove the stone from the ureter as effectively as possible. After all, final decision which treatment method to choose is made by the patient.

### **5.1. Preoperative data**

Although the initial data of both patient groups studied was gathered differently, when summarizing it (considering person's age, gender, stone size and its localization) no radical differences were noticed, the comparison of the treatment results of these groups is correct. It should be noticed that stones in the male group were larger (the difference is not solid statistically). According to the literary sources, it is the opposite, larger stones are diagnosed for women: it is related to female's physiological and anatomic peculiarities because of which female's ureter is wider, so larger stones get stuck in it.

In both groups 80% of all patients studied were of an employable age – up to 60 years old. Overall proportion of men and women was 2:1. In the ureteroscopy group a

number of patients who were treated in the in-patient department in emergency cases was two times higher than the number of patients that had planned procedures. Study results showed small relation between the stone size and patients' age. In the ureteroscopy group no correlation between the patients' operated age and their ASA class was indicated.

## **5.2. Comparison of ureteroscopy and extracorporeal lithotripsy treatment results**

After comparing the treatment result after the first procedure it can be stated that ureteroscopy is much more effective than extracorporeal lithotripsy. After performing ureteroscopy a result of successful treatment was 92,5%. It is more than four times effective when comparing with extracorporeal lithotripsy, which had a successful treatment result of only 20%. After performing a repeated extracorporeal lithotripsy session to 28 patients out of 40 who were not cured during the first session, the successful treatment result increased up to 28%. 12 more patients had a third extracorporeal lithotripsy session repeated, while two patients had a fourth session, but this did not improve the effectiveness of treatment, which was 30%. The statement mentioned in the literary resources that, when the first and the second extracorporeal lithotripsy sessions are not effective, repeated lithotripsies are not purposeful because they are not going to be effective, was confirmed.

After unsuccessful attempt to remove the stone by using extracorporeal lithotripsy, ureteroscopy was performed. Treatment result after performing additional intervention procedures was evaluated after 2 weeks, after 1 month and after 3 months and was accordingly 44%, 50% and 80%. In the group of patients who had only ureteroscopy, during the same period of time the effectiveness of treatment was 95%, 97,5% and 100%. So, a conclusion that ureteroscopy is superior to extracorporeal lithotripsy when evaluating effectiveness of treatment after 2 weeks, after 1 month and after 3 months, can be made. It is considered that this parameter is very important, because it allows the patient to decide themselves how fast they want to be cured. 80% out of all patients were up to 60 years old. These are patients of employable age and they want to come back to work as soon as possible. The comparison of treatment effectiveness according to the length when applying different treatment methods is given in table 14.



**Table 14.** The results of a complete stone removal in both groups

Treatment method	2 weeks	1 month	3 months	4 months	5 months
<b>ESWL</b>	44%	50%	80%	86%	88%
<b>URS</b>	95%	97,5%	100%	100%	100%

During the treatment it was indicated that the size of a stone is a prognostic factor of the ureteroscopy with laser lithotripsy regardless the fact whether the size of the stone was evaluated by the highest dimension or its area. From the approach of the density of the stone the study has shown that its chemical composition and solidity do not influence the length of the operation, because the laser is capable of breaking a stone of any composition. The body mass index of the patient treated, as the study results show, did not affect the length of the operation.

### **5.3. Comparison of ureteroscopy and extracorporeal lithotripsy efficiency quotient**

The effectiveness of treatment can be evaluated by calculating efficiency quotient. It reflects the effect of treatment more accurately, because when calculating it the number of repeated and additional treatment procedures performed was taken into consideration. After calculating the efficiency quotient it is accurate that the ureteroscopy EQ is two times higher comparing it to extracorporeal shock wave lithotripsy EQ (table 15).

**Table 15.** Efficiency quotient in both groups

Treatment method	EQ result		
	After 2 weeks	After 1 month	After 3 months
<b>Ureteroscopy</b>	0,43	0,42	0,43
<b>Extracorporeal lithotripsy</b>	0,19	0,2	0,23

Literary resources state that the effectiveness of these treatment methods could be even higher and reach 0,61 up to 0,94. According to the data of the research done in the ureteroscopy group despite the fast and effective stone removal it only reached 0,43. The

low coefficient was determined by the fact that 38 patients (95 % cases), who had ureteroscopy, at the end of procedure, regardless of the process of the operation (duration and intraoperative difficulties) had their ureter stented. It is an additional manipulation. Moreover, in such cases when during the operation the stone migrated to the kidney (22,5 % of cases) and flexible ureteropyeloscopy and lithotripsy were performed when removing the stone that had migrated from the kidney, which was also considered as an additional procedure. However, in the previously mentioned literary review it is stated that stenting or stent removal had not been included into calculations of effectiveness coefficient, so in this aspect the accuracy of the calculation causes serious doubts.

In the last decade it has been actively discussed if stenting of the ureter is needed if the ureteroscopy is not complicated. According to the recommendations provided, this procedure is not necessary if:

- ureteroscopy and laser lithotripsy are not complicated,
- diagnostic ureteroscopy is performed,
- the ureter is not dilated actively.

Stenting is necessary to avoid the formation of strictures if:

- the ureter was injured,
- there is a ureter mucous oedema,
- ureter biopsy was performed,
- tumour removal is performed,
- the incision and dilatation of the stricture are performed,
- there is a heavily dilated collecting system,
- if the stone is not removed completely or the ureteroscopy is unsuccessful.

Seeking to maximally reduce the number of possible complications (fever, renal colic, ureter strictures) it was decided to stent ureters of all the patients who had ureteroscopy.

#### **5.4. Failures during ureteroscopies.**

Regardless of the fact whether a stone withholding basket was used or not, in 22,5% of the patient cases stone migrated from the ureter to the kidney. 78% of the stones that migrated were at the level of the 3<sup>rd</sup> lumbar vertebrae ( $p = 0.005$ ). Thus, it is a prognostic factor for the process of the operation. Yet before the operation the operating urologist who sees that the stone may migrate should stress the necessity of the use of a flexible

ureterorenoscope and other instruments needed, so that the stone was completely removed after one operation.

### **5.5. Complications of ureteroscopies.**

There were few complications in the group of the patients treated ureteroscopically. For three patients (7,5 %), evaluating according to the modified Clavien complication scale, IIIb<sup>o</sup>“d” complication was diagnosed. They were operated because of the ureter strictures that evolved. Three patients had I<sup>o</sup> complication diagnosed: the perforation of the ureter during the operation. For one patient because of an appearance of a very intensive stent irritation stent had to be removed at the second postoperative day.

