The Moses holmium system – time is money

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Introduction: *The Moses technology of the holmium laser has been shown to decrease retropulsion in the ureter and procedural time in kidney stones during laser lithotripsy. Theoretically, these improvements could lead to cost savings for the patient.*

Materials and methods: *All patients with total laser energy data recorded who underwent ureteroscopy with laser lithotripsy by a single surgeon at a tertiary care center were included. Total lasing time was calculated from the total laser energy. Sub-analyses were done on stone size and stone composition. The procedure time using Moses technology was projected to be approximately 35% less than procedure time without the Moses technology based on prior in vitro studies. The projected cost savings was then utilized to predict cost-effectiveness of the Moses technology.*

Results: *Forty patients underwent ureteroscopy with laser lithotripsy. Mean stones size was 10.2 mm and mean lasing time was 3.02 minutes. Linear regression showed a positive association between stone size and laser time, p = 0.01. There was no significant correlation between stone composition or stone Hounsfield units and lasing time. On cost analyses, for stones of all sizes the Moses system has a price differential of an increase in $292.36 when compared to the standard Holmium TracTip system. Specifically for stones larger than 10 mm, the price differential is an increase in $253.16 for the Moses technology.*

Conclusion: *The decrease in lasing time achieved by the Moses system does not translate into sufficient cost savings to off-set the higher cost of the laser fiber and software.*

Key Words: costs and cost analysis, urolithiasis, lasers

Introduction

Ureteroscopy with laser lithotripsy is now the cornerstone of the surgical treatment for small to medium sized ureteral and kidney stones. Given the increasing popularity and use of ureteroscopy with laser lithotripsy in recent decades, scientific research has turned to trying to improve laser technology, with various companies working to be at the forefront of stone surgery.[1-3] One such novel innovation is the Moses technology for the Holmium laser. This technology uses a specialized laser pulse to first separate the fluid around the stone, to allow energy to be delivered directly to the target.[4] This technology has been shown to be more efficient in stone fragmentation with a shorter procedural time and has been shown to decrease retropulsion in the ureter.[5] Theoretically, these improvements could lead to cost savings for the patient given the hefty cost of operating room time (approximately $100 per minute). This study seeks to predict if the Moses technology is cost effective during ureteroscopy with laser lithotripsy.

Materials and Methods

All patients with total laser energy data recorded who underwent ureteroscopy with laser lithotripsy for ureteral or kidney stones by a single surgeon at a tertiary care center were included. Total lasing time was calculated from the total laser energy, given that all patients underwent laser lithotripsy with stone fragmentation at the same settings, 0.8 Joules and 8 Hertz. Sub-analysis with binary measurements was done on stone size and stone composition to see if there was a significant correlation with lasing time. The procedure time using Moses technology was projected to be approximately 35% less based on prior in vitro studies. The projected cost savings was then utilized to predict cost-effectiveness of the Moses technology utilizing $358.16 as the price differential between a Moses laser fiber and a Boston Scientific TracTip fiber (list price $919 versus $560.84), $39,900 as the price differential for Moses software amortized over 1000 procedures, and $100 as the cost per minute billed to insurance for our ureteroscopy procedures.

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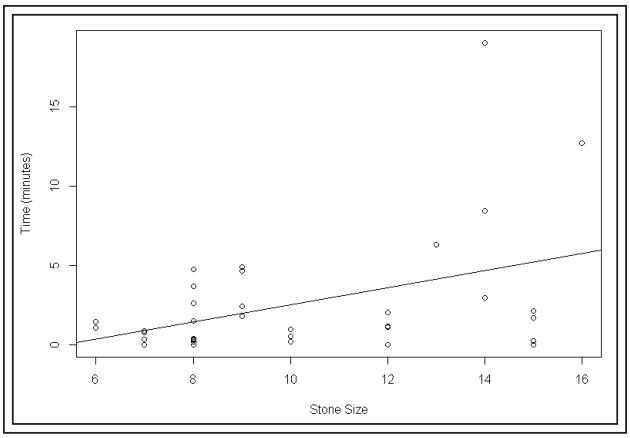

Figure 1. Linear regression analysis of stone size and laser time, p = 0.01.

