Original Article

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Effects on Laser Fibers after Using the 'Laser Holder'-Assisted Laser Fiber Cleavage

Yananan Ratanatherawichian, M.Sc.[1], Chonnakarn Kumjornkittikun, B.N.S.[1], Sunee Timtangboonrod, Cert.PN.[1], Taweechai Kansue, B.B.A.[1], Kittisak Bunyakars, B.Sc.[2], Supavadee Pratoomsut, M.D.[3], Ekkarin Chotikawanich, M.D.[3]

[1]Urological Surgery Unit, Perioperative Nursing Division, Department of Nursing. Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok Noi, Bangkok 10700, Thailand.

[2]Medical Education Technology Center. Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok Noi, Bangkok 10700, Thailand.

[3]Division of Urology, Department of Surgery, Faculty of Medicine, Siriraj Hospital. Mahidol University, Bangkok Noi, Bangkok 10700, Thailand.

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Abstract:

Objective: The precise cleavage of laser fibers is critical in urological surgery. However, traditional manual cleaving methods using ceramic scissors and a cleaving pen often result in inefficient cuts, affecting light dispersion and energy transmission. This study aimed to compare the effects of cleaved laser fibers with ceramic scissors and cleaving pen, combined with and without the use of the Laser Holder.

Material and Methods: A new 272 μm reusable laser fiber with a base power output of 1 W (0.2 J, 5 Hz) was evaluated for the quality of laser light dispersion, power output, and fiber tip morphology using ceramic scissors and a cleaving pen, compared with and without the Laser Holder. The results of the experimental comparisons between groups were analyzed using the chi-square test, two-way ANOVA, and Fisher's exact test.

Results: The Laser Holder significantly improved light dispersion (p-value<0.01), with the combination of cleaving pen and Laser Holder showing the best result (p-value<0.0125). Power output remained unaffected (p-value>0.05), with the cleaving pen combined with the laser holder exhibiting the highest efficiency (91.38%).

Conclusion: The Laser Holder significantly enhances the precision of the cleaved laser fiber, aligning with surgical standards, regardless of the cleaving instrument used. Cleaving pens provide optimal energy transmission. This knowledge may improve and simplify the handling of laser fibers in urological surgeries.

Contact: Ekkarin Chotikawanich, M.D.
Division of Urology, Department of Surgery, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok Noi, Bangkok 10700, Thailand.
E-mail: ekkarin.cho@mahidol.ac.th, ekkarinc@yahoo.com

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Keywords: cleavage, laser fiber, laser holder, laser lithotripsy, ureteroscopy

Introduction

Endoscopic urological surgery using lasers for kidney stone treatment is an effective method for patients. However, it is a high-cost procedure, especially due to the price of laser fibers. Consequently, reusable laser fibers, which are more cost-effective compared to single-use fibers, are commonly used.[1] Reusable fibers, unlike disposable ones that are ready to use without preparation, require a process of stripping and cleaving the laser fiber core to meet the manufacturer's standards. This is assessed by light dispersion to ensure proper cleaving as per the product manual for that specific type of laser fiber. In practice, cleaving these fibers with ceramic scissors and cleaving pen by hand, especially small 272 µm fibers, is challenging due to their slippery nature. This often results in uneven, sharp cut ends, leading to substandard laser light dispersion and energy transmission, potentially causing energy inefficiency, laser fiber breakage during surgery[2], and sharp ends that can injure or puncture renal tubes.[3]

Ideally, laser light dispersion should be circular, similar to that observed in uncut new fibers. An elliptical dispersion or uneven circumference indicates a deviation from the standard. The dispersion pattern is related to energy transmission from the laser fiber to the target. A smooth surface ensures consistent dispersion, whereas a rough surface leads to a more scattered and inconsistent dispersion, with reduced energy.[4] Damage to the tip of the laser fiber during lithotripsy can lead to inefficient stone fragmentation[2,4], reduced fiber lifespan[5], and unintentional damage to renal tube linings[2], regardless of whether the rough surface is due to damage during surgery or improper cleaving techniques.

