COMPARATIVE STUDY OF CONVENTIONAL VERSUS TORSIONAL PHACOEMULSIFICATION IN MANAGEMENT OF HARD NUCLEUS.

Thesis

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CCT: central corneal thickness.

CDE: cumulative dissipated energy.

ECC: Endothelial cell count.

ECL: endothelial cell loss.

IP: intelligent phaco.

LOCS: lens opacities classification system.

MICS : microincision cataract surgery.

PO: postoperative.

SD: standard deviation.

SPSS: statistical package for social sciences.

US: ultrasound.

UST: ultrasound time.

Introduction

Phacoemulsification is the main procedure of modern cataract surgery. Over the years, cataract surgery has become safer, with ongoing improvements in power modulation, pulse shaping and fluidics (1)**.** However, phaco energy is still the main risk factor for surgical induced trauma, especially for corneal endothelial cells (2).The aim of the recent phacoemulsification researches is to reduce phaco energy and shorten the phaco time .(3)

In the conventional ultrasound mode, the phaco tip moves forward and backward, this longitudinal movement produces a jackhammer effect causing repulsion as the phaco tip pushes the nuclear fragments away when it moves forward.(4)

The OZil® torsional handpiece of the Infiniti vision system® replaced the axial movement of a traditional phaco needle with the sideways oscillation of Kelman tip which eleminates longitudinal repelling forces at the phaco tip dramatically improving followability and reducing the chatter of fragments.(5)

Although the frequency of torsional phacoemulsification is lower (32 kHz) than traditional phacoemulsification (40 kHz), the

reduction of the repulsive effect and the added cutting in the lateral direction by torsional phacoemulsification makes it more efficient. However, there have been debates about the comparative efficacy and safety of torsional mode US in hard nucleus cataracts, as compared to longitudinal mode.(6)

The loss of endothelial cells is greater with hard than soft nuclei .This is because the increased particulate turbulence occurring with hard nuclear fragments causes the most damage to endothelial cells. This and the added stroke length of higher ultrasound power settings increase the chatter and turbulence of nuclear particles within the anterior chamber.(5)

Aim of the work

The aim of this work is to compare the safety and the efficiency of phacoemulsification using Conventional and Torsional ultrasound modalities for hard nucleus cataracts.

PHACOEMULSIFICATION PRINCIPLE

Charles Kelman application of ultrasound energy to cataract surgery in 1960s has resulted in many currently available variations on the original ultrasound technology. Today, surgeons have access to an array of various machines, handpieces, tips, and software settings for phacoemulsification. The progression of this technology is founded primarily on improving surgical efficiency and patient outcomes by decreasing iatrogenic injury.(7)

The corneal endothelium is a single layer of polygonal cells on the posterior surface of the cornea. Corneal transparency is controlled by the activity of endothelial ionic pumps, which maintain a low level of stromal hydration. The endothelial cell density (ECD) in the human eye decreases from 4000 cells/mm2 in childhood to approximately 2500 cells/mm2 at age 80 years, assuming a normal loss of 0.5% per year.(8)

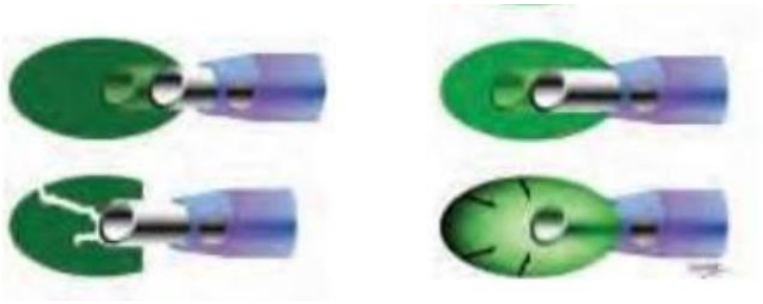
When the endothelial cell count (ECC) drops below 600 to 800 cells/mm2, corneal edema, corneal decompensation, and decreased visual acuity occur as a result of the compromised pump function. Endothelial cells are non replicative, and cell loss is compensated

by enlargement, migration, and increasing heterogeneity of residual cells.(9)

