

Application report on the Leonardo Dual 100 diode laser unit in upper airway surgery in horses

The **Leonardo Dual 100** diode laser device by BIOLITEC® Group, Germany, was tested for its handling, efficiency and side effects in minimally invasive transendoscopic ventriculocordectomy in horses. In the *ex vivo* test phase, ventriculocordectomy was performed on three laryngeal specimens. The device was subsequently tested in curative use on five horses with *hemiplegia laryngis sinistra*. The **Leonardo Dual 100** laser device proved to be extremely satisfactory in the practical test. We can confirm excellent cutting performance and consistently reliable hemostasis for the device in this application.

Requirements for a surgical laser

Surgical laser incision (a form of destructive laser-tissue interaction) utilizes the energy of the focused light beam. To make the most of the advantages of this procedure and minimize the disadvantages, certain physical requirements must be met. The wavelength of the laser beam must be matched to the target tissue and sufficient laser energy (the so-called wattage), must be available.

A laser device that can be used universally in surgery does not currently exist. When purchasing a surgical laser, the specific area of application is decisive because the emission wavelength of the laser device is tuned to a range of indications. Unfortunately, the laser power (wattage) and the laser price always have a positive correlation. Due to the considerable acquisition costs and special range of application, laser devices are still not part of a basic equipment in veterinary clinics and practices.

Common complications in endoscopic laser surgery of the upper airway.

Due to the endoscopic display of the target tissue, the three-dimensional perception of the working area is reduced. As a result, it is difficult to maintain constant contact between the optical waveguide and the tissue. In other words, one is constantly alternating between contact and non-contact procedures. With weaker laser devices (around 35 W or below), this leads to the fact that when contact is lost between the tissue and the optical fiber, the power of the device is no longer sufficient for the incision. The phenomenon of "repeated traversing of the incision line" with the optical fiber tip usually occurs in case of loss of contact with the tissue and/or insufficient laser power. In such a case, the "repeated traversing of the cutting line" can increase the thermal damage in the tissue.

The most important and also the most frequent complication of transendoscopic laser surgical ventriculocordectomy in horses is bleeding during the procedure. Although such bleeding is usually self-limiting, it makes it difficult to achieve the goal of treatment. The accuracy of the procedure is reduced due to the visual restriction, the so-called "redout" occurs and the duration of the procedure

is prolonged. The next step, laryngoplasty, is usually delayed by several hours until spontaneous hemostasis sets in.

Why did we decide to test the Leonardo Dual 100 by Biolitec®?

Biolitec® diode dual lasers have two emission wavelengths in the infrared range, which can be used simultaneously and whose energy can be regulated independently. The first wavelength $\lambda = 980$ nm, is subject to absorption in tissue by water as well as by hemoglobin and proteins and provides a good

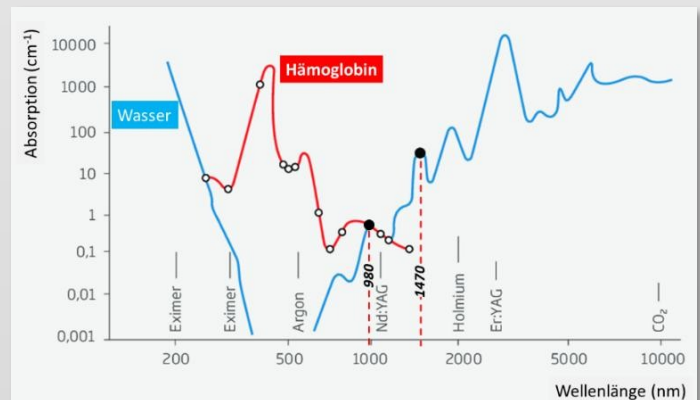


Fig. 1: Absorption curve for light spectrum of 980nm and 1470 nm, for water and hemoglobin.

coagulation. The second wavelength $\lambda = 1470$ nm is predominantly absorbed by water and proteins and provides good vaporization. In the 100 W version, the **Leonardo Dual** should provide sufficient power for all endoscopic procedures in the upper respiratory tract of horses. The 980 nm wavelength is adjustable to a maximum of 85 watts and the maximum output of the 1470 nm wavelength is 15 watts.

