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Durability of The MOSES 2.0 Laser for Urologic Surgery at A High-Volume Tertiary Care Center

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Abstract

Objectives: To provide a real-world analysis on the durability of the MOSES 2.0 Holmium Laser at a high-volume institution for laser lithotripsy and prostate enucleation.

Methods: We collected laser case logs from 4 MOSES 2.0 lasers acquired in 2019-2020 at a single high-volume institution used by 25 staff urologists. We collected the number of cases performed, amount of laser energy, laser time, and days of use. All maintenance requests and actionable results for the 4 lasers were collected. Date of request and result of request were recorded. Descriptive statistics were performed on the collected laser characteristics with SPSS.

Results: Each laser was used for an average of 1207.05 days with an average case volume of 899.25 cases per laser. There was a total of 25 maintenance requests with an average of 6.25 requests per laser. The most common actionable result of the request was part replacement (40.7%) followed by filter changes (29.6%). The lasers were used for an average of 484.75 days and 321.25 cases before their first maintenance request.

Conclusions: "The MOSES 2.0 laser can be expected to have high durability and perform a high volume of endourologic cases prior to requiring maintenance".

Keywords: Benign prostatic hyperplasia, MOSES, Holmium laser, Prostate enucleation, lithotripsy

Introduction

The first laser was invented in 1960, and lasers have since captured the imagination of scientists and sci-fi fans alike [1]. In modern urology, lasers are very much a reality and are used on a near daily basis for the endoscopic surgical treatment of urologic conditions such as nephrolithiasis and benign prostatic hyperplasia. With its precision and kinetic properties, the holmium laser specifically is the most commonly used energy modality for lithotripsy and prostate enucleation [1,2].

Over the last two decades, lasers have undergone significant innovation and optimization for urological surgery. The MOSES 2.0 holmium laser is the newest generation of modulated pulsed holmium laser technology by Boston Scientific. The pulse modulated technology allows for urologists to improve their lithotripsy and enucleation efficiency by up to 20-33%, thereby significantly reducing operative times and improving patient outcomes [3-5]. However, limited information is available on the durability of the current era holmium lasers. While pulse modulation has been shown to improve outcomes of enucleation and laser lithotripsy [3-5], to our knowledge there is no literature describing the durability of the MOSES 2.0 holmium laser and maintenance expectations to guide urology practices seeking to adopt and purchase this technology. Our objective is to provide a real-world analysis on the durability of the MOSES 2.0 laser used at a high-volume tertiary care center.

Methods:

At our single high-volume tertiary care center, four high-powered MOSES 2.0 holmium lasers were acquired, 1 in 2019 and 3 in 2020 (Table 1). These lasers were available for surgical use to 25 staff urologists during the studied time period. Case logs for these lasers were automatically generated, detailing the laser settings, amount of laser pedal time ("foot on the pedal"), and amount of laser energy delivered for each surgical case. These case logs were downloaded and analyzed with descriptive statistics. For each laser, we recorded days of use, number of cases performed, laser pedal times, and laser energies. In addition to routine servicing, these four MOSES 2.0 lasers were also sent for repair or maintenance as needed. Reports were created for each maintenance, including the actionable results of maintenance which were collected and incorporated in our descriptive analysis.

Table 1: Laser Acquisition dates and Date of last case.

	Laser #1	Laser #2	Laser #3	Laser #4
Acquisition date	9/3/2019	2/25/2020	2/25/2020	10/28/2020
Date of last data collection	10/11/2023	5/11/2023	2/10/2023	10/11/2023
Total days of use	1499 days	1171 days	1081 days	1078 days

Results

For our four MOSES 2.0 lasers, there was an average total day of use of 1207.25 days per laser (range: 1078-1499 days; Table 1), with an average number of cases per laser of 899.25 cases per laser (range: 523-1202), for a total of 3597 cases. The lasers produced an average amount of energy of 47,941.5 kJ (range: 9851-103,051 kJ) per laser over their days of use for a total energy delivered of 191,766 kJ collectively from the four lasers. There was an average laser pedal time of 13,318.25 min (range: 4608-24,937 min) per laser, for a total laser pedal time of 53,273 min or 887.88 hours

There was a total number of 25 maintenance requests (MR) and an average number of 6.25 MR (range 4-9 requests) per laser during this timeframe. Actionable results of MR included: software update, part replacement, routine maintenance (no fault found), filter change, and equipment adjustment/calibration (Table 2). For each laser, the number of cases and days before the first MR and their averages are shown in Table 3, as well as the number of MR per laser and the number of cases per MR, laser energy per MR, and laser pedal time per MR and their averages.

Table 2: Actionable results of maintenance requests (MR).

Result of maintenance request:	N (total = 27 reasons for 25 MR)	%
Software update	3	11.10%
Part replacement	11	40.70%
No fault (routine maintenance)	3	11.10%
Filter change	8	29.60%
Equipment adjustment/calibration	2	7.40%

Table 3: Characteristics of laser utilization and maintenance requests (MR) per laser.

