Phacoablation by Ultraviolet Laser

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***Abstract*—** *New method of multi mode fiberoptic endoscopic delivery of UV laser from Excimer can cause capsulorhexis and ablate cataract in human eyes. This shall eliminate LASER assisted cataract surgery which is exuberantly costly and also traditional phacoemulsification machine.*

***Keywords*— excimer laser fiber optics, phacosurgery.**

I. INTRODUCTION

LASER from excimer machine, if can be delivered on the surface of cataractous lens, then it can do cataract surgery easily. Phaco means lens and ablation means destruction. So cataract surgery done by light is called phacoablation.

An excimer laser, sometimes more correctly called an exciplex laser, is a form of ultraviolet laser which is commonly used in the production of microelectronic devices, semiconductor based integrated circuits or "chips", eye surgery, and micromachining.

II. HYPOTHSIS

Excimer laser can be transmitted through fiber optics to a distance place away from machine. This requires multi mode fiber optic system. The fibers can be embedded in a metallic tube of diameter 1mm.such a system has so many advantages. A bent tip delivery system can be used to make capsular rhexis and bent tip can be used for phacoablation.

PHOTO 1: PLANNED PLANNED OPTICAL FIBER for human eye

Photo 1

Optic fibers inside a metallic tube of diameter 1mm. in both the photos

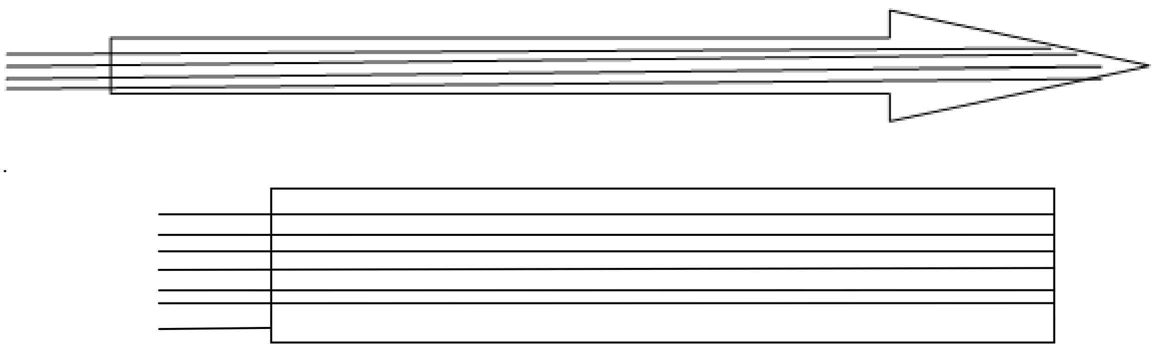


PHOTO 2:

Photo 2 of eye with lens at center Covered by capsule, that has to be cut before in this shape doing phacoablation for cataract surgery

