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Transmission efficiency laser fibers – Characteristics of different models during straight and bent configuration

A.M. Khoshbakht[1], C. Bach[2], N. Buchholz[2], M. Knight[1]
[1] *Queen Mary University of London, London, United Kingdom*
[2] *Barts and The London Nhs Trust, London, United Kingdom*

Background and Purpose: Flexible ureteroscopy for stone fragmentation obliges transmission of laser energy through an optical fiber. The more the scope is deflected, the more strain is put on it and breakage of fiber and consecutively the instrument has been reported. This is especially an issue for lower pole stones where the strong bending during energy transmission could stress the laser fibers beyond safe limits. In this study we test the hypothesis that Holmium:YAG laser fibers from different manufactures differ in performance and safety under such conditions.

Materials and Methods: Transmission efficiency of 200mm multimode step index laser fibers from five different manufactures American Medical System Fiber (AMS), Femcare-Nikomed, LEONI Fiber Optic GmbH, Electro Medical System (EMS) and Dornier-MedTech (Olympus) were tested in a newly developed model: The fiber was inserted through a ureteral catheter and flowed round with saline at a constant rate. With a power detector (Ophire NOVA II) the difference between energy input and output was measured at different energy and frequency settings (0.5 – 1.2 J and 5,10,15 Hz) first in a straight configuration and then after bending them by 180^0 with a diameter of 2.5 cm. Finally, the same fibers were tested again in the straight configuration and the power detector was calibrated by reducing the length of the fiber every 10 cm before straight testing. We used the VersaPulse Holmium® Laser and statistical analysis was performed using paired t-test using Mac: Excel 2011.

Results: The fibers from AMS and LEONI did not reliably tolerate more than 18 watts (n=3) in the straight configuration so no further testing was performed. In the straight configuration with all energy setting the fiber from Nikomed had the highest transmission efficiency, EMS was next and finally Olympus respectively (figure1). In the bent state, the transmission efficiency decreased considerably. The mean differed among fibers in bending configuration. The EMS and Nikomed had a more or less no significant result with different energy and frequency setting at 180^0 curvature($P>0.05$) it does this mean there was no difference using different settings (figure2). In addition, EMS and Nikomed were slightest significant after curvature ($P<0.05$). The rest of fibers had significant result in each set up ($P<0.001$). The power output was increased significantly due to reducing of length.

Conclusion: Overall, the results illustrated Fibers from different manufactures differ significantly in transmission efficiency. Even different fibres from the same company differ significantly (n=6). Ideally, fibers transfer energy in straight pattern, however some of them are not consistent and carry high hazard. The transmission efficiency was dropped knowingly after curvature in compare with straight state in particular for Olympus. The results of fibers after curvature were extremely dropped where were turned into straight condition in compare with first test. The highest impact on transmission efficiency has the overall length of the fibre.

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