Outcome of cataract extraction with IOL implantation after coaxial and bimanual phacoemulsification

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Abstract

Purpose: To compare the outcome of cataract extraction with IOL implantation after coaxial and bimanual phacoemulsification.

Materials and Methods: A prospective study was done to compare the outcome of cataract extraction with IOL implantation after coaxial and bimanual phacoemulsification. The study included 200 patients visiting ophthalmology OPD of Punjab Institute of Medical Sciences who were diagnosed as having cataract and were fit to undergo surgery. Of these 100 patients were randomly assigned to each group. Data analysis included demographics and evaluation of visual acuity (VA) outcome, surgically induced astigmatism, mean phacoemulsification time, effective phacoemulsification time and amount of BSS used.

Results: Age and sex distribution was similar in two groups. The mean BCVA in the coaxial and bimanual groups was 0.294 and 0.2903 respectively. The magnitude of surgically induced astigmatism had a mean of 0.845 in the coaxial group and a mean of 0.855 in the bimanual group; hence the difference was not statistically significant.

Statistically significant differences were found in mean phacoemulsification time ($p = 0.01$) which was significantly lower in bimanual phacoemulsification group than the coaxial group. Effective phacoemulsification time ($p = 0.022$) was significantly lower in bimanual phacoemulsification group (mean = 6.86) than the coaxial group (mean = 12.87). The total surgical time was lower in the bimanual group (mean = 21.94) than the coaxial group (mean= 24.29) and the difference was statistically significant.

Conclusion: Both techniques were considered safe and equally effective with regard to cataract surgery with minor differences which did not affect the final outcome and resulted in early post-operative visual rehabilitation with minimal post-operative morbidity, thus leading to increased patient comfort.

Keywords: Bimanual, Cataract, Coaxial, Microincision, Phacoemulsification, Surgical time.

Introduction

The technique of phacoemulsification introduced by Charles Kelman in 1967 revolutionized the cataract surgery by decreasing the incision size from 10.0 mm required for ICCE and 7.0 mm in ECCE to 2-3 mm for phacoemulsification. Advancements also allowed for use of small surgical instruments, foldable intraocular IOL`s, further reducing incision size and tissue trauma and promoting faster functional recovery.[1]

Phacoemulsification has several advantages over the conventional techniques as the smaller incision allows greater control over intraocular structures, less tissue injury, less post operative pain and inflammation and visual recovery is much more rapid because of less surgically induced astigmatism. But the high cost of machinery, steep learning curve and unforgiving complications limits its use in developing countries.[2]

The conventional technique for phacoemulsification consisted of the traditional handpiece which consisted of the phaco tip covered with an irrigating sleeve. The final incision size was around 2.75 mm.

The technique of bimanual phacoemulsification was described by Shearing et al in 1985. This procedure uses a separate irrigation instrument and a sleeveless phacoemulsification tip to remove the cataractous lens. Irrigation during phacoemulsification is provided through an irrigating chopper. This technique allows a corneal incision smaller than 1.5 mm but requires pulsed phacoemulsification energy, which prevents the development of high temperatures in the cornea and therefore reduces the incidence of corneal burns.[3]

The bimanual technique gained popularity initially due to better and early post-operative visual rehabilitation related to small incision but subsequent questions were raised regarding the high temperatures associated with the use of bare needle intraoperatively. Also the fluidics were found to be less efficient when compared to coaxial phacoemulsification but the use of new technologies such as using pulse and burst mode, modified tips and new phacoemulsification systems have proved that increased temperatures and corneal burns do not occur during routine phacoemulsification procedure and again bimanual technique gained popularity.

Since then the two techniques have been compared for various parameters. The coaxial phacoemulsification seems to have advantages of less intraoperative rise of wound temperature, better chamber stabilization and better sealing of corneal incision after surgery. Fluidics comparisons indicated greater irrigation flow, a more stable occlusion break response, less intraoperative temperature rise, better incision sealability and less incision leakage.

The present study is undertaken to compare the outcome of cataract extraction using coaxial and bimanual phacoemulsification techniques by studying various preoperative, intraoperative and postoperative parameters.