For two patients who were operated because of ureter strictures, impacted ureter stones were diagnosed during the ureteroscopies. When evaluating an overall number of such stones (11 stones – 27,5 %), out of which in two cases (18 %) strictures formed there is some base to think that an impacted ureter stone is a prognostic factor for a possible development of a ureter stricture. Moreover, this hypothesis is also proved by a fact that in recommendations for ureter stone treatment published in 2007, where the complications of ureteroscopy and extracorporeal lithotripsy are compared, it is stated that a number of strictures developed in the upper part of the ureter is similar and reaches 2 %. There is some base to think that the reason for the stricture is not the nature of the procedure, but the inflammation process developing in the location of the stone. It is very important to state that for the three patients mentioned above strictures were diagnosed three months after treatment, when patients came for a control check-up. In all three cases the patients were asymptomatic, they did not have any complaints, side pains, because of the fact that the narrowing of the opening was happening very slowly not causing any symptoms of severe renal colic. Attention should be paid to the fact that in such cases when the patient has an impacted ureter stone diagnosed, it is necessary to do control kidney sonoscopy even three months after the stone removal.

It is important to mention that in the patient group who had ureteroscopy, no fever and urosepsis cases occurred during the postoperative period. This result first of all was reached because the ureteroscopy was performed on the patients who did not have clinically expressed urinary tract infection and because during the treatment period they had an antibiotic therapy applied. All the patients who had a stone diagnosed in the upper

part of the ureter and who had a clinics of obstructive pyelonephritis were stented. Ureteroscopy was performed later when there were no more symptoms of infection left.

### **5.6. Extracorporeal lithotripsy shock wave complications**

For those patients who had their treatment started by using extracorporeal lithotripsy did not have any significant complications after the first treatment session. Overall number of complications in this groups studied was 10% yet later when patients were treated with additional intervention treatment procedures when removing the stone from the ureter.

### **5.7. Economic effectiveness of ureteroscopy and extracorporeal lithotripsy**

One of the most important facts that was found during the study when comparing both treatment methods is their different economic effectiveness. Since 2012 in Lithuania a DRG medical service coding system has been used, according to which medical institutions are paid for provided treatment services. In this service payment system there is a high inadequacy between the price of the services and disposable surgical equipment, which is acquired by medical institutions during the public procurement, prices. Even when counting only the prices of the disposable equipment used during the ureteroscopies, the payment from the compulsory health insurance fund is more than 2,5 times smaller, not even summing other parameters, such as the price of a hospital stay, price of anaesthesia, staff work, medicine, and the use of multiplex surgical equipment. So, despite of a very high effectiveness of this way of treatment and quick patient recovery, ureteroscopy is detrimental to Lithuanian medical institutions because of the payment which is too small.

## **6. CONCLUSIONS**

1. Comparing with extracorporeal lithotripsy, ureteroscopy with a laser lithotripsy is a more effective and quicker treatment method when seeking to reach a stone free rate in the upper part of the ureter.
2. When performing ureteroscopy with a laser lithotripsy the size of the stone does not influence the treatment results.
3. The localization of the stone at the level of the 3<sup>rd</sup> lumbar vertebrae is related to its high possibility of migrating to the kidney, so, seeking to completely remove the stone after one operation, it is necessary to prepare a more complex surgical equipment in advance.
4. Study results allow to state that, when performing ureteroscopy patient's age, gender, ASA degree, the fact whether the stone is in the left or in the right ureter, do not influence complication risks.
5. An impacted ureter stone is a prognostic factor of the ureter stricture in the stone location.
6. Ureteroscopy single use devices are more expensive than the payment for ureteroscopy and flexible ureteropyeloscopy from the compulsory health insurance fund in Lithuania nowadays.

## **7. PRACTICAL RECOMMENDATIONS**

1. When the stone is at the level of the 3<sup>rd</sup> lumbar vertebrae it is expedient to be ready to perform a flexible ureterorenoscopy if the stone migrated to the kidney.
2. When the installation of the optical instrument towards the stone is complicated because of an anatomically narrow opening of the ureter, it is expedient to finish the procedure, stent the ureter and repeat the operation later.
3. It is purposeful to have a control consultation of the patient who had an ureteroscopy by performing kidney sonoscopy even if there are no symptoms, because, if they had an intramural ureter stone diagnosed, a possibility of formation of the ureter stricture remains.

4. The payment for ureteroscopy and flexible ureteropyeloscopy from the compulsory health insurance fund which exists now is detrimental to Lithuanian medical institutions so, the tariffs of the procedures and operations should be reconsidered and corrected.
5. According to literature and ureteroscopy execution rules, which were determined in this study, it is recommended to perform ureteroscopy only when the urinary tract infection is cured, because it may cause pyelonephritis and urosepsis after the operation. Even if the urine is sterile before the operation, it is purposeful to use a preventive antibiotic therapy both during the operation and after it.

## **8. ARTICLES ON THE DISSERTATION TOPIC**

1. The Choice of the Ureter Stone Treatment Tactics. Literature Review. – Andrius Gaižauskas, Feliksas Jankevičius. Medical Theory and Practice. 2013. T-20 No. 3 (p. 256-267).
2. Age-related Prevalence of Diabetes Mellitus, Cardiovascular Disease and Anticoagulation Therapy Use in a Urolithiasis Population and Their Effect on Outcomes: the Clinical Research Office of the Endourology Society Ureteroscopy Global Study. – F.Pedro J Daels, Gaizauskas A. Rioja J, Varshney AK, Erkan E, Ozgok Y, Melekos M, de la Rosette JJet al. World Journal of Urology 2014 Aug 26. [Epub ahead of print].
3. Possible Complications of Ureteroscopy in Modern Endourological Era: Two Point or Scabbard Avulsion. – Andrius Gaizauskas, Marius Markevicius, Sergejus Gaizauskas, Arunas Zelvys. Case Rep Urol. 2014;2014:308093. doi: 10.1155/2014/308093. Epub 2014 Dec 28.

