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Original Article

A multicenter-based critical analysis of laser settings during intrarenal laser lithotripsy by the Turkish academy of urology prospective study group (ACUP study)

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ABSTRACT

Objective: In this multicenter prospective study, we aimed to evaluate the use of holmium:yttrium–aluminum–garnet laser during retrograde intrarenal surgery for kidney stones and the relationship between laser-related parameters and procedure-related perioperative parameters.

Material and methods: The 769 patients whose laser setting parameters (fiber thickness, number of shots, frequency (max.), laser power (max.), and total energy) were completely registered were included in this study program. The intraoperative ureteral lesions were evaluated using postureteroscopic lesion scale (PULS) scores and the postoperative complications with the modified Clavien-Dindo classification system.

Results: The maximum levels of laser power and the frequency were used in the middle calyceal stones; the value of total energy consumed was found to be higher gain in cases with multiple stones (all parameters $P < .05$). There was a significant positive correlation among (mean number of shots [$P < .001$, r = 0.46], frequency [$P = .009$, r = 0.1], maximum power [$P < .001$, r = 0.11], total energy [$P < .001$, r = 0.25]), anesthesia time ($P < .001$, r = 0.42), surgery time ($P < .001$, r = 0.47), and stone size. The mean number of shots increased ($P < .001$, r = 0.25), and the frequency level decreased ($P < .001$, r = –0.17) significantly with increasing Hounsfield unit (HU) values. Again, the mean number of shots and maximum laser power increased in correlation with the increasing hospitalization time ($P = .004$, r = 0.09 and $P = .02$, r = 0.07, respectively). In addition, it was observed that higher laser subparameter values and thicker fibers were used in PULS grade 2.

Conclusion: As the stone size and HU values increased, laser-setting parameters were found to show significant variability. The increase in different parameters of the laser setting was found to be associated with longer anesthesia time, surgery time, and hospitalization period and increased risk of local trauma with PULS grade.

Keywords: Ho:YAG laser; laser settings; retrograde intrarenal surgery; stone management

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Introduction

Retrograde intrarenal surgery (RIRS) has become a widely used technique in endourological surgery due to advances in laser technology, surgical instruments, and high-stone-free and low complication rates. The European Urology Association (EAU) recommends performing RIRS for the treatment of kidney stones smaller than 2 cm and incompatible with percutaneous nephrolithotomy and shock wave lithotripsy, and using holmium:yttrium–aluminum–garnet (Ho:YAG) laser.[1,2] Ho:YAG laser has been applied as the gold standard lithotripsy tool in the treatment of kidney stones during the last 15 years due to its effectiveness, wide safety range, and limited adoption of other laser types.[3] Although there are numerous publications regarding the RIRS procedure in the literature, limited data

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Main Points

- Ho:YAG laser has been applied as the gold standard lithotripsy tool in the treatment of kidney stones due to its effectiveness, wide safety range, and limited adoption of other laser types.
- Although there are numerous publications regarding the retrograde intrarenal surgery (RIRS) procedure in the literature, limited data could be derived on the clinical research focusing on the laser-related subparameters such as power, frequency, and fiber thickness in conjunction with clinical findings obtained.
- As the stone size and Hounsfield unit values increased, laser-setting parameters were found to show significant variability. The increase in different parameters of the laser setting was found to be associated with longer anesthesia time, surgery time, and hospitalization period and increased risk of local trauma with PULS grade.

could be derived on the clinical research focusing on the laser-related subparameters such as power, frequency, and fiber thickness in conjunction with clinical findings obtained. Available data are highly limited based on retrospective studies including small cohorts.[4,5] As a highly critical component of the RIRS procedure, there is no established consensus for laser settings to be used by each surgeon, where majority of the endourologists assess these parameters based on their personal experience. In this multicenter prospective study, we aimed to evaluate the use of Ho:YAG laser during RIRS for kidney stones and the relationship between laser-related parameters and procedure-related pre-intra-postoperative parameters.

Material and Methods

Outcome Measurements

The primary aim of this study was to determine the Ho:YAG laser settings, stone-related parameters, and pre-per-postoperative parameters used during RIRS for kidney stones in different centers. The secondary aim was to evaluate the relationship between laser settings and procedure-related preoperative, intraoperative, and postoperative parameters.

