Laser Bonding of Small Blood Vessels in Microsurgery

Progress Report - research performed during the year 2011

Submitted to the Slezak Foundation by Dr. Eyal Gur, Plastic Surgery, Ichilov

Brief description of the proposed research

In the field of microsurgery there is a need to bond small blood vessels whose diameters are of the order of 0.5-3.0 mm. There have been attempts to use laser heating for the anastomoses of such blood vessels, but these have not been very successful – probably because there was no temperature control during the procedure. Prof. Katzir's Applied Physics Group developed over the years a fiber-optic laser bonding system with temperature control, which was based on a CO_2 laser and on two IR fibers, made of AgClBr. The system heated spot of diameters 2-3mm on the approximated ends of an incision to a temperature of 60°C. The purpose of our research was to use this unique fiber-optic laser system for the bonding of small blood vessels. We proposed to properly approximate the vessel cut edges, using a special stent made of dried albumin.

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Samples of small blood vessels were obtained from a slaughter house. The albumin stents were made by a chemist at the Applied Physics Group. Each vessel was cut in two, and the cut edges were placed over the stent to achieve a full approximation. The laser system was then operated and set for average surface temperature of 60°C. In order to be able to heat a small spot (~1 mm dia.) on the tissue, the laser - handpiece working distance was approximately 2 mm. Unfortunately, it was found that at such a small distance it was impossible to align the sensing fiber so that it would gather IR emitted from the center of the heated spot. This caused erroneous temperature readings.

As a consequence, even when using the temperature feedback loop, the cut area was overheated. We observed bleaching and a slight retraction of the cut edges. To overcome this problem we tried a different calibration of the temperature sensor, but it hardly improved the results.

Conclusions

The use of the stent did not improve the results of laser bonding of small blood vessels. We observed that in experimentation with bovine blood vessels, the operation of the laser bonding system was complicated. We think that the changing geometry (vessel curvature, handpiece angle etc.) made the irradiation and sensing conditions different for each case and for each heated spot, which made our results inconsistent. We concluded that the major obstacle is the use of two fibers in the laser boning system. This will be solved only when a new system is developed, which is based on a single IR fiber. According to Prof. Katzir and his students, such a system will not generate false temperature reading and is likely to be able to efficiently bond small blood vessels.