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Surgery beyond robotics: Directed energy for non-invasive surgery

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Abstract

Non-healthcare industries have used a wide spectrum of energy-based systems for many different purposes, from microchip manufacturing to artist creations, whereas only a small portion of these commercially available systems have been exploited by surgeons. Although many of the technologies are large and sophisticated image-guided systems that provide precise targeting at the molecular and atomic level, numerous other technologies are small, hand-held portable systems. Thus, many time-honored surgical procedures will be performed as outpatient or office procedures with small, hand-held directed energy devices. Within the full spectrum of energy, one of the best opportunities is photonics, with numerous existing and emerging technologies that are being accepted by the clinical realm.

Even as laparoscopic surgery matures, and the fourth revolution in surgery in 25 years (robotic surgery) is gaining in popularity, a much more disruptive change is beginning with the next revolution: Directed energy for diagnosis and therapy (DEDAT). This advance takes the minimally invasive surgery (MIS) to the final step – non-invasive surgery. Building upon the success of MIS, and combining experience in lasers, photo-bio modulation, image guided surgery and robotic surgery, there are new energy-based technologies which provide the control and precision of photonic energy to begin operating (non-invasively) at the cellular and molecular level.

The evidence that has been building from the multiple disciplinary field of photonics, computer assisted surgery, genetic engineering and molecular biology communities (Radiology, Surgery, Plasma Medicine, Molecular Biology, the Human Genome) will be presented, and includes additional technologies beyond photonics such as high-intensity focused ultrasound (HIFU), terahertz imaging and therapeutics – to name a few. Though still in its infancy, DEDAT presages the emergence of the non-invasive approach to medicine and surgery with these pioneering techniques, which are but the tip of the iceberg that heralds the transition to non-invasive surgery. Such systems are based upon the premise which directed energy, robotics and biomolecular technologies can bring – precision, speed and reliability - especially as surgery 'descends' into operating at the cellular and molecular level. Nobel Laureate Richard Feynman was right – there is "plenty of room at the bottom"!

Biography

Richard Satava, MD, FACS, is Professor Emeritus of Surgery, University of Washington Medical Center in Seattle, Washington. Prior academic positions include Professor of Surgery at Yale University and a military appointment as Professor of Surgery (USUHS) in the Army Medical Corps assigned to General Surgery at Walter Reed Army Medical Center. Government positions included Program Manager of Advanced Biomedical Technology at the Defense Advanced Research Projects Agency (DARPA) for 12 years and Senior Science Advisor at the US Army Medical Research and Materiel Command in Ft. Detrick, Maryland, and Director of the NASA Commercial Space Center for Medical Informatics Telemedicine, and Advanced Technology (NASA-CSC-MITAT) at Yale University. Upon completion of military career and government service he had continued clinical medicine at Yale University and University of Washington.

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