Data Collection

Following the approval of the ethics committee of İstanbul Medipol University (No:2015/217), the data obtained from 1,112 cases undergoing RIRS for kidney stones in 15 different centers between April 2015 and June 2016 were prospectively registered in an electronic database (https://acup.uroturk.org.tr/). Surgeons who are known to perform the procedure frequently (>40 RIRS/year) in the centers where patients were included in the study were invited to the study by e-mail. The database included 65 different questions focusing on pre-, intra-, and postoperative findings, and long-term follow-up of these cases. This study has been designed as cross-sectional. An informed consent was obtained from all patients included in the study.

Inclusion Criteria

Patients whose laser adjustment parameters "Fiber thickness, Number of shots, Frequency (max.), Laser power (max.), and Total energy" values were fully available and whose data were recorded regularly were included in this study (n = 769).

Exclusion Criteria

Patients who were irregularly and/or incompletely registered in the system and did not include laser parameters were excluded from this study (n = 343).

In all patients, the diagnosis of kidney stones was made by computerized tomography. Residual stone status was checked

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Table 1. Postureteroscopic Lesion Scale (PULS) and Clavien-Dindo Classification[6,7]

Postureteroscopic Lesion Scale (PULS)		
Grade 0	No lesion	Uncomplicated URS (no grading according to the Dindo-modified Clavien classification of surgical complications)
Grade 1	Superficial mucosal lesion and/or significant mucosal edema/hematoma	
Grade 2	Submucosal lesion	
Grade 3	Perforation with less than 50% partial transsection	Complicated URS (Grade 3a or b according to the Dindo-modified Clavien classification of surgical complications)
Grade 4	More than 50% partial transsection	
Grade 5	Complete transection	
Dindo-modified Clavien Classification of Surgical Complications		
I	Any deviation from the normal postoperative course without the need for pharmacological treatment or surgical, endoscopic, and radiological interventions. Allowed therapeutic regimens include drugs, such as antiemetics, antipyretics, analgesics, diuretics, and electrolytes, and physiotherapy. This grade also includes wound infections opened at the bedside	
II	Requiring pharmacological treatment with drugs other than those allowed for grade 1 complications. Blood transfusions and total parenteral nutrition are also included	
III	Requiring surgical, endoscopic, or radiological intervention	
IIIa	Intervention not under general anesthesia	
IIIb	Intervention under general anesthesia	
IV	Life-threatening complications (including CNS complications)* requiring IC/ICU-management	
IVa	Single-organ dysfunction (including dialysis)	
IVb	Multiorgan dysfunction	
V	Death of a patient	
Suffix “d”	If the patients suffer from a complication at the time of discharge, the suffix “d” (for “disability”) is added to the respective grade of complication. This label indicates the need for a follow-up to fully evaluate the complication	

*Brain hemorrhage, ischemic stroke, subarrachnoidal bleeding, but excluding transient ischemic attacks.

CNS, central nervous system; IC, intermediate care; ICU, intensive care unit.

on the first postoperative day using direct radiography and/or ultrasonography. While the intraoperative ureteral lesions were evaluated using postureteroscopic lesion scale (PULS) scores,[6] evaluation of the postoperative complications was made using a modified Clavien-Dindo classification system[7] (Table 1). Detailed information on the method of the study has been previously described elsewhere.[8,9]

Statistical Analysis

Data were tested for normal distribution using the Kolmogorov–Smirnov test. Normally distributed variables have presented with means and standard deviations (SD), and non-normally distributed variables have been presented with medians and minimum-maximum values. Categorical variables have been presented as percentages. Descriptive information and percentages were based on available data. Statistical significance between continuous variables was determined using Student’s t test; the Mann–Whitney test and Kruskal–Wallis test were used for nonparametric data. Pearson’s Chi-square analysis was performed to test for differences in proportions of categorical variables between two or more groups. The Pearson’s correlation coefficients of continuous variables were calculated. Correlation coefficient r values were used to measure the strength and direction of the linear relationship between two variables in a scatterplot. $r > 0$ indicates a positive association and $r < 0$ indicates a negative association. Absolute value of r “$r < 0.3$ (+ or –) weak, $0.3 < r < 0.7$ (+ or –) Moderate, $r > \pm 0.7$ (+ or –) Strong” indicates the strength of the relationship.

