Micro Co-Axial Phacoemulsification

An Essay Submitted For the Partial Fulfillment of Master Degree in Ophthalmology

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Abstract

Cataract surgery has undergone remarkable growth in recent decades with the development of phacoemulsification machines in the late 1960s and foldable intraocular lenses (IOLs) in the late 1980s. These developments made cataract surgery through a micro incision a reality.

The trend in modern cataract surgery is to minimize surgical trauma. Micro coaxial phacoemulsification was created to try and insure a safe, more efficient cataract surgery. Micro coaxial phacoemulsification involves emulsification and aspiration of the cataractous lens using the same coaxial setup as with conventional phaco, but through a smaller wound, typically ranging in size from 1.6 to 2.4 mm.

Key Words:

History of phacoemulsification, Corneal Wound Architecture, Phacodynamics & Fluidics

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List of Abbreviations:

ABS	Advanced Bypass System
AC	Anterior Chamber
AFR	Aspiration Flow Rate
AS-OCT	Anterior Segment Optical Coherence Tomography
ATR	Against the rule
b-MICS	Bimanual Micro Incisional Cataract Surgery
BCVA	Best Corrected Visual Acuity
BSS	Balanced Salt Solution
CCC	Continuous Curvilinear Capsulorhexis
CCI	Clear Corneal Incision
CCT	Central Corneal Thickness
CDE	Cumulative Dissipated Energy
CFU	Colony Forming Units
c-MICS	Coaxial Micro Incisional Cataract Surgery
cps	Cycles per Second
cv	Coefficient of Variation
D	Diopters
DMPO	5,5 - dimethyl - 1 - pyrroline - N – oxide
ECD	Endothelial Cell Density
I/A	Irrigation Aspiration
IOL	Intra Ocular Lens
IOP	Intra Ocular Pressure

kHz	Kilo Hertz
LOCS III	Lens Opacity Classification III
LogMAR	Logarithm of Minimum Angle of Resolution
MDA	Malondialdehyde
MICS	Micro Incisional Cataract Surgery
mmHG	Millimeters of Mercury
Psi	Pounds per square inch
Pps	Pulses per Second
SIA	Surgically Induced Astigmatism
SICS	Small Incisional Cataract Surgery
SEM	Scanning Electron Microscopy
UCVA	Uncorrected Visual Acuity
US	Ultra Sound
UST	Ultra Sound Time
WTR	With the Rule

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coupled irregular steepening around the flattened area occurred in the MICS group (top left) and SICS group (top right). At 8 weeks, there was slight peripheral flattening in the MICS group (bottom left) and slight flattening and coupled steepening in the SICS group (bottom right)

Figure 11: Fluid leak from the side port

Figure 12: (a) Showing As the size of the phaco needle decreases linearly, the relative flow through the needle decreases exponentially

(b) Comparing tubing tips with a seemingly small difference in diameter can result in a dramatic difference in flow because of the exponential nature of tubing radius in Poiseuille's equation

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Introduction

Phacoemulsification cataract surgery has come a long way since Dr Charles Kelman's famous epiphany in the dentist's chair in the early 1960's. The idea that ultrasonic energy could be used to break up cataractous lenses was considered completely outrageous at the time, but of course now it has become the standard approach in the western world. In the initial procedure Dr Kelman used a four pound ultrasound handpiece, in a surgery that took four hours including 41 minutes of ultrasound time, resulting in endophthalmitis and phthisis in a blind patient. ***(Henahan . 2007)***

Complications that haunt the phaco surgeon are chamber instability, prolonged ultrasound time resulting in endothelial cell loss and corneal edema, thermal wound contracture and poorer uncorrected visual acuity due to incision induced astigmatism. ***(Emery, Wilhelmus et al. 1978)***

Many of the advantages of phacoemulsification are related to small incisions. Small incisions reduce tissue damage and postoperative inflammation and pain. They are also safer and provide faster and more stable postoperative visual and physical rehabilitation. Today, there is a clear trend toward smaller incisions and discussion that because of the small learning curve, better fluidics, same instrumentation, and same IOL inserted through a 2.0mm incision, coaxial microphacoemulsification is the ideal surgery technique. ***(Crema, Walsh et al. 2007)***

A common goal has been to minimize incision size with the potential benefits of reduced surgically induced astigmatism, shorter recovery time, and less propensity for wound leakage. ***(Lyle. & Jin 2006)***

Torsional phacoemulsification using an angled tip required less surgeon-generated tip travel and less time, suggesting that nuclear material may be more efficiently approximated to and aspirated through the tip aperture throughout the phacoemulsification process. Shorter cumulative tip travel and less procedure time imply increased nuclear followability, fewer reacquisition movements, and increased phacoemulsification efficiency and safety. ***(Davison, 2008)***

The phacodynamic advantages of torsional ultrasound is what optimized the micro-coaxial procedure. With the increased cutting efficiency, reduced repulsion, and favorable thermal profile of torsional ultrasound combined with optimal chamber stability, It have been able to reduce the fluidics parameters. The use of these conservative levels reduces intraocular turbulence and minimizes balanced salt solution use while allowing the surgeon to maintain excellent intraocular control and efficiency in a micro-coaxial environment. ***(Raviv, 2008)***

When phaco is performed using a torsional handpiece with a cataract removal system, measurable intraoperative and clinical benefits are achieved operating through a 2.2mm microcoaxial incision compared with a standard 2.8mm coaxial technique. ***(Kim, 2008)***

Aim of the work:

To review the literature and compare micro-coaxial phacoemulsification to conventional phacoemulsification in terms of average phaco time, cumulative dissipated energy, fluidics, thermal wound contracture, free radical production, post operative visual rehabilitation time, uncorrected/best corrected visual acuity, incision architecture, astigmatism, endothelial cell loss and corneal edema.