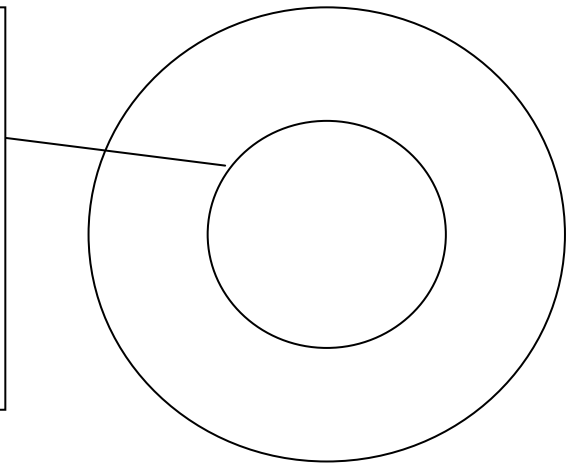


PHOTO 3:bent tip for capsulorrhexis

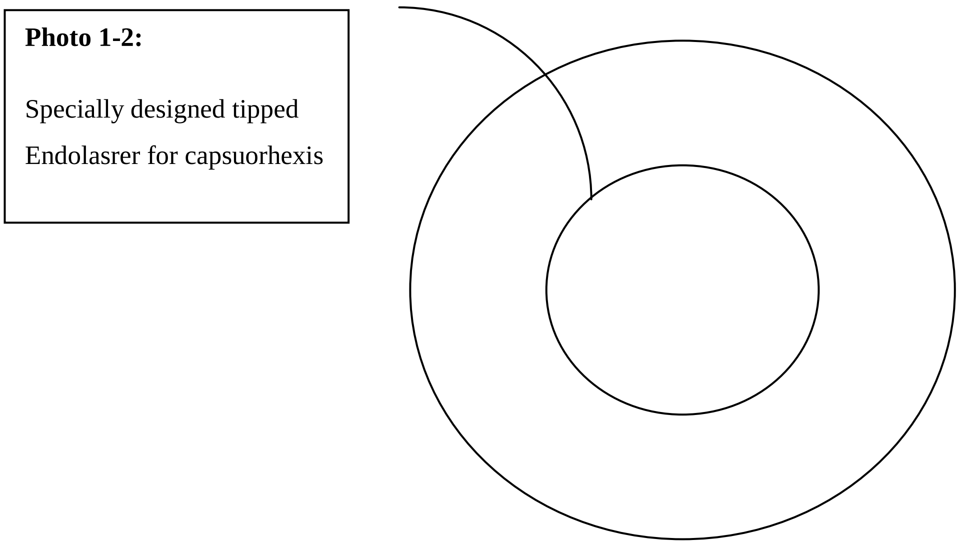
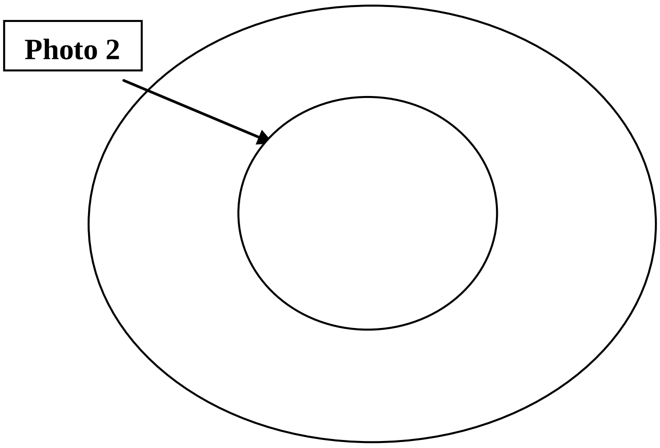


PHOTO 4: Straight tip for phacoablation



An optical fiber or optical fibre is a flexible, transparent fiber made by drawing glass (silica) or plastic to a diameter slightly thicker than that of a human hair.[1] Optical fibers are used most often as a means to transmit light between the two ends of the fiber and find wide usage in fiber-optic communications, where they permit transmission over longer distances and at higher bandwidths (data rates) than wire cables. Fibers are used instead of metal wires because signals travel along them with less loss; in addition, fibers are immune to electromagnetic interference, a problem from which metal wires suffer excessively.[2]Fibers are also used for illumination and imaging, and are often wrapped in bundles so that they may be used to carry light into, or images out of confined spaces, as in the case of a fiberscope.[3] Specially designed fibers are also used for a variety of other applications, some of them being fiber optic sensors and fiber lasers.[4]

Optical fibers typically include a core surrounded by a transparent cladding material with a lower index of refraction. Light is kept in the core by the phenomenon of total internal reflection which causes the fiber to act as a waveguide.[5] Fibers that support many propagation paths or transverse modes are called multi-mode fibers, while those that support a single mode are called single-mode fibers (SMF). Multi-mode fibers generally have a wider core diameter[6] and are used for short-distance communication links and for applications where high power must be transmitted. Single-mode fibers are used for most communication links longer than 1,000 meters (3,300 ft).

