***Original Article***

# VISUAL OUTCOME OF PARS PLANA VITRECTOMY FOR DROPPED NUCLEUS FOLLOWING COMPLICATED PHACOEMULSIFICATION

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## ABSTRACT

*Phacoemulsification complicated with dropped nucleus requires pars plana vitrectomy for removal of the dropped lens fragments. Many factors determined the visual outcome. The objective of this study was to evaluate the visual outcome and complications following pars plana vitrectomy for dropped nucleus post complicated phacoemulsification. This study was a retrospective, non-comparative interventional case series. A total of 90 patients were reviewed. Timing of surgery, intraocular lens implanted, size of dropped lens fragments and complication(s) were analyzed against visual outcome. The results revealed that 62.2% had visual acuity of ≥6/12. Better visual outcome was associated with delayed vitrectomy and more than a quarter dropped nucleus size. Types of intraocular lens implanted did not affect visual outcome. Complications included high astigmatism (10%), epiretinal membrane (7.8%), rhegmatogenous retinal detachment (5.6%), choroidal detachment (5.6%), and cystoid macula oedema (3.3%). In conclusion, vitrectomy within six to eight days and larger dropped nucleus fragment size were associated with better visual outcome.*

## INTRODUCTION

In 2002, only 39.7% of cataracts in Malaysia were managed by phacoemulsification technique while most were operated with extracapsular cataract extraction [1]. The rate of phacoemulsification continued to rise to 87.4% in 2014 [2]. With increasing number of phacoemulsifications performed, the rate and incidence of complications such as posterior capsular tear and dropped nucleus have shown corresponding increment, especially during the early learning curve of surgeons. Dropped nuclear fragments require removal of the lens fragments via vitrectomy. For more than a decade, Selayang Hospital Eye Department has been one of the national referral centres for vitreoretinal subspecialty in Malaysia, receiving cases that require vitreoretinal surgical intervention. This includes cases of dropped nucleus post complicated phacoemulsification. Dropped nucleus, or dislocation of the entire nucleus or nuclear fragments into the vitreous cavity is one of the known complications of phacoemulsification. Its occurrence is contributed by multiple factors such as polar cataract, brunescent cataract, previous vitrectomised eye, high myopia and pseudoexfoliation syndrome. Left untreated, retained lens fragments can lead to severe intraocular inflammation, cornea oedema, cystoid macular oedema, secondary glaucoma and retinal detachment, resulting in a decrease in visual acuity [3].

This study aims to determine the visual outcome of patients who underwent pars plana vitrectomy for dropped nucleus after phacoemulsification. Timing of vitrectomy, type of intraocular lens, size of dropped lens fragments and complications were evaluated and analyzed against visual outcome.

## MATERIAL & METHOD

This is a retrospective and non-comparative interventional case series. Electronic medical records of all patients who underwent pars plana vitrectomy with lens fragment removal in Eye Clinic, Selayang Hospital were retrospectively reviewed over a 3-year period between January 2015 and December 2017, which includes a total of 90 eyes from 90 patients. All the patients underwent pars plana vitrectomy with lens fragments removal. Data collected include demographic data (age and gender), laterality of involved eye, date of initial

surgery and vitrectomy, types of intraocular lens implanted, pre-existing ocular problem, category of surgeons (vitreoretinal consultant or fellow), final visual acuity and complications (intra and post-vitrectomy). The number and size of dislocated nuclear fragments, the timing of intervention, the type of intraocular lens (IOL) implanted, complications and visual outcome were analyzed. A minimum of 3 months of follow-up data after vitrectomy was necessary for inclusion in the study. Patients with pre-existing ocular disease other than cataract which could have affected the visual acuity prior to cataract surgery such as retina or macular disease, patients in whom primary aim of cataract surgery was not to improve vision such as patients with traumatic lens dislocation and uveitic cataract, defaulters or incomplete documentation were excluded.

All surgeries were performed by consultants and vitreoretinal fellows. The cases were referred either from government or private ophthalmology centers. Initial assessment was made during patient's first clinic visit. Those with high intraocular pressure (IOP) (defined as IOP of 25 mmHg or more) and oedematous cornea were managed medically (with topical antiglaucoma and corticosteroid) before being listed for operation.

