Trypan Blue Assisted Capsulorrhexius During Phacoemulsification in Corneal Opacities

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Short tile: Trypan blue assisted capsulorrehxius in corneal opacities.

ABSTRACT

Purpose: Study Trypan blue effectiveness for enhancing visualization during phacoemulsification of cataract with corneal opacities.

Method: a prospective cohort study was conducted on 50 eyes with cataract associated with mild or moderate corneal opacity who were attended to Mansoura ophthalmic center on the period from September 2019 to September 2020 divided into 2 groups (group A; with trypan blue and group B; without trypan blue) both groups had undergone standard phacoemulsification with posterior chamber IOL implantation followed by assessment of completion of rhexis and endothelial cell count using specular microscopy.

Results: Fifty eyes were included in the study (25 in each group), 18 males (36%) and 32 females (64%). There was significant reduction in mean endothelial cell count (cells/mm) in eyes with trypan blue compared to eyes without trypan blue (1329.08±896.53 vs 1865.52±738.37 respectively (P = 0.025). There was no statistically significant difference in BCVA (0.564±0.209 for group A and 0.580±0.178 for group B), lens opacity (Monte carlo test P= 452) and corneal opacity (Monte carlo test P= 176).

Conclusion: trypan blue is better in visualization during fashioning capsulorhexis, but has significant effect on endothelial cell density during phacoemulsification with coexistence of corneal opacity.

Key words: trypan blue, capsulorrehxius, phacoemulsification, corneal opacity.

INTRODUCTION:

Corneal opacity is a common clinical finding that prevents the cornea from performing its primary function of light transmission. There is no standard way to quantify it, so clinicians and researchers must describe it subjectively, usually based on their ability to see through the cornea to visualise retro-corneal structures like the anterior chamber or iris[1].

White cataracts, such as traumatic, intumescent, or Morgagnian cataracts, provide a unique capsulorhexis problem, since the high pressure within the lens capsule increases the likelihood of capsulorhexis run-out and capsular tears[2]. Several procedures, including as intravenous mannitol and needle decompression, have been published to assist reduce capsular problems during manual capsulorhexis in white cataracts[3].

Anterior subcapsular cataract associated with fibrous metaplasia of anterior lens epithelium. Posterior subcapsular cataract (PSC) is associated with posterior migration of epithelial cells. Cortical cataract commonly develops as radial or spoke shaped with vacuoles. Cuneiform changes affect anterior, posterior and equatorial cortex[4].

A round and well-centered anterior capsulorhexis prevents intraocular lens tilt and decentration. The 360 capsulotomy rim-optic overlap appears to be the most important interaction between anterior capsulotomy geometry and the IOL, as inadequate rim-optic overlap is linked to changes in anterior chamber depth[5].

Paul Ehrlich, a German chemist, was the first to synthesise trypan red (TR) and trypan blue (TB) in 1904. Toluidine, or any of numerous isomeric bases, C14H16N2, produced from toluene, is used to make trypan blue. Trypan

blue gets its name from the parasites that cause sleeping sickness, trypanosomes. Suramin, a trypan blue homologue, is used to treat trypanosomiasis pharmacologically. Diamine blue and Niagara blue are other names for trypan blue. In methanol, trypan blue has an extinction coefficient of 6104 M1 cm1 at 607 nm[6].

Staining the anterior capsule in the presence of a developed cataract to aid in visibility before producing the continuous curvilinear capsulorhexis is used in ocular cataract surgery. Trypan blue can be used in keratoplasty to stain the posterior stromal fibres during deep lamellar endothelial keratoplasty (DLEK) and the endothelium during Descemet's stripping endothelial keratoplasty (DSEK). In vitreoretinal surgery, trypan blue is also employed[7].

Some authors advocate that trypan blue 0.1% has not been found to be harmful to the endothelium in a clinical study in which endothelial counts and morphology were evaluated both preoperatively and postoperatively[8].

It is predicted that Trypan blue is effective for enhancing visualization during phacoemulsification in cases of cataract with mild to moderate corneal opacities.

PATIENTS AND METHODS:

This was a prospective cohort study. This study was conducted on 50 patients attending to Mansoura ophthalmic center on the period from September 2019 to September 2020.

Study groups:

25 patients per group:

1. Group A: phacoemulsification using trypan blue.
2. Group B: phacoemulsification without using trypan blue.

Inclusion criteria:

1. Corneal opacities of various etiologies partially involving visual axis associated with cataract.
2. Anterior capsule and pupillary margin are visible with brightest illumination of slit lamp.

