Update On The Uses Of Femtosecond Laser In Ophthalmology

Essay
Submitted for Partial Fulfillment of the Requirements of the Master Degree in Ophthalmology

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Introduction

The Femtosecond (FS) laser technology was discovered in 1997 by the famous Nobel prized Egyptian scientist Dr. Ahmed Zwail [(1)].

The femtosecond laser is a focusable infrared laser which utilizes pulses in the femtosecond (10^{-15}s) duration range. A femtosecond is one quadrillionth of a second, 1/1000 of a picosecond and 1/1,000,000 of a nanosecond. The 1053 nm wavelength of light used by the laser is transparent to the cornea, thus resecting only targeted tissue, while leaving the surrounding tissue unaltered [(2)].

A unique feature of the femtosecond laser is its ability to produce tissue disruption at very low energy settings. This is due to the very short pulse width (pulse duration) associated with the laser (600 to 800 fs), and to the very rapid pulse repetition (speed) of the laser (15,000 - 60,000 pulses per second) [(3)].

There are several uses for the femtosecond laser in Ophthalmic practice and these uses are expanding as surgeons gain more experience with this versatile device [(3)].

The use of femtosecond laser in LASIK is effective and safe procedure with less corneal higher-order aberrations resulting in better uncorrected visual acuity and contrast sensitivity, In comparison to microkeratome [(4)].

Femtosecond laser can be also used to make channels for implantation of intracorneal rings (INTACS) in the treatment of keratoconus [(5)] and pellucid marginal corneal degeneration [(6)].

Also the ability of the femtosecond laser to produce penetrating keratoplasty (PK) incisions improves the precision of donor–host alignment which translates into faster recovery of higher levels of visual acuity [7].

Femtosecond laser–assisted lamellar keratoplasty (FALK) is effective in restoring corneal structure and transparency in several corneal pathologies [8] The regularity and homogenicity of the femtosecond laser cut resulted in a favorable wound healing response [9].

Using femtosecond laser for certain steps in cataract surgery has the potential to increase the accuracy of surgical procedure, decrease recovery time and improve visual results [10].

Femtosecond laser allows highly precise and reproducible subsurface using long infrared wave lengths. One of the most important applications of this method is glaucoma surgery. Permanent drainage channel may be created to reduce the elevated intraocular pressure [11].

FS laser has excited many scientists because of its precise high energy, low heat generating qualities and it appears to be both safe and effective. It is likely that successful implementation into Ophthalmic use will continue to flourish [12]

AIM OF THE ESSAY

The aim of this study is to discuss the different uses of femtosecond laser as a new tool in Ophthalmology.

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References

1- Pedersen S, Herek JL and Zewail A. The Validity of the Diradical Hypothesis: Direct Femtosecond Studies of the Transition-State Structures. Science 1997; (266):1359-1364.

2- Mian SI, Soong HK, Patel SV, Ignacio T and Juhasz T. In vivo femtosecond laser assisted posterior lamellar keratoplasty in rabbits. Cornea. 2006; 25:1205–1209.

3- Soong HK, Nian S and Abbasi O. Femtosecond laser-assisted lamellar keratoplasty. Ophthalmology. 2005; 112: 44-49.

4- Montès-Micó R, Rodriguez-Galietero A and Alió JL: Femtosecond laser versus mechanical keratome LASIK for myopia. Ophthalmology. 2007; 114(1):62-8.

5- Shabayek MH and Alio JL. Intrastromal Corneal Ring Segment Implantation by Femtosecond Laser for Keratoconus Correction. Ophthalmology. 2007; 114(9): 1643-1652.

6- Ertan A and Bahadir M. Intrastromal ring insertion using a femtosecond laser to correct pellucid marginal corneal degeneration J Cataract Refract Surg. 2006; 32(10): 1710-6.

7- Anwar M and Teichmann KD. Deep lamellar keratoplasty: surgical techniques for anterior lamellar keratoplasty with and without baring of Descemet's membrane. Cornea. 2002; 21:374–83.

8- Ehrenhaus MP, Aliprandis E and Lazzaro DR. Sizing guidelines for performing lamellar keratoplasty with the Intralase femtosecond laser. Invest Ophthalmol Vis Sci. 2006; 47: 3594.

9- Meltendorf C, Burbach GJ, Buhren J, Bug R, Ohrloff C and Deller T. Corneal femtosecond laser keratotomy results in isolated stromal injury and favourable wound-healing response. Invest Ophthalmol Vis Sci. 2007; 48:2068–2075.