All patients underwent pars plana vitrectomy under retrobulbar or general anaesthesia. Standard three-port 23G pars plana vitrectomy ports were inserted and complete vitrectomy performed via standard manner. Posterior vitreous detachment was induced if necessary with aspiration and triamcinolone staining. When possible, small nucleus fragment of less than a quarter nucleus size and cortical matter were removed using vitreous cutter. Larger pieces of nucleus fragments were removed using a 20G phacofragmentation technique through a scleral incision made with MVR blade. Vitrectomy was completed with internal search for iatrogenic breaks. Finally, sulcus or anterior chamber intraocular lenses were implanted depending on adequacy of capsular support.

Post-operatively, patients were prescribed with topical dexamethasone and chloramphenicol every two hours for the first week and tapered off subsequently over one month. Intraocular pressure of 25 mmHg or more was treated with anti-glaucoma accordingly. Visual acuity was taken at every review until at least 3 months post vitrectomy using Snellen chart. Pearson chi-square test was performed to determine any significant difference between i) the timing of vitrectomy and visual acuity, ii) the different types of implanted IOLs and visual acuity, and iii) the size of dropped lens fragments and visual acuity and iv) any intraoperative or postoperative complications and visual acuity. A p value of 0.05 was taken as statistically significant difference between groups.

## RESULTS

### Demographic data

Of 145 patients (145 eyes) who underwent vitrectomy for dropped nucleus or dropped nuclear fragments at our centre during the period of study, 90 subjects [90 eyes] met the inclusion criteria and were included in this retrospective case review.

The mean age of patients was 65 (ranged 34 – 84) years. There was an equal gender distribution of 45 males and 45 females. Fifty patients (55.5%) had dropped nucleus fragments involving right eye and 40 patients (44.4%) had involvement in the left eye (Table 1).

### Visual acuity

At three months post vitrectomy, 62.2% (56 patients) gained visual acuity of 6/12 or better while

Table 1: Demographic data of patients.

| Demography | Number of patients (n=90) |
|---|---|
| Gender | |
| Male | 45 |
| Female | 45 |
| Eye operated | |
| Right eye | 50 |
| Left eye | 40 |
| Age (years) | |
| Range | 34-84 |
| Mean | 65 |

37.8% (34 patients) had visual acuity of 6/18 or worse. Seven patients (7.8%) achieved visual acuity of 6/6 and 11 patients (12.2%) had visual acuity of 6/60 or worse at three months' review.

Reasons for poor visual outcome (6/60 or worse) were due to complication[s] in eight eyes; namely rhegmatogenous retinal detachment (two eyes), choroidal detachment (four eyes), cornea decompensation (one eye), vitreous hemorrhage (one eye), cystoid macula oedema (one eye), post-operative endophthalmitis (one eye) and chronic anterior uveitis (one eye). Three patients had an unexplained cause of poor visual acuity.

**Timing of pars plana vitrectomy**

All cases underwent three-port pars plana vitrectomy (PPV). The timing of the intervention surgery ranged between same day (within 24 hours) and 162 days post phacoemulsification; with mean of 9.8 days. The reason for one patient to have vitrectomy performed late at day 162 post cataract surgery was due to his disagreeable for vitrectomy at initial stage. Fifty-two patients (57.8%) had vitrectomy done within five days and in 38 patients (42.2%) vitrectomy was done after five days of primary surgery.

Data analysis with Chi-Square test showed the timing of vitrectomy influenced the visual outcome. There was a significant difference in the final visual outcome when vitrectomy was performed within five days (early) or after five days (later) following the primary cataract surgery with p value=0.018 (Table 2).

Twenty-seven patients had visual acuity of 6/12 or better and 25 patients had visual acuity of worse

Table 2: Visual outcome following pars plana vitrectomy for phacoemulsification complicated with dropped lens fragments.

| | | Visual acuity at 3 months | | Chi square test |
|---|---|---|---|---|
| | | ≥6/12 | <6/12 | |
| Interval of surgeries | | | | |
| | Early (≤5 days) (n=52) | 27 (51.9%) | 25 (48.1%) | p=0.018 |
| | Later (≥6 days) (n=38) | 29 (76.3%) | 9 (23.7%) | |
| | ≤8 days (n=56) | 37 (66.1%) | 19 (33.9%) | p=0.095 |
| | ≥9 days (n=34) | 28 (82.4%) | 6 (17.6%) | |
| Type of IOL[a] | | | | |
| | Sulcus IOL[b] (n=41) | 29 (70.7%) | 12 (29.3%) | p=0.08 |
| | ACIOL[c] (n=46) | 24 (52.2%) | 22 (47.8%) | |
| | Aphakia (n=3) | 3 (100%) | 0 (0%) | |
| Size of dropped lens matter | | | | |
| | ≤1/4 nucleus (n=45) | 23 (51.1%) | 22 (48.9%) | p=0.03 |
| | >1/4 nucleus (n=45) | 33 (73.3%) | 12 (26.7%) | |
| Surgeon | | | | |
| | Consultant (n=32) | 21 (65.6%) | 11 (34.4%) | p=0.377 |
| | Fellows (n=58) | 32 (55.2%) | 26 (44.8%) | |