Being able to join optical fibers with low loss is important in fiber optic communication.[7] This is more complex than joining electrical wire or cable and involves careful cleaving of the fibers, precise alignment of the fiber cores, and the coupling of these aligned cores. For applications that demand a permanent connection a fusion splice is common. In this technique, an electric arc is used to melt the ends of the fibers together. Another common technique is a mechanical splice, where the ends of the fibers are held in contact by mechanical force. Temporary or semi-permanent connections are made by means of specialized optical fiber connectors.[8]

The field of applied science and engineering concerned with the design and application of optical fibers is known as fiber optics. The term was coined by Indian physicist Narinder Singh Kapany, who is widely acknowledged as the father of fiber optics.[9]

The tip of the multi mode fibers can be reduced to 1mm to deliver the laser to ablate the human cataractous lens. The fibers can be embedded in a metallic cylinder of caliber 1 mm. The tip of this cylinder can be introduced through cornea. The anterior capsule can be excised by ablating in circle. Subsequently the lens can be hydro dissected to make it free. Anterior chamber can be filled with viscoelastic substance. Then the tip of the fiber optics is set near the lens. Ablation lens can be continued in one direction covering maximum area possible till all nuclear material is ablated. Then the lens can be rotated to complete the ablation in all directions. Subsequently irrigation and aspiration may be used to complete phacoablation by UV laser from excimer laser.

III. History

Femtosecond laser is used now-a-days to make capsular rhexis of human lens. The same laser is used to soften the lens. Phacoemulsification of cataract is done then traditional method. This machine shall displace LASER ASSISSTED CATARCT SURGERY & made an useless tool,which is costing exuberantly high around $555000 and every year maintenance cost $30000.Along with this machine, the surgeon has to purchase a standard phacoemulsification machine. By this new method of transmitting laser to the surface of lens, surgeon shall get rid of phacoemeulsification machine also. Femtosecond Laser Technology Current femtosecond laser technology systems use neodymium: glass 1053 nm (near-infrared) wavelength. light. This feature allows the light to be focused at a 3 mm spot size, accurate within 5 mm in the anterior segment.[10] The critical aspect of femtosecond laser technology is the speed at which the light is fired. The focused ultrashort pulses (1015 seconds) eliminate the collateral damage of surrounding tissues and the heat generation associated with slower excimer and neodymium: YAG lasers.

IV. Discussion

4.1 Terminology

The term excimer is short for 'excited dimer', while exciplex is short for 'excited complex'. Most excimer lasers are of the noble gas halide type, for which the term excimer is strictly speaking a misnomer (since a dimer refers to a molecule of two identical or similar parts): The correct but less commonly used name for such is exciplex laser.

4.2 History

The excimer laser was invented in 1970[11] by Nikolai Basov, V. A. Danilychev and Yu. M. Popov, at the Lebedev Physical Institute in Moscow, using a xenon dimer (Xe2) excited by an electron beam to give stimulated emission at 172 nm wavelength. A later improvement, developed by many groups in 1975[12] was the use of noble gas halides (originally XeBr). These groups include the Avco Everett Research Laboratory,[13] Sandia Laboratories,14] the Northrop Research and Technology Center,[15]and the United States Government's Naval Research Laboratory[16] who also developed a XeCl Laser[17] that was excited using a microwave discharge.[18]

4.3 Construction

An excimer laser typically uses a combination of a noble gas (argon, krypton, or xenon) and a reactive gas (fluorine or chlorine). Under the appropriate conditions of electrical stimulation and high pressure, a pseudo-molecule called an excimer (or in the case of noble gas halides, exciplex) is created, which can only exist in an energized state and can give rise to laser light in the ultraviolet range.[19][20]

4.4 Operation

Laser action in an excimer molecule occurs not because it has a bound (associative) excited state, but a repulsive (dissociative) ground state. This is because noble gases such as xenon and krypton are highly inert and do not usually form chemical compounds. However, when in an excited state (induced by an electrical discharge or high-energy electron beams, which produce high energy pulses), they can form temporarily bound molecules with themselves (dimers) or with halogens (complexes) such as fluorine and chlorine. The excited compound can give up its excess energy by undergoing spontaneous or stimulated emission, resulting in a strongly repulsive ground state molecule which very quickly (on the order of a picosecond) dissociates back into two unbound atoms. This forms a population inversion.