Results

Forty patients underwent ureteroscopy with laser lithotripsy. Twenty-one patients had kidney stones, 17 ureteral stones, and 2 patients had both ureteral and kidney stones. The mean lasing time was 3.02 minutes and median time was 1.43 minutes. Mean stone size was 10.2 mm (range 6 mm-16 mm). Linear regression showed a positive association between stone size and laser time, p = 0.01, Figure 1. On binary analysis, there was a significant difference in lasing time for stones larger than 10 mm and stones equal to or less than 10 mm. The average lasing time for stones > 10 mm was 4.14 minutes versus 1.60 minutes for stones ≤ 10 mm (p = 0.03) with an estimate effect of 2.91 minutes, Figure 2.

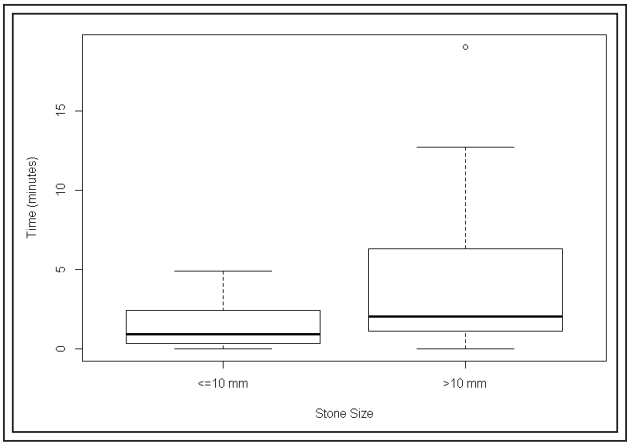

Figure 2. Binary effect of stone size on laser time. Stones larger than 10 mm had a significantly longer lasing time than stones equal to or less than 10 mm, p = 0.03.

Thirty-six patients had data on stone composition. Twenty-two patients had a majority (≥ 50%) calcium oxalate stone composition, 11 had a majority calcium phosphate, and 3 patients had a composition mostly non-calcium based. Laser time was not significantly affected (p = 0.10) by stone composition.

Thirty-one patients had data on the Hounsfield units of the stones treated. The other 9 patients had outside imaging that was not available for review. Binary analysis of stones with Hounsfield units more than 1000 or less than 1000 yielded insignificant results with respect to laser time, with an effect estimate of -2.06 minutes (p = 0.31).

Cost analyses was done using both mean lasing time for all stones and stones larger than 10 mm. For stones of all sizes, the mean lasing time was 3.02 minutes. Calculating the cost with the Moses system, the laser cost differential of $358.16 and software upgrade of $39.90 were added. Assuming $100 per minute the OR time with the Boston Scientific TracTip laser would cost $302. Assuming a 35% decrease in procedure time, the Moses system would lead to an OR cost of $196.30. In total, the Moses system has a price difference of an increase in $292.36 for stones of all sizes.

Specifically for stones larger than 10 mm, similar calculations were made. The mean lasing time was 4.14 minutes, leading to an estimated lasing time of 2.691 minutes assuming a 35% decrease. The same difference in laser fiber price and software upgrade applies. For stones larger than 10 mm the price differential is an increase in $253.16 for the Moses technology versus the standard TracTip Holmium system.

Discussion

Upper urinary tract urolithiasis is an extremely prevalent disease, affecting 8.8%-15% of people in the United States, with the incidence increasing.[6,7] Throughout the past three decades, the development and improvement in ureteroscopic treatment options have led to a revolution in the minimally invasive treatment of stone disease. Some estimate that ureteroscopy for the surgical management of upper urinary tract calculi has increased 103% to 251%.[2,3] Given the increasing utilization of ureteroscopy and laser lithotripsy, significant research has been dedicated to its improvement and efficacy. Recently, Lumenis developed a new technology for the holmium laser called the "Moses" technology. This technology modulates the laser pulse to first separate the water surrounding the stone from the stone, which then allows direct delivery of the remaining energy to the stone.[4,8] This technology is aimed to improve stone fragmentation efficiency and decrease stone

retropulsion, which can lead to a more difficult and less effective procedure.