The evaluation of one-way analysis of variance (ANOVA) and Levene test of homogeneity of variances was performed for comparison of means. Whenever statistical significances were found with one-way ANOVA, Tukey’s or Tamhane’s T2 post hoc tests were applied for mean comparison, depending on equal variances assumption or not. All statistical analyses were performed using Statistical Package for the Social Sciences

(SPSS) version 23.0 (IBM SPSS Corp.; Armonk, NY, USA). A P value $< .05$ was considered statistically significant.

Results

While the median age of patients was 44 (18-83), median body mass index (BMI) value was 27 (18-46), and male and female ratio was 63.2 and 38.8%, respectively. The median number of stones was 1 (1-12), and the stone size was 15 (6-42) mm. The most common laser fiber size used during RIRS procedure was 272 μm (90.76%), while the median number of laser shots was 4,373 (580-102,348), median laser power (max.) value was 1.8 (0.5-30) J, and finally, median total energy value was 13.8 (3-80.9) J.

Following the procedures, 75.8% of the cases were stone free, and among the patients with residual stones, the median fragment size was 6 (2-18) mm. 86.9% of the patients did not have any complications according to the Clavien-Dindo classification. Median hospitalization duration was 24 (4-240) hours. Patient demographics, stone, and laser application-related parameters are being presented in Table 2.

In the subgroup analysis evaluating the relationship between stone-free and laser parameters; between Stone Free (+) (n = 583) and Stone Free (–) (n = 186) groups; Number of shots, laser max. power (J), and laser max. frequency (Hz), total energy (J) values were found to be higher in the Stone Free (+) group, and this difference was found to be significant for all parameters except the total energy (j) group ($P < .001$, $P = .03$, $P = .02$, and $P = .08$) (Table 3).

Subgroup analysis of our findings regarding the relationship between laser parameters and the location of the stone(s) in the collecting system revealed that the largest and smallest sized fibers (365 and 200 μm) were more commonly used in cases with multiple stones, and the mean number of shots applied was reasonably higher in these cases when compared with the other ones. Additionally, while the maximum levels of laser power and the frequency were used in the middle calyceal stones, the value of total energy consumed was found to be higher again in cases with multiple stones ($P < .05$, all parameters).

In posthoc analysis for laser parameters and stone localization, it was determined that the mean values of number of shots differed significantly between middle calyx and renal pelvis, and middle calyx and multiple localization ($P < .001$ and $P = .001$, respectively), laser power mean values showed a significant difference between middle calyx and upper calyx, and middle calyx and lower calyx ($P < .001$ and $P < .001$, respectively), laser frequency mean values showed significant differences between middle calyx and upper calyx, and middle calyx and lower calyx ($P = .002$ and $P = .003$, respectively), and total energy mean values showed significant differences between multiple localization and renal pelvis ($P < .001$).

On the other hand, evaluation of the laser parameters in conjunction with the use of ureteral access sheath (UAS) during the procedure demonstrated that the mean value of maximum laser power was higher in cases operated with an UAS in place along with the use of smaller laser fiber ($P < .001$ and $P < .001$, respectively). However, no significant differences were present between the cases operated with and without UAS regarding the mean number of shots, mean frequency level, and mean total energy in this group.

On the other hand, subgroup analysis evaluating the laser parameters in conjunction with lithotripsy method showed that while the largest size fibers were commonly used in the combined group with relatively higher mean maximum power and total energy values, the smallest sized fibers were commonly utilized in the drilling group ($P < .001$, $P < .001$, and $P < .001$, respectively). There was no significant difference between these groups regarding the mean number of shots and mean frequency parameters. In posthoc analysis for laser parameters and lithotripsy method, it was determined that the mean values of laser power mean values showed a significant difference between combined and drilling, and combined and painting ($P < .001$ and $P < .001$, respectively), and total energy mean values showed significant differences between combined and drilling, and combined and painting ($P < .001$ and $P < .001$, respectively).

When we specifically focused on the possible relationship between the laser parameters and PULS grade, we observed that higher laser subparameter values and thicker fibers were used in PULS grade 2 (for all parameters <.05). In posthoc analysis for laser parameters and PULS grade, it was determined that the mean values of all laser parameters showed a significant difference between grade 0 and grade 2 (for all parameters, $P < .005$).

Detailed information regarding the relationship between laser parameters and stone localization, UAS usage, lithotripsy method, and PULS grade are shown in Table 4.

