Open-irrigated Electrode Laser Mapping and Ablation (ELMA) Catheter for perivascular nerve modulation

HypertenoLas®

A flexible Cardiovascular Laser-Catheter

INSTRUCTION FOR USE (IFU)

GENERAL DESCRIPTION

HypertenoLas® is a tripolar (8F) laser catheter designed for percutaneous transluminal renal and pulmonary denervation (RD and PD). It can be used for:

- **intravascular laser catheter application**
- selective anatomically renal or pulmonary perivascular **nerve modulation / denervation**
- Low and high frequency stimulation (**LFS**, **HFS**)
- infusion of liquids

The following additional devices are needed:

- an 8.5 French steerable sheath e.g., AGILIS
- the laser **CardioVascLas®**, 1064
- the Rolling pump **IriFlowLas®**
- a low and high frequency current stimulator

Catheter flexibility allows for safe and quick catheterization of the right and left renal artery from the abdominal aorta or of the pulmonary artery from the right ventricular outflow tract.

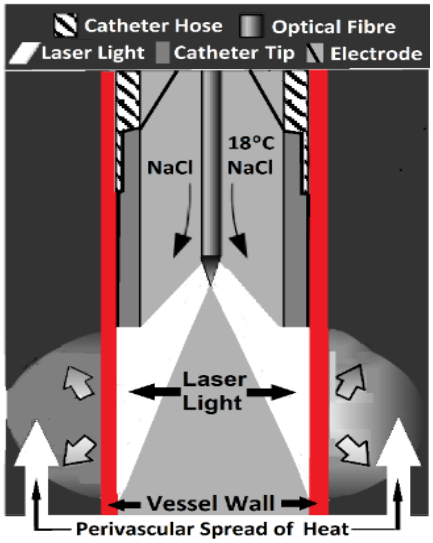
Intravascular Laser application is performed under **normothermic conditions.** During laser applications the **catheter itself is not heated up.** Saline irrigation creates a clear medium for the laser light.

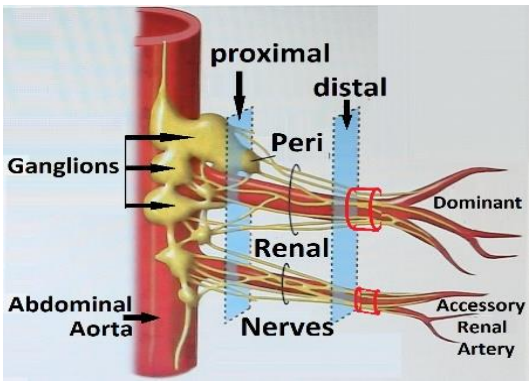
Laser induced absorptive heating is tissue specific and selective. Sympathetic nerves are **selectively heated up** and are coagulated, with minimal and reversible thermal damage to the vessel walls when using an appropriate energy setting. Light absorption of the transparent vessel intima and media are minimal.

Protection of the optical fiber within in the catheter lumen and continuous saline irrigation allows for a **non-contact** mode of laser application.

Saline irrigation at room temperature of 18°C has also a cooling effect on the inner vessel wall. Deep penetration of the laser light will achieve a level of temperature needed for thermal damage to the perivascular sympathetic nerves located in a network around the vessels.

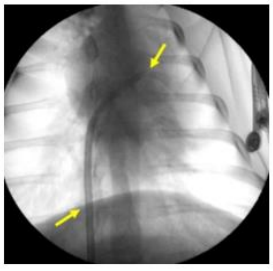
Perivascular laser denervation **is not thrombogenic**. Laser application under normothermic conditions and continuous saline irrigation avoids intravascular and mural thrombus formation. There is no intravascular temperature increase.





Renal nerves originate from proximal ganglia, converge on the renal artery, are closer to the artery distally: **red circles**, where laser application should be aimed at. Accessory arteries are common and are always innervated. Renal denervation requires complete treatment of distal main renal artery, and renal accessories.

Schematic representation of nerve distribution in human pulmonary artery



The laser catheter is placed with its tip in the trunk of the PA (arrow on the top)

The divergent laser beam produces circular radiation of a vessel segment of 4-5 mm. The sympathetic nerves around this vessels segment are heated up selectively and are coagulated/modulated. The length and depth of laser lesion hinders regeneration of permanently inactivated nerves.

Three 5mm long cable electrodes are mounted longitudinally at ≤2mm interelectrode distances on the catheter head and allow for **LFS** and for **HFS-mapping** guided stimulation, for localization of perivascular sympathetic and vagal pulmonary innervation.

Online monitoring of pulmonary electrical potentials is performed **during LFS and HFS** without interfering with the electrophysiologic monitoring principles, **without hum** in the intravascular electrical recordings **during laser application.**

Laser applications can be performed without electrical hum in the intravascular electrograms during LFS / HFS.

APPLICATIONS

Indications

The ***HypertenoLas®*** is designed for renal and pulmonary artery denervation by applying 1064nm laser light, for attenuation/modulation of the nerve overactivity, mainly for reducing high blood pressure, with the aim to **normalize** the systemic or pulmonary blood pressure permanently.
Via its conically shaped optical fiber the vessel walls can be radiated in a circular fashion with laser light. The divergent laser beam allows for **circular radiation** at lower power density and so helps avoid thermal damage of the vessel wall.