Objectives

To compare the outcome of cataract extraction with intraocular lens implantation using a coaxial and bimanual phacoemulsification technique

Materials and Methods

A prospective randomized study to compare the visual and surgical results after coaxial and bimanual phacoemulsification was done on 200 patients visiting the ophthalmology department, Punjab Institute of Medical Sciences, Jalandhar with operable senile cataract for phacoemulsification surgery were enrolled and randomized into two groups of 100 eyes in each group of coaxial and bimanual phacoemulsification. Informed consent was obtained from all the patients and approval from hospital ethics committee was obtained.

Inclusion Criteria

Patients of either sex, age above 45 years with visually significant senile cataract with nuclei of grade I to III (LOCS classification) was taken up for study.

Exclusion Criteria

(A) Preoperative

1. Patients with irregular and oblique astigmatism.
2. Patients having corneal pathologies such as opacities, pterygium, degenerations and dystrophy along with cataract.
3. Patients with small, non-dilating pupils.
4. Patients having microcornea or microphthalmos.
5. Patient with active or previous uveitis.
6. Patients who have undergone previous intraocular surgery like trabeculectomy or pterygium surgery in eye to be operated.
7. Patients having previous history of injury in eye to be operated.
8. Patients with retinal pathologies like diabetic retinopathy, hypertensive retinopathy, glaucomatous optic atrophy, central serous retinopathy.

(B) Operative

Patients who required extension of incisions intraoperatively to facilitate the surgery were excluded from the study.

(C) Postoperative.

Patients with inadequate follow up.

Operative Evaluation

1. Operative technique used whether coaxial or bimanual.
2. Amount of BSS used.
3. Mean phacoemulsification time (MPT).
4. Phacoemulsification power.
5. Effective phacoemulsification time (EPT) measured by multiplying MPT by average phaco power used
6. Total surgical time.
7. Intraoperative complications if any.

Surgical Procedures

1. Informed consent of the patient was obtained.
2. Maximum papillary dilatation was achieved with 0.8% tropicacyl and 5% phenylephrine eye drops.
3. Local anaesthesia (peribulbar bock) was given by injecting 5ml of xylocaine- sensorcaine mixture.
4. The eye to be operated was cleaned with 5% povidone – iodine solution and draped. Conjunctival cul de sac was irrigated with 1% povidone- iodine solution.
5. Lids were retracted using eye speculum.
6. For right eye surgery, two side port incisions about 1.1mm in size were made with microvitreoretinal (MVR) metal knife and were placed at 11 and 7 o`clock positions and for left eye they were placed at 1 and 5 o`clock positions.
7. Aqueous was replaced with 2% hydroxypropylmethyl cellulose.
8. Approximately 5.5mm capsulorrhexis was made using 26 guage cystitome.
9. Hydrodissection and hydrodelineation was done to ensure complete rotation of the nucleus.

The above steps were common in both coaxial and bimanual phacoemulsification.

Coaxial Phacoemulsification

1. A triplanar valvular clear corneal incision of 2.8 mm was made at the temporal limbus.
2. Nucleus disassembly was done by divide and conquer technique using Rossin`s and Nagahara`s choppers.
3. Phacoemulsification tip with sleeve on was inserted through corneal incision and nuclear fragments were aspirated one by one.
4. Irrigation and aspiration of remaining cortex was done using bimanual irrigation and aspiration technique.

Bimanual Phacoemulsification

1. Sleeveless phacoemulsification probe was inserted by extending one of the side ports to around 1.8mm.
2. Irrigating chopper was inserted through another side port.
3. Trenching of the nucleus was done with phaco probe followed by aspiration of nuclear fragments.
4. Irrigation and aspiration of remaining cortex was done using bimanual technique.

This was followed by implantation of Ultrathin IOL (ultrasmart by Ellis ophthalmic technology) in the bag with the help of disposable injector through same incision as used for insertion of phacoemulsification probe.

The remaining viscoelastic was aspirated.

Intracameral injection of 0.2ml of cefuroxime was given at end of the surgery.

Closure of wound was done by stromal hydration of side and main port incisions.

