Torsional Phacoemulsification and Tip Selection

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Summary

One of the recent advances in cataract surgery is torsional phacoemulsification. It was developed to increase the efficacy of ultrasonic emulsification. In torsional phacoemulsification, the torsional movement of the tip is translated to side-to-side cutting action with the aid of bent phaco tips. Lens material is cut in both directions, rather than only during a forward stroke. The efficiency of this technique is further enhanced by an improvement in followability provided by the inherent non-repulsive nature of the side-to-side motion. Tip selection is very important for the efficiency of torsional phacoemulsification. Theoretically, there are 2 ways to enhance the cutting efficiency of the tip. First is the stroke length; the 22-degree bent 30-degree Kelman mini-flared tip cuts longer than the 12-degree bent 30-degree mini-flared Kelman tip. Second is the angulation or bevel; the higher the degree (45 degrees), the better cutting efficiency. Retrospective analyses of the previously published clinical studies clearly demonstrated that the efficacy of the torsional phacoemulsification has positive correlation with both the aperture angles and neck angles of the tips. (Turk J Ophthalmol 2014; 44: 392-5)

Key Words: Torsional phacoemulsification, phaco tips

Özet


Anahtar Kelimeler: Torsiyonel fakoemülsifikasyon, fako iğneleri

Introduction

One of the most important surgical interventions of an ophthalmologist is cataract surgery. The main surgical option for elective cataract surgery is phacoemulsification, which has allowed surgeons to perform small incision cataract operations with good outcomes.1,2 Although there have been significant advances in technique and technology of emulsification, such as interrupted phaco modes, improved pump systems, nucleofractis techniques, and vacuum-assisted phaco, it still carries risk of injury to delicate ocular structures such as corneal endothelium.3,4

In conventional longitudinal phacoemulsification, emulsification occurs by the forward and backward movement of the tip. The energy is delivered directly to the nucleus by the forward movement of the tip which is also called the active part of the cycles. But same energy is also delivered to the eye during the backward movement. This passive part of the cycles creates no effective cutting but friction and heat production still
Heat production, which can lead to wound burn and have potential to damage intraocular structures, is an important handicap of emulsification. In the experimental study by Han et al.\textsuperscript{13}, heat productions of longitudinal and torsional phacoemulsification were compared. A straight 30-degree non-aspiration bypass system (ABS) microtip on an Infiniti US handpiece (Alcon, Inc.) and a 45-degree Kelman mini-flared ABS tip on an OZil torsional handpiece (Alcon, Inc.) were used. Continuous US in longitudinal or in torsional mode with same power, same stroke length, or with same applied energy were compared. Torsional phacoemulsification generated less heat than longitudinal phacoemulsification in all 3 comparison tests. In the experimental study by Jun et al.\textsuperscript{14}, incision temperatures of torsional and longitudinal US using 2.75 mm or 2.20 mm incisions were compared. A 0.9 mm 30-degree Kelman turbosonic miniflared aspiration bypass tip with a 0.9 mm Microsmooth MicroTip infusion sleeve or Microsmooth Ultra infusion sleeve (Alcon, Inc.) were used in 100% longitudinal or torsional power. Incision temperature was influenced by US modality and was significantly lower with torsional US than with longitudinal US.

Reuschel et al.\textsuperscript{15} conducted a clinical study to show endothelial cell changes after torsional and longitudinal phacoemulsification. Although the mean US time, CDE, and percentage total equivalent power imposition 3 were statistically significantly lower in the torsional group than in the longitudinal group, similar endothelial cell density changes were observed in both groups.

The effectiveness of phacoemulsification depends on the proportion of applied US energy and fluid exchange in the anterior chamber during the removal of nuclear material.\textsuperscript{9} The major handicap of the torsional phacoemulsification which decreases the efficacy of the emulsification is clogging. It is the obstruction of the tip’s shaft by emulsified nucleus material, mostly seen in the emulsification of dense cataracts and especially if 0.9 mm tips are used. When clogging happens, optimal shearing plane is lost and ineffective US energy is delivered since the obstructed tip does not allow aspiration of the emulsified nucleus materials. To overcome this handicap, surgeons add longitudinal component to the torsional movement. In the study by Rekas et al.\textsuperscript{16}, longitudinal 20% power was added to torsional phaco in hard cataracts to avoid clogging. Intelligent Phaco (IP) upgrade which delivers a very small amount (short pulse) of longitudinal US just after reaching the preset maximum vacuum level was combined with torsional technology to further increase its efficiency. Risk of clogging and shifts in the IOP decrease, and the eye is maintained in a more natural state throughout the surgery, theoretically, with the IP upgrade.