## 9. CURRICULUM VITAE

### PERSONAL INFORMATION

Name	GAIZAUSKAS ANDRIUS
Address	EISISKIU SODU 17-OJI, 25, LT-02194, Vilnius, Lithuania
Telephone	Mobile: (+370) 685 36280
E-mail	gaizauskas@yahoo.com
Nationality	Lithuanian
Date of birth	16 <sup>th</sup> of March, 1977

### WORK EXPERIENCE

- Dates July 2007 onwards
- Name and address of employer Department of Urology, Republican Vilnius University Hospital  
Siltnamiu 29, LT-04130 Vilnius.
- Occupation or position held Doctor Urologist
- Main activities and responsibilities Diagnosis and treatment of wide range of urological disorders mainly stone disease and BPH, urological surgery (incl. open surgery, TUR, ureteroscopy, RIRS, PCNL, holmium laser surgery (HoLEP))
  
- Dates March 2008 onwards
- Name and address of employer Medical Diagnostic and Treatment Center  
V. Grybo str. 32/10, LT-10318 Vilnius, Lithuania
- Occupation or position held Doctor Urologist
- Main activities and responsibilities Diagnosis and treatment of wide range of urological disorders

- Dates September 2002 – June 2007
- Name and address of employer
  - Department of General surgery, Vilnius University
  - Emergency Hospital
  - Siltnamiu 29, LT-04130 Vilnius.
- Occupation or position held
  - Medical doctor, surgeon's assistant
- Main activities and responsibilities
    - Surgeon's assistant on duty
  
- Dates November 2001 – May 2002
- Name and address of employer
  - Department of General surgery and traumatology, Zarasai Hospital,
  - Maluno 2, LT-32129, Zarasai
- Occupation or position held
  - Medical doctor, surgeon's assistant
- Main activities and responsibilities
    - Surgeon's assistant in department of General surgery and traumatology.
  
- Dates July 1999 – October 2001
- Name and address of employer
  - Department of traumatology, Children's Hospital at Vilnius University, Santariskiu 7, LT-08406, Vilnius
- Occupation or position held
  - Nurse
- Main activities and responsibilities
    - Nurse on duty in traumatology department
  
- Dates July 1997 – May 2001
- Name and address of employer
  - Operating theater
- Occupation or position held
  - Operating theater nurse assistant
- Main activities and responsibilities
    - Nurse assistant on duty



## EDUCATION AND TRAINING

- Dates October 2010 onwards
- Name and type of organisation providing education and training Vilnius University, Universiteto 3, LT-01513, Vilnius, Lithuania
- Principal subjects/occupational skills covered Postgraduate study
- Title of qualification awarded
  
- Dates August 2002-July 2007
- Name and type of organisation providing education and training Vilnius University, Universiteto 3, LT-01513, Vilnius, Lithuania
- Principal subjects/occupational skills covered Urology Residency
- Title of qualification awarded Doctor Urologist from 2007 July
  
- Dates August 2001-July 2002
- Name and type of organisation providing education and training Vilnius University, Universiteto 3, LT-01513, Vilnius, Lithuania
- Principal subjects/occupational skills covered General Medicine Residency
- Title of qualification awarded M.D.
  
- Dates September 1995-July 2001

- Name and type of organisation providing education and training Vilnius University, Universiteto 3, LT-01513, Vilnius, Lithuania
- Principal subjects/occupational skills covered Studies in Medicine Faculty
- Title of qualification awarded M.D.

### ADDITIONAL INFORMATION

- PUBLICATIONS**
- The Choice of the Ureter Stone Treatment Tactics. Literature Review. – Andrius Gaizauskas, Feliksas Jankevicius. Medical Theory and Practice. 2013. T-20 No. 3 (p. 256-267).
  - Age-related Prevalence of Diabetes Mellitus, Cardiovascular Disease and Anticoagulation Therapy Use in a Urolithiasis Population and Their Effect on Outcomes: the Clinical Research Office of the Endourology Society Ureteroscopy Global Study. – F.Pedro J Daels, Gaizauskas A. Rioja J, Varshney AK, Erkan E, Ozgok Y, Melekos M, de la Rosette JJet al. World Journal of Urology 2014 Aug 26. [Epub ahead of print].
  - Possible Complications of Ureteroscopy in Modern Endourological Era: Two Point or Scabbard Avulsion. – Andrius Gaizauskas, Marius Markevicius, Sergejus Gaizauskas, Arunas Zelvys. Case Rep Urol. 2014;2014:308093. doi: 10.1155/2014/308093. Epub 2014 Dec 28.
  - Gaizauskas A., Gaizauskas S. “Endoscopic recanalisation after accidental complete tear of urethra: case report”. Lietuvos chirurgija 2007, 5(4) p. 540-544
  - Sukys D, Gaizauskas S, Jankovski R, Gaizauskas A. Stankevičius E. Transrectal Ultrasound-guided prostate biopsies. Lietuvos chirurgija. 2005, 3(4), p. 262–265

## PUBLICATIONS

- Gaizauskas S, Gaizauskas A, Sukys D, Jankovski R. Failures, technical difficulties and complications in the treatment of the upper urinary tract stones (10 years of experience). Lietuvos chirurgija. 2005, 3(4), p. 293–298.
- A.Gaizauskas, D.Sukys "Treatment of benign hyperplasia of prostate". "Gydytojo žurnalas" 2004, Nr.3, p.46-50;
- A.Gaizauskas, D.Sukys "Prostatitis". "Gydytojo žurnalas" 2005, Nr.5(13) p. 43-47;
- A.Gaizauskas "Carcinoma of prostate". "Gydytojo žurnalas" 2006, Nr.5

## COURSES AND CONFERENCES

- Observership in Urology and Endourology in General Hospital Vienna – Department of Urology. Vienna, Austria, 2014.
- 2<sup>nd</sup> meeting of EAU section of urolithiasis (EULIS). 2013, September 5-7. Copenhagen, Denmark.
- 31<sup>st</sup> World Congress of Endourology, New Orleans, USA 2013.
- Practical course on Dornier Compact Sigma extracorporeal shock wave lithotripter. Torun, Poland, 2011.
- Practical course on PCNL and flexible ureteropyeloscopy. Patras, Greece, 2011.
- 29<sup>th</sup> World Congress of Endourology, Kyoto, Japan 2011
- Salzburg Medical Seminar. Urology. 1<sup>st</sup> place award for case presentation. 2010, Salzburg, Austria, 2010.
- 27<sup>th</sup> World Congress of Endourology, Munich, Germany 2009.
- 6<sup>th</sup> Baltic Conference of Urology and ESU Baltic States Course, Druskininkai, Lithuania 2009
- Salzburg Medical Seminar. Urology-2009, Salzburg, Austria, 2009.
- Laser surgery in urology workshops, London, UK 2008.
- 2<sup>nd</sup> North Eastern European EAU meeting, Vilnius, Lithuania 2008.
- Courses of laser surgery in urology, Ulm, Germany 2007.
- Laser surgery in urology workshops, Berlin, Germany 2007.
- European Urology Residents Education Program - 4<sup>th</sup> course in preparation for the EBU examination, Prague 2006.