Last but not least, there was a significant positive correlation between the laser-related parameters (mean number of shots [$P < .001$, r = 0.46], frequency [$P = .009$, r = 0.1], maximum

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Table 2. Patient, Stone, and Laser Demographics

Demographics	Age (years) (median [min-max])	44 (18-83)
	BMI (median [min-max])	27 (18-46)
	Gender, n (%)	
	Male	486 (63.2)
	Female	283 (36.8)
Stone-related parameters	Hounsfield unit (median [min-max])	855 (315-1,935)
	Number of stones (median [min-max])	1 (1-12)
	Stone size (mm) (median [min-max])	15 (6-42)
Intraoperative parameters	Fluoroscopy time (seconds) (median [min-max])	14 (5-102)
	Anesthesia time (minutes) (median [min-max])	62 (9-180)
	Surgery time (minutes) (median [min-max])	55 (7-160)
	PULS grade, n (%)	
	0	438 (57)
	1	299 (38.9)
	2	31 (4.03)
	3	1 (0.7)
Laser-related parameters	Fiber thickness, n (%)	
	200 μm	24 (3.12)
	272 μm	698 (90.76)
	365 μm	47 (6.11)
	Number of shots (median [min-max])	4,373 (580-102,348)
	Laser max. power (J) (median [min-max])	1.8 (0.5-30)
	Laser max. frequency (Hz) (median [min-max])	10 (1-20)
	Total energy (J) (median [min-max])	13.8 (3-80.9)
Postoperative parameters	Complete stone-free rate, n (%)	583 (75.8)
	Residual stone size (mm) (median [min-max])	6 (2-18)
	Clavien-Dindo-complications, n (%)	
	None	669 (86.9)
	1	82 (10.6)
	2	16 (2.1)
	3A	1 (0.2)
	3B	1 (0.2)
	Hospitalization (hours) (median [min-max])	24 (4-240)

power [$P < .001$, r = 0.11], total energy [$P < .001$, r = 0.25]) and stone size (Figure 1). As expected, there was a significant positive correlation among anesthesia time ($P < .001$, r = 0.42), surgery time ($P < .001$, r = 0.47), and stone size. The mean number of shots increased ($P < .001$, r = 0.25) and the frequency level decreased ($P < .001$, r = –0.17) significantly with increasing Hounsfield unit values of the stone (Figure 1). Again, the mean number of shots ($P = .004$, r = 0.09) and maximum laser power ($P = .02$, r = 0.07) increased in correlation with the increasing hospitalization time.

Discussion

RIRS began to be applied more commonly and effectively than ever with the clinical introduction of laser fibers to be used with flexible scopes. Over the past 20 years, holmium laser

Table 3. Details of the Relationship between Stone-Free + and – Groups and Laser Parameters

Parameters	Stone Free + (n = 583)	Stone Free – (n = 186)	*P*
Number of shots (mean ± SD)	4,448 ± 5,213	10,033 ± 10,007	<.001
Laser max. power (J) (mean ± SD)	1.6 ± 0.6	1.83 ± 0.5	.03
Laser max. frequency (Hz) (mean ± SD)	10.01 ± 3.6	10.86 ± 4.1	.02
Total energy (J) (mean ± SD)	12.3 ± 10.25	14.3 ± 12.6	.08

Table 4. Details of the Relationship between Laser Parameters and Stone Localization, UAS, Lithotripsy Method, PULS Grade