Prior to RSD or PAD procedures an aortogram/ pulmonary artery angiogram must be performed, and for RSD the anatomical dimensions of targeted vessel segments must be calculated. Radiation must be **limited to 15W.** Application times must be adapted to the irradiated surface of the vessel inner lumen for achievement of a safe and effective perivascular denervation. **Examples**:

For RSD 15W/15s (2-4x15 s), for PAD 15W/15s and repeated until unchanged atrial cycle lengths during atrial catheter stimulation are monitored (see page 8).

Contraindications

The use of the ***HypertenoLas®*** may be contraindicated if there is a known or suspected obstruction in the vessel access, a vessel spasm or a vascular malformation. Acute and severe chronic diseases especially substantially reduced left ventricular function, an obstruction of coronary arteries and angina pectoris, increase the procedure risk and may contra-indicate the use of the ***HypertenoLas®.***

SAFETY NOTES

Reuse

The ***HypertenoLas®*** is designed for single use only. Cleaning or reuse can result in serious complications. ***LasCor®*** will not be responsible for any direct or consequential damage or expenses which result from cleaning or reuse.

Sterilization

The catheter is shipped after gas sterilization with ethylene oxide (EO). Do not use products from open or damaged packaging. Under appropriate storage conditions, we guarantee sterility in undamaged packaging until the expiry date (use before date). Sterile products should be stored at humidity of 45-70% and at temperatures of 15-25°C. They should not be exposed to direct sunlight and must be used before the expiry date on the packaging.

External Interference

There is no external interference with the ***HypertenoLas®***.

Side Effects and Complications

Despite correct handling of the ***HypertenoLas®*** complications may occur such as:

- Vessel spasm and local bleeding with subcutaneous Hematoma.
- Perforation of the aorta or renal artery wall
- Thromboembolism, due to blood clotting/air bubbles.

!	**This device should exclusively be applied by consultant cardiologists trained and experienced in cardiovascular catheter intervention.** **Training should be supervised and certified by experts in the field of cardiovascular laser applications.**

Catheter Check

During catheterization and laser radiation of the renal or pulmonary artery the ***HypertenoLas®*** is subjected to a variety of mechanical and thermal strains. If catheter damage is suspected, both the mechanical and optical integrity of the catheter must be verified by visual inspection.

Laser Safety

The ***HypertenoLas®*** must be used in compliance with current laser safety regulations. Operators and personnel must have sufficient knowledge about potential hazards and safety measures for medical laser application.

Safety Hazard

Sympathetic denervation is performed by means of invisible continuous wave 1064nm laser light. Due to low absorption in water, it can easily penetrate the eyeball, and irreversible damage of the retina is the primary safety hazard.

! !	**Never point a connected *HypertenoLas®* towards a person or towards reflecting surfaces.** **Enable laser radiation only when the catheter *HypertenoLas®* is positioned inside the patient's body, inside the vessel lumen!** **Disenabling of the laser footswitch is:** **1. advisable after each laser application** **2. mandatory before removing the catheter from the patient** **Check the laser beam profile only by means of the pilot beam, never by releasing invisible 1064nm laser light.** **Use eye protection that blocks the 1064nm wavelength**

Laser safety measures primarily include the prevention of inadvertent laser emission and eye protection for people staying inside the laser area (defined by the area in which radiation exceeds the authorized value).

The ***HypertenoLas®*** causes a laser area of 1.3 m radius, measured from the catheter tip (calculated according to laser safety regulation DGUV-V11 (previously BGV B2 for an irradiation at 20 W over 10 s).

Safety hazards are significantly reduced if laser emission is inhibited on the laser panel whenever the ***HypertenoLas®*** is handled outside the patient. A temporary laser area is caused inside the patient when the foot switch is enabled. No hazardous radiation can be released into the operating room.
Therefore, safety goggles are not necessary. However, laser goggles may be mandatory due to local safety regulations!

To visualize the course of the non-visible laser beam, medical lasers are equipped with a harmless red pilot beam. This beam is suitable to control the radiation characteristics of the ***HypertenoLas®*** and to study the different beam properties in air and water.

Medical lasers and accessories such as optical fibers or catheters are controlled by a series of hardware switches to avoid inadvertent radiation or radiation under inappropriate conditions.

Before laser application can be started by pressing the laser foot switch, the catheter must be properly connected, and the foot switch must have been enabled on the laser front panel. Make sure to regularly check the functions of the laser safety chain.

RISK MANAGEMENT

A ***HypertenoLas®*** that is inserted into the patient cannot radiate hazardous laser light into the environment. Laser hazard increases when the connected catheter is handled outside the patient, e.g., during visual inspection of the catheter. Therefore, it is recommendable to enable the laser footswitch only when the ***HypertenoLas®*** is already placed in the patient's body and to inhibit laser emission after laser application.

Hazards can be also provoked when the ***HypertenoLas®*** is handled inappropriately, especially when the optical cable is bent around sharp edges or is jammed under wheels or heavy weights.

The fiber tip of the ***HypertenoLas®*** mounted at a given distance from the end hole coaxially in the central lumen of the catheter is effectively protected against mechanical forces acting on the catheter during vascular catheterization.

However, it must be strictly avoided to clean its distal end hole by means of sharp objects such as metal pins or cannula, as this might cause fiber breakage. In this case, the application of the ***HypertenoLas®*** could endanger patients.

HANDLING

Preparation of the Laser System

Calibration

The ***HypertenoLas®*** is optimized for radiation in an aqueous medium and cannot be calibrated in air. Light transmission is therefore measured by the manufacturer. Only qualitative control of the laser spot must be performed by operators with the pilot beam (see chapter "Catheter Control").