- COURSES AND CONFERENCES**
- 24<sup>th</sup> World Congress of Endourology, Cleveland, USA 2006.
  - Urological laparoscopic workshop, Brussels, Belgium 2005.
  - Urological laparoscopic workshop, Bydgoszcz, Poland 2005.
  - 3<sup>rd</sup> Baltic Conference of Urology and ESU Baltic States Course, Vilnius, Lithuania 2003.

**PERSONAL SKILLS AND COMPETENCES**

**MOTHER TONGUE** Lithuanian

**OTHER LANGUAGES**

• Language	English	Russian
• Reading skills	Excellent	Excellent
• Writing skills	Good	Good
• Verbal skills	Excellent	Excellent

**OTHER SKILLS AND COMPETENCES**

European Association of Urology active member since 2007.

Lithuanian Society of Urologists member since 2004.

Society of endourology member since 2006.

Holmium User Group member since 2008.

**10. REZIUMÉ**

**Sutrupinimai, sąvokos ir terminai**

ACHI – Australijos medicininių intervencijų klasifikacija

ASA – ligonio fizinės būklės klasifikacija pagal Amerikos anesteziologų asociaciją

Ch – (*Charriere gauge*) plonų vamzdelių spindžio matavimo vienetas, kuris lygus 1/3 milimetro (angliškai kalbančiose šalyse vadinamas *French gauge (Fr)*)

DRG – giminingų diagnozių grupė (*diagnosis – related group*)

EK – efektyvumo koeficientas

EKLT – ekstrakorporinė litotripsija, kartais dar vadinama ekstrakorporine smūginių bangų litotripsija (*extracorporeal shock wave lithotripsy – ESWL*)

„Įsikalęs akmuo“ – ši sąvoka neturi griežto apibrėžimo. Tokiu žodžių junginiu apibūdinamas akmuo, kuris mažiausiai du mėnesius nepakeitė savo lokalizacijos šlapimtakyje. Sąvoka vartojama tais atvejais, kai, atliekant ureteroskopiją, šalia akmens negalima prastumti stygos arba ureterkateterio arba kai po atliktų ekskrecinių urogramų šlapimtakyje žemiau akmens nematome kontrasto. Būtų pagrindo manyti, kad „įsikalusių akmeniu“ galima vadinti atvejus, kai ureteroskopijos metu matoma uždegimiškai pakitusi šlapimtakio sienelė bei paburkusi gleivinė toje vietoje, kur yra įstrigęs akmuo.

KMI – kūno masės indeksas

SFR – visiškas akmens pašalinimas (*stone free rate*)

URS – ureteroskopija.

## **Įvadas**

Dažniausiai taikomi akmens šalinimo iš šlapimtakio būdai yra ekstrakorporinė litotripsija ir ureteroskopija, retais atvejais - ureterolitotomija. Literatūros duomenimis, aktyviai šalinant akmenis iš šlapimtakio pasiekiamas geras gydymo rezultatas, kai akmuo yra visiškai pašalinamas iš šlapimo takų. Tačiau gydymo rezultatai skiriasi atsižvelgiant į tai, kurioje šlapimtakio dalyje akmuo yra įstrigęs. Jei akmuo yra šalinamas iš apatinio šlapimtakio trečdalyje, gydymo efektas, atliekant ureteroskopiją, siekia nuo 93 iki 97 procentų ir yra labai maža įvairių komplikacijų tikimybė. Akmenų šalinimas iš viršutinio šlapimtakio trečdalyje susijęs su didesne komplikacijų rizika. Taip atsitinka dėl anatominių šlapimtakio ypatumų, akmens dydžio ir jo padėties, todėl šio šlapimtakio segmento gydymo efektas yra mažesnis.

Šios disertacijos **tiriamoji problema** yra nustatyti rizikos veiksnius, kurie leistų prognozuoti ureteroskopinio gydymo šalinant akmenį iš viršutinio šlapimtakio trečdalyje efektyvumą.

## **Darbo aktualumas**

Literatūroje pateikiamų tyrimų duomenimis, visiškas akmens pašalinimas konstatuojamas įvairiu laikotarpiu po gydymo: iškart po operacijos, praėjus vienam mėnesiui po operacijos ir praėjus trimis mėnesiams po operacijos. Tai sunkina gydymo efektyvumo vertinimą.

Be to nėra tiksliai apibrėžta visiško akmens pašalinimo (*stone free*) sąvoka. Vieni visiška akmens pašalinimo faktą konstatuoja tuomet, kai visiškai nėra šalinamo akmens kristalų ar smulkių dalelių, kiti autoriai sąvoka „stone free“ apibrėžia atvejus, kai yra likę smulkesni nei 1 mm dydžio akmens kristalai, kurių nėra galimybės pašalinti, nes jie yra per smulkūs. Dar kituose literatūros šaltiniuose kalbama apie „stone free“, kai šlapimo takuose likę akmens fragmentai yra ne didesni nei 4 mm. Toks nevienodumas, esantis tyrimų išvadose, neleidžia tiksliai spręsti apie vienokio ar kitokio gydymo metodo efektyvumą, todėl, kai yra diskutuojama apie akmenligės recidyvavimą, lieka neaišku, ar tai yra šlapimo takuose susiformavęs naujas akmuo, ar tiesiog padidėjęs nevisiškai pašalinto akmens fragmentas.

Visi ankščiau paminėti aspektai yra svarbūs, kai su ligoniu aptariama galima gydymo taktika: kiek užtruks gydymas, kokia visiško akmens pašalinimo tikimybė, koks komplikacijų pavojus. Kai kuriais atvejais – kiek tai kainuoja. Todėl labai svarbu nustatyti rizikos faktorius, kurie leistų kuo tiksliau numatyti sėkmingo gydymo tikimybę ir galimas komplikacijas.

