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Keynote Address
Speaker: Assoc. Prof. Jodhbir S. Mehta

Femtoscience in Cornea, Refractive and Cataract Surgery

"There are many femtosecond lasers for refractive and cataract surgery but apart from the word femtosecond they all work differently. Understanding the nuances will allow you to get the best out of the laser system you have."

Assoc. Prof. Jodhbir S. Mehta, Head and Senior Research Consultant of Corneal and External Eye Disease Service & Refractive Service, Singapore National Eye Centre

Lasers - basically light amplification by stimulated emission of radiation - are widely used throughout various medical specialties, including dermatology, oncology, neurosurgery, angioplasty, orthopedics, gastroenterology and ENT, said Assoc. Prof. Jodhbir S. Mehta, Head and Senior Research Consultant of Corneal and External Eye Disease Service & Refractive Service, Singapore National Eye Centre (SNEC).

In ophthalmology, lasers hugely changed the way clinicians practice their expertise in the fields of refractive surgery, retina, glaucoma, oculoplasty and cataract, said Prof. Mehta, also Head of Tissue Engineering and Stem Cells Group, Singapore Eye Research Institute (SERI) and Associate Professor at Duke-NUS Graduate Medical School (Singapore). Prof. Mehta was the keynote address speaker at the recently held 31st Malaysia-Singapore Joint Ophthalmic Congress (MSJOC) in Pullman Kuching, Sarawak, Malaysia. Overall, he delivered a very interesting lecture on the science of femtosecond lasers and its role and in the practice of ophthalmology.

The application of lasers in these ophthalmic subspecialties, emphasized Prof. Mehta, revolves around laser's interaction with tissue in the following ways:

- Photochemical (crosslinking): photons excite molecules or atoms making the molecules more likely to undergo chemical reactions with other molecules (e.g. PDT, C3R). The photosensitizer (a molecule that becomes reactive when it absorbs light and can induce chemical reactions within other molecules or tissue) causes reactive oxygen species to form leading to necrosis and apoptosis.
- Photothermal (retinal): photons are absorbed by a chromophore (a light-absorbing molecule) and converted into heat energy. The thermal effects works from tissue coagulation to vaporization (e.g. tissue cutting and welding).
- Photoablation (excimer): high energy UV photons are absorbed. Higher amount of energy than the chemical bonds holding molecules together cause the dissociation of molecules. Rapid expansion of irradiated volume occurs which is then ejected from the surface.
- Plasma-induced photoablation (capsulotomy): a free electron is accelerated by the intense electric field in the vicinity of the laser beam. By colliding with a molecule and freeing another electron, this process initiates a chain reaction resulting in plasma – a soup of ions and free electrons.
- Photodisruption (femtoflaps): mechanical effects that accompany plasma generation (i.e. bubble formation, cavitation, jetting and shockwaves)

With extremely high power attained at relatively low energy, femtolasers can cut tissue by photodisruption. Through this mechanism and its properties, the first generation of femtosecond lasers used in ophthalmology were born (i.e. AMO Intralase 15 kHz, 30 kHz, 60 khz).

On the other hand, the need for speed has led to the second generation of femtolasers (i.e. Carl Zeiss Meditec VisuMax, 200 kHz; AMO IntraLase, 60 kHz; Technolas PerfectVision and FEMTEC 40 kHz; Ziemer FEMTO LDV, >5 MHz [oscillation]). Among these faster femtosecond lasers, there are differences in pattern application. The laser spots are either fired in a spiral or zigzag (raster) pattern (i.e. raster – IntraLase, Ziemer, FS200; spiral – FEMTEC, VisuMax). Also, the suction device on the femtosecond laser varies in mechanism (i.e. machine or syringe controlled).

In recent years, the addition of enhanced functions in keratoplasty, IntraCor, astigmatic keratotomy (AK), pocket software, ICR Rings, Small Incision Lenticule Extraction (SMILE) and femtocataract surgery have led to the evolution of third generation femtosecond laser systems.

Later in his keynote address, Prof. Mehta highlighted the clinical evidence on the safety, efficacy and predictability of the different femtosecond lasers available today.

"Lasers play an integral part in our practice in all subspecialties of ophthalmology, and understanding how they work is vital to get the best out of them," he said. "There are many femtosecond lasers for refractive and cataract surgery but apart from the word femtosecond they all work differently. Understanding the nuances will allow you to get the best out of the laser system you have, or the one you want to purchase," concluded Prof. Mehta.