[a] intraocular lens
[b] sulcus intraocular lens
[c] anterior chamber intraocular lens

than 6/12 if vitrectomy was performed early (five days or earlier) following dropped nucleus. When the visual outcome was compared to delayed vitrectomy (day six or later), 29 patients had visual acuity of 6/12 or better and only nine patients had visual acuity worse than 6/12. There was a significant different of the final visual outcome if the surgery was performed later compare to earlier with p=0.018. No significant difference if vitrectomy was performed after eight days following phacoemulsification with p=0.095 (Table 2). Thus, from this case series, it can be concluded that later vitrectomy [day six to day eight] resulted in a better visual outcome. Table 2 shows overall visual outcome according to interval of surgeries.

**Type of intraocular lens**

Intraocular lens (IOL) was implanted in 87 patients of which 33 patients had IOL implantation during the complicated cataract surgery and 54 patients had IOL implantation performed at the end of vitrectomy. Of the 87 lens implanted, 41 eyes (45.6%) received sulcus intraocular lens and another 46 eyes (51.1%) had anterior chamber intraocular lens implantation. Three eyes were left aphakic. One was due to the unavailability of sulcus intraocular lens during vitrectomy in which secondary sulcus intraocular lens was implanted later with final visual outcome of 6/9 at three months post vitrectomy, one had preexisting macerated and atrophic iris which was unsuitable for anterior chamber intraocular lens implantation with best corrected visual acuity of 6/9 and the other had choroidal detachment during vitrectomy which resolved subsequently with best corrected visual acuity of 6/7.5. Using Chi-Square test, it was shown that type of IOL did not influence the visual outcome significantly with p=0.08 (Table 2). Table 4 shows overall visual outcome according to types of intraocular lens implanted.

**Size of dropped lens fragments**

Forty-five patients (50.0%) had less than a quadrant nuclear dropped while twenty-nine

Table 3: Visual outcome according to interval of surgeries.

| Visual acuity at 3 months | Interval between phacoemulsification and vitrectomy | | | | | Total |
|---|---|---|---|---|---|---|
| | 0-5 days | 6-10 days | 11-15 days | 16-20 days | ≥21 days | |
| ≥³6/12 | 27 | 17 | 3 | 5 | 4 | 56 |
| 6/18 - 6/60 | 20 | 5 | 2 | 0 | 1 | 28 |
| <6/60 | 5 | 0 | 0 | 0 | 1 | 6 |
| Total | 52 | 22 | 5 | 5 | 6 | 90 |

Table 4: Visual outcome according to types of intraocular lens (IOL) implanted in eyes with dropped nucleus.

| Visual acuity at 3 months | Type of intraocular lens implanted | | | Total |
|---|---|---|---|---|
| | Sulcus | ACIOL | Aphakia | |
| ≥6/12 | 29 | 24 | 3 | 56 |
| 6/18-6/60 | 10 | 18 | 0 | 28 |
| <6/60 | 2 | 4 | 0 | 6 |
| Total | 41 | 46 | 3 | 90 |

patients (32.2%) had whole nucleus dropped during phacoemulsification. Twenty patients (22.2%) had only cortical matters dropped during phacoemulsification surgery (Table 5).

Statistical analysis using Chi-Square test showed size of dropped lens fragments significantly associated with visual outcome, p=0.03 (Table 2). Visual acuity of 6/12 or better was seen in 33 eyes with more than a quarter dropped nucleus and in only 23 eyes with quarter or less dropped nucleus. Table 6 showed overall visual outcomes according to the size of dropped lens fragments.

**Visual outcomes comparing surgeons**

From year 2015 until 2017, vitrectomy for removal of dropped lens fragments was performed by three vitreoretinal consultants and seven vitreoretinal fellows. Statistical analysis with Chi square found no significant difference in the visual outcomes comparing vitrectomy performed either by consultants or vitreoretinal fellows with p=0.377 (Table 2).

