Effects of phacoemulsification on the intraocular pressure and corneal endothelial cells of the patients with glaucoma

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Objective: To explore the intraocular pressure and corneal endothelial cells integrity changes in cataract phacoemulsification after anti-glaucoma surgery. Methods: Phacoemulsification was performed in 102 patients (118 eyes) with cataract after anti-glaucoma surgery and the intraocular pressure and corneal endothelial cell integrity changes of patients were observed at Day 1 and 3, first week and first month before and after surgery, including central corneal endothelial cell density, average cell area (AVE), cell area of coefficient of variation (CV) and central corneal thickness (CCT). Results: The intraocular pressure was elevated, the central endothelial cell density was reduced, the AVE, the CV and CTT thicken were increased at Day 1 and 3, first week and first month after surgery. The difference compared with preoperative was statistically significant. The intraocular pressure and CTT almost recovered to preoperative levels in 1 month after cataract phacoemulsification and the difference was not statistically significant; while the central endothelial cell density was still decreased and AVE and CV were still increased and the difference of these indexes and the coefficient of the patients was statistically significant compared with before surgery. Conclusions: For the patients with anti-glaucoma after cataract phacoemulsification, intraocular pressure and endothelial cell integrity change was initially observed at Day 1 after surgery, whereas they can almost return to the preoperative level in a month after surgery.

1. Introduction

Phacoemulsification is one of the conventional surgical treatment methods in cataract followed by glaucoma surgery[1]. The method of phacoemulsification has distinctive advantages compared with extracapsular extraction surgery of cataract treatment, such as small incision, rapid recovery and small astigmatism. However, it has a restrictive effect on the damage of intraocular pressure and corneal endothelial cells in patients after surgery in some extent and a series of complications will occur in patients underwent this surgery, for example intraocular pressure elevates and corneal endothelial cells integrity changes[2-4]. In this experiment research, phacoemulsification was performed in 102 patients (118 eyes) in our hospital with cataract after anti-glaucoma surgery and the intraocular pressure and corneal endothelial cell integrity changes of patients were observed at Day 1 and 3, first week and first month before and after surgery, mainly including central corneal endothelial cell density (CED), average cell area (AVE), cell area of coefficient of variation (CV) and central corneal thickness (CCT). The study was aimed to explore the effect of phacoemulsification on intraocular pressure and corneal endothelial cell of glaucoma.

2. Materials and methods

2.1. Clinical data

A total of 102 patients (118 eyes) with cataract after anti-glaucoma surgery from June 2013 to June 2015 in our hospital were selected and all the patients were treated with phacoemulsification. The patients included 44 male cases (44 eyes) and their age from 43 to 85 years old and mean age was (64.5 ± 7.62) years old, and 58 female cases (69 eyes) and their age from 37 to 78 years old and
mean age was (56.3 ± 7.36) years old. Parameters of 118 eyes were as follows: nuclear hardness was from 2 to 4 grade, mean hardness was (2.8 ± 0.7) grade; chamber depth was from 2.45 to 3.42 mm and mean depth was (2.97 ± 0.55) mm and axial eye length was from 22.3 to 26.8 mm and mean length was (24.3 ± 2.10) mm. Parameters of surgery were as follows: injection time was from 168.36 to 286.3 seconds and mean time was (246.3 ± 62.3) seconds; volume of liquid flow was from 26.3 to 112.3 cc and mean volume was (82.3 ± 23.21) cc; ultrasonic energy was from 2.5% to 8.1% and mean ultrasonic energy was 4.83% ± 1.134%; phacoemulsification time was from 5 to 297 seconds and mean time was (52.6 ± 32.45) seconds as well as cumulative dissipated energy was from 4.3% to 40.2% and its mean value was 11.34% ± 4.22%.

Exclusion criteria: (1) patients had eye disease which effected corneal endothelium, such as corneal dystrophy (2) a black nuclear with great hardness in eyeball presented or dark brown nuclear cataract occurred in eyeball and patients were not suitable for phacoemulsification due to dislocation or subluxation in cataract and (3) patients had eye traumas or were treated with other eye surgery, apart from glaucoma surgery.