One factor affecting the inefficiency of laser fiber cleaving in medical units is the lack of tools to stably hold and cut the fiber at a 90-degree angle every time, ensuring a smooth, non-sharp cut end as per the standard. This maintains the efficiency and quality of the laser fiber. Therefore, the Laser Holder was developed to improve operational quality (Figure 1). This study investigated the effects of cleaving laser fibers with ceramic scissors and cleaving pens, comparing the use and non-use of the Laser Holder. The researchers hypothesized that using the Laser Holder would yield better results than using it without it.

Objective

This study compared the effects of cleaving laser fibers with ceramic scissors and cleaving pen, combined with and without the use of the Laser Holder.

Material and Methods

This study was exempted from ethical approval, as it did not involve humans, human products, or animals, and thus did not fall under the purview of the Human Research Ethics Committee.

The study was conducted using new 272 µm laser fibers, set to a basic energy output of 1 W (0.2 J, 5 Hz), which is the minimum standard safe setting for these experiments. Laser fibers were cut 1 cm from the fiber tip using all four methods (Figure 2).

Method A: Cleaved the laser fiber with ceramic scissors combined with the Laser Holder.

Method B: Cleaved the laser fiber with ceramic scissors without using the Laser Holder.

Method C: Cleaved the laser fiber with a cleaving pen combined with the Laser Holder.

Method D: Cleaved the laser fiber with a cleaving pen without using the Laser Holder.

The cleavage was performed by nurses with similar experience, more than 5 years working with the laser, who randomly selected the method by simple randomization.

The results were checked by two individuals with similar experience who were unaware of the cleavage method used. The results were assessed on the basis of the energy output from the laser fiber, light dispersion, and the smoothness of the laser fiber cut end, comparing groups using and not using the Laser Holder.

The energy output of the laser fiber was evaluated using a Versatile Laser Power/Energy Meter and described as a percentage. Physical characteristics were assessed on the basis of the cut end of the laser fiber, whether it was smooth or not, sharp or blunt, using an electron microscope. The quality of laser light dispersion was assessed based on whether it was a good circular pattern or not, by connecting the laser fiber to a laser machine and pointing it at a light quality measurement screen, located at the base of the Laser Holder, with the fiber end perpendicular and 1 cm away from the screen.

The use of the Laser Holder was evaluated based on the stability of holding the laser fiber while cleaving, using a laser fiber cleaved record form, and overall satisfaction with the use of the Laser Holder (Figure 3), assessed from the same record form.

Data analysis included descriptive statistics, such as frequency, percentage, and average for describing the general characteristics of the sample group, and analytical statistics to compare the effects of cleaving the laser fiber with ceramic scissors and the cleaving pen between the groups using and not using the Laser Holder. The Chi-square test was used for the comparison of categorical data, and the two-way ANOVA for continuous data. Satisfaction with the use of the Laser Holder was analyzed as categorical data using the Chi-square test and Fisher's exact test. A significance level of p-value<0.05 was established, and Fisher's exact test was used to compare the quality of the laser light dispersion rates, adjusting the significance level using the Bonferroni correction method, set at 0.0125.

Results

The outcomes of cleaving the laser fiber with ceramic scissors and a cleaving pen, comparing the use and non-use of the Laser Holder, were measured on the basis of the dispersion of laser light, the energy output of the laser fiber, and changes in the shape of the laser fiber's cut end. Additionally, the effectiveness of the Laser Holder was also evaluated. The study findings are as follows:

1. Laser Fiber Cleaved Results

The study found statistically significant differences (p-value<0.01) in the results of cleaved laser fibers with