Pump Triggering

Pump triggering via the laser footswitch should be checked before clinical use. Make sure that the footswitch changes the pump flow rate, and that laser light is only applied simultaneously with the increase of flow from 10mL/min continuous "Low Flow" to 35 mL/min the lasing "High Flow".

!	**The *HypertenoLas®* must be irrigated and must be surrounded by an aqueous medium.** **Laser application without saline irrigation can destroy the catheter and could endanger patients.**

Preparation of the Patient

The patients should be in good clinical condition. Preferably, primary diagnosis is performed without anti-hypertensive medication. An additional venous access line is needed for volume and electrolyte substitution, antithrombotic and optional for other drug treatment.

Percutaneous venous or arterial puncture is performed under sterile conditions. Access to the renal arteries is achieved via a femoral artery. From there, the aorta abdominalis and the left and right renal arteries can be catheterized. For pulmonary denervation a femoral vein is punctured.

Connecting the Catheter

Main functions of the ***HypertenoLas®*** and its connections to external devices must be checked prior to a clinical application. This mainly includes:

- Integrity and sterility of the packaging,
- Catheter irrigation,
- Laser spot

Thoroughly inspect the packaging and expiry date before opening. Draw off the cover sheet of the double sterilization envelope and pass the catheter under sterile conditions, with the inner envelope to the operator. For connection of the FSMA to the laser, the operator hands it over to the non-sterile technical assistant.

Be sure not to touch or soil the polished proximal end of the optical fiber. Insert the plug into the coupling port of the laser and fully tighten the screwcap until the safety interlock reacts by switching on the pilot laser.

Check the course of the optical cable. It should not run next to wheels or across sharp edges.

Avoid bending radii below 5 cm. Light should only be radiated from the catheter end hole. Do not use the catheter if light leaks through the cable or through the catheter hose.

!	**Inappropriate handling of the catheter, bending around sharp edges, jammed under wheels or heavy weights can destroy the catheter.**

Plug the electrical cables into the manifold unit according to chapter "Connections". Insert sterile original tubing into the peristaltic pump (See Operating Manual ***IriFlowLas®***).

Connect the inflow to heparinized saline and the outgoing line to the ***HypertenoLas®***. Set the flow rate of the pump to 80mL/min “Flush Flow” and flush the line and catheter to remove air bubbles.

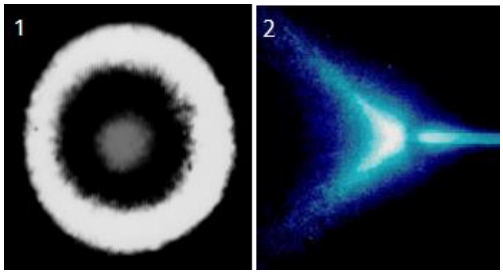
By releasing the footswitch, a continuous flow of 10mL/min saline must leave the distal catheter end. Control the tightness of all connections. The tubing must not be distended by excessive pressure.

Test the program! Set the continuous background flow rate to 10mL/min, and lasing “High Flow” rate to 35 ml/min. Start the background “Low Flow” and step on the laser footswitch while laser emission is still inhibited.

The pump must now automatically switch to the “High Flow” rate. When releasing the footswitch, the pump must return to the continuous “Low Flow”.

Inspect the laser spot. This test must be performed after irrigation, as the dry catheter radiates a completely different laser beam in water as compared to air.

Dip the catheter tip into a white cup filled with sterile water or saline. Avoid reflective metal surfaces. The laser spot must be visible as a clear-cut continuous ring (“Donut”). An additional spot may be visible in its center that must not be brighter than the ring. Do not use catheters with anomalous laser spots.



1 Laser beam frontal view and **2** lateral view

Catheter Insertion

The following description of renal and pulmonary artery laser applications is a proposal based on general experience in the use of cardio-vascular catheters. Investigators may change procedure details according to their personal experience.

The ***HypertenoLas®*** is inserted percutaneously via a Guiding system, special long introducer sheaths and steerable guides such as the AGILIS (St. Jude). Guiding sheaths and introducers adapted to the ***HypertenoLas®*** are commercially available.

Do not use inappropriate sheaths or guiding catheters as they may jeopardize the functions of the ***HypertenoLas®*** and can cause complications.

PROCEDURE

After aseptic skin preparation of the insertion area and sterile covering of the groin, a femoral vessel, a vein, or artery is punctured by using Seldinger technique.

A guide wire is introduced through the cannula into the

- femoral artery and is advanced under fluoroscopic guidance in the aorta abdominalis for perirenal, or
- via the femoral vein when pulmonary denervation is aimed at.

If necessary, make a small incision to widen the puncture site for insertion of the tapered tip of the dilator.

The proximal part of the guide wire must remain outside the patient over the length of approximately 90 cm.

- Dilator with guiding sheath is pushed over the wire and is advanced under fluoroscopic guidance into the abdominal aorta or pulmonary trunk respectively.
- Remove wire and then the dilator while flushing it with heparinized saline 0.9%.
- For **RSD** perform an aortogram via the guiding sheath, measure and calculate the vessel dimensions as described in the example below.
- Manipulate the guiding sheath from the abdominal aorta into the renal artery and position the endhole of the guide 5-10mm from the artery ramification.