	Laser #1	Laser #2	Laser #3	Laser #4	AVERAGE
Days of use before 1st MR	675	444	500	320	484.75
Cases before 1st MR	419	347	223	296	321.25
Total # MR	7	4	5	9	6.25
Cases per MR	151.29	203.25	104.6	133.56	148.17
Days of use per MR	214.14	292.75	216.2	119.78	210.72
laser energy (kJ) per MR	4946	11060.5	1970.2	11450.11	7356.7
Laser pedal time (min) per MR	1634	3072.5	921.6	2770.78	2099.72

Discussion

Urology, and particularly endourology, is a highly adaptive dynamic field which celebrates invention and innovation. This willingness to adopt and implement pioneering technology has resulted in the boom of minimally invasive surgery and techniques, ultimately yielding significantly improved urologic outcomes for patients. Newer technologies, however, are also coupled with increased costs which can be a significant barrier to urologists or hospitals seeking to adopt the latest advancements. To purchase newer technologies, urologists need to demonstrate clinical benefit as well as perform a cost-analysis, with an understanding of the durability of the new technology to project expectations and future costs. A significant number of quality analyses of newer urologic equipment have been performed and published, looking at the durability of flexible ureteroscopes [6], the DaVinci Robot [7], and reusable laser fibers [8]. However, there is no literature available describing the durability of the MOSES 2.0 holmium

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laser. We sought to address this gap in knowledge and provide a descriptive analysis on the durability of MOSES 2.0 to assist urologists and hospital systems seeking to adopt this advanced laser technology.

The MOSES 2.0 laser certainly represents a significant capital cost to urologists and hospital systems. However, the MOSES 2.0 laser has also demonstrated clinical benefit and cost-savings compared to the prior generation of lasers for prostate enucleation. Lee et al demonstrated that MOSES 2.0 technology resulted in a cost-savings of $840 per prostate enucleation compared to the conventional holmium laser [9]. For lithotripsy, there is differing data on whether advanced laser technology ultimately yields cost savings. Stern et al reported that there was not a cost-saving benefit from the first-generation MOSES technology for laser lithotripsy [10]. However, early results from MOSES 2.0 trials on laser lithotripsy demonstrated significant improvements in laser efficiency and performance [11]. It is yet to be discerned whether MOSES 2.0 offers significant cost-savings for laser lithotripsy.

From our single high-volume tertiary center, we employed four MOSES 2.0 holmium lasers to perform a total of 3597 cases over a duration of approximately four years. Over these four years, we delivered a total of approximately 191 megajoules for treatment of nephrolithiasis and prostate enucleation. This is the kinetic energy equivalent of approximately two Tour-De-France's by a 65kg cyclist. We delivered this energy over 887.88 hours of laser pedal time. From this high-volume utilization of MOSES 2.0, we garnered an in-depth understanding of the durability of this technology.

We identified that the lasers could be used for an average of 321.25 cases over an average of 484.75 days before requiring their first MR. A urologist or hospital system could expect to use the MOSES 2.0 laser for nearly full calendar year before needing servicing (Table 3). Over the lifetime of these lasers, however, the average number of cases and days per MR is less at 148.17 and 210.72 respectively. The most common reasons for maintenance included part replacement (40.7%) and filter changes (29.6%) (Table 2).

Our study is limited by its retrospective nature. Because of this, we do not have a detailed understanding of the reasons for maintenance requests. There were three requests where nothing was identified to be at fault and only routine servicing was performed. Furthermore, there was some heterogeneity to laser use and case type performed. The lasers were available to all staff urologists and the specific surgeons are not detailed in the laser case logs. In addition, the type of case (e.g., prostate enucleation versus lithotripsy) was not documented. This heterogeneity, however, allows for a more accurate representation of real-world use of the MOSES 2.0 laser.

Conclusion

The MOSES 2.0 laser can be expected to have a high durability and perform a high volume of endourologic cases prior to requiring maintenance. The most likely reason for requiring maintenance is part replacement, followed by filter changes.

Author Contributions

i. Perry Xu was involved in conceptualization, data curation, formal analysis, investigation, visualization, and writing.

ii. Clarissa Wong was involved in data curation, methodology, and review.

iii. Kyle Tsai was involved in data curation, methodology, and review.

iv. Amir Patel was involved with methodology and review.

v. Amy Krambeck was involved in conceptualization, methodology, project administration, supervision, and editing.

Declarations

Competing Interests: Dr. Amy Krambeck is a consultant for Boston Scientific, Wolf, Storz, and Virtuoso Surgical. She is a data safety monitoring board member of Sonomotion and Uriprene. The other authors have no conflict of interests or disclosures.

Availability of Data and Materials: Data including statistical data files may be provided on request but are not publicly available.

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