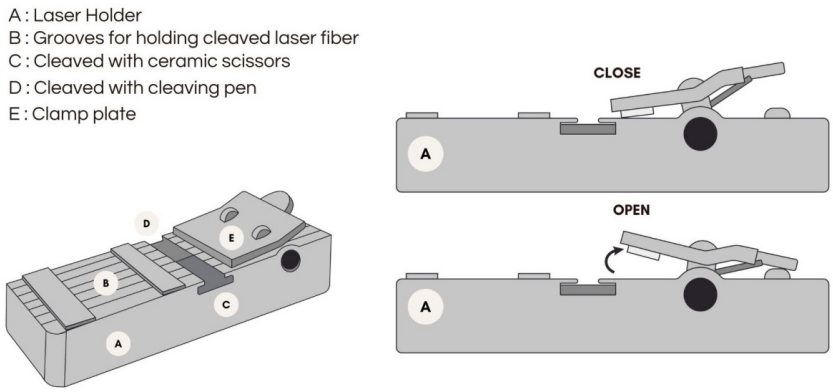
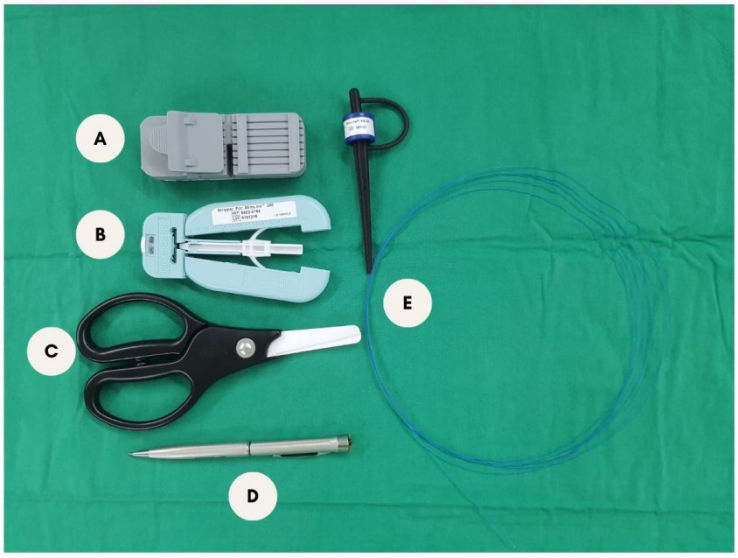


Figure 1 Model of laser holder



A = Laser Holder
B = stripper
C = ceramic scissors
D = cleaving pen
E = laser fiber 272 micron

Figure 2 Cleaving tools used in this study

A = Laser Holder
B = Ceramic scissors combined with the Laser Holder
C = Cleaving pen combined with the Laser Holder

Figure 3 Using the laser holder

ceramic scissors and a cleaving pen, comparing the use and non-use of the Laser Holder. The group using the laser holder during cleavage achieved better cleaving outcomes.

The energy output results from cleaving the laser fiber with ceramic scissors and a cleaving pen, compared with the use and non-use of the Laser Holder, did not show a significant statistical difference (p-value>0.05). The group using the Laser Holder achieved an energy output close to the preset value, up to 90.22%, which was similar to the group not using the Laser Holder (Table 1).

2. Mean power output as a percentage of assisted laser fiber cleavage.

When comparing the mean power output in watts among the four cleaved methods, there were no statistically significant differences in power output (p-value>0.05) (Figure 4).

3. Light dispersion

compared across the different methods of cleaving laser fibers.

Evaluation of laser light dispersion from cleaved laser fiber with ceramic scissors and a cleaving pen, comparing the use and non-use of the Laser Holder (Figure 5), showed that using the Laser Holder significantly improved the quality of laser light dispersion, aligning it with acceptable standards. This improvement was statistically significant compared to the traditional methods using ceramic scissors and a cleaving pen without the holder (p-value<0.01).

Comparison of light dispersion between cleaving with ceramic scissors and the Laser Holder (A) and cleaving with only ceramic scissors (B) showed no significant statistical difference (p-value>0.05), indicating that the use of the Laser Holder with ceramic scissors does not affect light dispersion.

Comparison of light dispersion between the cleaved with a cleaving pen and the Laser Holder (C) and the cleaved with only a cleaving pen (D) showed a significant statistical difference (p-value<0.05), indicating that the use of the Laser Holder with a cleaving pen provides better dispersion than without it.

Table 1 Comparison of laser fiber-cleaved outcomes based on light dispersion and power output with and without the use of the Laser Holder

Laser fiber cleaved results	With the laser holder (n=20)	Without the laser holder (n=20)	p-value
Good light dispersion	14	5	0.004*
Mean power output in percentage (S.D.)	90.22 (4.95)	89.42 (2.46)	0.525

