# *Power Modulation in Phacoemulsification*

**Essay**

**Submitted for partial fulfillment of master degree in ophthalmology**


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Egypt
2015

# تعديل القوة المستخدمة في تفتيت المياه البيضاء بالموجات فوق الصوتية

**بحث**

مقدم تمهيدا للحصول على درجة الماجستير
في طب وجراحة العيون

من


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*كلية الطب*
*جامعة عين شمس 2015*


*"قُلْ هُوَ الَّذِي أَنشَأَكُمْ وَجَعَلَ لَكُمُ السَّمْعَ وَالْأَبْصَارَ وَالْأَفْئِدَةَ قَلِيلاً مَّا تَشْكُرُونَ ﴿٢٣﴾"*

(سورة الملك)

# Acknowledgement

Let me start by giving all glory to God Almighty for his enduring mercy, faithfulness, guidance and blessing that made this research effort possible.

My sincere appreciation goes to Professor Doctor **Ali Hassan Saad** who guided and supervised me, his guidance supervision and intellectual wealth in greater way enriched my knowledge and perception of the subject matter. I am deeply indebted to Doctor **Mohamed Omar Yousif**, I acknowledge his tireless support, meticulous guidance, kind gestures and positive criticism have enriched my knowledge, experience and the structuring of the material content. My appreciation also goes to my esteemed colleagues and all others I may have not mentioned in person, for their valuable contributions and support.

Lastly but not the least, I take pride of being a part of my dear family, I acknowledge with gratitude their spiritual and other kind of supports kept me focused throughout the course, I have always enjoyed the wonderful love, understanding and patience of my great parents.

# List of Abbreviations

| | |
|---|---|
| CME | Cystoid Macular Edema |
| CZ | Central Zone |
| GZ | Germinative Zone |
| HPMC | HydroxyPropyl MethylCellulose |
| HZ | Hertz |
| IOL | Intraocular Lens |
| LOCS | The Lens Opacity Classification System |
| NSAID | Non-Steroidal Anti-Inflammatory Drugs |
| OVDs | Ophthalmic Viscosurgical Devices |
| PCO | Posterior Capsule Opacification |
| PGZ | Pregerminative Zone |
| RD | Retinal Detachment |
| TZ | Transitional Zone |

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# INTRODUCTION

In 1967, Charles Kelman started clinical trials of phacoemulsification after nearly three years of research, and began teaching the method to other ophthalmologists in 1969. Even in those days, he was insistent that surgeons knew how to set up the machine before being allowed to use it and had to practice many times on plastic eyes  and animal before proceeding to human cases**. *(Benjamin, 2007)***

Phacoemulsification is the removal of a cataractous lens using ultrasonic energy via small incision. **(*Benjamin, 2007)***

Early patient rehabilitation and excellent long term visual outcome have made phacoemulsification much preferred technique of cataract extraction today. Rapid strides in ophthalmology and surgical techniques have made the procedure safe and comfortable for the patient. ***(Grover and Popli, 2003).***

Phacoemulsification cataract surgery requires the use of complex phaco machines. Understanding the mechanical principles underlying this technology allows the surgeon to optimize machine settings and safely trouble shoot problems encountered during surgery. ***(Shugarman , 2013).***

All Eye Surgeons ,Regardless of level of surgical expertise, will benefit from reviewing the fundamentals of phacoemulsification, including fluidics and ultrasound power modulation. The accomplished surgeon can improve the safety and efficiency of their techniques and the novice surgeon will have a distinct advantage to mastering these skills. ***(Shugarman , 2013).***

During the eighties and nineties, ophthalmologists have become increasingly convinced that the amount of phaco energy delivered in an eye directly affects corneal endothelial cells and in some cases, causes corneal decompensation and compromised vision. Technological advances and surgical techniques aimed at minimizing the iatrogenic effects of phaco energy have evolved rapidly but surgeons today are faced with an even bigger challenge***. (Devgan , 2004)***

Power modulations were developed in the late 1980s and early 1990s and resulted in a modification in the delivery of phaco power, going from the delivery of continuous phacoemulsification to allowing milliseconds of rest between milliseconds of ultrasound activity **.(Fine et al, 2004)**

Many modulations in the delivery of power are now available. With these modulations, significantly less total ultrasound energy is delivered into the eye. In addition, some new systems provide occlusion mode phacoemulsification, allowing for different parameters of percentage power, vacuum levels, and aspiration flow rate on tip occlusion compared to an unoccluded tip. **(Fine et al, 2001)**

# AIM OF THE STUDY

To review the literature on the power modulation of phacoemulsification and to evaluate different techniques needed to decrease the energy used, to shorten phaco time and to improve efficiency, So as to improve the outcome of phacoemulsification with minimal eye injury.

# Chapter One

# THE ANATOMY AND EMBRYOLOGY OF THE LENS

## The Lens Definitions:

Lens, in anatomy, a nearly transparent biconvex structure suspended behind the iris of the eye, the sole function of which is to focus light rays onto the retina. The lens is made up of unusual elongated cells that have no blood supply but obtain nutrients from the surrounding fluids, mainly the aqueous humour that bathes the front of the lens. Waste products are removed through these fluids as well.

The cornea and the lens are the principal refractive elements of the eye. They are responsible for, respectively, stationary and variable refraction. However, although both must be transparent to function properly, the basis of their transparency is different. Lens transparency is the result of a unique arrangement of its fiberlike cells, or fibers, and a gradient of refractive index produced by a variable crystalline protein concentration within these fibers. In fact, alterations in lens morphology affected during specific periods of development and growth, lead to quantifiable improvements in lens optical quality. Thus, the human lens is a prime example of form following function and malformation leading to malfunction. (***Kuszak and Costello, 2006***)

In this chapter we will describe lens anatomy, development and Embryology; this is considered a crucial step to achieve a clear understanding of the Cataract (chapter two) and therefore figuring out the Phacoemulsification concepts and the cataract surgery.

## The Lens Anatomy

The Lens Structure: The lens consists of:

1. The lens capsule: The capsule completely envelops the lens and the cells of origin are completely contained in it. The capsule is the basement membrane of the lens epithelium and is the thickest basement membrane of the body. It is much thicker in front than behind and the anterior and posterior portions are thicker towards the periphery (equator) just within the attachment of the suspensory ligament than at the poles. The thickness at the posterior pole is 2.8- 4 μm and at anterior pole is 15.5 μm. Capsule thickness increases anteriorly with age but there is little change at the posterior pole. Under the light microscope the capsule appears transparent, homogenous and under polarized light, birefringent with an indication of a lamellar structure with fibers arranged parallel to its surface. Under electron microscope, the capsule appears to have a relatively amorphous appearance. There are up to 40 lamellae, each of which is 40nm thick. (***American Academy of Ophthalmology,2011***)