- Flush the ***HypertenoLas®*** 80mL/min "Flush Flow" removing air bubbles, insert its tip into the hemostatic valve of the guide and push it under "Low Flow" into the guide.
- Advance the ***HypertenoLas®*** under continuous "Low Flow" of 10mL/min and under Xray control up to the endhole of the guide
- Start laser applications at 15W, for the radiation time as calculated for an energy level of 10J/mm²
- Deliver 2-3 applications at intervals of 3-5s and repeat the procedure in the other renal artery, and if needed also in an accessory renal vessel if disclosed in the aortogram.
- Remove the ***HypertenoLas®*** and perform a final control aortogram via the guide.

For **PSD** perform a pulmonary angiogram. Laser applications are performed as described below, including **LFS** and **HFS** pace mapping. Pulmonary artery application times are limited to the effects achieved under HFS.

Catheter manipulation

The ***HypertenoLas®*** can be manipulated by advancing, withdrawing, and twisting the steerable guide and can be pushed up to 10 cm beyond the end hole of the Guide.

Laser Application

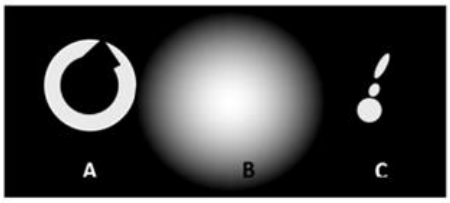
The laser is used in the continuous wave irradiation mode at a distal laser power of 15W. Energy setting must be applied according to the targeted inner surface of the vessel wall. To avoid inadvertent release of laser light, triggering by the laser footswitch must be disenabled during catheter insertion and manipulation.

After Xray guided positioning of the catheter tip in the renal artery segment, laser radiation is enabled by means of the laser button on the laser front panel, and laser radiation can then be released by the two-staged laser foot switch. By depressing the foots-witch the peristaltic pump flow rate increases to the preset lasing value. Simultaneously laser radiation is released. Laser alarm sounds during laser application.

Radiation is terminated automatically after the preset pulse duration or by releasing the footswitch. Longer application times are achieved by consecutive pulses. In this effort, the default pulse durations should be applied, and the radiation statistics displayed on the laser panel should be documented.

For safety reasons, the laser footswitch should be disenabled immediately after each laser application, no matter if the catheter remains in the patient for further treatments.

Deteriorated beam profiles:



A. Interrupted ring. Tip deformation casts a shadow. Potential overheating of the catheter. Reduced effect!

D. Diffuse radiation. Contamination, overheating of the fiber tip. Reduced effect.

C. Collimated and partly asymmetric radiation spot, due to fiber breakage. DANGER! High risk of perforation, increased laser safety hazard.

Do not use catheters with deteriorated beam profile

Laser radiation may produce a painful sensation of heat or pressure in the chest, or minimal pain in the kidney region. In rare cases analgesics may be required.

Catheter Control

Whenever suspecting a reduced catheter performance or a malfunction, the ***HypertenoLas®*** should be removed and inspected. This includes its general appearance and the shape of the laser beam profile.

Radiation from a damaged optical fiber can cause severe complications such as vessel burning with crater formation, perforation, rupture of the vessel wall, and may produce thrombi with the risk of renal and systemic infarction with stroke.

CONNECTIONS

Laser

The ***HypertenoLas®*** is connected to a 1064nm diode laser via a flexible optical fiber provided with an FSMA connector at its proximal end. The connector is provided with a chip as a time limiter of the laser transmission via the catheter. As light transmission and radiation characteristics of the catheter depend on the laser model, only the Laser ***CardioVascLas®*** can relate to the ***HypertenoLas®***

There is no electrical connection between the laser and the patient or the working field. Damages of the Laser or the patient by a Cardioverter-Defibrillator can be ruled out.

Catheter Irrigation

The Irrigation Pump flushes the ***HypertenoLas®*** continuously with 10mL/min *"Low Flow"* heparinized saline. Irrigation must be performed by a laser-triggered peristaltic pump. This is mandatory for a safe and correct application of the ***HypertenoLas®.***

Irrigation is to be performed at a rate of at least 10 mL/min "Low Flow", a rate that is automatically increased to 35ml/min "High Flow" during laser application. Manual pump adaptation is not recommendable. Do not use other pumps than the laser accessory peristaltic pump: ***IriFlowLas®***

EXCLUSION OF LIABILITY

HypertenoLas® is used in the thoroughly aggressive environment of the human body. Moreover, the needed flexibility and the very small diameter of the catheter invariably result in limited reliability.

Catheters can fail for any number of reasons, among which there are medical complications, rejection reactions of the body, fibrosis, dislocation, erosion or migrating through body tissue or resulting from a break or tear in insulation.

Despite the greatest possible care taken in development, choice of components, assembly, and final control prior to delivery, the ***HypertenoLas®*** can become damaged by negligent handling or other influences, during or after introduction.

As a result, we do not assure or guarantee in any way that a disturbance or discontinuation of function will occur, nor that the human body will not reject the introduced catheter, nor that there will be no medical complications, including myocardial perforation, because of introducing the catheter.

!	**The *HypertenoLas®* is for single use only.** **Resterilization and reuse of the catheter would jeopardize its function and endanger the patient**

Since the accessories can become damaged by negligent handling or other influences before, during or after introduction, we do not assure or guarantee in any way that a disturbance or discontinuation of function will not occur.

In cases of defects detected **prior to use**, the **catheter** can be replaced by the manufacturer, provided the catheter is sent back with documents describing the detected defect, according to our fax template. **Contaminated catheters** can be returned using the return form under sterile conditions.