*p-value<0.0125, S.D.=standard deviation

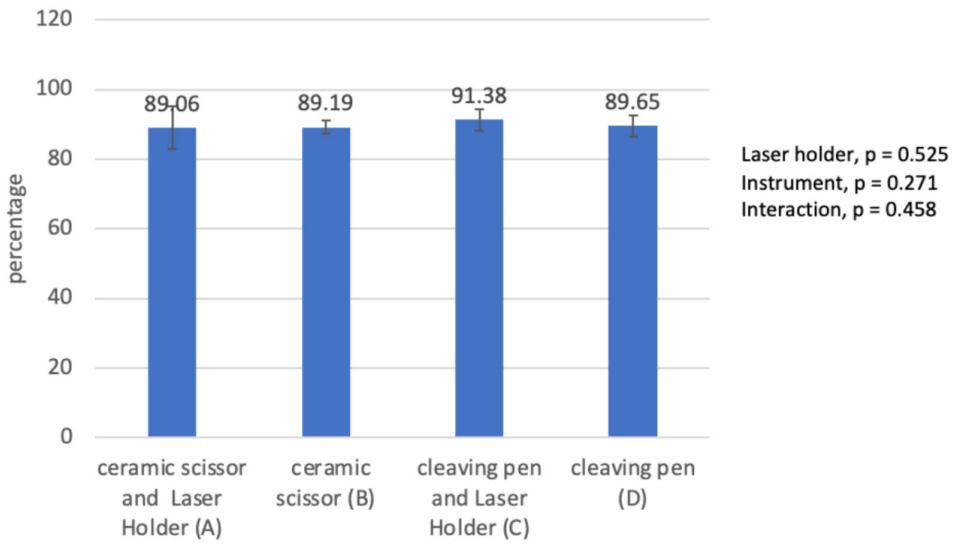


Figure 4 Mean power output as a percentage of assisted laser fiber cleavage

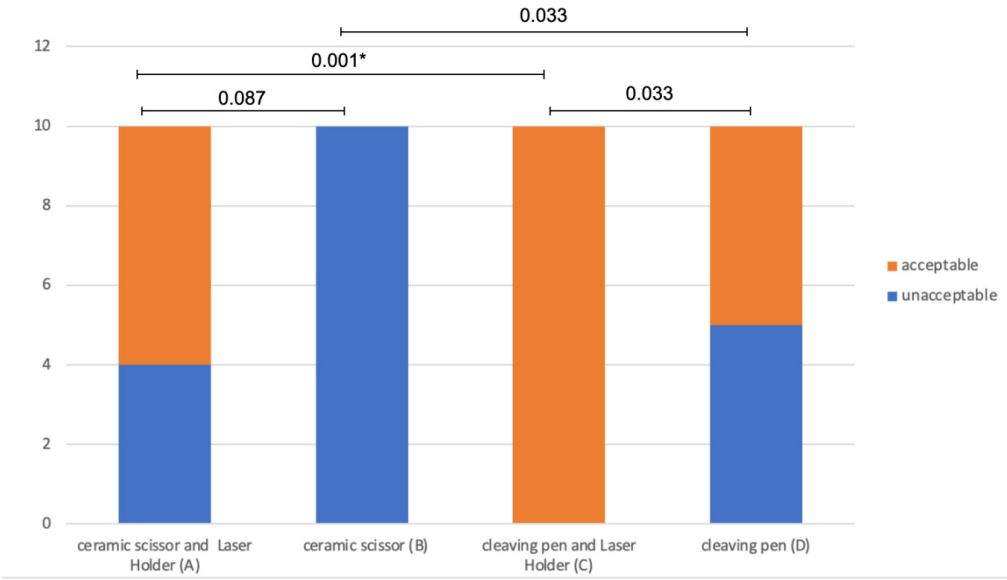


Figure 5 Light dispersion laser fiber cleavage

4. Light dispersion and morphology

According to the manufacturer's guidelines, light dispersion, a characteristic of the laser beam, is deemed 'good' if it forms an ideal and acceptable circular shape. If the light dispersion is not circular, it is considered to be 'unacceptable.' Methods A and C provided the best circular light dispersion, while Method D was acceptable (Table 2); hence, all three methods resulted in good light dispersion. However, Method B resulted in unacceptable light dispersion and, therefore, is considered to have bad light dispersion.

The SEM morphology images showed that the new tips were cut smooth and circular. For Methods A, C, and D, the laser fiber tips had a smooth cut on the inner core with minor edge marks. In contrast, Method B resulted in a relatively smooth inner core cut with more noticeable cracks and damage around the sheath.