These changes increase the thickness of the cornea. This naturally occurring process is exacerbated when there is additional cell loss resulting from intraocular surgery, such as cataract removal.(7)

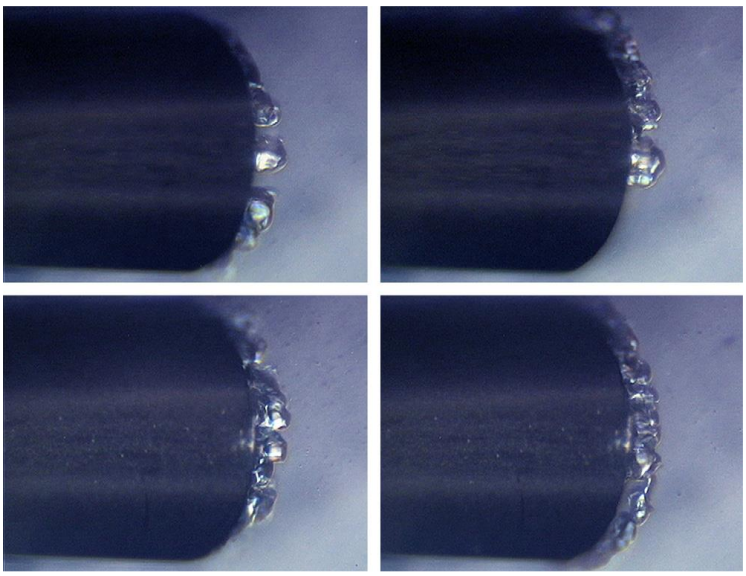
Factors such as advanced age, increasing the amount of ultrasound energy and phaco time are the main risk factors for corneal endothelial damage. Endothelial changes and alterations of central corneal thickness (CCT) are considered important parameters of surgical trauma and are indispensable in evaluating the safety of new surgical methods.(10).

It is well reported that the nucleus is broken down by the ultrasonic effects of the ultrasound tip, in which the phenomenon of cavitation plays a role and the power of the jackhammer effect; or both forces.(11)



(A) Jack Hammer effect (B) Cavitation phenomenon

Figure (1). Mechanism of phaco. (A) Jack Hammer effect: The rapid to and fro movement of the tip bombards the tissue in front and disintegrates it. (B) Cavitation phenomenon: The swift backward movement of the tip results in a cavitation phenomenon causing an implosion of surrounding tissue .(12)



Figure(2). Transient cavitation seen during backstroke of the phaco tip only. All images are at US 100% power.(13)

The energy for breaking up cataracts is usually delivered by a blunted titanium needle attached to an ultrasonic transducer. The needle tends to become hot and is cooled by the continuous inflow of saline as well as by the movement of aspirated fluid and lens emulsion up the needle bore and out of the eye.(14)

Studies have evaluated several methods to reduce the amount of ultrasound (US) energy intraoperatively; these include various power modulations, nuclear chopping techniques, microincision cataract surgery, and infusion and irrigation systems. Ultrasound power is considered a risk factor for endothelial cell loss and the use of high US energy is associated with heat generation and damage to the endothelium.(15)

FLUIDIC ELEMENT OF PHACOEMULSIFICATION:

The fluidic subsystems of the phacoemulsifiers used in cataract surgery account for much of their performance and safety.(16)

Compliance is a measure of a system's ability to expand or contract in response to applied fluidic pressure. Compliance, which is the inverse of stiffness, is defined as volume/D pressure, where D is the change. In phacoemulsification systems, compliance is a function of the mechanical properties of the aspiration line tubing and the cassette that mates the tubing to the pump mechanism.(17)

The fluidics module or phaco pack comes into contact with bodily fluids and is usually disposable or consumable. Highly compliant fluidic modules are undesirable because they increase the risk of postocclusion-break surge.(18)

Most current phacoemulsification systems use a peristaltic or flow-based mode of operation. This contrasts with posterior vitrectomy systems, which generally use a venturi- or vacuum-based mode of operation. (18)