2.2. Surgical methods

Some materials were prepared and patients were treated with surface anesthesia before doctor performed phacoemulsification formally. The mainly prepared work were sterilizing and binding up the head, then patients were covered with towel of eye and opened the lid using eye speculum, and saccus conjunctivae was washed using diluted gentamicin. In the surgery, anterior chamber irrigating solution was Ringer’s solution and injected viscoelastic substance was Healon. USA Alcon foldable artificial crystals were implanted. USA AMO ultrasound emulsification instrument was used in the opration. About 2.65 mm incision was opened in upper right of transparent corneal limbus and about 1.5 mm auxiliary incision was opened in its upper left. Posterior continuous curvilinear capsulorhexis was performed after injecting the viscoelastic substance and about 6 mm diameter was maintained during capsulorhexis. Energy setting was determined according to the lens nucleus hardness. The head of ultrasonic emulsification was stretched from incision and chopping nucleus knife of lens was stretched from its lateral, then nuclear emulsion of lens was sucked out using ultrasonic emulsification head. The rest of the lens cortex was sucked cleanly using I/A note suction after sucking nuclear emulsion of lens. The posterior capsule of eyes was polished and viscoelastic substance was injected into capsule bag. Therewith, in order to suck viscoelastic substance cleanly, foldable intraocular lens was needed to inject into capsule bag, then balanced salt solution was injected into anterior chamber and incision was closed tightly using water. Simple eye was wiped with tobradex ointment and bound up after closing tightly and then the surgery was completed.

2.3. Observation methods and indicators

2.3.1. Intraocular pressure testing

Intraocular pressure was tested by a examiner using non-contact tonometer NT510 automatically (Japan, NIDEK) at Day 1 and 3, first week and first month before and after surgery respectively. The mean values were gained after three times testing.

2.3.2. Corneal endothelial cell integrity testing

Living organism of central corneal endothelium of patients was took a photo and analyzed before and after surgery using non-contact corneal endothelial microscope (Italy, C.S.O.SRL SP-1). Corneal endothelial cell changes included CED, AVE, CV and CCT.

2.4. Statistical methods

Data interfered with this research were inputted in SPSS 13.0 to analyze. Measurement data of various groups were expressed and analyzed using ANOVA and were tested using t-test. Comparative analysis between groups at P<0.05 showed that difference was statistically significant.

3. Results

3.1. Intraocular pressure and corneal endothelial cell changes of patients at Day 1 and 3, first week and first month after surgery

The intraocular pressure was elevated, the CED was reduced and AVE, CV and CTT thicken were increased at Day 1 and 3 and first week after surgery. The difference compared with preoperative was statistically significant (P<0.05) (Tables 1, 2 and 3).
Table 3
Intraocular pressure and corneal endothelial cell changes at first week after surgery.

<table>
<thead>
<tr>
<th>Groups</th>
<th>Intraocular pressure</th>
<th>CED</th>
<th>AVE</th>
<th>CV</th>
<th>CCT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before surgery</td>
<td>17.3 ± 2.4</td>
<td>2 784.3 ± 58.9</td>
<td>387.42 ± 50.31</td>
<td>37.63 ± 6.64</td>
<td>512.8 ± 17.0</td>
</tr>
<tr>
<td>At first week after surgery</td>
<td>18.4 ± 2.2</td>
<td>2 587.7 ± 40.0</td>
<td>451.41 ± 51.39</td>
<td>42.38 ± 6.13</td>
<td>529.8 ± 20.3</td>
</tr>
<tr>
<td>t</td>
<td>6.569</td>
<td>53.686</td>
<td>17.299</td>
<td>10.319</td>
<td>12.483</td>
</tr>
<tr>
<td>P</td>
<td>&lt; 0.001</td>
<td>&lt; 0.001</td>
<td>&lt; 0.001</td>
<td>&lt; 0.001</td>
<td>&lt; 0.001</td>
</tr>
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</table>

3.2. Intraocular pressure and corneal endothelial cell changes at first month after surgery

Intraocular pressure and CCT almost recovered to preoperative levels at first month after surgery and the difference was not statistically significant (t = 1.270 and 0.968, P = 0.102 and 0.167), compared with before surgery; while CED was decreased and AVE and CV were increased and the difference was statistically significant, compared with before surgery (P < 0.05) (Table 4).

