Lasers in surgery

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Editorial

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Laser in der Chirurgie

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Lasers have a long tradition in medicine. In surgery, they have been used for about 40 years. After the invention of the CO_2 laser – as the first high power, continuously emitting laser – by C. Kumar N. Patel in 1964 at the Bell Laboratories [1, 2], it took some years until the laser became a surgical instrument [2, 3]. It was the work of the engineer, Uzi Sharon, and the plastic surgeon, Isaac Kaplan, (the founders of Sharplan Laser Ltd., later Lumenis®) who combined the beam of a visible (red) helium-neon laser with the invisible beam of a CO_2 laser, matched them in the focal plane, and put them together in a rugged housing. The device from the early 1970s was equipped with an articulated arm and a focusing hand piece and has made an important contribution to the needs of clinical surgery [4]. In the years that followed, Isaac Kaplan developed numerous laser-surgical techniques that helped to define new basic conditions in plastic and reconstructive surgery. Thus, it is not surprising that he is known as the "father of laser surgery". Isaac Kaplan died in 2012 at the age of 93 years, and in the last years of his life he wrote some poems about laser surgery which give a lasting and unique view of this field [5].

Today the CO_2 laser is available in a variety of technological development stages from basic to high-end devices, and therefore its practical application has steadily increased [2]. Spot sizes in the micrometer range and helpful scanners to support precision surgery are now widely available. However, because of the limitations of the articulated arm, the CO_2 laser has mostly been used for tissue surface surgery; it is even used inside the body by means of a micromanipulator via natural orifices.

More recently, photonic crystal fibers have been introduced and are now available for medical use [6–8]. They seem to meet the surgical needs in endoscopy for the first time, and may pave the way for endoscopic surgery beyond that of the ear, nose and throat (ENT) field, which currently is the leading medical application of these lasers [9]. As was mentioned previously, laser application has been restricted to cutaneous surfaces for a long time until transmission of considerable amounts of energy through silica fibers became a possibility in the mid-1970s. Light transportation was possible when Kao introduced silica fibers in 1966, but it took nearly a decade until Kiefhaber and Naht developed fibers for laser power transmission of near-infrared laser radiation in 1975 [10]. Of these concurrently designed fibers only the first one – the bare fiber – survived, and has remained as the gold standard.

The concept of endoscopy, for examination of the inside of the body, was firstly developed in ENT and shortly after by gynecology and urology. Laparoscopy followed because of the diagnostic need in gynecology. Within a short time, the specific diagnostic approach was left and therapeutic applications were developed. However, it took a few more years until general surgeons adopted these techniques, and there was even a generation change necessary until endoscopic surgery became the successor of the earlier open-surgery dominance. Pediatric surgeons such as J. Waldschmidt realized the potential of small instruments in combination with lasers and a number of new operation techniques were introduced [11–17].

The laser opened the field, but high-frequency surgery took over. Nevertheless, for some indications the superiority of the laser has remained the determining factor. Today benign prostate hyperplasia treatment and a larger number of ENT techniques are an established and integral part of clinical routine [18, 19]. Moreover, lasers helped to establish a new interventional technique in addition to conventional surgery, the so-called *in situ* coagulation which can be performed superficially, interstitially or intravascularly [20–22]. In this issue of *Photonics & Lasers in Medicine*, Philipp et al. [23] present data of 450 patients diagnosed with pyogenic granuloma who were treated using the Nd:YAG laser (1064 nm) in impression technique or by direct coagulation. The results reflect the considerable expertise of this department in applying the *in situ* coagulation, ensuring not only sustained therapeutic success but also an excellent cosmetic outcome.