Endourologinė akmenų šalinimo metodika smarkiai ištobulėjo per pastaruosius du dešimtmečius. Šiuo metu taikomos pačios įvairiausios akmenų skaldymo ir šalinimo metodikos. Technikos naujovių įdiegimas operacinėje praktikoje leidžia pasiekti gerų gydymo rezultatų bei sumažinti komplikacijų tikimybę. Jei akmuo yra apatiniame ir viduriniame šlapimtakio trečdalyje, pasirenkama ureteroskopija. Šalinant akmenis, esančius viršutiniame šlapimtakio trečdalyje, iki šiol labiau rekomenduojama ekstrakorporinė litotripsija.

Atlikto tyrimo tikslas yra įrodyti, kad ureteroskopija yra saugi gydymo procedūra, sukianti mažai komplikacijų. Atliekant ureteroskopiją viršutiniame šlapimtakio trečdalyje pasiekiamas puikus gydymo rezultatas visiškai pašalinant akmenį iš šlapimo takų, jeigu operacija atliekama centruose, turinčiuose visą reikiamą įrangą. Todėl URS galėtų būti pirmo pasirinkimo gydymo metodika šalinant akmenis iš viršutinio šlapimtakio trečdalyje.

Tiksliai pasirenkant gydymo taktiką, įvertinus akmens dydį ir lokalizaciją pasiekiamas greitas ir visiškas akmens pašalinimas, trumpa ligonio hospitalizacija.

Atsižvelgiant į rizikos veiksnius, pacientas informuojamas apie galimą tam tikrų komplikacijų pavojų.

Kitas tyrimo tikslas yra palyginti efektyvumo koeficientą, kai pasirenkamos dvi skirtingos gydymo metodikos (ureteroskopija ar ekstrakorporinė litotripsija) esant akmeniui viršutiniame šlapimtakio trečdalyje ir nustatyti, kiek papildomų procedūrų gali reikėti norint visiškai pašalinti akmenį iš šlapimtakio.

### **Darbo tikslas**

Įvertinti priešoperacinių rizikos rodiklių, leidžiančių prognozuoti gydymo rezultatą ir galimų komplikacijų tikimybę, svarbą, palyginti ureteroskopijos ir ekstrakorporinės litotripsijos taikymo efektyvumą.

### **Darbo uždaviniai**

Įvertinti gydymo efektą ir komplikacijų dažnį šalinant akmenis iš šlapimtakio viršutinio trečdalyje kai atliekama ureteroskopija su lazerine litotripsija. Nustatyti veiksnius galinčius sukelti intraoperacines ir pooperacines komplikacijas. Palyginti ureteroskopijos ir ekstrakorporinės litotripsijos efektyvumo koeficientą, kai akmuo šalinamas iš viršutinio šlapimtakio trečdalyje. Įvertinti ureteroskopijos ir ekstrakorporinės litotripsijos ekonominį efektą.

### **Darbo naujumas**

Iki šiol Lietuvoje yra atlikta tikrai keletas palyginamųjų retrospektyvinių ir prospektyvinių tyrimų, vertinančių įvairių gydymo būdų efektyvumą šalinant akmenis iš šlapimtakio. Tačiau nėra atlikta nei vieno prospektyvinio tyrimo, kuris analizuotų ureteroskopinio akmenų šalinimo rezultatus tikrai iš viršutinio šlapimtakio trečdalyje. Iki šiol atliktuose tyrimuose nebuvo vertinamas gydymo efektyvumas apskaičiuojant taikomos metodikos efektyvumo koeficientą. Publikuotuose straipsniuose nėra kalbama apie rizikos veiksnius, galinčius turėti įtakos gydymo rezultatams. Nėra atlikta ekonominių skaičiavimų, kuris gydymo būdas yra ekonomiškai pigesnis Lietuvoje įvedus paslaugų kodavimo sistemą pagal ACHI klasifikaciją.

## **Praktinė reikšmė**

Gauti atlikto tyrimo rezultatai leidžia prognozuoti gydymo efektyvumą atsižvelgiant į gydymo trukmę, galimų papildomų procedūrų kiekį bei komplikacijų riziką šalinant akmenis iš viršutinio šlapimtakio trečdalyje.

## **Ginamieji disertacijos teiginiai**

1. Ureteroskopija su lazerine litotripsija yra efektyvus ir greitas gydymo būdas visiškai pašalinant akmenį iš viršutinio šlapimtakio trečdalyje.
2. Atliekant ureteroskopiją akmens dydis neįtakoja galutinio gydymo rezultato.
3. Akmens lokalizacija viršutiniame šlapimtakio trečdalyje L3 slankstelio projekcijoje yra susijusi su didele akmens migravimo tikimybe.
4. Paciento lytis, amžius, ASA laipsnis, akmens buvimas kairiajame ar dešiniajame šlapimtakyje neįtakoja komplikacijų rizikos.
5. „Įsikalęs akmuo“ šlapimtakyje yra prognostinis šlapimtakio striktūros akmens buvimo vietoje veiksnys.
6. Šiuo metu akmenų šalinimas iš viršutinio šlapimtakio trečdalyje atliekant ureteroskopiją yra nuostolingas Lietuvos gydymo įstaigoms.

## **Darbo metodologija**

Tiriami buvo ligoniai nuo 18 metų, kuriems buvo nustatytas šlapimtakio viršutinio trečdalyje akmuo ir kurie buvo gydomi Respublikinėje Vilniaus universitetinėje ligoninėje ir VUL „Santariškių klinikos“. Tyrime dalyvauti kviešti visi ligoniai, atitinkantys įtraukimo kriterijus. Visi tiriamieji pacientai pasirašė asmens informavimo ir informuoto asmens sutikimo formą. Buvo atliekama pacientų randomizacija naudojant sugeneruotą atsitiktinių skaičių seką. Tačiau dėl dažnai besikartojančių *Dornier DoLi S* litotriptoriaus gedimų, randomizacijos teko atsisakyti. Prospektyviai surinkti tik tų pacientų duomenys, kuriems buvo atliekama ureteroskopija. Palyginimui palikta antroji (EKLT) pacientų grupė, kurios duomenys surinkti retrospektyviai. Pacientui sutikus dalyvauti tyrime, surenkami reikalingi duomenys (amžius, lytis, ūgis, svoris, kūno masės indeksas, kreatinino ir šlapalo rodikliai kraujyje), nustatoma ASA klasė, atliekamas bendras šlapimo tyrimas bei kompiuterinė tomografija, kurios metu nustatomas akmens dydis, tankis,



