Blood vessels anastomosis using two lasers

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1. Brief Description of the Research Subject: Achieving good bonding of blood vessels is a difficult task. Suturing is still the standard procedure used today, in spite of its disadvantages. Thirty years ago, it was suggested that lasers can be used for bonding (anastomosis) of blood vessels. Laser radiation gently heats the cut area to a temperature of approximately 60ºC and "welds" the tissues. The process improves if the bonded area is covered with a biological solder, which is heated by the laser beam. This is called "laser soldering". Successful experiments have been carried out in animal models, on different tissues, but the method has not yet been approved for wide clinical use, because it was not reliable.

2. Research Hypothesis: The research hypothesis was that two lasers soldering is more suitable for bonding of tubular organs (e.g. blood vessels) anastomosis since it generates a stronger bonding needed in such cases. The method works as follows: two parts of the tubular organ are approximated and then one laser is acting on the outer surface while the other laser is penetrating the tissue and acting on the inner surface of the tubular organ (inside the tube).

3. Results: In the past year the Applied Physics Group from Tel Aviv University has been working on the subject in few aspects. In order to bond blood vessels successfully, we had to make sure that the tissue was not overheated. In our system, temperature feedback arises from the upper tissue surface only. As explained, one of the lasers is penetrating deep into the tissue, heating the inner area. Tissue temperature inside, however, can not be monitored. We had to make sure that we do not cause thermal damage inside.

In order to do that, a computer simulation was written. The simulation visualized the simultaneous heating with two lasers. Fig. 1 shows the correspondence between simulation and experiment when heating a tissue phantom (i.e. a material with thermal properties that resemble soft tissues). A very good match can be seen from the graphs. Future calculations will also take into account metabolism processes to simulate a living tissue.
The measured temperature is an average over the surface (of a spot on the tissue, 4 mm in diameter). Simulation enables us to know the exact temperature reached at each point of the tissue phantom. It showed us that as time passes, a better temperature distribution is reached inside the tissue. This means that a better bonding will be achieved.

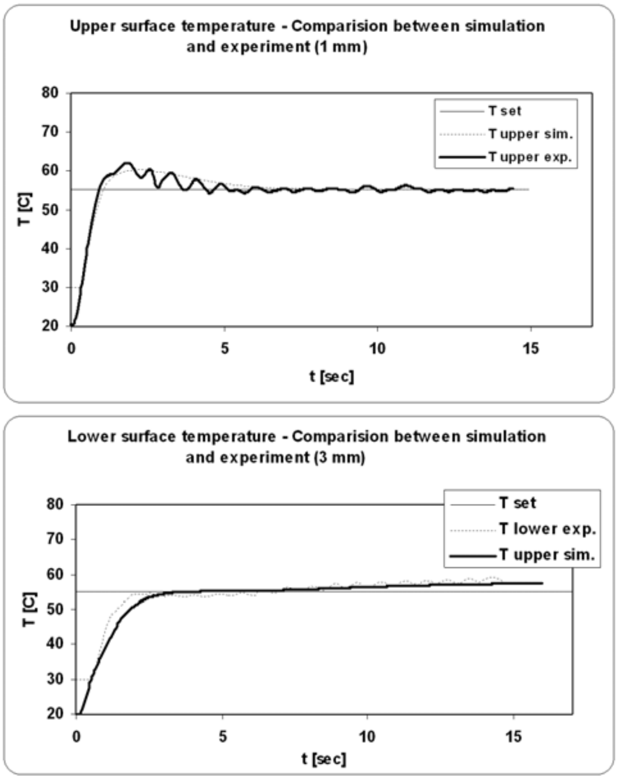

Figure 1: Comparison between simulation and experiment for the surface temperature of the upper surface (top) and the lower surface (bottom).

4. Discussion: The experimental system used for two lasers tissue soldering was improved. We faced a problem when we found that the silica fiber that delivered the GaAs laser radiation to the tissue was heating its surroundings, causing a false radiometric reading. That problem was solved using air cooling.

5. Conclusions: We accomplished dual laser soldering with temperature control. We found that the temperature distribution inside the tissue was more uniform then with a single laser. We were able to make sure that the temperature was controlled beneath the cut. Due to the above mentioned problems (which were all solved), the application of animal experiments for blood vessels soldering will begin in a later phase.