10- Nagy Z, Takas A, Filkorn T and Sarayba M. Initial clinical evaluation of intraocular femtosecond laser in cataract surgery. J Refract Surg. 2009; 25 (12):1053-60.

11- Juhasz T, Kurtz RM, Sacks ZS, and Mourau GA. High precision subsurface photodisruption in human sclera. J Biomed Opt. 2002; 7 (3): 442-50.

12- Kohnen T and Koch D D. Essentials in Ophthalmology. J Cataract Refract Surg. 2005; (11):179-18.

استخدامات ليزر الفيمتوثانية فى طب وجراحة العيون

رسالة
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مقدمة:

تم اكتشاف ليزر الفيمتوثانيه في أواخر التسعينات من القرن العشرين على يد العالم المصرى الحاصل على جائزة نوبل الدكتور أحمد زويل .

و يعد ليزر الفيمتوثانية (10^{-15} من الثانية) من أنواع الليزر ذو الأشعة تحت الحمراء (طول موجي 1053 نانو متر) الذي يعطي نبضات فائقة القصر مع حجم بقعة حوالي 1 ميكرومتر. وقد ظهر كتطور لليزر البيكوثانية (10^{-12} من الثانية) والنانوثانية (10^{-9} من الثانية). ويحدث الليزر تأثيره بتكوين فقاعات تجويفية فى الأنسجة.

ويعتبر استخدام ليزر الفمتوثانية في عمل السديله الأمامية للقرنية من الطرق المتقدمة في عمليات تصحيح الإبصار بالليزر من حيث دقة سمك السديله و شكلها وزواياها و حوافها، و كذلك فى حالات القرنية المخروطية عن طريق عمل قنوات لزرع حلقات داخل القرنية تستغرق من 5 - 8 ثواني ويتم ذلك بطريقه غير مؤلمه تستغرق حوالي 5 دقائق يستطيع بعدها المريض العودة لعمله و بدون غطاء للعين.

يستخدم أيضا ليزر الفمتوثانية في عمليات الترقيع النافذ و الطبقي للقرنية، فهو قادر على قطع القرنية بدقه كما انه يستطيع عمل أشكال و زوايا مختلفة لا يمكن عملها بقاطع القرنية المعتاد. كما يستخدم تصحيح الاستجماتيزم وأخذ عينات من القرنية وفى وشم القرنية بكفاءة عاليه حيث انك لا تستطيع التفريق بين كلتا العينتين.

كما يستخدام ليزر الفمتوثانية الآن بنجاح في بعض خطوات عملية المياه البيضاء مثل عمل الجرح الخارجي بالقرنية، عمل الفتحة الأمامية بكيس العدسة و تقسيم العدسة وهو بذلك يؤدى إلى زيادة دقة العملية و تحسين نتيجة النظر. و في جراحات المياه الزرقاء غير النافذة وكذلك عمل فتحات بزاوية الخزانة الأمامية للعين.

لقد جذب الليزر فيمتوثانية انتباه الكثير من العلماء بسبب انتاجه لطاقة هائلة ودقيقة مع الحفاظ على خاصية انتاج حرارة قليلة و غير مدمرة للانسجة كما انه وسيلة آمنة وفعاله فى مختلف مجالات طب وجراحة العيون مستمرا فى التطور والانتشار فى الايام المقبلة.

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It would not have been possible to write this essay without the help and support of the kind people around me, my father, my mother, my husband and my sisters for whom my mere expression of thanks does not suffice.

✍ *Somaya Samy Diyab*

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ABBREVIATIONS

AC= Anterior Chamber

AK= Astgmatic Keratotomy

ALK= Anterior Lamellar Keratoplasty

ARVO= Association for Research in Vision and Ophthalmology

BCVA= Best Corrected Visual Acuity

BSCVA= Best Spectacle Corrected Visual Acuity

CCI= Clear Corneal Incision

CE= European Community

CXL= Collagen Crosslinking

D= Diopter

3D-CSI= Three dimentional Confocal Structured Illumination

DALK=Deep Anterior Lamellar Keratoplasty

DLK= Diffuse Lamellar Keratitis

DSAEK= Descemet's Stripping Automated Endothelial Keratoplasty

DSEK= Descemet's Stripping Endothelial Keratoplasty