The ***HypertenoLas®*** is sold in "as is" condition. No responsibility will be assumed for any deficiencies that are not immediately declared upon delivery of the goods.

The purchaser assumes the total risk related to the quality and function of the catheter and accessories when they are put into use.

In cases of defects detected **prior to use**, the **non-contaminated catheter** can be replaced by the manufacturer, provided the catheter is sent back with documents describing the detected defect, according to our fax template. **Contaminated catheters** can be returned using the return form under sterile conditions.

LasCor® assumes no responsibility whatsoever for any loss, damage, or injury, be it directly or indirectly related to the catheter or accessories or determined to be subsequent damage resulting from the use thereof.

Consequently, ***LasCor®*** does not and will not assume any expenses incurred by the purchaser or a third party, ensuing from the use, malfunction or total failure of any catheter or accessories.

This exclusion encompasses physician's fees, costs of hospitalization, costs incurred by using medicinal products, any secondary expenses, and all subsequent damages.

Let it be known that no institution, organization, or individual has ever been empowered or in any other manner obtained the right to issue any notification deviating from the above or to make any guaranty in the name of ***LasCor®***.

NOTE

After its use the catheter is biologically contaminated and must be disposed according to the local regulations. The catheter does not contain toxic components that would need special measures.

TECHNICAL DATA	
HypertenoLas®	**Version 2024-12-11**
Body size	8 F
Useable length	115 cm
Total Length	300 cm
Optical fiber Core	400 µm
Numerical aperture	0.22
Beam divergence fiber in water	70°
Distributor	3way
Irrigation tube	15 cm
Laser-connector	FSMA
Order data	
Catalogue No.:	H 003-115-XXX
Packaging:	carton box with one sterile set
Delivery box:	with 10 single carton boxes
UDI-DI:	4260691560030

CE 0481	0481 ecm Aachen expired 2024 0123 TÜV SÜD in process
Patents:	EP Nr. 3653155 US Nr. 12,150,706 B2 Russian Federation Nr. 2770278

Annexes:
1. Patient Information
2. Patient's Statement + Written Informed Consent
3. Fax Template: Post Market Clinical Follow-up (PMCF)

SYMBOLS

This medical product is labelled according to **DIN EN ISO 15223-1:2022-02** by using the following graphical symbols:

MD	Medical Device
	Manufacturer
LOT	Lot number
	Date of manufacturing
STERILE EO	Sterile, sterilization method
	For single use only
	Regard operating manual
	To be used until

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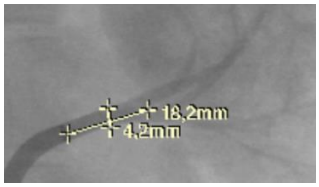
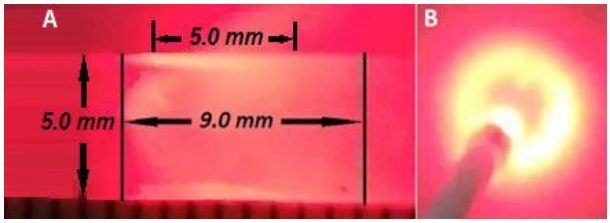
Example of peri-renal artery nerve modulation, for calculation of energy density to be applied in the treatment of hypertension:



Left renal angiogram ***showing*** an **18.2mm** long vessel with a uniform caliber and diameter of **D = 4.2mm**

Based on our results: *J Vet Sci Ani Husb 9(1):103-113 2021 ISSN: 2348-9790,* for optimal peri-renal nerve modulation, for safe and effective permanent perivascular nerve modulation laser applications at **10J/mm²** is aimed at the vessel wall.



Laser radiation in a transparent tube **A** lateral **B** frontal view

Calculation of power needed based on figure A above:

1. Diameter measured = **5mm**,
2. Circumference is 5 x 3.14 (π) = **15.7mm**.
3. Length of the illuminated vessel inner wall = **5.0mm**
4. The illuminated inner surface is: circumference x length (5mm) **15.7 x 5** = **78.5 mm²**
5. Laser application at **15W** on **78.5mm²** will achieve: 15:78.5 = **0.19 (0.20) W/mm².**

To achieve **10 J/mm²** a radiation time of **50s** is needed:

0.19 W/mm² x **50s** = 9.51J/mm² **(~ 10 J/mm²)**

To achieve 10 J/mm² you must adapt radiation times to the vessel diameter you have measured on your Xray screen as shown in the table:

Table

Artery Diameter (mm)	Radiation Time (s)	
	Calculated	Suggested
2,6	27	2 x 15
3,0	31	2 x 15
3,5	37	2 x 15 + 10
4,0	41	2 x 15 + 10
4,5	47	3 x 15
5,0	52	3 x15 + 5
5,5	58	4 x 15
6,0	63	4 x 15
6,5	66	4 x 15

Examples: for laser modulation of perivascular nerve in a vessel with a diameter of 3.0 mm

