Novel approach for phacoemulsification during combined phacovitrectomy

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Purpose: To evaluate the safety and efficacy of surgeon’s superior sitting position during temporal clear corneal incision (TCCI) phacoemulsification, with a 90° working angle, during combined phacovitrectomy.

Methods: Prospective interventional case series were performed on 65 eyes of 63 patients. TCCI phacoemulsification was done in all cases (whether right or left eyes), while the surgeon was sitting superiorly to the operating table.

Outcome measures included: Shift in sitting position, keratometric astigmatism, surgically induced astigmatism, posterior capsule integrity, and intraocular lens centration.

Results: Phacoemulsification was performed completely in all cases (100%). Shift in position to temporal sitting position happened in two cases (3%). The keratometric astigmatism showed mean changes of 1.09 D (0.25–3.75 D) to 0.84 D (0.00–3.25 D) at 1 month, which remained stable at 6 months; 0.84 D (0.16–3.21 D). The surgically induced astigmatism was 0.25 DC (−0.50 to 1.0 DC) at 1 month, which stayed stable at 6 months; 0.25 D (−0.63 D to 0.98 D). Posterior capsular rupture occurred in one case (the second case) (1.5%). The intraocular lens was centered in all cases (100%).

Conclusion: Superior sitting TCCI phacoemulsification, with a wide working angle, during combined phacovitrectomy proved safe and easy, without the burden of changing and disrupting the operative setting. The anatomical and optical outcomes were acceptable.

Keywords: clear corneal incisions, temporal nasal horizontal superior, surgically induced astigmatism, keratometric astigmatism, superior sitting position, working angle

Introduction

Combined cataract and vitreoretinal surgery (phacovitrectomy) has gained popularity in the recent years. The combined surgery offers advantages including: adequate visualization of the posterior segment, adequate access to the vitreous base, more rapid visual recovery, and avoiding the need for cataract surgery in the vitrectomized eye. Cataract surgery in a vitrectomized eye is risky because of instability of the zonules and posterior capsule, absence of vitreous support, and adherent posterior subcapsular plaques.1–5

The most common approach for phacoemulsification is temporal, where the surgeon sits at a temporal position to the surgical table, and performs the procedure through a temporal clear corneal incision (TCCI). The working angle is usually approximately 45°. The advantages of temporal approach include: it induces the least surgically induced astigmatism (SIA); it provides adequate visualization of the posterior segment because the temporal incision is further from the visual axis than the superior incision; it provides better accessibility, especially in deep set eyes or prominent orbital rims; and it offers an excellent red reflex.5–9

The major drawback for the temporal approach during combined phacovitrectomy is that the surgeon and assistants need to arrange the situation with the operating table and
move their operating position after finishing the phacoemul-
sification and before starting the pars plana vitrectomy. This
teants shifting the position of various machines and tables in
the operating room, which is close to the patient’s bed.6

This study was designed so that the surgeon attains a
superior sitting position, but performs the phacoemulsifica-
tion through a TCCI. The working angle is approximately
90° (between the surgeons viewing axis and the phaco probe
axis). This achieves the advantages of temporal phacoemul-
sification without changing position during the combined
phacovitrectomy. This approach avoids shifting of surgical
machines and tables in the operating room. This means that
there is much less interruption, time loss, and less entrance by
technicians and nursing staff. This reduces the operative time,
and reduces the risk of postoperative endophthalmitis.

Patients and methods
This prospective consecutive interventional case series
included 65 eyes of 63 patients. Superior sitting temporal inci-
dation phacoemulsification was performed during the combined
phacovitrectomy in all the cases. The surgeries were performed
by a single surgeon (WAE) from December 2013 to August
2014. Approval from the Research Ethics Committee of the
Faculty of Medicine, Cairo University was obtained. Written
informed consents were obtained from all the patients.

Inclusion criteria included: candidates for phacovitrec-
tomy with clear cornea. Exclusion criteria included: lens
subluxation, trauma cases, corneal opacity, keratoconus or
keratectasia, and irregular astigmatism.

Preoperative evaluation was done for keratometric astig-
matism (KA) as part of the optical biometry (IOL Master).