lokalizacija viršutiniame šlapimtakio trečdalyje. Taikomas vienas iš dviejų akmenų šalinimo būdų – ureteroskopija su akmenų skaldymu lazeriu arba ekstrakorporinė litotripsija. Jei procedūra nesėkminga (akmuo nepašalintas arba nesuskilo), tas pats gydymo būdas kartojamas vėliau. Po atlikto gydymo įvertinama ligonio būklė, registruojamos galimos atsiradusios komplikacijos, suvartoti analgetikai. Po 2 savaičių atliekant echoskopiją ir apžvalginę urogramą įvertinama, ar akmuo iš šlapimtakio pašalintas. Jei gydymo metu šlapimtakis buvo stentuotas, stentas šalinamas. Praėjus 1 mėn. po gydymo atliekant echoskopiją bei apžvalginę urogramą, dar kartą įvertinama, ar akmuo liko šlapimtakyje. Po 3-jų mėn. galutinis gydymo įvertinimas tuo atveju, jeigu akmenų šalinimas per pirmą gydymo mėnesį buvo nesėkmingas. Ekonominiai skaičiavimai buvo atliekami remiantis 2014 metų rugsėjo mėnesio privalomojo sveikatos draudimo fondo pateiktais įkainiais. Paskaičiuota, kiek gydymo įstaigoms sumokama iš privalomojo sveikatos draudimo fondo. Atlikta paslauga vertinama balais, dauginamais iš koeficiento, kuris kiekvienai Lietuvos gydymo įstaigai yra skirtingas ir svyruoja nuo 0,71 iki 0,93, todėl apskaičiavus suteiktos paslaugos vertę, pateikiama tik balų suma už išgydytą pacientą. Statistinė analizė atlikta statistikos programų paketu *SPSS Statistics 17.0* (angl. *Statistical Package for Social Sciences*) ir *Excel 2013* (*Microsoft office 2013*). Aprašant tiriamųjų pacientų grupes pateiktos kategorinių kintamųjų absoliučios ir procentinės vertės, o intervalinių kintamųjų - vidurkiai ir standartiniai nuokrypiai. Intervalinių kintamųjų su normaliuoju skirstiniu skirtumui tarp dviejų nepriklausomų imčių įvertinti naudotas *Studento t testas*, o tarp priklausomų imčių – poruotų duomenų *Studento t testas*. Kategorinių kintamųjų skirtumas tarp dviejų imčių įvertintas *Chi kvadrato testu*. Skirtumas tarp dviejų imčių laikytas statistiškai reikšmingu, kai  $p < 0,05$ . Ryšiams tarp kintamųjų nustatyti apskaičiuotas *Spearmano koreliacijos koeficientas*.

## **Tyrimo rezultatai**

Nuo 2011 metų liepos mėnesio iki 2014 metų balandžio 1 dienos tyrime dalyvavo 90 pacientų. Keturiasdešimčiai pacientų atlikta ureteroskopija, penkiasdešimčiai gydymas pradėtas atliekant ekstrakorporinę litotripsiją. Iš viso tirta 61 (67%) vyras ir 29 (32,2%) moterys, kurių amžius  $50 \pm 13$ . Vertinant abiejų tiriamųjų grupių pacientų sirgimo dažnio pasiskirstymą pagal amžių matyti, kad dažniausiai šlapimtakio viršutinio trečdalyje akmenlige sirgo asmenys nuo 41 iki 60 metų. Tai yra darbingo amžiaus pacientai.

Vertinant pacientų, kuriems atlikta ureteroskopija, fizinę būklę ASA laipsniais, nustatyta, kad nėra koreliacijos tarp pacientų amžiaus ir ASA laipsnio ( $Rho = 0,259$ ,  $p = 0,116$ ). Abiejose tirtų pacientų grupėse yra koreliacija tarp jų amžiaus ir akmenų dydžio ( $Rho = 0,220$ ,  $p = 0,037$ ). Vyrų grupėje pasitaikė didesni akmenys negu moterų grupėje, nors skirtumas nėra statistiškai reikšmingas. Didžiausias akmenų matmuo vyrų grupėje  $9,3 \pm 2,9$  mm, moterų -  $8,8 \pm 2,1$  mm, ( $p = 0,44$ ). Akmenų plotas vyrų grupėje  $49,0 \pm 28,8$  mm, moterų -  $39,9 \pm 17,3$ , ( $p = 0,067$ ). 92,5% tiriamųjų pacientų, kuriems buvo atlikta ureteroskopija akmuo buvo visiškai pašalintas pirmos operacijos metu. Dviem ligoniams operacijos metu nepavyko pasiekti akmenų ir atlikti litotripsiją. Visiškai pašalintų akmenų rezultatas (SFR) buvo 95% po 2 savaitių, 97,5% po 1 mėnesio ir 100% po 3 mėnesių. Atliekant ureteroskopiją su lazerine litotripsija operacijos trukmė buvo  $64,5 \pm 31,3$  minutės. Operacijos trukmės priklauso nuo akmenų dydžio ( $Rho = 0,417$ ,  $p = 0,007$ ). Taip pat operacijos trukmė priklauso ir nuo akmenų ploto ( $Rho = 0,393$ ,  $p = 0,012$ ). Atliekant ureteroskopiją su lazerine litotripsija operacijos trukmė nepriklausė nuo akmenų tankio ( $Rho = 0,271$ ,  $p = 0,099$ ). Paciento kūno masės indeksas nėra operacijos trukmės prognostinis veiksnys ( $Rho = -0,063$ ,  $p = 0,707$ ). Atliekant ureteroskopiją buvo susidurta su sunkumais, dėl kurių nepavyko iškart suskaldyti ir pašalinti akmenis iš viršutinio šlapimtakio trečdaliu naudojant tiesų 9,8 Ch ureteroskopą. 9 (22,5 %) akmuo migravo į inkstą, 1 (2,5%) akmuo nebuvo pasiektas dėl siauro šlapimtakio, 1 (2,5%) akmuo nebuvo pasiektas dėl ryškios šlapimtakio edemos aplink akmenį, 1 (2,5%) akmuo nebuvo pasiektas aukštaūgiui pacientui dėl nepakankamo kietojo ureteroskopo ilgio. Pažymėtina, kad 7 (77,8 %) akmenys iš visų 9 atgal į inkstą migravusių akmenų buvo L3 slankstelio projekcijoje ( $p = 0,005$ ). Vienas akmuo buvo L4 slankstelio projekcijoje (11,1 %) ( $p = 0,09$ ), dar vienas akmuo - L5 (11,1 %) ( $p = 0,09$ ). Trimis pacientams akmenys nepavyko pasiekti dėl skirtingų priežasčių. Esant siauram vienos pacientės šlapimtakiui ureteroskopo stūmimas buvo kompliktuotas: optinio instrumento nepavyko prakišti aukščiau klubinių kraujagyslių projekcijos, buvo jaučiamas didelis audinių pasipriešinimas. Todėl operacija buvo nuspręsta pabaigti nepašalinant akmenų, o šlapimtakis buvo stentuotas. Po penkių parų šlapimtakis pasyviai išsiplėtė dėl stento ir operacija pakartota iš jo sėkmingai pašalinant visą akmenį. Kitam pacientui pasiekti akmenį šlapimtakyje pavyko, tačiau buvo nustatytas „įsikalęs akmuo“ su ryškia šlapimtakio sienelės edema. Akmuo buvo blogai matomas ir kontaktinė litotripsija lazeriu negalima, todėl operacija buvo baigta, stentuotas

