Medical Xpress

Laser-ing in on brain surgery

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Medical operations have become almost commonplace, but the delicacy of medical procedures involving the brain and the spinal cord force physicians and patients to consider other alternatives. European researchers, however, could change this following their development of a laser for minimally invasive brain surgery. The achievement is a result of an interdisciplinary EU project that involved partners from seven European countries, creating a table-top solid-state laser system that can cut brain tissue with unprecedented precision.

The inspiration for the project began back in 1999 when scientists from Vanderbilt University in the United States removed a brain tumour from a patient with a free-electron laser at a wavelength of 6.45 microns. The wavelength is important to note, as this wavelength in the mid-infrared spectral region had been recognised in a number of early experiments with different soft tissues as being the most suitable one for such surgical operations. Despite this acknowledgement, this technological know-how has not transferred itself into operating rooms as the equipment needed could not fit; free-electron lasers, for example, are huge and accelerator-based facilities are both expensive and generally not suitable for routine use in clinical conditions.

In 2008, the MIRSURG project was launched with the objective to develop a laser source that would emit a wavelength near 6.45 micrometres (µm) and provide high single pulse energy and average power which would enable minimally invasive neurosurgery. The project partners believed such an achievement would close the gap for diode-pumped solid-state lasers in the mid-infrared spectral range around 6.45 microns.

'There were so far no compact and reliable solid-state lasers emitting at the desired mid-infrared wavelength,' said Dr Valentin Petrov from the Max Born Institute for Nonlinear Optics and Short Pulse Spectroscopy (MBI), which headed the project.

The MIRSURG team presented a fairly compact all-solid-state prototype that fits on a table-top at a recent meeting in Saint-Louis, France. The desired optical wavelength of 6.45 microns is generated by frequency conversion. A laser beam with a wavelength near 2.0 microns is converted to the mid-infrared by the use of nonlinear optical crystals.

The new laser emits short pulses exactly at 6.45 microns with a repetition rate of 100-200 hertz (Hz) which ensures the targeted average power of over 1.0 watt. The greatly reduced collateral damage at this wavelength is due to the combined absorption of water and resonant laser heating of non-aqueous components (proteins). The penetration depth at this wavelength is on the order of several microns, which is comparable to the cell size, and is therefore close to the optimum value, not achievable by any other state-of-the-art lasers.

The MIRSURG partners plan to further optimise the new table-top laser, assess its tissue ablation capabilities and, possibly within a follow-up project, demonstrate real solid-state laser surgery at 6.45 microns. 'I hope that in the near future such a laser could become a practical surgical tool in every specialised operating room,' said Dr Petrov.

More information: MIRSURG project: www.mirsurg.eu

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