**Complications following pars plana vitrectomy**

Fifty-two eyes (57.8%) did not have any complications following pars plana vitrectomy while 38 eyes (42.2%) had complications. Of the 38 eyes, 29 eyes had one complication and nine eyes had combinations of two complications (Table 7). Amongst the highest complications were high astigmatism (10%), epiretinal membrane (7.8%), choroidal detachment (6.7%), intra operative retinal tear (5.6%) and rhegmatogenous retinal detachment (4.4%).

Chi square test comparing the complication following pars plana vitrectomy with lens fragments removal to visual acuity proved that the visual acuity was worse than 6/12 whenever there was complication with p=0.000. Chi square test comparing complications to the timing of vitrectomy, dropped nucleus size and surgeons revealed no significant difference, p>0.05 (Table 8).

In group where the whole nucleus dropped, 13 out from 29 patients had complications. Six patients had visual outcome of 6/12 or better. Of the 15 patients who had no complications, only two had visual acuity worse than 6/12.

Table 5: Size of dropped lens fragments.

| Size of dropped lens fragments | Frequency | Percent |
|---|---|---|
| Cortical matter | 20 | 22.2 |
| 1/4 nucleus matter or less | 25 | 27.8 |
| 1/2 nucleus matter or less | 13 | 14.4 |
| 3/4 nucleus matter or less | 3 | 3.3 |
| Whole nucleus | 29 | 32.2 |
| Total | 90 | 100.0 |

Table 6: Visual outcome according to the size of dropped lens fragments.

| Visual acuity at 3 months | Sizes of nucleus fragments | | | | | Total |
|---|---|---|---|---|---|---|
| | Cortical matter | ≤1/4 nucleus | ≤1/2 nucleus | ≤3/4 nucleus | Whole nucleus | |
| ≥6/12 | 13 | 10 | 9 | 3 | 21 | 56 |
| <6/12-6/60 | 4 | 14 | 4 | 0 | 6 | 28 |
| <6/60 | 3 | 1 | 0 | 0 | 2 | 6 |
| Total | 20 | 25 | 13 | 3 | 29 | 90 |

Table 7: Complications following vitrectomy for dropped lens fragments.

| | Combinations of complications | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | None | CD | VH[l] | Decom. Cornea[m] | Ref. error[n] | $2^0$ glau-coma[e] | Sublux-IOL[o] | ERM[c] | Ret tear[j] |
| None | 52 | | | | | | | | |
| RRD[a] | 2 | 1 | | | | | 1 | | |
| CD[b] | 2 | | 2 | 1 | | | | | |
| ERM[c] | 6 | | | | | 1 | | | |
| CMO[d] | 2 | | | | | | | | 1 |
| $2^0$ Glau-coma[e] | 1 | | | | | | 1 | 1 | |
| High astig[f] | 9 | | | | | | | | |
| Endoph[g] | 1 | | | | | | | | |
| CSME[h] | 1 | | | | | | | | |
| SIS[i] | 1 | | | | | | | | |
| Ret. Tear[j] | 3 | | 1 | | | | | | |
| Chr. AU[k] | 1 | | | | | | | | |

[a] rhegmatogenous retinal detachment
[b] choroidal detachment
[c] epiretinal membrane
[d] cystoid macula oedema
[e] secondary glaucoma
[f] high astigmatism
[g] endophthalmitis
[h] clinically significant macula oedema
[i] surgical induced scleritis
[j] retinal tear
[k] chronic anterior uveitis
[l] vitreous haemorhage
[m] decompensated cornea
[n] refractive error
[o] subluxated intraocular lens

Table 8: Complications comparing with timing of vitrectomy, dropped nucleus size and surgeons.

| | Complications | | p value (Chi Square) |
|---|---|---|---|
| | None (n=51) | Present (n=39) | |
| Timing of vitrectomy Early (≤5 days) | 27 | 25 | 0.234 |
| Later (≥6 days) | 24 | 14 | |
| Dropped nucleus size | | | |
| Small (≤1/4 nucleus) | 26 | 19 | 0.832 |
| Large (>1/4 nucleus) | 25 | 20 | |
| Surgeons | | | |
| Consultants | 20 | 10 | 0.176 |
| Fellows | 31 | 29 | |

## DISCUSSIONS

### Demographics

Rate of dropped nucleus in Malaysia was 0.2% in 2014 [2]. From January 2015 to December 2017, there were 145 cases of dropped nucleus which were referred to the vitreoretinal unit at Selayang Hospital for pars plana vitrectomy and lens fragments removal.

Out of 145 cases, 90 patients (90 eyes) met the study criteria and were included in this retrospective case series review. In this review, the youngest patient was 34-years-old and the eldest was 84-years-old. The mean of years of those presented with dropped nucleus during phacoemulsification surgery was 65 years, similar to the mean age for cataract surgery population performed in Malaysia from previous years, which ranged from 65 to 65.9 years of age from 2010 until 2014 [1].