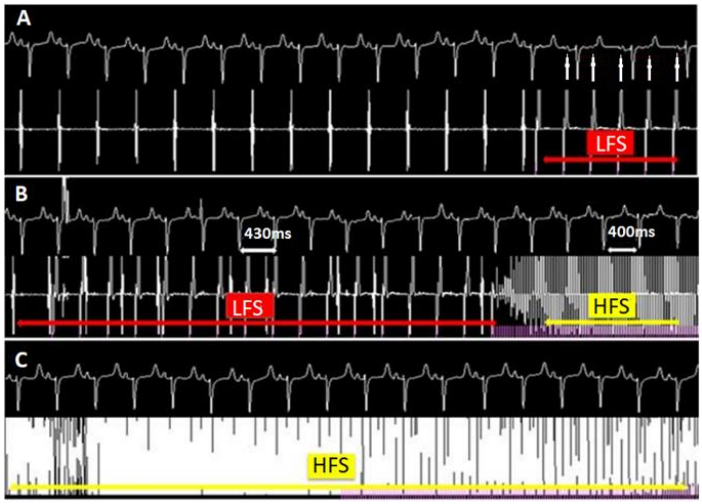
1. Laser power is preset to **15W** (touch screen).
2. The length of the illuminated inner wall is approximately **5mm**.
3. To achieve **10 J/mm²** two laser applications at **15s** with an **interval of 3s** are needed (**Table**)**.**

For a vessel diameter of **3.5 mm** more energy is needed to achieve the 10 J/mm², an effective perivascular nerve modulation: **15W/37s**, radiation time must be 2x15s+7s (**10s**). See the table above.
Thus, there is a stepwise increase in radiation time and a linear increase in the level of total energy applied.

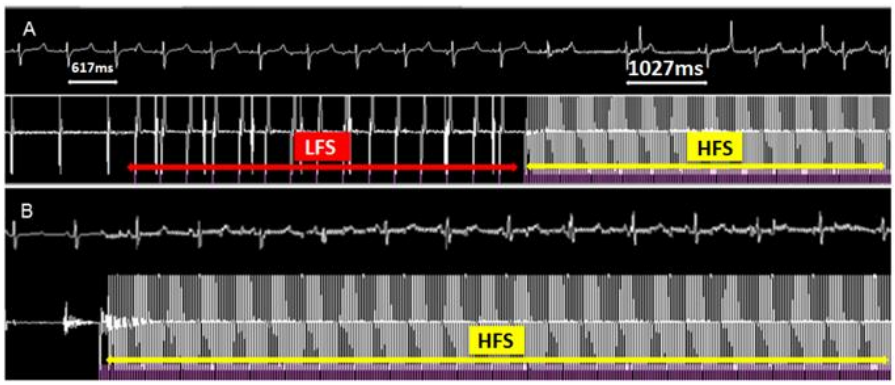
Perivascular pulmonary artery nerve modulation

Laser effects can be controlled by laser catheter LFS and HFS stimulation. The level of energy to be applied for pulmonary artery perivascular nerve modulation in the treatment of resistant pulmonary artery hypertension depends on the LFS and HFS.

ECG recordings during PA stimulation mapping



A. Low-frequency stimulation (LFS) at a point in the right pulmonary artery (PA) results in atrial capture, paced atrial rhythm is indicated by white vertical arrows.
B. No atrial capture during LFS at a point in the right PA. High-frequency stimulation (HFS) at the same point results in a shortening of atrial cycle length from 430 to 400ms
C. The ablation catheter is positioned at the same point as in panel B. After energy application, no change in the atrial cycle length is seen during HFS.



A. No atrial nor ventricular capture during LFS at a point in the right PA. However, HFS results in a significant atrial rhythm slowing - cycle length prolongation from 617 to 1027ms.
B. The ablation catheter is positioned in the same point as in panel A. After energy application no change in the atrial cycle length is seen during HFS.

Patient Information

Peri-Renal and -Pulmonary Artery Nerve Laser Modulation (LM)

What it's all about?

Introduction

Perivascular Laser Denervation (LD) is a non-surgical technique, a percutaneous, transluminal, minimally invasive catheter procedure that selectively modulates perivascular sympathetic nerves causing your high blood pressure.

It involves percutaneous puncture or a tiny incision in the skin, which is performed without general anaesthesia. In fact, you will be awake during the procedure and be able to talk with the staff. The procedure is used for treating resistant systemic or pulmonary hypertension that has not responded adequately to medication and your improved lifestyle. Catheterization of the renal or pulmonary arteries with the catheter enables doctors to destroy or modify selectively the perivascular nerves by laser radiation.

Current catheter ablation techniques utilize radiofrequency (RF) energy or ultrasound (US). By using the open-irrigated catheter ***HypertenoLas®*** laser ablation is a new promising method developed with the intention to reduce the risks, to increase success rates, and to shorten procedure duration times for renal or pulmonary sympathetic denervation.

For the laser procedure, doctors insert after a small incision of a vessel, or percutaneously, a steerable guiding sheath for vessel angiography to visualize vessel anatomy and localize its root for selective catheterization. After angiography the laser catheter is introduced through that steerable sheath and is advanced under X-ray control together with the sheath into the targeted vessel, the main renal artery up to its ramifications or the pulmonary trunk, and then pass laser light through the catheter. The irradiated circular area of the vessel at lengths of several millimetres is repeated if needed. If the treatment is successful, you will be cured from your hypertension or ineffective medication will work. The laser application is virtually painless; however, the method is experimental but has shown to selectively inactivate the sympathetic nerves without damaging renal or pulmonary artery wall.

In case if you suffer also from cardiac arrhythmias that were ablated prior to renal denervation, renal as well as pulmonary sympathetic laser denervation can be performed also by using the catheter ***RytmoLas®*** in the same session after the arrhythmia ablation.