Exclusion criteria:

1. Dense leucomatous corneal opacification present in direct visual axis.
2. Posterior segment pathology debilitating visual acuity.

Methods:

- Preoperative evaluation:

	0	No corneal haze.
Mild	1	Iris details visible.
	2	Pupillary margin visible and iris details not visible.
Moderate	3	Pupillary margin not visible.
Severe	4	Total corneal opacity.

Demographic data (name, age, gender), general history, uncorrected and best corrected visual acuity using Landolt's broken ring chart then converted to log MAR, slit lamp examination of anterior segment including: site and grading of corneal opacity (mild, moderate and severe) determined over the pupil area by sclerotic scatter illumination techniques[9] and lens opacity grading using chromatic grading[10]

I. Grade I: Transparent with marked red reflex all over the entire pupillary field.
II. Grade II: Pale grey or yellowish with slightly reduced red reflex.
III. Grade III: Yellow with reduced red reflex specially at pupillary area.
IV. Grade IV: Amber with almost no red reflex.
V. Grade V: Brown with no red reflex.

a) Refraction (Topcon RM-800), fundus examination using indirect ophthalmoscope to exclude other causes of diminution of vision, ocular tension measurement Goldman applanation tonometer.
b) Investigations: preoperative corneal endothelial cell count using specular microscope (non-contact Tomey EM-3000), B-scan ultrasound and IOL power measurement using IOL master or A-scan.

- Surgery:

All patients had undergone standard phacoemulsification with PCIOL.

Steps of phacoemulsification:

a) Local or general anesthesia.
b) Sterile eye pad application.
c) Application of wire lid speculum and eye wash with povidone iodine.
d) Clear corneal tunnel incision in steep meridian with two side ports.

e) Formation of anterior chamber with sodium hyaluronate.
f) Injection 1 ml of Trypan blue with concentration 0f 0.6mg/ml under air bubble for 30 seconds. (group A patients).
g) Continuous curvilinear capsulorrhexis using bent insulin needle through the incision and curved incision in anterior capsule to create flap and take the flap with capsulorrhexis forceps to continue rhexis opening with size of about 4-5 mm round.
h) Hydrodissection by injecting Ringer's solution through blunt tipped needle, followed by hydrodelination of the nucleus.
i) Phacoemulsification using divide and conquer technique, followed by phacoaspiration of nucleus.
j) Aspiration of residual cortex.
k) Inflation of capsular bag using viscoelastic agent.
l) Implantation of foldable IOL in the bag using injector.
m) Final adjustment of IOL position using dialing instrument.
n) Wash viscoelastic agent.
o) Hydration of section and side ports and eye pad application.

- Follow up:

All patients will be followed up (one day, one week, and one month) postoperatively: Uncorrected and best corrected visual acuity, slit lamp examination for evaluation of (section coaption, presence or absence of edema, epithelial defect and striate keratopathy, Anterior chamber depth and abnormal contents (e.g. flare, blood, exudate or lens matter), Iris for detection of posterior synechiae or irregular pupil, position of intraocular lens (IOL), ocular tension measurement using Schiotz tonometer, refraction, fundus examination and postoperative corneal endothelial cell density using specular microscope.

Statistical analysis of the data:

IBM's SPSS statistics (Statistical Package for the Social Sciences) for windows (version 25, 2017) was used for statistical analysis of the collected data. All tests were conducted with 95% confidence interval. P (probability) value < 0.05 was considered statistically significant using (t: Student t test, χ^2: Chi-Square test, FET: Fischer exact test, MC: Monte Carlo test and Z: Mann Whitney U test). Charts were generated using SPSS' chart builder and Microsoft Excel for windows 2019.

Ethics approval and consent to participate:

This prospective cohort study was approved by Mansoura Medical Research Ethics Committee, Faculty of Medicine, Mansoura University. All subjects provided written informed consent prior to study participation.

RESULTS:

Fifty eyes were included in the study, 18 males (36%) and 32 females (64%) were included in the study. All patients had cataract associated with mild or moderate corneal opacity. The measured parameters were evaluated using IBM SPSS software.

Table 1: Baseline parameters of both groups.