In this review, causes of dropped nucleus were not included due to inadequate data. The primary aim of this review is to evaluate visual outcomes based on timing of vitrectomy performed on patients with dropped nucleus following complicated phacoemulsification. Early surgery was defined as vitrectomy that was done within five days of primary phacoemulsification, while later vitrectomy was defined as vitrectomy performed on day six or later following primary phacoemulsification.

### Visual outcome

Surgical intervention with pars plana vitrectomy and removal of lens fragments is commonly required in the management of dropped nucleus post complicated cataract surgery. However in selective cases where the dropped lens fragments were small and consist of only cortical matter, patients may be treated medically with oral prednisolone and observation alone [4]. The visual outcomes of 6/12 or better in patients who had pars plana vitrectomy for dropped lens fragments varies from 45.5%-71.0% [5-9]. This present study finding is comparable to previous studies with visual acuity at three months was 6/12 or better in 62.2% (56 eyes).

The interval after complicated phacoemulsification and pars plana vitrectomy for removal of the retained lens fragments has been studied with no conclusion of the best optimal timing of the later surgery. Several studies demonstrated that there were no significant correlation between the interval of phacoemulsification and pars plana vitrectomy for dropped lens fragments removal with the final visual outcomes [5,6,8,9,11,12]. A systematic review and meta-analysis studying the effect of vitrectomy of three days or more in which 43 studies were reviewed and 27 studies were analyzed showed that it is best to avoid vitrectomy during the first week following phacoemulsification to clear off ocular congestion, inflammation and corneal oedema [10]. There were reports on associated reduced visual acuity, retinal tears, cystoid macula edema, choroidal detachment, moderate to severe inflammation where pars plana vitrectomy was performed during the first two days after phacoemulsification producing inferior outcomes [11]. The meta-analysis suggested that the optimal timing of vitrectomy begins three to seven days after cataract surgery. The underlying reason was unclear, however it was presumed that the delay would allow recovery following cataract surgery just shortly before immunologic response became advanced.

This review demonstrated that there was a significant difference in the visual outcomes when compared to timing of pars plana vitrectomy with p=0.018. Of the 38 eyes that underwent later vitrectomy (more than five days following phacoemulsification), 29 eyes (76.3%) had visual acuity of 6/12 or better while only nine eyes (23.7%) had visual acuity worse than 6/12. There was no significant difference of the final visual acuity when vitrectomy was performed after day eight with p=0.095. This indicated that better visual acuity was gained when vitrectomy were performed later (from day six to day eight) following primary phacoemulsification.

A retained dropped nucleus incites inflammatory reaction. The severity and intensity increases according to the size of the dropped lens fragments. Vitrectomy performed within a week of dropped nucleus post complicated cataract surgery was associated with low inflammatory reaction in the vitreous compared when vitrectomy was done later on [11]. A few days is given to allow reduction of inflammation, regression of cornea oedema and better control of intraocular pressure. In this present study, four patients had vitrectomy within 24 hours following complicated phacoemulsification with three patients attaining visual acuity of 6/12 or better and only one patient had visual acuity of 6/18 due to high post-operative astigmatism. Previous studies found that vitrectomy after three weeks of dropped lens fragments were associated with poor visual outcome [11]. In the present study, of six eyes who had pars plana vitrectomy done at day 21 or later following phacoemulsification, four eyes had visual acuity of 6/12 or better. All the six eyes had dropped lens fragments of less than a quadrant of lens nucleus or smaller. One patient who had final visual acuity of 3/60 was due to choroidal detachment with cornea decompensation and another patient had visual acuity of 6/18 with secondary glaucoma following the procedure.

Few factors may have been contributed to the delay of vitrectomy in the present study. Delay of referral may be due to minimal lens fragments retained in the eye which necessitated observation and medical therapy to be taken first at initial point. Secondly it could be due to the obscuration of fundus view by cornea oedema and uncontrolled intraocular pressure. Patient who was not medically fit for surgery was optimized first prior to vitrectomy. Hence, a few patients in this study had vitrectomy done at 21 days or more post primary surgery.