Several studies have evaluated the Moses technology. Elhlali et al evaluated the Moses system in vitro and in the porcine model. They found significantly reduced retropulsion with the Moses fiber as well as higher stone ablation volumes and higher fiber flexibility in the in vitro model. In the porcine model, they confirmed a significant decrease in retropulsion without any difference in bleeding noted. There was no significant difference in lasing time or procedural times.[4] Ibrahim et al also looked at the Moses system in both a stone simulator model and in vivo in a 22 patient pilot clinical study. In the simulator study there was decreased retropulsion and decreased procedure duration in both the dusting and fragmentation models. In the fragmentation model, the decrease in procedural time was approximately 35% (13.9 min versus 9.1 min), which is the approximation we used in our calculations.[5] Mullerad and colleagues looked at urologist satisfaction, comparing the Moses system to the traditional holmium lithotripsy. Urologists noted excellent fiber durability and flexibility in most procedures. Stone retropulsion minimization was noted to be excellent or good in 18 of 23 procedures. In three procedures, surgeons described the Moses technology as much better than the traditional holmium technology and in 15 procedures it was ranked better. Although not statistically significant, the stone fragmentation rate with the Moses technology was faster (approximately 40%) than the standard system.[8]

While the existing literature seems to indicate that the Moses technology is an improvement in the standard Holmium laser system, the cost benefit remains unknown. Health care costs are increasing, with recent research estimating that the United States health care costs increased $933.5 billion between 1996 to 2013.[9] Health care costs in 2015 made up 17.8% of the United States economy.[9] A significant portion of the increase is proposed to be secondary to service price increases.[9] These estimations indicate the necessity to decrease health care costs, when available. Operating room costs were estimated to be $22-$133 per minute, depending on the complexity of the case back in 2005, and have likely increased.[10] At our tertiary care center the operating room costs in 2016 were $66 to $124 per minute after the first 30 minutes of the procedure, depending on the complexity of the procedure. That cost does not include the anesthesia cost, physician fees, or equipment fees. In our study we determined that ureteroscopy is likely billed as a mid-level complex case, and we estimated the OR costs to be approximately $100 per minute. These costs may differ, up or down, on an individual facility basis or with each case specific complexity.

This study looks to see if there would in fact be a cost benefit to utilizing the Moses system for the surgical management of upper urinary tract calculi. For all stone sizes, and stones specifically larger than 10 mm, there was no cost benefit. In fact, the Moses system was estimated to cost $292.36 and $253.16 more, respectively, for an individual case. The laser fiber cost differential and the system upgrade, amortized over 1000 procedures add an additional $398.06 to each case. The laser time decrease, assuming a 35% decrease based on prior literature, does not translate into significant enough savings to justify the use of the system on a cost analysis basis. However, decreasing stone retropulsion can theoretically increase stone clearance rates by decreasing stone fragments that are pushed up into the kidney during ureteroscopy and may not be removed during the procedure. Ultimately, this could lead to a decrease in secondary procedures, and thus, significant cost savings. In addition, the cost estimates for the laser fiber were based on full price company estimates, and not the price that that surgical centers, particularly busy tertiary care urologic centers, may pay for the laser. A significant decrease in laser price could make the Moses system cost advantageous over the standard Holmium system for the surgical treatment of upper urinary tract calculi, however the Lumenis Pulse 120H laser platform is a closed system that will only recognize Lumenis lasers so the opportunity for market-driven cost migration is limited.

Limitations of our study include the theoretical application of the Moses technology in the calculations instead of actual laser time data using the Moses system. In addition, the research indicates that procedural time is decreased, which we assumed to be equivalent to laser time. The sample size is small secondary to some limitations on laser energy data collection in the operating room. In addition, there is no direct comparison to lasers with varying pulse widths. Several studies assess pulse width and the effect on retropulsion, but they do not quantify time saved in vivo.[11-13]

Conclusion

The decrease in lasing time achieved by the Moses system does not translate into sufficient cost savings to off set the higher cost of the laser fiber and software. If the laser fiber price were decreased significantly or a reduction in total procedure time of 4 minutes or greater were accomplished due to decreased stone retropulsion, a cost savings could be realized. □

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