5. Evaluation of the laser holder

The evaluation of the Laser Holder found that it provided stability while cleaving the laser fiber with ceramic scissors and a cleaving pen, compared with the use and non-use of the device (Table 3). There were no significant statistical differences in ease of handling (p-value>0.05). However, overall satisfaction with the use of the Laser Holder, especially satisfaction with the light quality measurement screen located at the base of the device, was significantly higher (p-value<0.01). The device was found to be appropriately sized, easy to use, and significantly better at measuring light dispersion than not using it (p-value<0.01).

Discussion

Accurate cleavage of reusable laser fibers is essential to preserve their optimal functionality. This study quantitatively assessed the impact of cleaving with ceramic scissors and a cleaving pen after utilizing the 'Laser Holder' assisted laser fiber cleavage on power output, illustrating the morphological alterations through microscopic analysis. The experimental findings regarding light dispersion are crucial for understanding the clinical implications and operational efficiency in laser-based urological procedures, particularly in laser lithotripsy.

Table 2 Light dispersion from laser fiber tips and morphology images with scanning electron microscopy after cleaving-assisted laser fiber cleavage

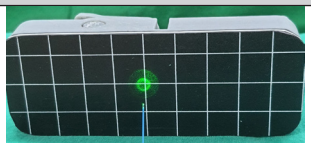
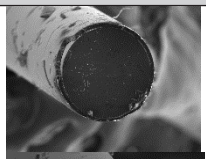
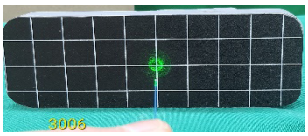
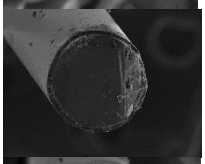
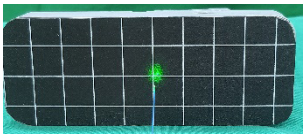
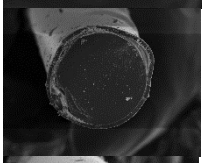
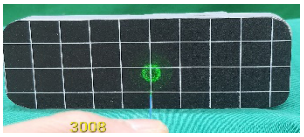
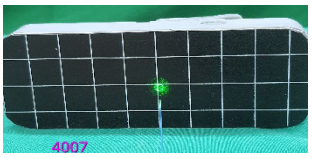
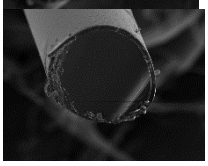
Technique	Light dispersion	Morphology
New Tip		
Method A: Cleaved the laser fiber with ceramic scissors combined with the Laser Holder.		
Method B: Cleaved the laser fiber with ceramic scissors without using the Laser Holder.		
Method C: Cleaved the laser fiber with a cleaving pen combined with the Laser Holder.		
Method D: Cleaved the laser fiber with a cleaving pen without using the Laser Holder.		

Table 3 Evaluation of the Laser Holder after cleaving the assisted laser fiber cleavage

Variable	without using the laser holder (n=20)	combined with the laser holder (n=20)	Chi-square Sig
Using the laser holder			
Stability	10 (50)	16 (80)	0.160
Ergonomics	12 (60)	20 (100)	0.025*
Ease of use	16 (80)	20 (100)	0.136
Overall Satisfaction	12 (60)	20 (100)	0.025*
Use of laser light dispersion screen			
Appropriate size	0 (0)	16 (80)	0.001*
Ease of use	4 (20)	16 (80)	0.007*
Effective measurement	0 (0)	16 (80)	0.001*
Overall satisfaction	0 (0)	16 (80)	0.001*

*p-value=0.05

The importance of light dispersion and morphology observed in this study can be summarized as follows: the efficiency of laser energy delivery is significantly influenced by the interrelation between light dispersion patterns and the cleavage surface morphology of laser fibers. Smooth, planar cleavage surfaces yield uniform light dispersion, predictable by Snell's law of refraction, which accounts for the refractive index difference between silica glass and the interacting material[6]. In contrast, rough cleavage surfaces cause increased light scattering, diverging from the optimal refraction angle specified by Snell's law, leading to diffuse dispersion patterns and reduced laser energy directed at the target[6]. Thus, cleavage surface quality directly impacts the precision and effectiveness of laser transmission, highlighting the importance of smooth surface cleavage for optimal light dispersion and energy delivery[5]. Therefore, light dispersion and morphology play critical roles in the various aspects of endoscopic urological surgery employing lasers for kidney stone treatment, as follows:

Efficiency in Stone Fragmentation: The pattern of light dispersion directly influences the efficiency of kidney stone fragmentation. The ideal light dispersion, which is uniform and circular, ensures a concentrated and powerful delivery of laser energy to the target site[7]. This precision is vital for effectively breaking down kidney stones while minimizing the dispersion of energy to surrounding tissues[7].