Implantation of intraocular lens depends on the

stability of the anterior curvilinear capsulorrhexis and early management of dropped nucleus during phacoemulsification. Some surgeons may prefer anterior vitrectomy and removal of anterior cortical remnant allowing a better assessment of the capsule remnant and possibility of sulcus intraocular lens implantation. Others may prefer to immediately close the cornea wound and refer to vitreoretinal unit for further management. A few studies found that there were no significant difference in the visual outcomes comparing to the types of intraocular lens or the timing of intraocular lens implantation [5,8,12]. The finding of the present study is similar to previous studies, whereby there was no significant difference found in relation to the type and timing of intraocular lens implantation with the visual outcome of the patients.

Implantation of sulcus intraocular lens through preexisting corneal wound made during phacoemulsification reduces the possibility of high astigmatism due to suturing of cornea wound compared to patients with anterior chamber intraocular lens implantation which requires extension of the cornea wound. The incidence of astigmatism in this study was 10.0% (nine eyes). Four had sulcus intraocular lens implanted (three eyes during vitrectomy and one eye during phacoemulsification) and five eyes had anterior chamber intraocular lens implanted (four eyes during vitrectomy and one eye during phacoemulsification). In present study, there were no significant differences in relation to the type of intraocular lens used and the risk of poorer vision following pars plana vitrectomy with lens fragments removal (p=0.08). Twelve patients with sulcus intraocular lens had vision worse than 6/12 compared to 22 patients who had anterior chamber intraocular lens implanted. However, early implantation of the intraocular lens may shorten the time of surgery during pars plana vitrectomy. Sulcus placement of an intraocular lens may allow faster cornea recovery compared to anterior chamber intraocular lens.

Lens fragment may be removed with phacofragmentation with or without the use of perfluorocarbon liquid. Perfluorocarbon liquid has been introduced as an intraoperative adjunct since 1982 and was used in several studies to assist removal of lens fragments during pars plana vitrectomy [13]. Perfluorocarbon liquid helps to protect the retina from thermal damage during phacofragmentation, avoid trauma to the retina from falling nucleus while doing phacofragmentation and in certain cases to float the dropped nucleus with removal of the nucleus through corneal limbal wound. Phacofragmentation is proven to be a safe and effective choice for removal of dropped nucleus [14]. In this present study, the surgeons did not use perfluorocarbon liquid for removal of lens fragments. Cortical matter and lens fragments that are smaller than a quadrant and of moderate hard in consistency were removed by using vitrectomy cutter Phacofragmentation technique was used in cases with harder and bigger nuclear fragments of more than a quarter nucleus size.

A bigger and denser dropped nucleus was associated with poorer visual outcome compared to non-nuclear fragments [15]. This may be explained by requirement of higher power and longer duration of phacofragmentation when dealing with denser and bigger nuclear fragments. In our study, there was a significant difference observed in the relation of the dropped nucleus fragments size to the visual outcome with p=0.03. Interestingly, we have found that lens fragments of bigger than a quarter of the nucleus had better visual outcome compared to patients with nucleus dropped of a quarter or less. This reflects that phacofragmentation which was used for bigger nuclear segment (more than a quarter of nucleus) in this study did produce good visual outcome. This findings were not seen in previous study. Moisseiev et al in their study found a statistically significant difference in final visual outcome when comparison was made between nuclear and non-nuclear fragments [15]. However the difference was not statistically significant when final visual outcome was compared to the size of nuclear fragments (small or large). In our study, we divided the dropped lens fragments according to the size (less or more than a quarter nucleus size) and not between nuclear or non-nuclear types. This may explained the difference in our findings. A smaller nucleus size had a tendency to be treated medically first prior to surgical intervention. Patients would only be referred to vitreoretinal surgeon if failure to medical therapy ensued, development of high intraocular pressure or increased intraocular inflammation. Smaller size of dropped lens fragment referred to size of a quarter nucleus or less or only cortical matter found during vitrectomy. In our study, 22 out of 45 patients with smaller nucleus dropped size had vitrectomy done after day five (ranged 6-162 days) of phacoemulsification. Of the 45 eyes, 19 eyes had complications such as rhegmatogenous retinal detachment, choroidal detachment, corneal decompensation, vitreous haemorrhage, secondary glaucoma, chronic anterior uveitis, high astigmatism and chronic cystoid macula oedema. The poor final visual outcome may be contributed by the occurrence of complications in this group. Fifteen eyes (78.9%) had visual outcome of 6/18 or worse. These findings supported our data analysis which showed smaller nucleus size had poorer visual outcome (p=0.03). This observation leads to our suggestion that all cases of dropped nucleus regardless of size should be treated surgically.