Surgical procedure
The cases were performed under local peribulbar anesthesia in
55 cases (84.6%), and general anesthesia in ten cases (15.4%).
Surgeries were performed by one surgeon (WAE). The
surgeon sat at the head of the table at 12 o’clock position
(superior sitting position).

Two side port 19G micro vitreoretinal blade incisions
were done at 6 and 12 o’clock positions, respectively, fol-
lowed by the main stab keratome incision, which was done
clear corneal, uniplanar, with a 2.4 mm width. The keratome
incision was done along the horizontal meridian temporally
at 3 o’clock in left eyes and at 9 o’clock in right eyes.

Conventional coaxial phacoemulsification was done in
all cases, with the horizontal orientation of the phaco probe,
90° working angle.

A foldable intraocular lens (IOL) was implanted in the
capsular bag. It was a 6 mm hydrophobic acrylic IOL (Alcon
Acrysof SA60, Alcon Laboratories Inc., Fort Worth, TX,
USA). The IOL was implanted using an injector system
(Monarch, Alcon Laboratories Inc.).

The stab incision was secured with a single radial 10/0
nylon suture, which was removed at the end of the surgery.

After all phacoemulsification was done, 23G trocars
(Alcon 23G, Alcon Laboratories Inc.) were inserted in an
oblique single step fashion 3.0 mm from the limbus, and
vitrectomy was then performed. The tamponading agent used
at the end of surgery was either air, sulfur hexafluoride 6
(SF6) gas, or silicone oil.

The outcome measures included shift of position to tem-
poral sitting during the procedure, posterior capsule integrity
during the procedure, IOL centration, KA, and SIA. IOL
centration was defined as equally distanced IOL optic edges
from the edge of the capsulorhexis.

The postoperative evaluation was performed 1 day after
the procedure for IOL centration, and keratometry was done
1, 3, and 6 months, after the procedure for KA, IOL Master
optical biometry was used for KA measurement. SIA was
calculated, from KA, by the vector analysis formula using
the Holladay–Cravy–Koch formula.10

Results
The study was performed on 65 eyes of 63 patients, including
28 male patients (43%) and 37 female patients (57%).

The mean age was 50 years (standard deviation [SD]: 12,
19–74 years). Sixty-five percent of the patients were ≥50 years
old. Age distribution is illustrated in Figure 1.

Systemic disease: eight cases were diabetic (12.3%),
24 cases had both diabetes mellitus and systemic hypertension
(36.9%), and six cases were hypertensive only (9.2%).

The ocular indications for combined phacovitrectomy
included: proliferative diabetic retinopathy in 15 cases
(23.1%), fractional diabetic macular edema in 14 cases
(21.5%), simple rhegmatogenous retinal detachment in
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13 cases (20%), proliferative vitreoretinopathy in 14 cases (21.5%), and vitreoretinal interface disorders in nine cases (13.8%). They are displayed in Figure 2.

The crystalline lens was clear in 19 cases (29.2%), with a mature cataract in six cases (9.2%), nuclear I cataract in 12 cases (18.5%), and nuclear II and III in 28 cases (43.1%). Figure 3 illustrates lens status.

Baseline criteria are demonstrated in Table 1.

Intraoperative shift in position from superior sitting to temporal sitting was needed in two cases (3.1%); they were the second and the third cases in the study.

Posterior capsule remained intact in 64 cases (98.5%). It was ruptured in only one case (1.5%), and this was the second case in the study. This case had a mature nuclear cataract.

The IOL was centered in the capsular bag at day 1 in all cases (100%).

**KA**
The mean preoperative KA was 1.09 DC, with an SD of 0.65, and a range 0.25–3.75 DC.

There was a statistically significant change in the mean postoperative KA, 1 month after the procedure, to 0.84±0.58 DC, with a range 0.00–3.25 DC (P<0.05). KA remained stable over 3 and 6 months; respectively, 0.84±0.58 DC and 0.84±0.57 DC (P>0.05).

Change in KA is illustrated in Figure 4.

Keratometric data were reviewed to identify the pattern of astigmatism; whether with the rule (WTR), or against the rule (ATR). Most of the cases had preoperative ATR astigmatism, 61 eyes (93.8%). WTR astigmatism existed in only four eyes (6.2%).