Post-operative Treatment

1. Topical combination eye drops of 0.3%ciprofloxacin and 0.1% dexamethasone eye drops 1 hourly for first one week and slowly tapered over to 4 times a day over 6 weeks.
2. Topical flurbiprofen 4 times a day for 6 weeks.

Follow up

Post operative follow of patients was done at 2 hrs post operative, 1 week, 3 weeks and 6 weeks.

Post-operative Evaluation

1. Visual acuity for distance was determined using a Snellen`s chart at a distance of 6m. Near vision was

measured using Times New Roman chart at a distance of 40cm with and without near correction.

2. Refraction was done using a streak retinoscope and autorefractometer. Best corrected distance visual acuity was determined. Visual acuity was converted to decimal form for analysis. Manifest refraction was written in minus cylinder form for analysis purpose.
3. Contrast sensitivity was measured using Pelli – Robson chart at a distance of 3 m with distance correction on.
4. Keratometry was done in the horizontal and vertical meridians at follow up visits using a manual keratometer to measure corneal astigmatism. Preoperative and postoperative 6 weeks keratometric readings were used for analysis. All calculations were performed using the vector method. Amplitude of preoperative and postoperative astigmatism was calculated from the difference in the steeper and flatter meridian plus cylinder notation. Astigmatism was considered a vector with a magnitude equal to this value directed towards steeper meridian.
5. Recording of complications if any slit lamp examination was done to look for anterior chamber cells and flare for post-operative inflammation.

Observation and Results

Sex Distribution

The total number of patients in each group was 100. The populations in regard to sex distribution were comparable and the difference was not statistically significant (p=0.3).

Age Distribution of Patients in two Groups

For comparing the age distribution between two groups patients were divided into 6 age groups. The patient distribution in regard to age was similar in two groups and maximum number patients were in the age group of 61 to 70 years. There was no statistically significant difference in age distribution between two groups (p = 0.994).

Distribution of Preoperative BCVA

The populations in two groups were comparable as compared to preoperative BCVA. Maximum number of patients in both the groups had visual acuity in the range of 6/18 to 6/60. (Fig. 1)

Distribution of Preoperative type of Astigmatism

The populations in two groups were compared in regard to preoperative astigmatism. The magnitude of preoperative corneal astigmatism was comparable between the two groups and the difference was not statistically significant (p = 0.65). (Fig. 2)

Distribution of Postoperative BCVA in 2 Groups

The patients were followed up on post operative day 1, post operative 1 week, 3 weeks and 6 weeks and visual acuity was recorded on snellen`s chart after full correction for refractive error and visual acuity was converted to decimal equivalent. The populations in two groups had similar BCVA on follow up visits and the difference in visual acuity on first and final follow up visit is very minimal. (Fig. 3)

Distribution of Post-operative Distance Corrected Near Vision in 2 Groups

The two populations were compared with respect to post operative distance corrected near vision. The mean values for post operative distance corrected near vision were similar in two groups and the difference was not statistically significant.

Mean Phacoemulsification Time

The coaxial and bimanual phacoemulsification techniques were compared for mean phacoemulsification time. The mean phacoemulsification time was higher for coaxial group as compared to bimanual group and the difference was statistically significant (p = 0.01). (Fig. 4)

Effective Phacoemulsification Time

The effective phacoemulsification time was calculated by multiplying the mean phacoemulsification time with average phaco power used.

The effective phacoemulsification time was higher for the coaxial phacoemulsification group as compared to bimanual group and the difference was statistically significant (p= 0.022). (Fig. 5)

Total Surgical Time

The time taken from first incision to the hydration of wound i.e. the total surgical time was measured for the two groups. The total surgical time taken was higher for the coaxial phacoemulsification as compared to the bimanual phacoemulsification group and the difference was statistically significant (p=0.00). (Fig. 6)

Amount of BSS used

The amount of BSS used was measured for both the coaxial and bimanual phacoemulsification group. The amount of BSS used was higher for the coaxial group as compared to the bimanual phacoemulsification group and the difference was statistically significant (p = 0.00).

