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

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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 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.
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.

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
portion of the increase is proposed to be secondary to
17.8% of the United States economy. A significant
1996 to 2013. Health care costs in 2015 made up
health care costs increased $933.5 billion between
with recent research estimating that the United States
remains unknown. Health care costs are increasing,
standard Holmium laser system, the cost benefit
that the Moses technology is an improvement in the
system. 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. 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.

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. Health care costs in 2015 made up
17.8% of the United States economy. A significant
portion of the increase is proposed to be secondary to
service price increases. 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. 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.

Conclusion

The decrease in lasing time achieved by the Moses
system does not translate into sufficient cost savings
to offset 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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References


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