4. Discussions

Since Kelman carried out the first case of phacoemulsification to treat cataract in 1967, phacoemulsification causes great attention worldwide. This new surgery is popular in many ophthalmologists and patients due to its advantages like rapid healing and small effect on corneal curvature[8]. Whereas, in the early 80’s, many cases of phacoemulsification were reported that phacoemulsification can lead to elevate intraocular pressure and damage corneal endothelial cell integrity in patients after this surgery and ophthalmologists given up this surgery gradually. However, due to the improved surgery methods, especially posterior chamber surgery instead of anterior surgery, distance between corneal endothelial cell and lenticular nucleus is increased and direct stimulation of corneal endothelial cell is also reduced as well as the incidence of some complications because of loss compensation of corneal endothelial cell after surgery like corneal edema and bullous keratopathy is greatly decreased[6,7]. In currently, the proportion of corneal endothelial cell damage of phacoemulsification is still high, compared with another common cataract surgery (capsule outside enucleation). Therefore, in clinical practice, this is one of core issues that the effect of phacoemulsification on the intraocular pressure and corneal endothelial cells of glaucoma was evaluated to reduce corneal endothelial cell damage by optimizing surgery methods[8].

In this study, the results showed that intraocular pressure was increased transiently in cataract phacoemulsification at Day 1 after anti-glaucoma surgery, decreased after 3 days initially and intraocular pressure of patients recovered almost to preoperative level, which explained that phacoemulsification can lead to occur transiently raised intraocular pressure of patients with cataract after anti-glaucoma surgery. The reasons of raised intraocular pressure of phacoemulsification after anti-glaucoma surgery are very sophisticated and all kinds of reports are not unified. Some of studies showed that in surgery, residues such as viscoelastic agent, fragment of lens cortex, capsule membrane fragments of lens, shedding modified cells, pigment granules and red blood cell block trabecular meshwork, which lead to intraocular pressure raised[9]. Another report said that energy and hemostasis in surgery factors of phacoemulsification destroy anterior chamber angle structure and aqueous discharge system and disturb blood - aqueous humor barrier function, which lead to elevated intraocular pressure transiently[10]. Arnavielle et al believed that secretion levels increasing of epithelium of ciliary processes stimulating by surgery and artificial lens can induce anterior chamber angle structure edema transiently and lead to raise intraocular pressure[11].

CED, AVG and CV of patients were compared in this research and the results showed that CED was decreased and AVG and CV were increased at Day 1 and 3, first week and first month after surgery. The difference before and after surgery was statistically significant (P < 0.001). However, CCT was higher than before surgery at Day 1 and 3, decreased initially after one week and almost recovered to preoperative level after one month, which showed that phacoemulsification will damage corneal endothelial cells integrity, but some indexes were reversible[12]. Currently, scientific research results showed that the use of phacoemulsification can inevitably cause endothelial cells reducing and cell density declining. At the same time, endothelial cells covered descemet’s membrane by expanding area passivity to maintain the status of corneal transparency and dehydration and increase AVE and CV[13]. Normal hexagonal cells of corneal endothelial cells in patients were reduced due to cell shape change[14]. For the healing of corneal endothelial cell capacity, the view of many scholars is relatively uniform and they believed that the capacity should be greater than 1 000/mm. If smaller than the level, corneal endothelial cells were easily to occur decompensation and some complications[15]. However, acute decompensated and complications were not occurred in this research, such as bullous keratopathy.

In conclusion, cataract phacoemulsification after anti-glaucoma surgery can lead to increased intraocular pressure and corneal endothelial cells integrity changes. Therefore, parameters of surgery of are regulated according to patients’ self-condition and surgery time is shortened farthest. Moreover, surgery should be performed in pupil area away from the cornea, which can protect corneal endothelial cells and prevent complications occurrence.
References