Ratnarajan et al.\textsuperscript{17} and Cioni et al.\textsuperscript{18} conducted a study comparing the outcomes of torsional phacoemulsification with or without the IP upgrade. A 30-degree Kelman-style mini-flared phaco tip was used in both studies. Significantly reduced CDE, foot pedal 3 times, balanced salt solution (BSS) volume, and shorter durations of occlusive events during surgery were observed with the upgrade.
We had also conducted a study to compare the safety and efficacy of micro coaxial phacoemulsification surgeries performed with the Ozil IP torsional mode and combined torsional/longitudinal US mode. A 0.9-mm 30-degree mini-flared 12-degree bent tip was used in all of the operations. Although lower CDE values were found in the IP group, statistical significance could not be achieved. Ozil IP torsional mode provided more effective lens removal than the combined torsional/longitudinal US mode with a statistically significant lower UST and volume of BSS used.\(^{19}\) IP was introduced in order to facilitate the lateral movement in lens material emulsification avoiding the complete tip occlusion. The longitudinal pulse occurs when a presetted vacuum threshold is reached and is less frequent than the pulse with a fixed rate in mixed longitudinal-lateral movement. For this reason, a reduced delivered energy has to be expected using IP. The key point was the tips that we used in our study. Twelve degree bent tip was not a good choice to show the real efficacy of torsional phacoemulsification. Tip selection is very important for the efficiency of torsional US amplitude of this group was significantly lower than of the IP group, efficiency of the emulsification was not gradually affected by the type of tip. Probably less CDE can be achieved with IP torsional phacoemulsification by using more bent tips. Tip selection is very important for the efficiency of torsional phacoemulsification. Theoretically, there are 2 ways to enhance the cutting efficiency of the tip. First is the stroke length; the 22-degree bent 30-degree Kelman mini-flared tip cuts longer than the 12-degree bent 30-degree mini-flared Kelman tip. Second is the angulation or bevel; the higher the degree (45 degrees), the better cutting efficiency (Figure 1). To show the influence of the stroke length on the outcomes of the torsional phacoemulsification, we performed a study. IP upgraded torsional micro coaxial phacoemulsification surgeries were compared by 22-degree or 12-degree bent tips. The 22-degree bent tip provided more effective lens removal than the 12-degree bend tip with a lower UST and CDE regardless of nucleus grade (Table 1).\(^{21}\) We have also conducted a study to analyze the cutting efficiencies of the 22-degree bent, 30- and 45-degree aperture angled tips. Theoretically, it is known that the 45-degree tip provides better “cutting”, and it is believed that the 30-degree tip provides better “holding”. Therefore, it would make some sense that the 45-degree tip would perform better in a more chop-dominant approach. On the other hand, a more tip-occlusive/less chopping technique could theoretically lead to greater efficiency with a 30-degree tip. Most of the surgeons get used to use 30-degree Kelman tips since the smaller holding surface of this tip, when compared to 45-degree tips, provides better control over the nucleus material. But with the chop technique and fluid-energy settings used in our study, no significant difference was observed between the groups for the amount of BSS used and the followability of the groups was

<table>
<thead>
<tr>
<th>Groups</th>
<th>UST</th>
<th>CDE</th>
<th>Longitudinal Us Amplitude</th>
<th>Torsional Us Amplitude</th>
<th>Mean Operation Time</th>
<th>Mean Volume of BSS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1</td>
<td>60.50 sec. ±27.23 sec.</td>
<td>11.53±6.99</td>
<td>0.22±0.26</td>
<td>42.86±15.64</td>
<td>985 sec.±306 sec.</td>
<td>73.33 cc±28.58 cc</td>
</tr>
<tr>
<td>Group 2</td>
<td>84.5 sec. ±45.04 sec.</td>
<td>16.68±10.66</td>
<td>0.48±0.68</td>
<td>46.27±14.74</td>
<td>950 sec.±325 sec.</td>
<td>82.08 cc±26.21 cc</td>
</tr>
<tr>
<td>p-value</td>
<td>p=0.003</td>
<td>p=0.008</td>
<td>p=0.022</td>
<td>p=0.291</td>
<td>p=0.808</td>
<td>p=0.134</td>
</tr>
</tbody>
</table>

UST: Ultrasound time, CDE: Cumulative dissipated energy. BSS: Balanced salt solution.

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</tr>
</thead>
<tbody>
<tr>
<td>Group 1</td>
<td>58.21 sec.±33.81 sec.</td>
<td>7.74±6.23</td>
<td>0.45±0.30</td>
<td>26.30±12.60</td>
<td>888,37 sec.±165.25 sec.</td>
<td>73.30 cc±19.87 cc</td>
</tr>
<tr>
<td>Group 2</td>
<td>63.83 sec.±23.42 sec.</td>
<td>12.36±6.75</td>
<td>0.23±0.26</td>
<td>44.65±14.38</td>
<td>919.02 sec.±277.92 sec.</td>
<td>74.30 cc±19.44 cc</td>
</tr>
<tr>
<td>p-value</td>
<td>p=0.389</td>
<td>p=0.002</td>
<td>p=0.001</td>
<td>p=0.001</td>
<td>p=0.545</td>
<td>p=0.821</td>
</tr>
</tbody>
</table>

UST: Ultrasound time, CDE: Cumulative dissipated energy. BSS: Balanced salt solution.
similar. Although it could be influenced by many factors such as techniques, fluid-energy settings, and proximity of emulsification to the cornea during the operation, statistically significant less CDE and CCT changes were observed in the 45-degree group (Table 2). Since the stroke lengths of the tips are same, the efficacy would be directly related to the aperture angles of the tips. As a result, the operations were performed more efficiently with enhanced cutting effect of the 45-degree aperture angled tips.22 These studies clearly demonstrated that the efficacy of the torsional phacoemulsification has positive correlation with both the aperture angles and neck angles of the tips. Our advice for the tip selection in torsional phacoemulsification is to use 22-degree bent tips, which clearly increases the stroke length. And for the angle at aperture of the tips, 45-degree tip would be a better choice regardless of cataract grade. Before getting used to performing surgeries with this tip, 30-degree aperture angled, 22-degree bent so called ‘Kelman tip’ could be efficiently used in cataracts up to grade 3.

References