	n (%)	Fiber Thickness, n (%)	Number of Shots	Laser Power (max.) (J)	Laser Frequency (max.) (Hz)	Total Energy (J)
Stone localization						
Upper calyx	40 (5.2)	200 μm: 1 (2.5)	5,052.4 ± 5,506	1.43 ± 0.59	9.16 ± 2.6	11.6 ± 8.8
		272 μm: 38 (95)				
		365 μm: 1 (2.5)				
Medium calyx	77 (10)	200 μm: 1 (1.2)	3,620 ± 4,672	1.80 ± 0.66	11.2 ± 3.9	13.3 ± 9.6
		272 μm: 73 (94.8)				
		365 μm: 3 (3.8)				
Lower calyx	170 (22.1)	200 μm: 3 (1.8)	4,411.2 ± 5,588	1.46 ± 0.6	9.6 ± 3.8	10.5 ± 7.8
		272 μm: 161 (94.7)				
		365 μm: 6 (3.5)				
Pelvis	233 (30.3)	200 μm: 7 (3.1)	4,187.1 ± 5,096	1.67 ± 0.66	10.33 ± 4	12.5 ± 10.6
		272 μm: 209 (89.6)				
		365 μm: 17 (7.3)				
Multiple localization	249 (32.3)	200 μm: 11 (4.4)	6,626.8 ± 10,142	1.68 ± 0.79	9.92 ± 3.7	15.2 ± 11.1
		272 μm: 215 (86.3)				
		365 μm: 23 (9.3)				
p stone localization		**0.03***	**0.005‡**	**<0.001‡**	**0.007‡**	**<0.001‡**
UAS (+)	580 (75.5)	200 μm: 20 (3.4)	5,674 (200-40,619)	1.8 (0.5-3)	10 (4-20)	13.1 (1-51)
		272 μm: 544 (93.8)				
		365 μm: 16 (2.8)				
UAS (–)	189 (24.5)	200 μm: 3 (1.6)	4,711 (281-27,330)	1.6 (0.6-3)	10 (2-20)	15 (1-39)
		272 μm: 154 (81.5)				
		365 μm: 32 (16.9)				
p UAS		**<0.001***	0.13†	**<0.001†**	0.2†	0.87†
Lithotripsy method						
Drilling	36 (4.7)	200 μm: 4 (11.1)	6,329.8 ± 16.350	1.15 ± 0.4	9.94 ± 4.2	9.5 ± 6.3
		272 μm: 32 (88.9)				
		365 μm: 0				
Painting	149 (19.4)	200 μm: 9 (6)	5,142.3 ± 7,283	1.42 ± 0.9	9.69 ± 3.36	7.3 ± 6.9
		272 μm: 135 (90.6)				

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Table 4. (Continued)

	n (%)	Fiber Thickness, n (%)	Number of Shots	Laser Power (max.) (J)	Laser Frequency (max.) (Hz)	Total Energy (J)
		365 μm: 5 (3.4)				
Popcorn	30 (3.9)	200 μm: 3 (10)	3,983.1 ± 4,802	1.41 ± 0.6	9.7 ± 1.4	14.59 ± 15.4
		272 μm: 26 (86.7)				
		365 μm: 1 (3.3)				
Combined	554 (72)	200 μm: 7 (1.2)	4,937.6 ± 6,458	1.73 ± 0.6	10.24 ± 4	14.87 ± 10.2
		272 μm: 505 (91.2)				
		365 μm: 42 (7.6)				
p lithotripsy method		**<0.001***	0.37‡	**<0.001‡**	0.7‡	**<0.001‡**
PULS grade						
0	438 (57)	200 μm: 20 (4.6)	4,545.7 ± 7,891	1.53 ± 0.7	9.71 ± 3.6	10.3 ± 9.6
		272 μm: 410 (93.6)				
		365 μm: 8 (1.8)				
1	299 (38.9)	200 μm: 2 (0.7)	5,493.6 ± 6,552	1.72 ± 0.63	10.52 ± 4.2	15.9 ± 10.2
		272 μm: 260 (86.9)				
		365 μm: 37 (12.4)				
2	32 (4.03)	200 μm: 2 (6.3)	5,545.6 ± 4,709	2.03 ± 0.83	10.64 ± 2.6	18.1 ± 11.6
		272 μm: 26 (81.2)				
		365 μm: 4 (12.5)				
p PULS grade		**<.001***	**.001‡**	**<.001‡**	**.003‡**	**<.001‡**

*Chi-square test.
†Mann–Whitney U test.
‡Kruskal–Wallis test.