Vitrectomy performed by consultants who are considered as an experienced surgeon were compared to the vitreoretinal fellows in this study. Since there was more than one surgeon involved, comparison was made among them to reduce bias of this study. No significant difference was noted when visual outcomes or incidence of complications were compared to surgeons (vitreoretinal consultants and the vitreoretinal

fellows). The learning curve of a vitreoretinal trainee might be shortened and enhanced with good supervision and adequate surgical exposures in the training center.

**Complications**

The incidence of complications in this present study were high astigmatism (10.0%), epiretinal membrane (7.8%), choroidal detachment (6.7%), retinal tear (5.6%), retinal detachment (4.4%), cystoid macula oedema and glaucoma (3.3%) each.

High astigmatism was observed in nine patients, which ranged from four to 12 diopter. Their visual acuity ranged from 6/12 to 6/36. One study reported astigmatism incidence of 12.5% which was related to limbal and sclerostomy incisions' sutures performed during removal of dropped lens fragments [16]. A 23G pars plana vitrectomy offers some benefits over the former 20G procedure due to creation of smaller sclerotomy incision size. It imposes less trauma on the conjunctiva and avoids the necessity of scleral suture due to its self-sealed nature. This helps to reduce surgical induced astigmatism [17]. In the current study, a standard three-port 23G pars plana vitrectomy was performed in all eyes. However, eyes with larger or harder nucleus fragments were removed using 20G phacofragmentome probe which required suturing for the larger scleral incision. In our study, of nine eyes with high astigmatism, six of them underwent pars plana vitrectomy with phacofragmentation to remove dropped nucleus. This would partly explained the incidence of high astigmatism in this group of patients. In the other three eyes who had no phacofragmentation done; one had pre-existing astigmatism, one had leaking of cornea wound post primary phacoemulsification requiring cornea wound resuturing and one had unexplained cause of high astigmatism. Anterior chamber intraocular lens (IOL) implantation is associated with higher risk of surgical induced astigmatism as a result of cornea surface irregularities from placement of multiple cornea sutures. In our study, only five from nine patients had ACIOL implantation while four patients had sulcus IOL implanted. Nevertheless in this study comparison made between types of IOL implanted and complications revealed no significant difference. Being a retrospective study, detailed and precise information pertaining to surgery may be missed due to lack of documentation. A prospective study design looking at the outcome of different types of IOL implanted in dropped nucleus patients would be of superior value in evaluating this.

In our study, seven patients (7.8%) developed epiretinal membrane (ERM). Ghasemi et al reported a lower incidence of 4.5% [18]. Their study excluded patient with preexisting diabetic retinopathy and one patient who developed ERM had pre-existing high intraocular pressure, proliferative vitreoretinopathy (PVR) and rhegmatogenous retinal detachment (RRD) before vitrectomy [18]. In our study, one patient had preexisting diabetic retinopathy and one had glaucoma after the first surgery. Four out of seven patients had vitrectomy performed later (day 13 to 44). Yeo et al observed that eyes receiving vitrectomy within one week of primary phacoemulsification had significantly less ocular inflammatory activity [11]. Inflammation induced by residual lens materials in the eye was further exaggerated by vitrectomy surgery itself. This may predispose to ERM formation [19]. Though our study did not observe a significant difference between timing of vitrectomy and complications, trend of later vitrectomy contributing to ERM formation has been observed. A better study design looking into more risk factors, bigger subjects size and longer duration of follow-up would offer more valuable and meaningful information.

We observed development of choroidal detachment in six (6.7%) of our patients. Incidence of 2% to 15.8% was previously reported [16,20,21]. Choroidal detachment occurs when either serous fluid or hemorrhage occupies the potential space (suprachoroidal space) located in between the choroid and sclera. Early post-operative hypotony, choroidal detachment and scleral gap at sclerostomy incision site are frequent findings following a transconjunctival sutureless 23G vitrectomy [22]. Tarantola et al in their study has proposed that intraoperative cannula retraction during 23G pars plana vitrectomy has cause an increased in serous and hemorhagic choroidal detachment due to diversion of infusion fluid into the suprachoroidal space following cannula retraction. The retraction was observed following a shallow angle trocar insertion which caused insufficient internal exposure of the cannula in the vitreous cavity and thus increasing the risk of inadvertent cannula retraction into the suprachoroidal space [23]. Valved cannula aid to minimize intra-operative fluid egression thus offer more stable intraocular fluidics and improved dynamic control of intraocular pressure (IOP) [24]. This together with proper sclera and cornea wound closure at the end of the surgery may help to reduce the occurrence of choroidal detachment. Being retrospective, we were unable to gather a detailed intraoperative information to relate the above possible mechanisms to the occurrence of choroidal detachment in our patients.