Distribution of Post-operative Corneal Astigmatism

The two techniques of phacoemulsification were compared for post operative corneal astigmatism. The final post-operative astigmatism at 6 weeks follow up after stabilisation of wound was comparable in two groups and the difference was not statistically significant.

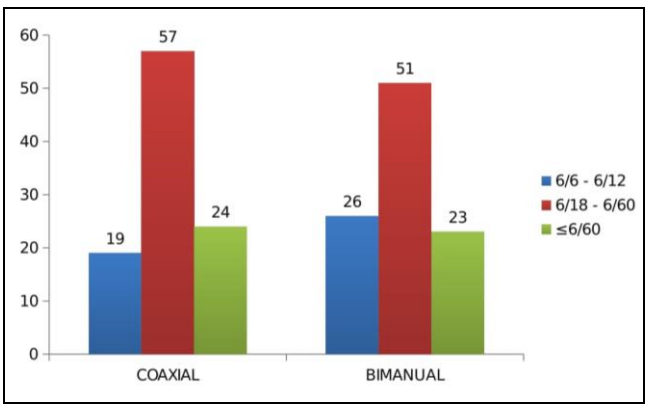

Fig. 1: Comparison of preoperative BCVA in 2 groups

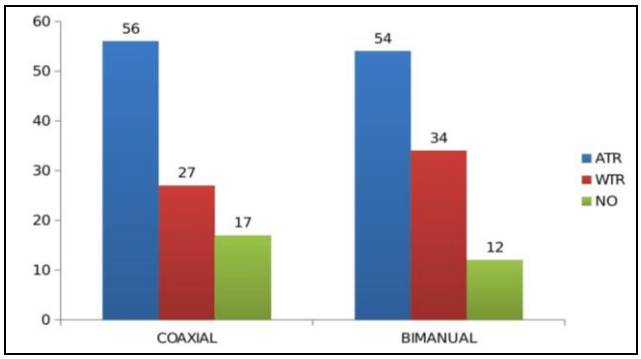

Fig. 2: Comparison of preoperative astigmatism in 2 groups

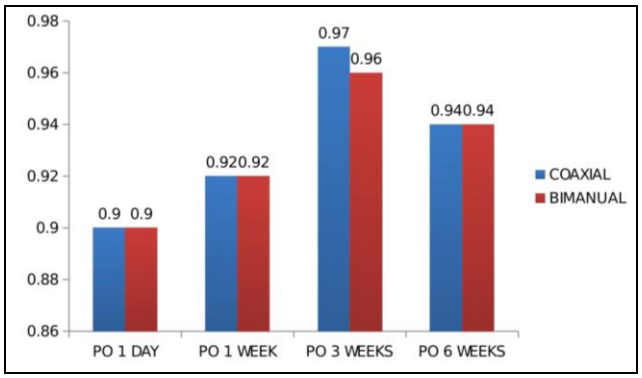

Fig. 3: Distribution of post-operative BCVA in 2 groups

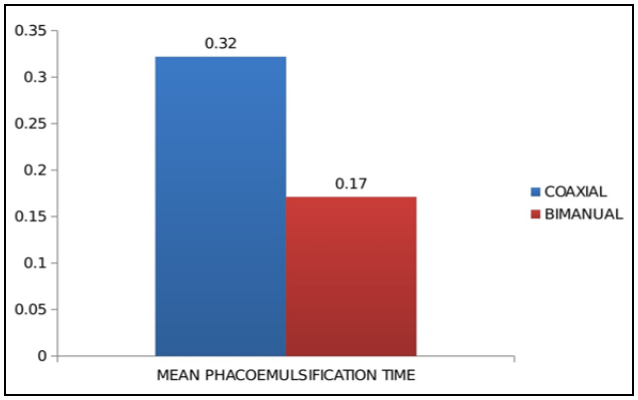

Fig. 4: Distribution of post-operative BCVA in 2 groups

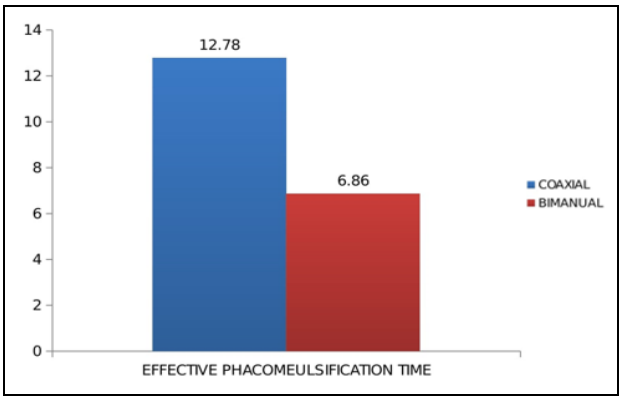

Fig. 5: Comparison of effective phacoemulsification time

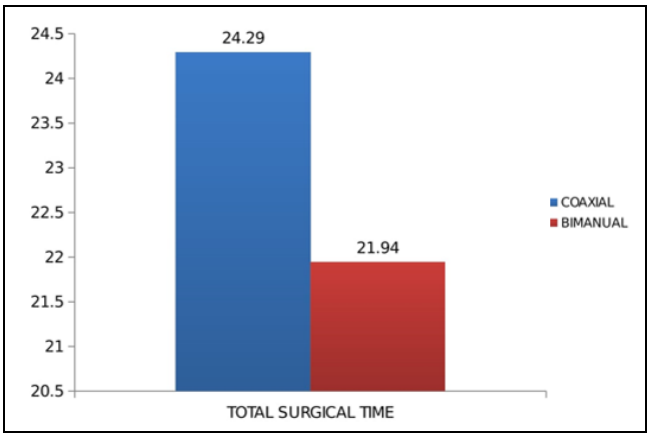

Fig. 6: Comparison of total surgical time between two groups

Discussion

The smaller incisions used for cataract extraction today make the surgery less invasive and safer, resulting in less postoperative intraocular inflammation, fewer incision related complications, lower surgically induced astigmatism and shorter total surgical time. These factors provide faster postoperative visual recovery and increased patient satisfaction. Increasingly, patients expect good refractive outcome after cataract surgery in addition to the therapeutic benefits from treating the pathology. Today, there is clear trend towards smaller incisions because of small learning curve, better instrumentation and better fluidics. A decrease in astigmatism is another important achievement of modern cataract surgery. The decrease in surgical time with bimanual phacoemulsification as compared to coaxial phacoemulsification is an important factor in determining the total phacoemulsification percent liberated inside the eye. The decrease in surgical time reduces the ultrasound energy liberated inside the eye, thus leading to less corneal endothelial damage and better postoperative outcomes.