lithotripsy has proven its effectiveness and safety in the minimal invasive management of kidney stones.[2,10] Despite the adequate number of studies focusing on the laser disintegration of renal stones, majority of these reports generally have retrospective design, which include single or few surgeons operating limited number of patients. Additionally, authors mentioned only about the average laser power and energy parameters used in general, which really seemed to vary from one department to another.[10–12] It is clear that despite the widespread application of this procedure in all parts of the world, a true standardization of some specific essential parameters of the procedure such as laser settings during treatment, the definition of stone-free status, and the clinical effects is certainly needed due to the personal preference-based different application of this unique technology.Taking the need for standardization particularly for the laser energy settings during RIRS procedure into account, in this prospective observational study, we particularly aimed to focus on the variations in the laser settings applied during RIRS on a true multicenter-based manner (769 cases managed by surgeons from 15 different centers). In addition to the laser fiber size and the laser parameter settings used for stones located in different parts of the kidney, the possible relationship between these parameters and UAS use as well as fragmentation technique was also evaluated. A special emphasis has been made regarding the possible effects of these parameters on the operative factors such as local trauma, duration of anesthesia, and the procedure. To our knowledge, there is no study in the literature aiming to assess the possible effects of certain laser application-related parameters, namely, fiber size, number of shots, frequency level, laser power, and total energy level from different aspects. As the only large-scale prospective trial on this aspect, with this trial, we aimed to detect the most commonly used laser settings for stone disintegration. Although it is not a standard approach in general, our findings clearly demonstrated that a median of 1.8 J power and 10 Hz frequency values is being used along with high preference of 272 μm laser fiber size. As expected, the laser settings increased significantly as the stone size increased (Figure 1).

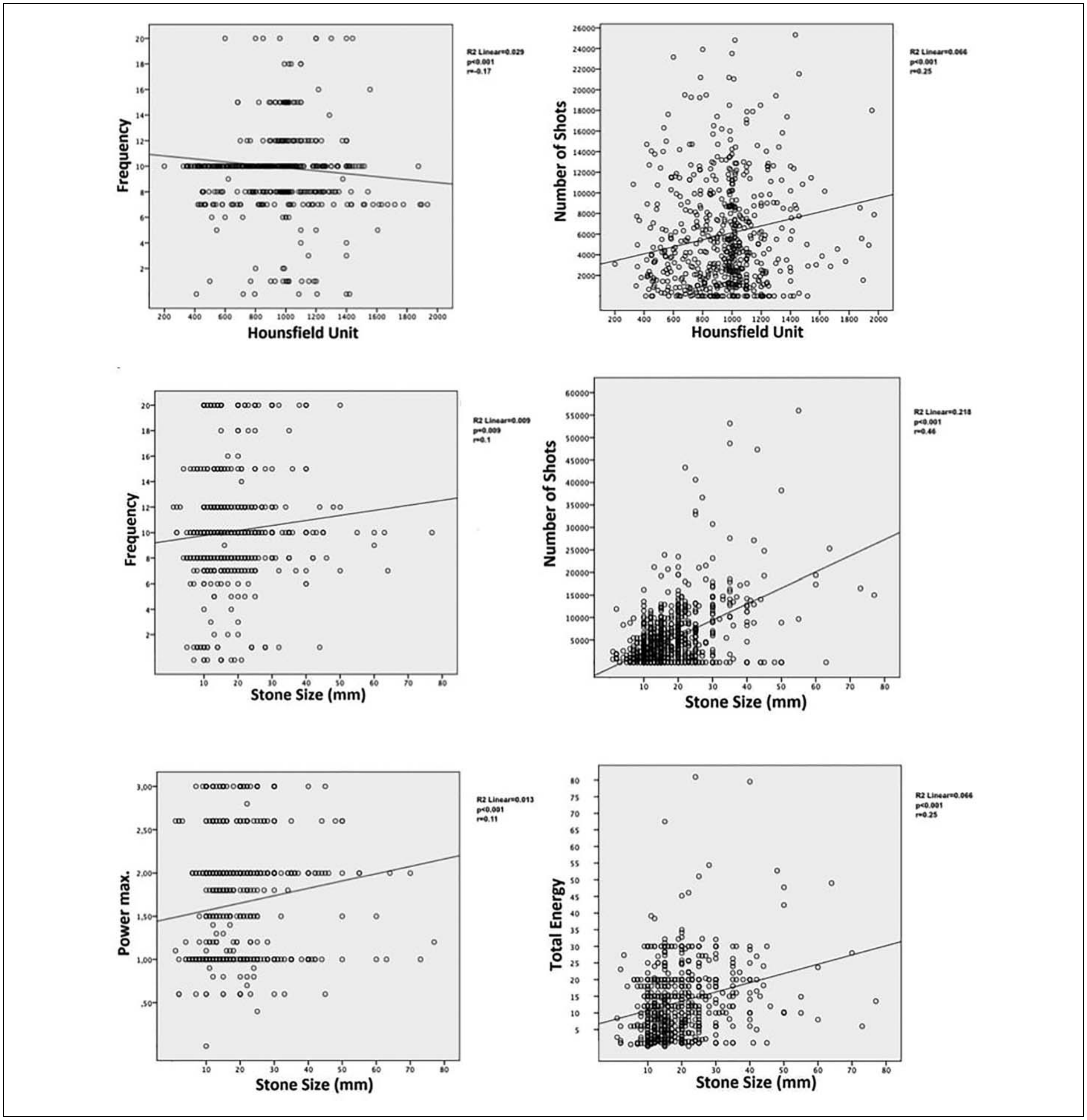

Figure 1. Scatter plots of correlation analysis.