Cutting off some tissue and, maybe approximating the edges with sutures, is a main issue in surgery. There are many types of scalpels available and the laser scalpel is one of them. The superiority of the laser technique is obvious and is defined by a number of properties such as cutting quality, hemostasis, controllability, versatility, ease of use (learning curve), etc. Consequently, the laser is the established first choice for some operations where it has shown its superiority. However, this is still not the case for every surgical field mostly because of a lack of meta-analysis data. A larger number of clinical studies are required in order to evaluate and define specific techniques. Some of these specific techniques are presented in this issue. Mungnirandr et al. [24] compare the combined use of a CO_2 laser and tissue glue with conventional surgical techniques for circumcision. The authors conclude that the combined use of CO_2 laser and tissue glue has advantages over standard surgical techniques for circumcision because it requires a significantly shorter operation time, has a lower rate of local irritation and a better cosmetic appearance, whereas the cost of surgery was similar for both treatment modalities.

Kirschbaum [25] used a Nd:YAG laser with a wavelength of 1318 nm in order to cut lung parenchyma and at the same time to coagulate the resected surface. Using this method a large number of lung metastases can be removed with relatively little loss of blood. At the same time, a maximum of healthy lung tissue can be spared so that repeated operations can be carried out if the lung metastases recur.

Rupel et al. [26] report on a 57-year-old Caucasian woman suffering from oral sclerotic chronic graft-versus-host-disease (cGvHD) which the patient developed after having an allogeneic bone marrow transplantation because of diagnosed B-cell acute lymphoblastic leukemia. Oral cGvHD is accompanied by severe disability and morbidity due to impaired oral hygiene and food intake, jaw pain, tightness and discomfort. After conventional treatment with topical applications of a gel formulation containing clobetasol, nystatin and hyaluronic acid had failed, the patient underwent a laser-assisted surgical procedure using a blue light-emitting diode (LED) laser (445±5 nm). The patient did not experience any bleeding, pain or discomfort, and during a follow-up period of 6 months, the mouth opening was increased and stabilized from 12 mm to 25 mm, enabling the maintenance and improvement of oral hygiene together with an overall improvement in comfort and the quality of life.

Finally, the case series presented by Ali M. Osman and Nafie A. Almuslet [27] demonstrates the utility of lasers even in developing countries where financial resources for high-end devices are often lacking. The authors describe their experiences in the treatment of a group of 10 Sudanese patients with cutaneous leishmaniasis, a disfiguring protozoal skin disease widely to be found in Afghanistan, Algeria, Saudi Arabia, Iran, Sudan, Syria, Brazil and Peru.

But surgery does not end with the operation. In order to achieve the best results the wound healing process has to be controlled and supported. Low-level laser therapy (LLLT), also known under the term photobiomodulation, is aiming toward this therapy goal, either by using lasers or other intense light sources such as LEDs. Currently there is a change in the recognition of LLLT from an esoteric to a possible therapy option as more solid and trustworthy data has now been published [28, 29].

Also in this issue, Assis et al. [30] investigate the effectiveness of LLLT on the modulation of the systemic inflammatory processes and skeletal muscle morphology in an experimental sepsis model using rats. The results suggest that LLLT was able to decrease the systemic inflammation and muscle atrophy markers preventing muscle protein degradation. However, further studies are needed to provide more information about the long-term performance of this therapy.

Finally, we want to draw your attention to the abstracts of the DGLM Application Panel "Laser-advanced new methods for diagnostics and therapeutics" which was organized by the *Deutsche Gesellschaft für Lasermedizin* (DGLM) e.V. as part of the LASER World of PHOTONICS Congress and Exhibition in Munich, Germany [31]. The emphasis of the application panel was directed at how cooperation between clinicians, researchers, engineers and innovators from industry can ensure the success of biophotonic and laser innovations from bench to bedside, which is crucial for both surgical/therapeutic and diagnostic applications.

In this context, we would once more like to take the opportunity to encourage authors from all the fields mentioned above – clinics, research institutes and health care industries – to contribute to our journal *Photonics & Lasers in Medicine*. Submission of original research contributions, review articles, preliminary research reports, case studies, short communications or technical notes via http://mc.manuscriptcentral.com/plm are very welcome. Deadlines for the next issues are as follows: Medical and aesthetic dermatology (submission deadline: August 21, 2015), Vascular lesions (submission deadline: November 6, 2015). We are looking forward to your participation.

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