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In vitro stone disintegration with standardized BON(N) stones comparing the Diode Laser 1.318nm with the Holmium Laser 2.100nm: Evolution of the first multipurpose standard laser in Urology?

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Introduction: Lasers are the standard tool for stone disintegration (SD) in endourology. The diode laser (DL) with a wave length of 1318nm exhibits excellent cutting and coagulating properties, proven for laparoscopic partial laser nephrectomy (lapPNE) and prostate enucleation. Our group investigated histopathological alterations following DL lapPNE in a pig survival model. As efficacy for ablational purposes has been shown, the DL was primarily not considered and evaluated for SD so far. Since first description in 1999, the artificial BON(N) stones have never been evaluated for laser SD. In this study, we compared the DL to the gold standard Holmium laser (HL) in an *in vitro* trial using BON(N) stones.

Material and Methods: BON(N) stones are standardized (mass, volume, diameter, density) uniform artificial stones (Whewellit, Struvit, Cystin), made of natural crystals. Cystin (n=11), Whewellit (n=6) and Struvit (n=7) stones were investigated using HL with a wave length of 2.100nm (Sphinx MPL 40, LISA laser, Katlenburg/FRG, energy level 10 W, frequency 8Hz) and DL with a wave length of 1.318nm (ERASER, Rolle & Rolle, Salzburg/A, energy level 120W, pulse duration 0.1sec, pause 0.1sec). Stones were placed in a customized basket in a 37°C warm, 0.9% NaCl solution. Laser pulse energy was obtained by a PVDF hydrophone (RP acoustics, Leutenbach/FRG) in 5mm distance to the (laser) glass fiber at an angle of 110°. Laser-on time and fragment size were measured.

Results: Average positive/negative peak pressure was 14.6 bar (+/- 5.4bar)/-1.8bar (+/-1.5bar) (DL) and 17.6bar (+/-4.3bar)/-1.9bar (+/-0.8bar) (HL). HL waves were more uniform as those of the DL. Average disintegration time for Cystin was 105 sec (85 - 138 sec, DL) and 128sec (102 - 155sec, HL), for Whewellit 500sec (195 - 780 sec, DL), 464sec (439 - 489 sec, HL) and for Struvit 165sec (43 - 220 sec, DL only). Final fragment size of <1mm was achieved for Cystin in 94.3%/92% (DL/HL), for Whewellit in 68.4%/52.8% (DL/HL) and for Struvit in 85% (DL only). Temperature increased approx. 0.8°C/min during laser-on time (DL only) in 250ml of the 0.9% NaCl solution (starting temperature 37°C, steady state).

Conclusions: Besides the well established coagulation/cutting properties, the DL unexpectedly exhibited excellent stone disintegration power, using artificial BON(N) stones. Based on the findings of this study, BON(N) stones represent a feasible model to investigate stone laser devices. For all tested stone compositions, disintegration rate and laser-on time of the DL were similar compared to the HL. In this steady system, temperature increased slightly during use of DL. Continuative to this preliminary study and prior to set out for human endoscopy investigations, an *in vitro* study will be conducted, evaluating the disintegration of human calculi as well as monitoring the temperature rise during permanent irrigation. In the nearer future, the DL may be step by step established as a universal laser combining several applied properties for urological practice.