WTR astigmatism worsened significantly at 1 month from a baseline mean 1.06±0.31 D to a mean 1.44±0.24 D (P<0.05). There was an insignificant change at 3 months; 1.59±0.21 D, and at 6 months 1.55±0.16 D (P>0.05). Change in WTR astigmatism is illustrated in Figure 5.

However, there was an insignificant change at 3 and 6 months; consecutively, 0.79±0.56 D (P>0.05) and 0.79±0.56 D (P>0.05). Changes in ATR astigmatism are illustrated in Figure 6.

**Table 1** Baseline demographic and clinical data

<table>
<thead>
<tr>
<th>Baseline criteria</th>
<th>Results</th>
<th>Range (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male/female</td>
<td>28/37</td>
<td>43/57</td>
</tr>
<tr>
<td>Age (years)</td>
<td>50</td>
<td>19–74</td>
</tr>
<tr>
<td>DM</td>
<td>8</td>
<td>12.3</td>
</tr>
<tr>
<td>DM and HTN</td>
<td>24</td>
<td>36.9</td>
</tr>
<tr>
<td>HTN</td>
<td>6</td>
<td>9.2</td>
</tr>
<tr>
<td>PDR</td>
<td>15</td>
<td>23.10</td>
</tr>
<tr>
<td>TDME</td>
<td>14</td>
<td>21.50</td>
</tr>
<tr>
<td>RRD</td>
<td>13</td>
<td>20</td>
</tr>
<tr>
<td>PVR</td>
<td>14</td>
<td>21.50</td>
</tr>
<tr>
<td>VR interface</td>
<td>9</td>
<td>13.80</td>
</tr>
</tbody>
</table>

**Abbreviations:** RRD, simple rhegmatogenous retinal detachment (with PVr 0, A, B); PVR, proliferative vitreoretinopathy; PVR C, proliferative vitreoretinopathy grade C; PDR, proliferative diabetic retinopathy; TDME, tractional diabetic macular edema; VR interface, vitreoretinal interface.

**Notes:** N I = nuclear cataract grade I (mild density, yellowish). N II-III = nuclear cataract grades II and III (moderate density, greenish brown).

**Figure 2** Indications for phacovitrectomy.

**Abbreviations:** RRD, simple rhegmatogenous retinal detachment (with PVr 0, A, B); PVR, proliferative vitreoretinopathy; PVR C, proliferative vitreoretinopathy grade C; PDR, proliferative diabetic retinopathy; TDME, tractional diabetic macular edema; VR interface, vitreoretinal interface.
The SIA was 0.25±0.4 DC at 1 month. SIA remained stable; 0.25±0.4 D at 3 months and 0.25±0.39 D at 6 months.

In the four WTR astigmatism cases, there was an initial statistically insignificant increase in SIA from a mean 0.38±0.14 D at 1 month to 0.53±0.12 D at 3 months ($P>0.05$), followed by a statistically insignificant reduction to a mean 0.48±0.16 D at 6 months ($P>0.05$). SIA changes are illustrated in Figure 7.

In the 61 cases of ATR astigmatism, SIA remained stable over the 6 months, as shown in Table 2 and Figure 8.

There was almost no relation between the age of patients and the baseline KA, $r \ (63)=0.22, P>0.05$, in addition to the SIA, $r \ (63)=0.17, P>0.05$. However, there was a significant positive relation between age and SIA in ATR astigmatism cases, $r \ (63)=0.70, P>0.05$. There was no relation between sex of patients and KA ($r \ (63)=0.06, P>0.05$), and SIA ($r \ (63)=0.09, P>0.05$).

There was a significant moderate relation between diabetes mellitus (DM) and baseline KA ($r \ (63)=0.31, P<0.01$). However, there was no relation between systemic hypertension and baseline KA ($r \ (63)=0.05, P>0.05$). There was no correlation between the underlying indications for vitrectomy and the baseline KA ($r\ (63)=0.24, P<0.05$), and SIA ($r \ (63)=0.05, P>0.05$). There was no relation between the lens status and baseline KA ($r \ (63)=0.09, P>0.05$), and the SIA ($r \ (63)=0.09, P>0.05$).

Tamponading agents were used in the cases as follows: Air in 22 eyes (33.8%), SF6 gas in 19 eyes (29.2%), and silicone oil in 24 eyes (36.9%). Figure 9 illustrates tamponading agents in the study.

