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Ideation and realization of a heated laparoscopic optic with temperature controller

Laparoscopic optics is the key to endoscopic surgery. We can achieve the optimal function of this device by preventing fogging of the optic lens and maintaining a warm CO_2 gas inflow.

During these years, industry has developed different methods to heat the optic and the gas, such as heated gas tubes, trocars, and lenses with reduced light transparency.[1]

This work aims to develop a device that can heat the optic and the CO_2 gas in the endoscopic cavity at the same time. Moreover, the laparoscopy technique with vaginal steps typically exposes the optic to a cold ambient temperature, requiring it to be hot when it exits the abdominal cavity.[2]

Therefore, this device can eliminate the need to heat the optics with hot water, particularly when using bipolar forceps, which produce a lot of steam and cause fogging of the optic lenses.

The device (Figure 1A, B) consists of two main parts: the electrical energy regulator (Figure 2) and the removable copper sheath with the heater (Figure 3), from which the connection cable originates.

We found a copper tube with a thickness of 1-mm, an inner diameter of 10-mm, and a small copper block. We purchased two small 12-V, 24-W resistors, each measuring 6 mm, a PT100 thermistor, and an autoclavable cable for the electrical part of the device that we installed on the optic. We collected a 220/24 V alternating current transformer, a temperature PID (proportional-integrative-derivative) regulator, a solid-state relay, and a metallic box for the power regulator.

First, we cut the copper tube to the correct length to cover the entire optic. Second, we made a 12-mm hole in the upper part of the copper block to insert it into the proximal copper sheath. Furthermore, we divided the copper block into two symmetrical parts, making two holes in the inferior part to accommodate the resistors (about 6mm) and other holes to insert the bolts necessary to tighten the two symmetrical parts of the copper block. A small stainless-steel cap covered the synthetic resin, concealing the electrical connections. We plated the metallic parts with chromium before the electrical connections.

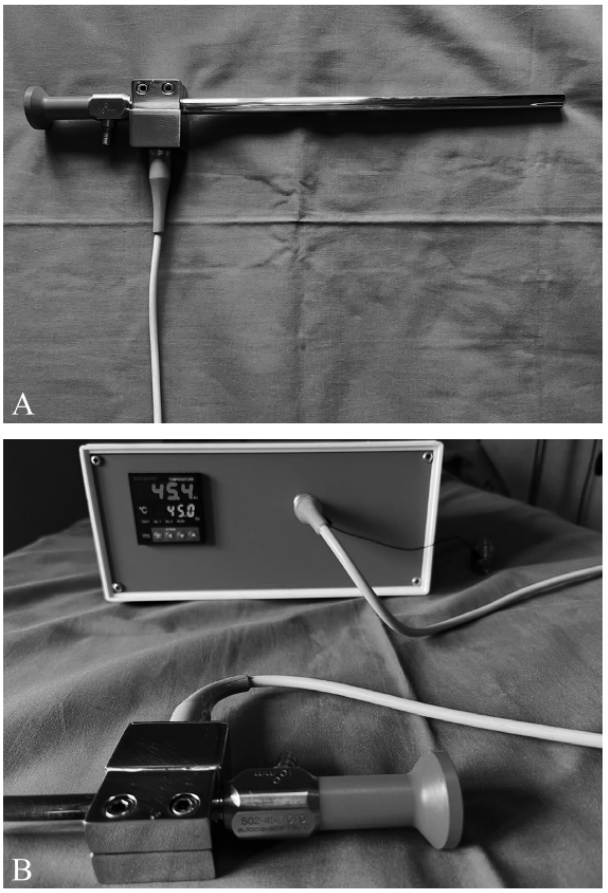

Figure 1.—A, B) The device.

The laparoscopic optic's silicon sterile cable easily connected the PID regulator, transformer, and solid-state relay in a metallic box.

The system received 220 V, 50 Hz of public grid power to test the device. We entered the PID parameters into the regulator and set the display to 45 °C.

We used an infrared thermometer to record the distal optic temperature after 10 minutes.

In an ambient temperature condition, the PID display initially showed a rapid rise in temperature after the current supply started. After about 10 minutes, we observed the perfect stabilization of the desired temperature, particularly in the distal part of the optic, where the lens is located. Obviously, we found a gradient of temperature from the proximal part to the distal part of the laparoscopic optic of about 5 °C/m at an ambient temperature of 18 °C.

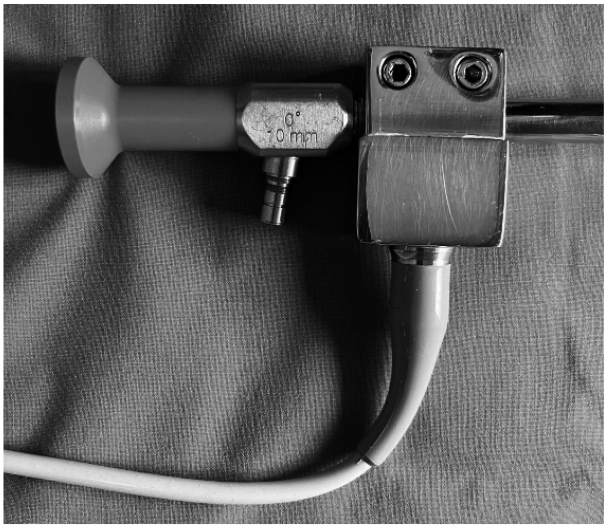

Figure 2.—Electrical energy regulator.

Figure 3.—Removable copper sheath with the heater.

The test showed that the laparoscopic optic achieves a good temperature and that there is an acceptable gradient from the proximal to the distal part.

We conducted the test without a trocar and CO_2, but we believe that the gas inflow can aid in the heat transfer along the laparoscopic trocar.

In this instance, we employed a 1-mm-thin copper tube to achieve an outer diameter of 12 mm. But there are also 14-mm inner-hole trocars that could accept a device with a 2-mm-thin copper tube, permitting a higher heat transfer from the resistances and a lesser temperature gradient.

The tests show that this new device can be very helpful, particularly in surgeries that use strong electrocoagulation and surgical steps with the optic out of the abdomen.

Therefore, during laparoscopic surgery, we can prevent fogging of the distal length and obtain warm CO_2.

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Conflicts of interest
The authors certify that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript.

Authors' contributions
All authors read and approved the final version of the manuscript.

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