

---

# **Advantages and Disadvantages of Femto-SMILE Procedure Compared To Other Refractive Surgeries**

Essay

Submitted for Partial Fulfillment of M.S. Degree in Ophthalmology

By

***Nehal Zaghloul Darwish Ibrahim***

M.B., B.CH.

Faculty of Medicine, Zagazig University.

Under supervision of

***Prof. Dr. Sherif Zaky Mansour***

Professor of Ophthalmology

Faculty of Medicine, Ain Shams University

***Prof. Dr. Thanaa Helmy Mohamed***

Professor of Ophthalmology

Faculty of Medicine, Ain Shams University

***Dr. Rania Gamal El-Din Zaki***

Assistant Professor of Ophthalmology

Faculty of Medicine, Ain Shams University

Faculty of Medicine

Ain Shams University

Cairo - Egypt

2018

---

# مميزات وعيوب تقنية الفيمتو سمايل مقارنة بجراحات تصحيح عيوب الابصار

دراسه تمهيديه للحصول على درجة الماجستير في طب وجراحة العيون

مقدمه من

طبيبه/ نهال زغلول درويش ابراهيم

بكالوريوس الطب والجراحه

كلية الطب - جامعة الزقازيق

تحت اشراف

الأستاذ الدكتور

**شريف زكي منصور**

أستاذ طب وجراحة العيون

كلية الطب - جامعة عين شمس

الأستاذ الدكتور

**ثناء حلمي محمد**

أستاذ طب وجراحة العيون

كلية الطب - جامعة عين شمس

الدكتور

**رانيا جمال الدين زكي**

أستاذ مساعد طب وجراحة العيون

كلية الطب - جامعة عين شمس

كلية الطب - جامعة عين شمس

القاهرة - جمهورية مصر العربيه

٢٠١٨

---

## Acknowledgments

*I wish to express my deep appreciation and sincere gratitude to Prof. Dr. Sherif Zaky Mansour, Professor of Ophthalmology, Ain Shams University, for his supervision, help, valuable instructions, patience, advices and guidance. He has generously devoted of his time and effort. It was a great honor to work under his supervision.*

*I wish to express my great thanks and gratitude to Prof. Dr. Thanaa Helmy Mohamad, Professor of Ophthalmology, Ain Shams University, for her kind supervision, indispensable advice and great help in this work.*

*I wish also to express my great thanks and gratitude to Dr. Rania Gamal El-Din Zaki, Assistant Professor of Ophthalmology, Ain Shams University, for her support, help, kind supervision, patience, and valuable observations in this work.*

---

---

## Table of Contents

List of Abbreviations.....	i
List of Figures .....	<u>iii</u>
List of Tables .....	<u>v</u>
Introduction .....	<u>1</u>
Aim of the work .....	<u>5</u>
physics of Femtosecond Laser .....	6
Corneal Laser Refractive surgeries .....	19
Small incision Lenticule extraction .....	29
Complications and management.....	45
Comparative Studies.....	53
Future Applications.....	68
Summary.....	77
References .....	80

---

---

## List of Abbreviations

<b>AK</b>	<b>Astigmatic Keratotomy</b>
<b>AS-OCT</b>	<b>Anterior segment optical coherence tomography</b>
<b>BCVA</b>	<b>Best corrected visual acuity</b>
<b>BSS</b>	<b>balanced salt solution</b>
<b>CH</b>	<b>corneal hysteresis</b>
<b>CRF</b>	<b>corneal resistance factor</b>
<b>CDVA</b>	<b>Corrected distance visual acuity</b>
<b>DLK</b>	<b>Diffuse lamellar keratitis</b>
<b>EBK</b>	<b>Epithelial Bowman keratectomy</b>
<b>FEMTOLASI</b> <b>K</b>	<b>femtosecond laser-assisted laser in situ keratomileusis</b>
<b>FSL</b>	<b>femtosecond laser</b>
<b>FLEx</b>	<b>Femtosecond lenticule extraction</b>
<b>HOAs</b>	<b>Higher order aberrations</b>