Reduced risk of complications: Nonuniform light dispersion can lead to uneven energy distribution, potentially causing incomplete stone fragmentation and requiring additional time and energy to achieve the desired result. This inefficiency not only prolongs the procedure but also increases the risk of heat-related damage to surrounding tissues[8].

Findings of this experiment

Improved dispersion with the laser holder: The experiment demonstrated a significant improvement in light dispersion when using the Laser Holder, particularly with a cleaving pen. This finding is pivotal as it shows that the method of cleaving the laser fiber can have a direct impact on the quality of light dispersion, thereby affecting the overall efficiency and safety of the procedure[8].

Implications for surgical practice: The study suggests that by optimizing the cleaving method of laser fibers, surgeons can achieve better control over light dispersion. This improved control can potentially lead to more precise stone fragmentation, a reduced risk of tissue damage, and, overall, more efficient surgical procedures[7].

Standardization of practices: These results highlight the need for standardization in the preparation of laser fibers for urological surgeries. By adopting methods that enhance light dispersion, such as using a Laser Holder, surgical teams can improve the predictability and safety of laser lithotripsy.

This study faced several limitations that should be acknowledged. The choice of cleaving tools and methods may limit the broader applicability of our findings. The size and diversity of the laser fiber samples used might also affect the strength and generalizability of the results to various clinical scenarios. Additionally, the specific techniques used to evaluate light dispersion and power output could introduce bias or might not capture all the clinically relevant effects. Lastly, controlled experimental conditions may not fully reflect the complexities of actual surgical settings, which could influence how these findings apply in practice.

Conclusion

The experiment underscores the critical role of light dispersion in the effectiveness of laser-based procedures. The ability to achieve optimal light dispersion through the use of tools such as the Laser Holder can significantly impact the success rate of lithotripsy, patient safety, and procedural efficiency. These findings advocate for a reevaluation of the current practices and suggest

incorporating standardized methods to prepare laser fibers for enhanced clinical outcomes.

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References

1. Faaborg D, Miao E, Hodgson H, Peplinski B, Myklak K, Alsyouf M, et al. The effect of laser fiber tip cleaving technique upon risk for ureteroscope damage or ureteral injury. J Urol 2015;193:4S.
2. Jongjitaree K, Subpayakorn C, Taweemonkongsap T, Leewansangtong S, Srinualnad S, Chotikawanich E. The effect of laser fiber on the damage of the working channel of a flexible ureteroscope. Heliyon 2020;6:e05337.
3. Vassantachart JM, Lightfoot M, Yeo A, Maldonado J, Li R, Alsyouf M, et al. Laser fiber cleaving techniques: effects on tip morphology and power output. J Endourol 2015;29:84-9.
4. Peplinski B, Faaborg D, Miao E, Alsyouf M, Myklak K, Kelln W, et al. The effect of laser fiber cleave technique and lithotripsy time on power output. J Endourol 2016;30:678-84.
5. Mues AC, Teichman JM, Knudsen BE. Quantification of holmium: yttrium aluminum garnet optical tip degradation. J Endourol. 2009;23:1425-8.
6. Walter B, Marschner SR, Li H, Torrance KE. Microfacet models for refraction through rough surfaces. In: Proceedings of the 18th Eurographics conference on Rendering Techniques; 2007 Jun 25; p.195-206.
7. Black SE. Laser ablation: effects and applications. [homepage on the Internet]. New York: Nova Science Publishers, Inc; 2011. Available from: https://research-ebsco-com.ejournal.mahidol.ac.th/linkprocessor/plink?id=9824ae59-2cb9-35bf-996e-9c6a5521ab24
8. Duchamp JG. Evaluation of holmium: YAG laser optical fibers for flexible ureteroscopy using a relevant benchtop model. EndoBeam™ White Paper; 2012.