The optical fibers for **Leonardo Dual** are available in several versions, depending on the area of application. For endoscopic procedures on the upper airways in horses, the suitable transmission fibers are available in 3m and 5m lengths, in 600 μ m fiber thickness. These can thus be combined with most flexible laryngo-bronchoscopes.

Practical test of the Leonardo Dual 100 by Biolitec®.

The **Leonardo Dual 100** was tested for ventriculocordectomy on three laryngeal specimens and five patients with *hemiplegia laryngis sinistra*. A 160 cm long and 8.0 mm thick videoendoscope with a working channel of 2.3 mm in diameter, was used. The optical fiber had a diameter of 600 µm fused silica core, an outer diameter of 1.2 mm, and a length of 3 m (*Reusable Bare Fiber, REF 503201320*).



In the test phase, ventriculocordectomy, *ex vivo*, was evaluated on three laryngeal specimens. One objective was to test the performance of the device in relation to the variation between contact and non-contact procedures expected under real-life conditions. This is because under real conditions, respiratory movements or minor body movements regularly cause temporary loss of contact. Therefore, the distance between the optical fiber and the tissue was changed several times, arbitrarily, between full contact and a distance of 2-3 mm. The set laser power, as a continuous wave, was 35 to 40 W for the 980 nm and 13 W for the 1470 nm (total power 48 to 53 W). In this application, even in the non-contact process, we were able to observe ourselves of a clean, powerful cutting performance. The second objective was to assess the macroscopic effects on the tissue of the specimen: the color and texture of the incision surface, as well as the width of visible changes around the incision margins. The incision margins showed blackish-brown discoloration (carbonization) and the incision surface was uniformly discolored brownish-beige. The tissue around the incision margins showed no deeper thermal changes by inspection.

The subsequent curative use for ventriculocordectomy was performed in five horses with left-sided laryngeal hemiplegia. The patient group included three warmblood horses (two geldings and one mare, aged between two and four years) and two English Thoroughbred horses (geldings, aged three and five years). The patients were sedated for the procedure with romifidine and butorphanol i. v., and the mucosa of the larynx was locally anesthetized by drizzling 2% lidocaine. In the following, the results obtained with regard to the device setting, vaporization properties, hemostase properties, carbonization behavior and coagulation depth will be specified.

In the first two patients, the power of the continuous laser beam (continuous wave) was set to 35 W for the 980 nm and 15 W for the 1470 nm (total power 50 W). With better patient preparation and a more precise fiber guidance, the laser power could be reduced to 22 W for

the 980 nm and to 13 W for the 1470 nm (total power 35 W). The OR time for the first patient was 55 min, and for patients 2 to 5, the OR time ranged from 20 to 30 min.

The cutting performance of the **Leonardo Dual 100** was extremely satisfactory, the cutting line usually only had to be traversed once. The coagulation effects of the laser provided a good hemostatic effect with drastic reduction of bleeding complications. The estimated bleeding volume during the procedure measured a few drops. A thin black-brownish line of carbonized tissue was regularly visible at the incision margins. The incision surfaces were brownish-beige in color and showed no bleeding. A pale, 1-2 mm wide edematous fringe was evident around the incision margins (estimate, compared to the diameter of the visible fiber optic cable).



Conclusion

The **Leonardo Dual 100** laser device by Biolitec® proved to be extremely satisfactory in the practical test for endoscopic ventriculocordectomy in horses. We can confirm excellent cutting performance and consistently reliable hemostasis for the device in this application. Due to its power and two wavelengths that can be combined simultaneously, **Leonardo Dual 100** could also be suitable for other uses in veterinary surgery, both equine and small animal. Following existing recommendations from human medicine, our surgical team is evaluating a list of additional indications and device settings in equine and small animal surgery.

Currently, a scientific project in the field of surgery of the upper respiratory tract in horses is being worked on in cooperation between the Veterinary Clinic of the Research Center for Medical Technology and Biotechnology in Bad Langensalza and Vidocq Equine Surgery Consulting GmbH.

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