---

---

<b>ICRS</b>	<b>Intra Corneal Ring Segments</b>
<b>INTRACOR</b>	<b>Intrastromal Presbyopia Correction</b>
<b>IR</b>	<b>Infra-red</b>
<b>IVCM</b>	<b>In vivo confocal microscopy</b>
<b>kHz</b>	<b>Kilo hertz</b>
<b>LASEK</b>	<b>Laser-assisted sub-epithelial keratectomy</b>
<b>LASIK</b>	<b>Laser-assisted in situ keratomileusis</b>
<b>LogMAR</b>	<b>Logarithm of the minimum angle of resolution</b>
<b>MRSE</b>	<b>Manifest refraction spherical equivalent</b>
<b>Nd: YAG</b>	<b>neodymium-doped yttrium aluminium garnet</b>
<b>Nd: YLF</b>	<b>neodymium-doped yttrium lithium</b>
<b>Ns</b>	<b>nanoseconds</b>
<b>OBL</b>	<b>Opaque bubble layer</b>
<b>ORA</b>	<b>Ocular Response Analyzer</b>
<b>Ps</b>	<b>picosecond</b>
<b>PRK</b>	<b>Photo refractive keratectomy</b>

---

---

<b>ReLEx</b>	<b>Refractive Lenticule Extraction</b>
<b>RK</b>	<b>radial keratotomy</b>
<b>RMS</b>	<b>Root mean square</b>
<b>RSBT</b>	<b>residual stromal bed thickness</b>
<b>SE</b>	<b>Spherical equivalent</b>
<b>SMILE</b>	<b>Small Incision Lenticule Extraction</b>
<b>TBUT</b>	<b>Tear film break-up time</b>
<b>TLSS</b>	<b>Transient light sensitivity syndrome</b>
<b>tPRK</b>	<b>transepithelial Photo refractive keratectomy</b>
<b>TZ</b>	<b>Transition Zone</b>
<b>UAVA</b>	<b>Unaided visual acuity</b>
<b>UDVA</b>	<b>Uncorrected distance visual acuity</b>
<b>UV-A</b>	<b>Ultra Violet A</b>
<b>VA</b>	<b>Visual acuity</b>
<b>μJ</b>	<b>Micro joule</b>
<b>μm</b>	<b>Micrometer</b>



---

<b>WF-LASIK</b>	<b>Wave front laser-assisted in situ keratomileusis</b>
-----------------	---

---

---

## List of Figures

<b>Fig. No.</b>	<b>Title</b>	<b>Page</b>
	Mechanism of microplasma formation and the cavitation bubble	
	Mechanism of corneal femtodissection	
	Decreasing tissue bridges by the "double pass" technique.	<b>0</b>
	Decreasing tissue bridges by overlapping laser pulse.	<b>0</b>
	high pulse energy vs. low pulse energy	<b>1</b>
	Distance between laser pulses and laser pulse energy	<b>2</b>
	Laser pulses are connected together to define a resection plane and resection plane is created	<b>3</b>
	horizontal cleavage plane by positioning the laser spots horizontally	<b>4</b>

---

---

  

	Laser pulses stacked on each other obliquely to create an angled cleavage plane.	<b>4</b>
	VISUMAX femtosecond laser	
<b>0</b>		<b>8</b>
	Difference between generations of laser refractive surgeries	
<b>1</b>		<b>5</b>
	Incision geometry and ranges for surgical parameters	
<b>2</b>		<b>1</b>
	Curved contact glass	
<b>3</b>		<b>4</b>
	Docking procedure	
<b>4</b>		<b>4</b>
	Centration onto optical axis	
<b>5</b>		<b>6</b>
	Preparation of the refractive part of the lenticule	
<b>6</b>		<b>6</b>
	Preparation of the frontside of the lenticule	
<b>7</b>		<b>6</b>

<hr/>		
	Drawing of corneal cut Incision geometry of the SMILE procedure.	
<b>8</b>		<b>7</b>
	Clinical pictures of corneal interface in retroillumination after dilatation a)conventional dissection b) lenticuloschisis	
<b>9</b>		<b>0</b>
	CIRCLE profiles	
<b>0</b>		<b>3</b>
	(AS-OCT) showing retained lenticule remnant.	
<b>1</b>		<b>9</b>
	Site of SMILE vs. LASIK procedures	
<b>2</b>		<b>9</b>
	Scatter plot of the percentage of maximum cohesive tensile strength against the percentage of residual stromal depth	
<b>3</b>		<b>7</b>
	Preoperative limbal marking with the Ganesh bubble marker Method of manual cyclotorsion compensation	
<b>4</b>		<b>9</b>
	Geometry of the hyperopic SMILE lenticule parameters	
<b>5</b>		<b>3</b>
	Clinical Photographs of an eye following FILI	
<b>6</b>		<b>5</b>

---

---

## List of Tables

Table No.	Title	age
1	Commercially available fs laser devices.	5
2	Visual and refractive outcomes, safety and predictability of some recent studies performed on SMILE.	3



# Introduction