Of 90 eyes who had pars plana vitrectomy with lens fragments removal, five developed retinal tear and four had retinal detachment. Al-Khaier et.al observed higher occurence of retinal tear and retinal detachment in eyes with ultrasound phacofragmentation usage [21]. Borne et al, who made similar observation postulated that the suction created by the large-bore ultrasound fragmentation probe may cause inadvertent engagement and traction on residual peripheral vitreous gel, causing a retinal tear and, ultimately, a retinal detachment [25]. In the current study, phacofragmentation was performed in all five patients with retinal tear and in three out of four patients (75%) with retinal detachment. The incidence of retinal detachment for this study (4.4%) was comparable to other studies that ranged from 4.1%-21.5% [6,21,26,27]. Only one

out of five eyes had good final visual acuity of 6/9, with the remaining eyes had visual acuity of worse than 6/12. Retinal detachment is one of the most common reported complication in a post vitrectomised eye following dropped nucleus. Effort and strategy should be channeled to prevent this potentially visual threatening condition. Morris et al. observed a 6-fold reduction in incidence of retinal detachment when prophylactic 360-degree laser retinopexy was performed in all patients underwent pars plana vitrectomy for removal of retained lens fragments(28). Thorough search for iatrogenic break is also a crucial element to prevent this complication.

Glaucoma is a known complication of pars plana vitrectomy ranges from 15.8%-25.53% [6,9,15]. Later vitrectomy of more than a week is associated with persistently higher intraocular pressure and poorer visual outcomes [11,21]. In this present study only two patients (2.2%) had high intraocular pressure during follow up which required anti-glaucoma treatment. Both had anterior chamber intraocular lens implanted. One patient had vitrectomy done within four days following phacoemulsification with whole nucleus dropped and the other had vitrectomy done after 83 days following dropped nucleus consisting of only cortical lens fragments.

The incidence of cystoid macula oedema increases with the longer interval of surgeries [8]. Major visual decrease was observed within the first six months up to years following vitrectomy [9]. However, in this study only three out of 90 patients were documented to have cystoid macula oedema at three months post vitrectomy. We were unable to correlate it with the interval of surgeries due to the limited sample identified. Two patients had vitrectomy done three days after phacoemulsification surgery and one patient had vitrectomy performed on the same day of primary surgery. It should also be noted that cystoid macula oedema may occur several months after surgery, thus longer study follow-up may be of more value in this study [29].

**Limitation of the study**

The main limitation of our study was being retrospective in nature, imposed restrictions to our data availability and adequacy. There were also several factors that may have confounded our study outcome. Variability in patient's underlying ocular conditions such as myopia, axial length differences and pre-existing retinopathy impose bias in interpretation of our results. There was more than one surgeon involved in patients' care thus this may result in variability in clinical judgement, assessment and reporting as well as surgical technique and outcome. There was also dissimilarity in the surgical instruments utilized. Tracing medical records from other referring hospitals were also challenging as most of the centers used manual data keeping. As a referral center, most patients were sent back to their respective referring hospital after vitrectomy was done. Review of patients were done from several hospitals which may have limited resources such as unavailability of Optical Coherence Tomography (OCT) machine to document subtle underlying macula problem such as mild cystoid macula edema which could explain the cause of reduce vision. In our center, pars plana vitrectomy with phacofragmentation alone (without perfluorocarbon liquid) was opted to remove harder or bigger nucleus. While aid of perfluorocarbon liquid (PFCL) was considered the safest and most efficient way of delivering very hard nucleus or bigger nucleus fragment,28 our data suggested that in experienced hand and timely surgery, good visual outcome may still be attainable when this ideal approach may be source limited in some centers.

## CONCLUSION

Our study found that in patients with dropped nucleus post complicated phacoemulsification, later pars plana vitrectomy which was performed between six and eight days carried better visual outcome. High astigmatism accounted for the highest complications followed by epiretinal membrane formation, choroidal detachment, retinal tear and rhegmatogenous retinal detachment. In the current study, we have also found that nucleus dropped of more than a quarter size showed better visual outcome when compared to smaller size of nucleus. Smaller size of dropped lens fragments tend to be treated medically first and this resulted in delayed vitreoretinal intervention and higher rates of vision threatening complications. We propose that all cases of dropped nucleus should be treated surgically regardless of its size.

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## DECLARATION OF CONFLICT OF INTEREST

The authors report no conflicts of interest.

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