	Group A (n=25)	Group B (n=25)	Test of significance
Age/years	70.96±7.84	69.24±6.31	t=0.857
Mean ± SD			P=0.396
UCVA	0.10(0.05-0.40)	0.05(0.05-0.40)	Z=1.38
	0.134±0.111	0.096±0.077	P=0.168
BCVA	0.25(0.05-0.70)	0.20(0.05-0.5)	Z=0.811
	0.262±0.149	0.227±0.132	P=0.417
Grade of corneal opacity			MC
Faint opacity			P=0.176
Paracentral opacity	10(40.0)	6(24.0)	
Moderate opacity	2(8.0)	0	
Faint diffuse nebula	5(20.0)	5(20.0)	
Crocodile shagreens	7(28.0)	14(56.0)	
	1(4.0)	0	
Lens opacity			MC
Rt SIC (PSC, N II & C)	5(20.0)	3(12.0)	P=0.452
Rt SIC (PSC, N III & C)	4(16.0)	2(8.0)	
Rt intumescent cataract	1(4.0)	0	
Lt SIC (PSC, N II & C)	12(48.0)	19(76.0)	
Lt SIC (PSC, N III & C)	1(4.0)	1(4.0)	
Lt SIC (PSC, N VI & C)	1(4.0)	0	
Lt intumescent cataract	1(4.0)	0	
Endothelial cell count	2123.84±576.31	2399.36±468.07	t=1.855
			p=0.07

n: number of patients in each group, SD: standard deviation, t: Student t test, P: test of significance, UCVA: uncorrected visual acuity, Z: Mann Whitney U test, BCVA: best corrected visual acuity, MC: Monte carlo test

There was no statistical difference between both groups as regard age (70.96±7.84 for group A and 69.24±6.31for group B with P=0.396), un corrected visual acuity (0.134±0.111 for group A and 0.096±0.077 for group B with P=0.168) and best corrected visual acuity (0.262±0.149 for group A and 0.227±0.132 for group B with P=0.417).There was no statistical difference in corneal opacity (P=0.176), lens opacity (P=0.452) and endothelial cell count (2123.84±576.31 for group A and 2399.36±468.07 for group B with p=0.07)

Table 2: Comparison of endothelial cell count between studied groups at initial assessment and during follow up

Endothelial cell count	Group A (n=25)	Group B (n=25)	Test of significance
Initial	2123.84±576.31	2399.36±468.07	t=1.855
			p=0.07
Day 1	1329.08±896.53	1865.52±738.37	t=2.31
			p=0.025*
After 1 week	1617.52±857.53	1685.48±726.19	t=0.302
			p=0.764
After 1 month	1722.24±585.72	1753.0±628.55	t=0.179
			p=0.859
Paired comparison	P1<0.001*	P1=0.003*	
	P2=0.042*	P2<0.001*	
	P3=0.007*	P3<0.001*	
	P4=0.201	P4=0.123	
	P5=0.093	P5=0.231	
	P6=0.851	P6=0.893	
Percent of change	%1=37.4	%1=22.2	
	%2=23.8	%2=29.8	
	%3=18.91	%3=26.9	
	%4=21.7	%4=9.7	
	%5=29.6	%5=6.03	
	%6=6.5	%6=4.0	

P1: changes between initial and day 1, P2: changes between initial and after 1 week, P3: changes between initial and after 1 month, P4: changes between day 1 and after 1 week, P5: changes between day 1 and after 1 month, P6: changes between after 1 week and after 1 month

There was significant change in endothelial cell count in both groups in 1st day postoperative (1329.08±896.53 for group A and 1865.52±738.37 for group B with p=0.025). there is statistical significance in both groups as regard changes in count after 1 week and after 1-month postoperative form initial count preoperative (P2=0.042 for group A and P2<0.001 for group B). There were no significant changes in both groups between 1st day, after 1 week and after 1-month (P4=0.201 for group A and P4=0.123 for group B, P5=0.093 for group A and P5=0.231 for group B and P6=0.851 for group A and P6=0.893 for group B).

Table 3: complications among studied groups.