Alternative Therapies to Renal or Pulmonary Sympathetic Laser denervation (SLD)

The following antihypertensive therapies are nowadays available:

1. *Medication* (which was not successful in the treatment of your resistant hypertension).
2. *Baroreceptor stimulation* (is a surgical procedure)
3. *Radiofrequency and Ultrasound Catheter Ablation* (also experimental procedures).

Preparing for the Ablation Procedure

Unless you are already hospitalized, you will probably be admitted to the hospital or, in some cases, you may undergo the treatment in outpatient hypertension unit.

Several routine laboratory tests will be performed prior to the intervention including an ECG, blood tests, and possibly ambulatory long-term blood pressure measurements. These may be done one or two days ahead of catheter ablation. The doctor performing the ablation procedure will review your medical history and examine you. You may be seen by the doctor at the office several days before the procedure.

The doctor will explain the ablation technique, its purpose, potential benefits, and possible risks. This is a good time to ask questions and, most importantly, to share any feelings or concerns you may have about the ablation intervention.

You will be asked to sign a consent form, a document that allows drugs to be injected directly into the vein if necessary. To help you relax, you will be given a sedative if necessary. Generally, you will be asked not to eat 6 hours or drink two hours anything prior to the intervention but if you are scheduled for an afternoon study, you may be given a light breakfast. You may have a small amount of water with medication.

You may be asked to stop taking certain medications for two or three days before the ablation procedure. Be sure to check with your doctor several days before the intervention. Please bring a list of all the medications you are currently taking. It is very important for the doctor to know the exact names and dosages of any medication that you take. Be sure to mention to the doctor if you have had allergic reactions to any medication or contrast medium.

For your comfort, empty your bladder as completely as possible before the procedure starts. Once preparations are completed, you will be taken to the catheter laboratory where the procedure will be performed. You will be transferred to an X-ray or NMR table. The table has a large camera above it and television screens close by. The equipment in the lab also includes heart monitors and various instruments and devices. The lab team generally includes the angiologist with special training, radiologist, an anaesthetist, an assistant, nurses, and technicians.

During the Ablation Procedure

After being positioned on the table, you will be hooked to a variety of monitors and manifolds, and you will be covered with sterile sheets. The staff will be wearing sterile gowns and gloves. The groin where the catheter will be inserted is cleansed thoroughly. A local anaesthetic is injected into the skin with a tiny needle to numb the area. This may cause a stinging sensation. A small incision is made in the skin, and a needle system is used to puncture the artery, into which the catheter will be inserted. The open-irrigated laser ablation catheter ***HypertenoLas***® is a long flexible tube provided with a flexible optical fibre mounted coaxially in its inner lumen that can transmit laser light. The catheter is not heated up and it is flushed continuously with saline through its central lumen during the procedure.

The catheter will be advanced into the main renal artery or pulmonary artery depending on your type of hypertension, systemic or pulmonary to irradiate this artery at a length of approximately 5mm. Laser applications at 15W can be repeated depending on the inner surface of the targeted vessel wall. By doing so perivascular sympathetic nerves are selectively inactivated whereas the vessel wall and perivascular tissues are less absorbing laser photons and therefore are not damaged permanently by the laser induced heat. This process of reducing sympathetic activity of periarterial nerves will reduce your blood pressure, in optimal case to normal values permanently and without the need of any antihypertensive drugs.

You will be awake during the procedure; although medication will be given to help you relax. The staff will be monitoring your process constantly. Let the staff know at any time if you experience pain or discomfort. The laser procedure usually is not painful, although you may feel some discomfort during the insertion of the catheters or during laser application.

There may also be some discomfort from lying still for a long time. You will not feel the catheters moving through the blood vessels, the aorta, or pulmonary arteries. Depending on the anatomy of your arteries procedures may last from one to two hours.

The insertion of catheters is accompanied by certain risks. Some patients may develop bleeding at the insertion site. Blood collects under the skin resulting in local swelling and “bruise”. Both swelling and bruise will disappear in time as the blood is slowly absorbed by the body. Less frequently, ablation procedures may be associated with more serious complications.

These include damage to blood vessels, formation of blood clots and infection. Fatalities such as renal lesions of coagulation necrosis cannot occur provided laser applications are not performed in small artery ramifications close to the kidney hilum. However, laser procedure-related complications cannot be completely ruled out and of the risks. To learn about your particular risk, you should discuss the matter with the doctor.

After the Ablation Procedure

After the laser procedure is completed and the catheters are removed, the doctor or nurse will apply slight pressure over the groin for about 10 to 20 minutes. This is done to prevent bleeding. The doctor may close the incision with a few stitches.

Subsequently, a dressing with pressure will be applied over the wound or puncture. You will then be transported to your room or to the recovery area. You will probably be allowed to drink and eat following the procedure but check with the nurse. You will lie flat in bed for six to eight hours to allow a small seal to form over the puncture in the artery.

During this time, you may move your foot or wiggle your toes. You may move your arms freely. You will stay under observation for one night and if you are able to go home after control of the punctured groin or wound. However, if the procedure was without complications your doctor may decide to perform the treatment ambulatory.

Please remember the following to ensure a quick recovery:

- Limit your activities during the first 24 hours at home. You can move about, but do not strain or lift heavy objects.
- If you notice new blood on the dressing, place your fingers over the site and press for about 20 minutes. If bleeding continues, call your doctor, or the ambulance to the nearest emergency room while continuing to apply pressure.
- You may remove your dressing three days after the procedure and have shower but wait another day or two before taking a bath.
- A black-and-blue mark (bruise) or a small lump under the skin at the insertion site is common. These generally disappear within three to four weeks.
- Call your doctor if the insertion site becomes painful or warm, or if it shows signs of infection.
- Ask your doctor when you can return to normal activities, usually one week after procedure, and if there are any specific restrictions.
- Ask your doctor about your medication, which ones to continue and which ones to stop.