This can be explained by the surgeons' desire to disintegrate the stone(s) more straightforward and faster. However, the use of a high-power system in Ho:YAG technology may cause higher retropulsion and visibility problems and reduce the efficiency of lithotripsy.[13,14] It is also worth mentioning that higher laser power and frequency settings were increased in middle calyceal stones, which could depend on the surgeons' confidence. This location is the most convenient location to reach the stone during retrograde laser lithotripsy. However, we also noted that as these parameters increase, in addition to

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the duration of both the anesthesia and surgery, the level of local trauma (PULS grade) also tended to increase significantly. Therefore, we believe that rational and cautious use of laser settings may reduce the rate of intraoperative injuries. Also, as the Hounsfield unit value of the stone increased, surgeons were found to decrease the frequency and increase the number of shots significantly (Figure 1). This finding was not expected and opened to the discussion because it could be the desire to effectively fragment these harder stones by avoiding the retropulsion and producing smaller fragments, mainly dust, for spontaneous passage. Taking the reported data so far in the literature mainly based on the studies with retrospective design and limited number of cases treated by single surgeon in a single institution into account, we strongly believe that our current findings may bring new insights as well as new clinical implications into the routine clinical application of laser energy in the disintegration of renal stones. It is clear that the inclusion of a large series of cases operated in different centers particularly by different surgeons will certainly shed a new light on the possible (not very well evaluated) impact of varying laser-related parameter on the stone (stones with different location, volume, and hardness) as well as procedure-related outcomes. In other words, data obtained from our current study could be helpful in an attempt to pave the road for the standardized use of laser parameters during RIRS. EAU guidelines suggest the Ho:YAG laser lithotripsy as the most effective system to disintegrate all types of calculi during ureterorenoscopy (URS) and flexible URS with a strong rating.[2] However, the surgical experience gained over the past three decades clearly showed that despite its current gold standard status, the use of laser energy for stone management has some certain disadvantages such as retropulsion, heterogeneity (use of different devices and equipment), and versatility.[15,16] Moreover, we observe that the intrarenal stone surgery is turning into a new era with the clinical introduction of new novel laser types. The increasing interest in thulium laser lithotripsy due its inherent greater versatility and control of pulse parameters has attracted wide scale attention in recent years[17–19]; thulium on this aspect has been reported to allow the use of low energy and high frequency to provide faster stone ablation with limited risk of retropulsion as its unique characteristics. However, we believe that despite the entirely different power and frequency settings of these new laser technologies that may be preferred and applied in the near future, similar concerns are prone to arise following the common use of this technique and the accumulation of adequate experience.

Long-term follow-up of patients could not be performed because it was very difficult to continue collecting long-term data in a multicenter prospective study. The lack of long-term follow-up data is the main limitation of this study. For this reason, information about the management of complications and residual stones and recurrence status could not be given.

In conclusion, our study clearly demonstrated that as the stone size and Hounsfield unit values increased, laser setting parameters were found to show significant variability. Increase in the different parameters of laser setting was found to be associated with longer anesthesia time, surgery time, and hospitalization period coupled with the increased risk of local trauma with PULS grade. Data obtained from our analysis indicate the relationship between Ho:YAG laser settings used and the stone localization, disintegration technique, use of UAS, and complication rates. Additionally, in the light of our findings, we may say that although ideal standardization of Ho:YAG laser parameters (settings during RIRS) is not so easy to achieve, like many other parameters affecting the final outcomes of the procedure, we believe that our data can constitute a guidance for the optimal use of laser energy during the management of renal stones with RIRS.

Ethics Committee Approval: Ethical committee approval was received from the İstanbul Medipol (No:2015/217).

Informed Consent: Written informed consent was obtained from all participants who participated in this study.

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