4.5 Wavelength determination

The wavelength of an excimer laser depends on the molecules used, and is usually in the ultraviolet:

TABLE 1
THE WAVELENGTH OF AN EXCIMER LASER

Excimer	Wavelength	Relative power
Ar_2*	126 nm	
Kr_2*	146 nm	
F_2*	157 nm	
Xe_2*	172 & 175 nm	
ArF	193 nm	60
KrF	248 nm	100
XeBr	282 nm	
XeCl	308 nm	50
XeF	351 nm	45
KrCl	222 nm	25

Excimer lasers, such as XeF and KrF, can also be made slightly tunable using a variety of prism and grating intracavity arrangements.[21]

4.6 Medical uses

The ultraviolet light from an excimer laser is well absorbed by biological matter and organic compounds. Rather than burning or cutting material, the excimer laser adds enough energy to disrupt the molecular bonds of the surface tissue, which effectively disintegrates into the air in a tightly controlled manner through ablation rather than burning. Thus excimer lasers have the useful property that they can remove exceptionally fine layers of surface material with almost no heating or change to the remainder of the material which is left intact. These properties make excimer lasers well suited to precision micromachining organic material (including certain polymers and plastics), or delicate surgeries such as eye surgery LASIK. In 1980–1983, Rangaswamy Srinivasan, Samuel Blum and James J. Wynne at IBM's T. J. Watson Research Center observed the effect of the ultraviolet excimer laser on biological materials. Intrigued, they investigated further, finding that the laser made clean, precise cuts that would be ideal for delicate surgeries. This resulted in a fundamental patent [22] and Srinivasan, Blum and Wynne were elected to the National Inventors Hall of Fame in 2002. In 2012, the team members were honored with National Medal of Technology and Innovation by the President of The United States Barack Obama for their work related to the excimer laser.[23] Subsequent work introduced the excimer laser for use in angioplasty.[24] Xenon chloride (308 nm) excimer lasers can also treat a variety of dermatological conditions including psoriasis, vitiligo, atopic dermatitis, alopecia areata and leukoderma.

As light sources, excimer lasers are generally large in size, which is a disadvantage in their medical applications, although their sizes are rapidly decreasing with ongoing development.

Research is being conducted to compare differences in safety and effectiveness outcomes between conventional excimer laser refractive surgery and wavefront-guided or wavefront-optimized refractive surgery, as wavefront methods may better correct for higher-order aberrations.[25]

4.7 Scientific research

Excimer lasers are also widely used in numerous fields of scientific research, both as primary sources and, particularly the XeCl laser, as pump sources for tunable dye lasers, mainly to excite laser dyes emitting in the blue-green region of the spectrum.[26][27]

4.8 Repetition rate

Excimer lasers are usually operated with a pulse repetition rate of around 100 Hz and pulse duration of ~10 ns, although some operate at pulse repetition rates as high as 8 kHz and some have pulse widths as large as 30 ns.

V. ENDOSCOPIC LASER SYSTEM

Endoscopic cyclophotocoagulation (ECP) is a cyclodestructive procedure developed by Martin Uram in 1992. It functions to minimize the disadvantages of more traditional cyclodestructive procedures while maximizing the advantage of ablating the ciliary body epithelium to decrease intraocular pressure (IOP). It uses a laser endoscope containing three fiber groupings: an image guide, a light source, and the semiconductor diode laser. This technology allows direct visualization of the ciliary epithelium. Allowing the laser energy to be precisely delivered to the ciliary processes, thus limiting damage to the underlying ciliary body and surrounding tissue.[28]

Cataract surgery is the most commonly performed surgical procedure in the world, with an estimated 19 million operations performed annually. World Health Organization estimates this number will increase to 32 million by the year 2020 as the over65 population doubles worldwide between 2000 and 2020.29] Globally, more than 3000 eye surgeons (more than 1000 United States surgeons) have been trained. Femtosecond laser technology, introduced clinically for ophthalmic surgery in 2001 as a new technique for creating lamellar flaps in laser in situ keratomileusis (LASIK), has recently been developed into a tool for cataract surgery.[30]

So such a new endoscopic surgery of cataract shall be easier, faster, cheaper and has a wide market.

VI. CONCLUSION

Multi mode fiberoptic endoscopic delivery of excimer laser around 126-156 nm through clear cornea can make capsule rhexis easy and ablate cataractous lens, eliminating phacoemulsification machine and laser assisted cataract surgery. It will be cheaper and reduce the cost of cataract surgery.

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