Follow-up Ablation Procedure

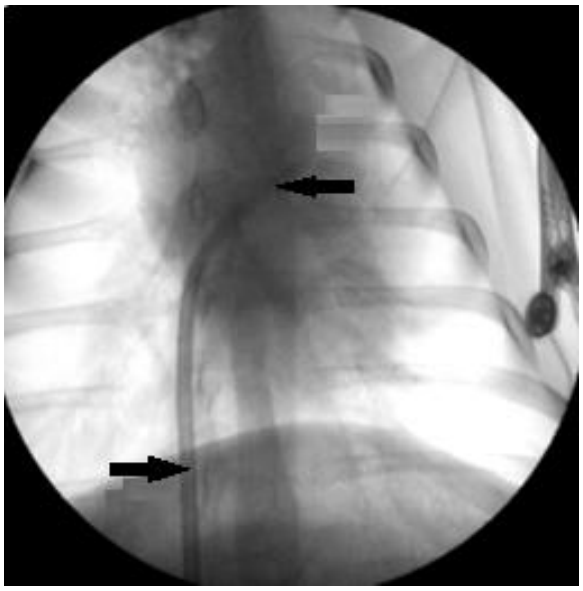
If successful, the laser treatment has inactivated a part of the perivascular renal or pulmonary nerves, thereby reducing your blood pressure. Hopefully you will be cured from hypertension permanently without the need for medication. In rare cases, medication may still be needed after the ablation procedure, and medication not effective prior to the laser treatment may now work. It can be anticipated that your blood pressure will further decrease in the months following the laser treatment.

Follow-up examinations can be performed in the outpatient clinic. If results indicate that medication is still required, needs adjustment or is not effective, you may be brought back to the laboratory to repeat the arrhythmia ablation attempt.

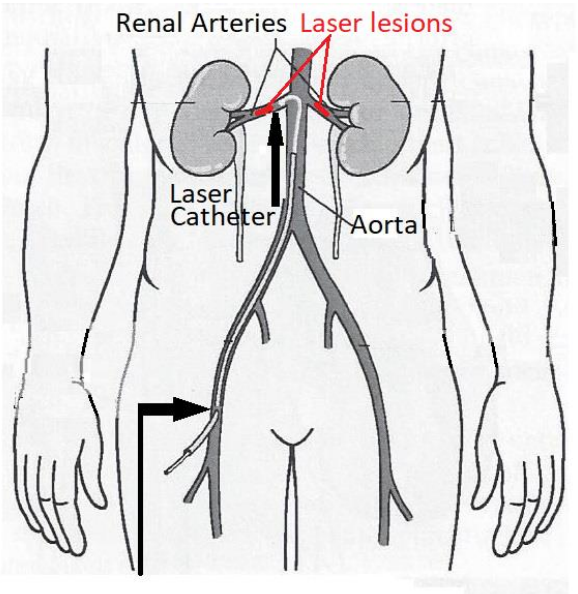
For your *long-term follow-up,* you will be seen by your doctor in his office or at the outpatient department of the hospital for a regular control including physical examination and blood pressure control, preferably long-term, at time intervals decided by your doctor.

However, you should come to your doctor whenever you have other signs or symptoms which in your opinion may be related to the hypertension, as you have suffered from prior to the ablation procedure. Eventually, regular controls of your blood pressure will be performed by a visit at your house doctor.

Don’t hesitate and ask your doctor if you need more information or if some of the above is still unclear to you or if you would like to know more about the procedure, possible complications, and risks.
Your doctor will give you further information.



Anterior posterior Xray image showing the position of the laser catheter in the pulmonary artery trunk during laser application (top arrow). The lower arrow points towards the guiding Catheter in the inferior vena cava.



CATHETER ACCESS IN THE RIGHT GROIN

Scheme showing the main renal artery segment where laser radiation is aimed at colored in red.

Notes:

Patient's Statement and Written Informed Consent

Signature File in accord with 21 CFR 50 with the Patients Statement

I had detailed discussion(s) with my doctor (print):_____
Concerning my questions, problems, concerns and doubts of the laser ablation procedure and the possible complications and risks, I have received a complete file of **Patient Information,** and I have no further questions.

Herewith I agree with the proposed Renal ☐ Pulmonary ☐ Laser catheter denervation, with the emergency interventions, necessary for the treatment of possible complications, and with the follow-up controls or studies.

I do not give my consent for the laser catheter ablation because (comment):
.....
.....
.....
.....

↑

Delete what not applicable.

Patient: _____ _____ _____
Name (print) Date Signature

Investigator: _____ _____ _____
Name (print) Date Signature

Further comments:

LasCor Laser Medical Devices
Cardiovascular Laser Application

Fax Template for Post Market Clinical Follow-up (PMCF) for Renal ☐ / Pulmonary ☐ Laser Catheter Denervation

Please fax to +49 (0)89 759 5770	***HypertenoLas®*** **H 003-115-XXX**
Patient ID:	Hospital / Health Service Unit:
Diagnosis:	Physician (print):

If no events, please mark with **X** here: **O**

Signature_____

Or describe:

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