Is Very High Power/ Frequency Really Necessary During Laser Lithotripsy? RE: Understanding the Popcorn Effect During Holmium Laser Lithotripsy for Dusting (Aldoukhi et al, Urology. 2018 Dec;122:52-57)

TO THE EDITOR:

While the endourologic community is still wondering about the most effective laser settings and strategies for intracorporeal lithotripsy, Aldoukhi et al[1] recently tested in a laboratory setting different popcorning scenarios. Aside from the main study outcomes, the authors concluded that overall results trend favored using the highest frequency settings possible, regardless of pulse energy. More specifically, they claimed that settings with higher frequency may improve dusting outcomes.

We gladly welcome such studies aiming at improving stone treatment, and the authors should be complimented for their efforts. However, we believe that it is not clearly demonstrated that high frequency in a high power setting is clearly superior. As shown in Figure 2, popcorning at 0.5 J and 80 Hz is faster than using 40 Hz, but does not results in higher percentage of fragments <1 mm. As a whole, we should all be more cautious in defining what dust and dusting really are even in presence of fragments <1 mm, since clear evidence at this regard is currently lacking.[2] Some other aspects deserve further discussion.

One of the purposes of working at very high frequency is to increase lithotripsy speed.[2] With this premise, it is possible to observe a linear relationship in a laboratory setting between frequency and working speed, as the authors brilliantly showed. As the real-life experience disappointingly reminds us every day, our practice is hardly linear. When it comes to laser lithotripsy during flexible ureteroscopy, at least 3 intervening factors derange this linear effect. First, the issue of quality of vision. The authors themselves declared in the method section that better visualization and quantification of the fragmentation process at 80 Hz with the high-speed camera required using a lower number ($n = 3$) of stones in the caliceal mode as compared to the lithotripsy experiments ($n = 10$). Second, the issue of caliceal distensibility. Popcorning on a solid glass surface results in a more efficient process due to the fragments bouncing back after hitting the solid walls; however, caliceal distensible walls absorb more kinetic energy and reduce this bouncing effect.[3] Third, as a consequence, the issue of microbleedings. Hypothetically, faster popcorning speed can stochastically cause a higher number of fragments to hit the caliceal walls; this repeated microtraumatism could increase the risk of bleeding, which could further interfere with the quality of vision.

As a whole, we are not dully standing against the use of very high frequencies. We believe that they will be able to play a major role in achieving better dusting, provided that all the above listed limitations will be worked out.

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Reply to: Letter-to-the-editor: Understanding the Popcorn Effect During Holmium Laser Lithotripsy for Dusting

We thank the authors for their interest in our study. Our fundamental finding was that increasing the pulse frequency and the overall power led to significantly more fragmentation during popcorning. This was similar to what was also reported by Emiliani et al.[1] Moreover, we found that increasing the distance between the fiber tip and the stone decreased fragmentation. As noted, figure 2 showed that the percentage of submillimeter fragments when utilizing 40 Hz and 80 Hz at 0.5 J was 67% and 73%, respectively. These results were obtained when the fiber was initially placed in contact with the stone. However, when the fiber to stone distance was increased to 2 mm, the difference between these 2 laser settings was more pronounced; the percentage of submillimeter fragments when utilizing 40 Hz

and 80 Hz were 41% and 66%, respectively, with most of the fragments >2 mm in size with the 40 Hz setting.

Indeed, we agree that the quality of vision during laser lithotripsy can be affected when using high frequencies during dusting. Currently, one can overcome this issue by increasing the irrigation rate. This may lead to an increase in the intrarenal pressure and such cases might require the use of a ureteral access sheath. It is possible that use of pulse modulation, 1 example is the newly launched Moses Technology, may allow us to do dusting utilizing high frequencies while maintaining better vision. More importantly, current ureteroscopes are not optimized for dusting technique. New endoscopes are required, which are fit for purpose, to address both the issues with vision, and heat generation when using high power settings.[2]

Laboratory studies that investigate optimal laser settings have limitations, and do not simulate the complete clinical scenario. While a glass model might not mimic the compliance and distensibility of the urinary tract, using rigid models is the current investigative standard with prior studies utilizing glass, 3D printed, and vacutainer models.[1,3-5] These models allow for visualization and high-speed imaging analysis. We lack an appropriate simulated model and further work is needed to develop one.

Regarding the comment on microbleeding when using high frequency during popcorn laser lithotripsy, we have not noticed bleeding in our clinical experience with this technique. The situation in which we have observed bleeding is when the laser pulse fires on the calyceal wall. In particular, we have noticed that bleeding is pulse energy dependent and is more likely to occur when using 1 J versus 0.5 J. This is why we prefer to use 0.5 J and 80 Hz, and more importantly to keep the fiber away from the stone (2 mm distance). As noted above, this setting ensures that we maximize stone fragmentation when the fiber is away from the stone. Another advantage of using pulse energy of 0.5 J versus 1 J, is that it limits fiber burnback, another important variable determining lithotripsy efficiency.

DISCLOSURES

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References

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