The study proves that there is a weak relationship between the used tamponade and baseline KA, postoperative KA in the cases, preoperative: $r\ (63)=0.28, P<0.05$, and postoperative $r\ (63)=0.28, P<0.05$. Silicone oil cases had the largest mean preoperative and postoperative KA; 1.30 D and 1.06 D, consecutively. However, there was no relationship between the tamponade and the SIA, $r \ (63)=0.05, P>0.05$, thus confirming the null hypothesis. Preoperative and postoperative mean KA, for cases according to the used tamponade, are listed in Table 3 and Figure 10.

**Discussion**

TCCIs elicit less astigmatism than superior clear corneal incisions. Our study achieved 0.25 DC SIA, compared to 0.87 DC induced by superior clear corneal incisions in a study done by Lee et al. Even though the SIA gradually decreased

**Table 2 SIA changes in ATR astigmatism cases**

<table>
<thead>
<tr>
<th>Follow up</th>
<th>SIA (mean ± SD)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 month</td>
<td>0.30±0.37</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>3 months</td>
<td>0.30±0.36</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>6 months</td>
<td>0.30±0.35</td>
<td>&gt;0.05</td>
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</tbody>
</table>

**Abbreviations:** SIA, surgically induced astigmatism; ATR, against the rule; SD, standard deviation.
corneal incisions in other studies. This was done for left eyes. The major disadvantage of nasal incision is intraoperative difficulty from nasal bridge. In addition, it results in much more SIA. Pakravan et al.\(^6\) achieved a mean 1.80 DC at 1 month, which decreased to 0.92 DC at 6 months. Yoon et al.\(^7\) had a mean 0.92 DC at 1 month, which decreased to 0.62 at 6 months. Barequet et al.\(^9\) achieved a mean 1.65 DC SIA at 6 weeks, which persisted at 12 months (1.41 DC). Kohnen et al.\(^8\) had a mean 1.55 DC at 2 weeks, which decreased to 1.05 DC at 6 months.

We had a similar SIA to other studies where a TCCI of 2.2–2.4 mm size was done. Luo et al.\(^12\) achieved a mean 0.28 DC at 1 month in the 2.2 mm group, and 0.86 DC at the 3.0 mm group.

Unintentionally, most of the recruited cases had preoperative ATR astigmatism. This explains why in spite of dead temporal incision, there was a minimal SIA (0.30 D) in the cases. We had only four eyes with WTR astigmatism, and they showed an initial worsening at 3 months (0.53±0.12 D), then gradual improvement, but still to a higher level at 6 months (0.48±0.16 D).\(^6\)

Three types of tamponading agents were used in the study: air, SF6 gas, and silicone oil. The type of tamponade did not influence the SIA in the patients all over the study duration. Even though silicone oil cases had the highest postoperative KA, they had the highest preoperative KA,

Table 3 KA change with different tamponades

<table>
<thead>
<tr>
<th>Tamponade</th>
<th>Preoperative KA (DC)</th>
<th>Postoperative KA (DC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air</td>
<td>0.93</td>
<td>0.73</td>
</tr>
<tr>
<td>Gas</td>
<td>0.95</td>
<td>0.63</td>
</tr>
<tr>
<td>Silicone oil</td>
<td>1.30</td>
<td>1.06</td>
</tr>
</tbody>
</table>

Abbreviation: KA, keratometric astigmatism.

Figure 8 SIA changes in ATR astigmatism cases.

Figure 9 Tamponading agents in the study.
and the same SIA values. It is compatible with literature data about refractive changes with silicone oil fill, which are either hyperopic or myopic, depending on the lens status.13–15

Our study had a better SIA because all the horizontal clear corneal incisions were temporal, and also the incision size was 2.4 mm; however, the major limitation of our study is the short follow-up of SIA for only 6 months, compared to long durations up to 12 months in some studies.10,12,16,17

Conclusion
Superior sitting TCCI phacoemulsification during combined phacovitrectomy proved safe and easy, without the burden of changing the operative setting, with an acceptable anatomical and optical outcome.

Author contributions
All authors contributed toward data analysis, drafting and revising the paper and agree to be accountable for all aspects of the work.

Disclosure
The authors report no conflicts of interest in this work.

References