Bimanual microincision phacoemulsification, also known as MICS, phakonit, cold phaco, and microphaco[4] is an effective and safe technique to manage all types of cataract.[5-8] It is performed through smaller incisions than conventional phacoemulsification. In comparing two techniques bimanual phacoemulsification was found to be superior to coaxial phacoemulsification as it reduced surgically induced astigmatism and effective phacoemulsification time.

The surgical outcome of cataract extraction with IOL implantation after coaxial and bimanual phacoemulsification was compared in a randomized prospective controlled study, after defining proper inclusion and exclusion criteria. The results are comparable with the findings of previous authors.

Age and Sex

There was no statistically significant differences in age between two groups (p = 0.9) with maximum number of patients in the age group of 61- 70 and is in accordance with study of Domple et al.[9] This shows increase in incidence of cataract with age. The number of males and females in both groups was comparable and the difference was not

statistically significant (p = 0.3). This shows that cataract occurs with equal frequency among both the gender and there is no sex predilection.

Visual Acuity

In present study, the mean BCVA, in coaxial and bimanual groups, was 0.294 and 0.2903 respectively, so there was no statistically difference between the two groups and the results are in accordance with other studies.[10-12] This was because although bimanual and coaxial phacoemulsification have different techniques but both reduce incision size significantly thus leading to early post operative visual rehabilitation and better visual outcome.