šlapimtakis ir tris savaites ligoniui taikytas priešūždegiminis gydymas. Po trijų savaičių ureteroskopija pakartota ir akmuo sėkmingai pašalintas iš šlapimtakio. Trečiam 188 cm ūgio pacientui nepavyko pasiekti šlapimtakio akmens, nes neužteko kietojo ureteroskopo ilgio (45 cm). Todėl tos pačios operacijos metu į šlapimtakį buvo įkišta mova ir ureteropieloskopas. Akmuo suskaldytas ir pašalintas. Devyniais atvejais, kai šlapimtakyje esantis akmuo migravo atgal į inkstą, buvo atliekama ureteropieloskopija, akmens dezintegracija lazeriu inkste ir pašalinamos skeveldros, vėliau stentuojamas šlapimtakis. Aštuoni ligoniai kuriems akmuo iš šlapimtakio migravo atgal į inkstą, stacionare buvo gydyti skubos tvarka ir tik vienam ligoniui akmuo migravo į inkstą, kai pacientas buvo operuojamas planine tvarka. Paskaičiuota  $p = 0,11$  parodė, kad skubos tvarka stacionarizuoti ligoniai nėra prognostinis akmens migravimo veiksnys. Atlikus 42 ureteroskopijas keturiasdešimčiai tirtų ligonių komplikacijos įvyko 7 pacientams. Įvairių komplikacijų dažnis siekė 16,7%. Septynios komplikacijos įvyko skirtingiems pacientams: penkiems vyrams ir dviem moterims ( $p = 0,59$ ). Penkiais atvejais kairiame šlapimtakyje ir dviem atvejais dešiniame šlapimtakyje ( $p = 0,41$ ). Perforacija 3 (7,1%), stento dirginimas 1 (2,4%), striktūra 3 (7,1%). Pagal modifikuotą Clavien komplikacijų skalę pirmo laipsnio stebėtos 3 komplikacijos, IIIa<sup>o</sup> - 1 komplikacija, IIIb<sup>o</sup>, „d“ – 3 komplikacijos. Trijų operacijų metu pašalinus akmenis iš šlapimtakio ir suleidus kontrastinės medžiagos rentgenologiškai buvo matoma kontrasto ekstravazacija už šlapimtakio į minkštuosius audinius. Toks radinys buvo traktuojamas kaip perforacija, net jei vizualiai šlapimtakio sienelės defekto nebuvo matyti. Beveik po visų ureteroskopijų buvo stentuojami šlapimtakiai, todėl kitos papildomos manipuliacijos dėl šlapimtakio perforacijos nebuvo atliekamos. Vienam pacientui po sėkmingos operacijos pirmomis pooperacinėmis dienomis išryškėjo stento dirginimo simptomatika (stiprūs pilvo apatinės dalies skausmai, dizurija, išliekantys skausmai nepaisant skiriamų analgetikų ir spazmolitikų), todėl antrą pooperacinę parą stentas buvo pašalintas, ligonis pasveiko. Trims pacientams vėlyvuoju pooperaciniu periodu (po 1 ir 3 mėnesių) atliekant kontrolines echoskopijas diagnozuotos ureterohidronefrozės. Po trijų mėnesių atliekant intravenines urogramas arba retrogradinę pielografiją jiems nustatytos šlapimtakio striktūros. Vienai tirtai pacientei nustatyta šlapimtakio vidurinio trečdaliao striktūra klubinių kraujagyslių projekcijoje, kuri tikriausiai įvyko dėl ureteroskopijos. Šiai ligonei atlikta ureteroskopija, išplėsta striktūra ir stentuotas šlapimtakis. Vėliau pašalinus stentą ir

