

Multiquadrant versus single quadrant cortical cleaving hydrodissection during phacoemulsification of age related cataract



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Abstract

Purpose: To evaluate and compare single and multiquadrant hydrodissection in age related cataract.

Design: Prospective, observational case series.

Methods: In this study, 220 patients were consecutively assigned to either single ($n = 110$) or multiquadrant ($n = 110$) hydrodissection during phacoemulsification. Patients having operable cataract in the nuclear grade of 1–3 of Lens Opacities Classification System III were included in the study. After hydrodissection of the nucleus nuclei were not rotated. Parameters assessed were amount of balanced salt solution (BSS) required to accomplish the hydrodissection, nucleus emulsification time (NET), and cortical aspiration time (CAT). Ease in nucleus rotation during chopping of the nucleus, cortical aspiration (easy, difficult, or very difficult) and intraoperative surgical complications were qualitatively assessed.

Results: Average amount of BSS required in multiquadrant hydrodissection was 1.7 ml (± 0.9), which was more than double the single quadrant group 0.71 (± 0.17), $p = 0.001$. No statistically significant differences were observed between the two studied groups with respect to the following parameters: mean NET (single quadrant 277 sec ± 95.5 , multiquadrant 267 sec ± 98.8 , $p = 0.379$), CAT (single quadrant 75.7 sec ± 31.2 , multiquadrant 73.4 sec ± 33.9 , $p = 0.301$), and total fluid required (single quadrant 154 ml ± 64.9 , multiquadrant 157 ml ± 66.4 , $p = 0.708$).

Almost equal number of patients in both the groups had easy rotation of the nucleus (single quadrant: $n = 105$, 95.45% and multiquadrant $n = 103$, 93.64%) and cortical aspiration ($n = 102$, 92.72% both the groups). Three patients in multiquadrant group had posterior capsular rupture during hydrodissection.

Conclusions: A single quadrant hydrodissection is sufficient for the efficient removal of nucleus and cortex.

Keywords: Hydrodissection, Phacoemulsification

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Introduction

Hydrodissection is one of the major steps during phacoemulsification. Cortical cleaving hydrodissection was first described by Fine in 1992.¹ It involves separation of

corticocapsular adhesions by injecting balanced salt solution with 26-gauge cannula by tenting the rim of the anterior capsule. The importance of hydrodissection in the era of modern cataract surgery is well recognized as the nucleus rotation becomes easy during its emulsification. It also facilitates

Received 2 May 2017; received in revised form 23 September 2019; accepted 24 September 2019; available online xxxx.

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Peer review under responsibility of Saudi Ophthalmological Society, King Saud University



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removal of residual cortical matter after emulsification of nucleus.

Experimental study on human cadaver eyes by Peng et al. has shown, shearing effect of fluid wave during hydrodissection detaches the equatorial lens epithelial cells from equatorial capsular area, allowing its easy removal during phacoemulsification and irrigation/aspiration process preventing posterior capsular opacification.²

Various techniques described to separate nucleus from cortex and capsule include hydrodelineation, multilamellar, single/multiquadrant hydrodissection after nucleus fracture, and translenticular hydrodissection.³⁻⁵ Vasavada et al. have shown multiquadrant hydrodissection helps in easy and faster removal of nucleus and cortex compared to hydrodelineation technique.⁴ We have found, 0.7–0.8 ml balanced salt solution at a single site is sufficient to complete hydrodissection procedure (unpublished data). Injection of excessive amount of fluid during hydrodissection can sometimes be associated with capsular block syndrome, blowing of posterior capsule with nucleus luxation into the vitreous cavity and iris prolapse.⁶⁻⁸

To the best of our knowledge, the effect of single site versus multiquadrant hydrodissection on intraoperative performance of phacoemulsification in senile cataract has not yet been studied. Hence, we designed this prospective observational case study to compare various aspects of single and multiquadrant hydrodissection in phacoemulsification of age related cataract.

Materials and methods

Sample size

In order to assess the difference of 15% between two groups and considering nucleus emulsification time as an important criterion with 80% power of study and an alpha error of 5%, a sample size of 110 was considered in each group.