Surgically Induced Astigmatism

In present study, the magnitude of surgically induced astigmatism had a mean of 0.845 in coaxial group and a mean of 0.855 in the bimanual group; hence the difference was not statistically significant. The findings are in accordance with the study of Cavillini et al and Michal et al as the incision size used in present study is comparable to their study.[12,13] Further both the techniques reduced the incision size thus leading to a decrease in the surgically induced astigmatism and hence better visual outcomes. Clinical trials have also found that the length of the incision is directly proportional to the amount of surgically induced astigmatism and inversely proportional to its stability over time.[12]

Mean Phacoemulsification Time

In present study, statistically significant differences were found in mean phacoemulsification time (p = 0.01) and it was found to be significantly lower in bimanual phacoemulsification group than the coaxial group. This is in accordance to the study by Alio et al[10] and is due to the increased speed of nucleus emulsification with bimanual technique as well as better access to all nuclear quadrants in bimanual technique. Crema et al in 2007 and Wang et al in 2009 made a comparison of bimanual and coaxial phacoemulsification techniques using torsional ultrasound and found ultrasound time to be significantly lower in coaxial group than bimanual group.[11,14] Crema et al explained the higher phacoemulsification time in the bimanual group which is a contradictory finding when compared to other studies to the fact that surgeon had less experience with the technique by the peristaltic pump of legacy phacoemulsification machine that is not considered ideal for microincision cataract surgery and due to lower aspiration settings used in bimanual group.[11]

Effective Phacoemulsification Time

Effective phacoemulsification time was measured by multiplying mean phacoemulsification with phacoemulsification power percent used. In present study, statistically significant differences were found in effective phacoemulsification time (p = 0.022) and it was found to be significantly lower in bimanual phacoemulsification group (mean = 6.86) than the coaxial group (mean = 12.78). This is because the phacoemulsification power was kept constant in both the techniques and hence similar results as mean phacoemulsification time was obtained.

Total Surgical time

In present study, the two techniques had statistically significant difference regarding total surgical time and total surgical time was lower in bimanual group (mean=21.94) than the coaxial group (mean=24.29). This is in accordance with the study of Cavillini et al[12] and is because of increased speed and simplicity of nucleus emulsification with the bimanual technique because of better access to all nuclear quadrants in the bimanual technique when compared to the coaxial phacoemulsification, thus leading to reduction in time taken for completion of procedure.

Amount of BSS used

In present study, the two techniques differ in regard to the volume of BSS utilized. In bimanual phacoemulsification, the mean was 219.00 while in coaxial phacoemulsification, the mean was 241.50 and the difference was statistically significant (p = 0.00). Although statistically significant, the difference in BSS volumes between the two techniques was not clinically relevant and did not affect the post-operative outcome. Thus the findings of present study are in accordance with the previous studies with minor differences which are due to different surgical techniques used by different authors.[12,14]

Fluidics optimization in bimanual technique aims for an improved control in pressure and value changes during cataract surgery, which requires a closed and stable anterior chamber. Using a closed compartment leads to a reduction of fluid circulation in the anterior chamber. Immediate detection and compensation of the pressure changes in the anterior chamber helps to eliminate the surge phenomenon.

The two techniques were comparable as far as visual criteria were concerned, Snellen`s uncorrected distance visual acuity, best corrected visual acuity, near visual acuity both uncorrected and distance corrected and contrast sensitivity function were comparable in two groups. The type and magnitude of surgically induced astigmatism also did not have significant difference.

Significant differences were found in the intraoperative criteria, that is, mean phacoemulsification time, effective phacoemulsification time, total surgical time and the amount of BSS used.

Conclusion

From the present study it was concluded that, both techniques were safe and effective for cataract surgery. The two techniques differ in regard to.

1. Mean phacoemulsification time.
2. Effective phacoemulsification time.
3. Total surgical time taken.
4. Amount of BSS used.

The total surgical time and phacoemulsification time was significantly shorter for bimanual phacoemulsification as compared to coaxial phacoemulsification. The amount of BSS used in the surgical procedure was significantly less in the bimanual process as compared to coaxial process.

However the two techniques did not differ as far as visual results were concerned. Hence both techniques were considered safe and equally effective with regard to cataract

surgery with minor differences which did not affect the final outcome and resulted in early post operative visual rehabilitation with minimal post operative morbidity, thus leading to increased patient comfort.

Conflict of Interest: None.

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