atliekant kontrolines echoskopijas hidronefrozė neatsirado, ligonė pasveiko. Dviem pacientams striktūros diagnozuotos toje pačioje vietoje, kur buvo akmuo. Retrogradinės pielografijos metu konstatuoti dėl striktūros visiškai užakę šlapimtakiai, todėl endoskopinis šlapimtakio striktūrų plėtimas nebuvo galimas. Ligoniai buvo operuoti atliekant šlapimtakio rezekciją ir suformuojant anastomozes „galas į galą“. Abiem pacientams buvo šalinami „įsikalę akmenys“ ( $p = 0,02$ ), todėl manoma, kad striktūros priežastimi yra uždegimas akmens buvimo vietoje, kuris sąlygojęs randinio audinio vystymąsi. Tirtų pacientų grupėje po operacijų nebuvo karščiavimo, sepsio ir mirčių atvejų. Nefiksuota nei viena komplikacija, kuri būtų susijusi su ASA laipsniu. Iš septynių komplikacijas patyrusių pacientų keturiems nustatytas pirmas, o trims antras ASA laipsnis. Įvertinus chi kvadrat testu tirtų pacientų amžiaus ir komplikacijų dažnio ryšį galima teigti, kad amžius nėra komplikacijų rizikos veiksnys. Šalinant akmenis iš viršutinio šlapimtakio trečdalis ureteroskopijos efektyvumo koeficientas (EK) buvo 0,42 po operacijos, 0,43 po 2 savaitių, 0,42 po 1 mėnesio ir 0,43 po 3 mėnesių. 50 pacientų, kuriems taikytos 92 ekstrakorporinės litotripsijos, sėkmingo gydymo rezultatai buvo 10 (20%) po pirmo EKLT seanso, 14 (28%) po antro EKLT seanso, 15 (30%) po trečio EKLT seanso, 15 (30%) po ketvirto EKLT seanso. Pabrėžtina tai, kad keturiolikai pacientų, kuriems taikyta EKLT kai akmuo nesuskilo ir po antrojo seanso, pakartotinės EKLT nebuvo rezultatyvios nei po trečio, nei po ketvirto skaldymo seanso. Pacientams, kuriems buvo nesėkminga EKLT, taikytos kitos akmens šalinimo metodikos 35 ureteroskopijos, 4 pakartotinės URS, 4 lanksčiosios ureteropieloskopijos, 1 perkutaninė nefrolitotripsija, 52 stentavimai, 1 perkutaninė nefrostomija. Taigi ekstrakorporinės litotripsijos grupėje iš viso buvo atliktos 185 gydomosios procedūros. Bendras akmenų pašalinimo rezultatas (SFR) atliekant ekstrakorporinę litotripsiją ir tais atvejais, kai ji nebuvo efektyvi ir buvo taikomos kitos gydymo metodikos buvo 20% po pirmo EKLT seanso, 44% po 2 savaitių, 50% po 1 mėnesio, 80% po 3 mėnesių, 86% po 4 mėnesių, 88% po 5 mėnesių. Komplikacijų dažnis pacientų grupėje, kurie buvo pradėti gydyti ekstrakorporine litotripsija, siekė 10%, tačiau šios komplikacijos atsirado po atliktų ureteroskopijų kai ekstrakorporinės litotripsijos buvo nesėkmingos. EKLT EK po procedūros buvo 0,15, po 2 savaitių – 0,19, po 1 mėnesio 0,19, po 3 mėnesių - 0,23, po 4 mėnesių – 0,23, po 5 mėnesių - 0,24. Pacientai, kuriems taikyta ureteroskopija, buvo ilgiau gydomi liginėje. URS -  $5,0 \pm 2,0$  lovadienis ir EKLT -  $3,2 \pm 2,8$  ( $p < 0,05$ ). Tačiau pooperaciniai lovadieniai abiejose tiriamosiose grupėse

nesiskyrė  $2,4 \pm 1,0$  ir  $2,2 \pm 2,3$  ( $p = 0,56$ ). Remiantis 2014 metų rugsėjo mėnesio privalomojo sveikatos draudimo fondo pateiktais įkainiais buvo suskaičiuota, kokia pinigų suma sumokama iš privalomojo sveikatos draudimo fondo. Tiriamąjoje grupėje, kurioje pacientams iš viršutinio šlapimtakio trečdalyje buvo pašalintas atliekant ureteroskopiją vieno paciento gydymui iš privalomojo sveikatos draudimo fondo vidutiniškai yra sumokėta 1541 balo. Kitoje tirtų pacientų grupėje, kur akmenis pašalinimui iš viršutinio šlapimtakio trečdalyje pradėta taikyti ekstrakorporinė litotripsija, vieno paciento gydymui iš privalomojo sveikatos draudimo fondo vidutiniškai yra sumokėta 4034 balo.

## **Išvados**

1. Lyginant su ekstrakorporine litotripsija ureteroskopija su lazerine litotripsija yra efektyvesnis ir greitesnis gydymo būdas siekiant visiškai pašalinti akmenį iš viršutinio šlapimtakio trečdalyje.
2. Atliekant ureteroskopiją su lazerine litotripsija akmenų dydis gydymo rezultatų neįtakoja.
3. Akmenų lokalizacija šlapimtakio viršutinio trečdalyje L3 slankstelio projekcijoje yra susijusi su didele jo migravimo į inkstą tikimybe, todėl siekiant visiškai pašalinti akmenį vienos operacijos metu, būtina iš anksto pasiruošti papildomą operacinę įrangą.
4. Tyrimo rezultatai leidžia teigti, kad atliekant ureteroskopiją paciento amžius, jo lytis, ASA laipsnis, akmenų buvimas kairiame ar dešiniame šlapimtakio komplikacijų rizikos neįtakoja.
5. Šlapimtakio „įsikalęs akmuo“ yra prognostinis šlapimtakio striktūros akmenų buvimas vietoje veiksnys.
6. Šiuo metu ureteroskopijos vienkartinė priemonė sąnaudos yra didesnės lyginant su paslaugos apmokėjimu iš privalomojo sveikatos draudimo fondo.

## **Praktinės rekomendacijos**

1. Akmeniui esant viršutiniame šlapimtakio trečdalyje (L3 slankstelio projekcijoje) tikslinga būti pasiruošus atlikti lanksčiąją ureterorenoskopiją, jeigu akmuo migruotų į inkstą.

2. Esant komplikuotam optinio instrumento įkišimui iki akmens dėl anatomiškai siauro šlapimtakio spindžio, procedūrą tikslinga baigti, stentuoti šlapimtakį ir operaciją pakartoti vėliau.
3. Tikslinga paciento, kuriam atlikta ureteroskopija, kontrolinė konsultacija atliekant inkstų echoskopiją net ir nesant jokių simptomų, nes jei jam buvo diagnozuotas „įsikalęs akmuo“, tai išlieka ir šlapimtakio striktūros formavimosi tikimybė.
4. Šiuo metu esantis ureteroskopijos ir lanksčiosios ureteropieloskopijos apmokėjimas iš privalomojo sveikatos draudimo fondo Lietuvos gydymo įstaigoms yra nuostolingas, todėl taikomų procedūrų ir operacijų įkainius būtina peržiūrėti ir patikslinti.
5. Remiantis darbo metu nustatyta operacijos metodika ir pateikiama literatūra, rekomenduojama taikyti ureteroskopiją tik esant išgydytai šlapimo takų infekcijai, nes ji gali sukelti pielonefritą ir urosepsį po operacijos. Net esant steriliam šlapimui prieš operaciją, tikslinga profilaktinė antibiotikų terapija tiek operacijos metu, tiek ir po jos.