	Group A (n=25) %	Group B (n=25) %	Test of significance
Rhexis			
incomplete	1(4.0)	0	FET
complete	24(96.0)	25(100.0)	P=1.0
Converted to ECCE			
No	22(88.0)	24(96.0)	FET
Yes	3(12.0)	1(4.0)	P=0.609
Corneal edema			
No	11(44.0)	13(52.0)	χ^2=0.321
Yes	14(56.0)	12(48.0)	P=0.571

χ^2: Chi-Square test, FET: Fischer exact test, ECCE: extracapsular cataract extraction, IOL: intraocular lens

There was only 1 (4%) extended rhexis in group A "during phacoemulsification step as a result of medium sized rhexis (about 4 mm) and hard nucleus" and no extended rhexis in group B (0%). 3 (12%) eyes were converted to ECEE in group A and only 1 (4%) eye in group B. There were 14 (56%) eyes with postoperative corneal edema "mild" in group A and 12 (48%) eyes in group B.

DISCUSSION:

Although performing cataract surgery, especially phacoemulsification, in cases with corneal opacity is challenging but proper case selection and proper technique is aiming to achieve optimum visual outcomes[11-12]. Trypan blue improved the success of rhexis completion in the lens by decreasing the elasticity of anterior lens capsule[6]. Staining during capsulorhexis in cataract surgery changes the capsule texture[13].

Therefore, our study aimed to evaluate the effectiveness of Trypan blue (0.6 mg/ml) for enhancing visualization during phacoemulsification in cases of cataract with corneal opacities and its effect on ECD. Our prospective cohort study included fifty patients (twenty-five in each group) with average age in group A (70.96 ± 7.84) and group B (69.24 ± 6.31) perform standard phacoemulsification[14]. Non-contact Tomey EM 3000 specular microscopy were used to assess corneal endothelial cell count preoperative, 1st day, 1st week and 1 month postoperative.

In our study, regarding BVCA, in group A 3% 1 month postoperative (P < 0.001; 114.8) with less significant improvement than group B 3% (P<0.001; 155.5).

Several studies were matched with our study, Kusumesh, R., et al.,[15] reported that visual outcomes of phacoemulsification with corneal opacity alone was significantly improved postoperative from the baseline to 0.76 ± 0.40 in more than two-third patients (P< 0.05). Ho, Y.J., C.C. Sun, and H.C. Chen,[16] included 23 eyes in 19 patients, 92.3% cases achieved improvement of visual acuity were as good as or better than that preoperatively. Lin, H., et al.,[17] The mean BCVA improved from 1.24±0.17 to 0.73±0.22 In12 patients with mild to moderate corneal opacities after DALK and coexisting cataracts.

Regarding ECD, in our study, we found that at initial assessment and during follow up there is more significant change in group A (P<0.001) at 1 day postoperative 1% (37.4) than group B (P=0.003) 1% (22.2). while at 1 month postoperative there less significant change in group A (P=0.007) 3% (18.91) than group B (P<0.001) 3% (26.9).

Nagashima, T., K. Yuda, and T. Hayashi,[18] included thirty-six eyes with Corneal ECD were 2810 ± 272m preoperative had significantly decreased relative to the preoperative value in (P<0.001).

On the other hand, Ucar, F., E. Kadioglu, and L. Seyrek,[19] Injection of 1% trypan blue for staining the anterior capsule during phacoemulsification did not cause significant corneal endothelial loss at 3rd months postoperatively (p = 0.71), despite the increased fragility of corneal endothelial cells in patients with pseudoexfoliation (PEX). Abdelmotaal, H., et al.,[20] reported that the degree of endothelial cell loss (CD loss%) four weeks postoperatively was positively correlated with ECD in both the study and control eyes (r= 0.233 and 0.355, respectively). The mean (±SD) ECD loss% 1 month postoperatively was 7.23 ± 13.31 for the study eyes and 9.94 ± 9.36 for the control eyes. (P < 0.157).

Our study had some limitation, first limited visual acuity improvement could be either pre-existing amblyopia or reactivation of herpetic keratitis. Second, short follow up. Third, using only one concentration of trypan blue (0.6mg/ml). fourth, small sample size.

Conclusion:

In conclusion, trypan blue is effective in visualization of capsulorrehxius during phacoemulsification with coexistence of mild to moderate corneal opacity, but has significant effect on endothelial cell density.

It is important to assess corneal endothelial state before phacoemulsification associated with corneal opacity.

DATA AVAILABILITY

All data are included in this article.

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None

Conflict of Interest

Authors declare no conflicts of interest.

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Ethics declarations

Conflict of interest

Abdulla A. Abdelmaksoud, Walid M. Gaafar, Sherief E. El-Khouly, Ashraf I. Moawad. all authors have no conflicts of interest that are directly relevant to the content of this review.

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