Patient selection and study design

This prospective observational case series comprised of 220 patients (220 eyes) with age related cataract scheduled for phacoemulsification and implantation of intraocular lens (IOL). Patients having operable cataract in the nuclear grade of 3–5, cortical C4 AND C5 and posterior subcapsular P4 AND P5 of Lens Opacities Classification System III were included in the study.⁹ Exclusion criteria include corneal degeneration, dystrophies and scarring, glaucoma, uveitis, previous intraocular surgeries, subluxated cataracts, pseudoexfoliation, posterior polar cataract, poor pupillary dilation, and extremely shallow anterior chamber.

Preoperative assessment included best-corrected visual acuity, slit lamp examination, intraocular pressure, retinal evaluation, and A-scan biometry for intraocular lens power calculation.

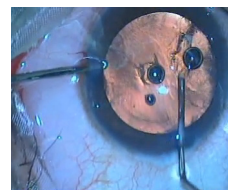
The Hospital Ethics Committee approved the study. The written informed consent was obtained from each participant. Patients were divided equally into two groups as single and multiquadrant hydrodissection groups. The single quadrant cortical cleaving hydrodissection group ($n = 110$) had

hydrodissection in one quadrant. In the multiquadrant group ($n = 110$), the corticocleaving hydrodissection was performed in different quadrants until the fluid wave was observed. Patients were randomized to receive either single quadrant or multiquadrant hydrodissection. When the patient came for the surgery, patient was asked to pick up one envelope out of two containing either single quadrant or multiquadrant hydrodissection technique to be performed during the surgical procedure. The content of envelope was disclosed to the surgeon.

Surgical technique

A single experienced surgeon performed all the surgeries. Preoperative dilatation of the pupil was achieved using a combination of 0.8% tropicamide and phenylephrine 5%. Patients were operated under 0.5% topical proparacain hydrochloride drops instilled twice 10 min before the surgical procedure, supplemented by 0.5 ml subconjunctival injection of 2% lignocaine hydrochloride at the beginning of the surgery. A side port incision was created on the appropriate side as required. Viscoelastic 2% hydroxypropyl methylcellulose solution (Appavisc, Appasamy Ocular Devices, Puducherry, India) was injected through the side port with 23 G blunt tip cannula. A 2.8 mm clear corneal temporal incision was performed. Continuous curvilinear capsulorhexis was completed using capsulorhexis forceps under viscoelastic solution. The size of the rhexis was maintained approximately at 5–5.5 mm.

In the single quadrant hydrodissection group, corticocleaving hydrodissection was performed with 26-gauge cannula attached to 2 cc syringe filled with balanced salt solution. The rim of anterior capsule opposite to the clear corneal incision was tented with the hydrodissection cannula, and the fluid was injected gently. The completion of the procedure corresponded to the passage of continuous fluid wave, seen against the red glow, which reached opposite to the site of fluid injection (Video 1). The nucleus-cortex complex, which elevated out of the capsular bag, was depressed with the cannula (Fig. 1).



Video 1. Single quadrant hydrodissection.

In a multiquadrant group, two additional sites were selected to perform corticocleaving hydrodissection (Figs. 2a–c and Video 2). In right eye the sites selected were 3,5 and 10 o'clock and in left eye 9, 7 and 11 o'clock. Care was taken to avoid inadvertent hydrodelineation. Even if there was an occurrence of fluid wave, BSS was injected in the additional sites. The completion of the procedure corresponded to the passage of continuous fluid wave from each site of the fluid injection.

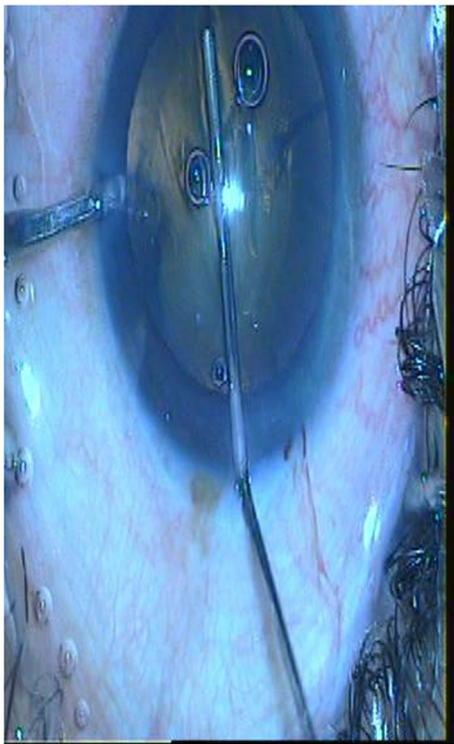


Fig. 1. Single quadrant hydrodissection.

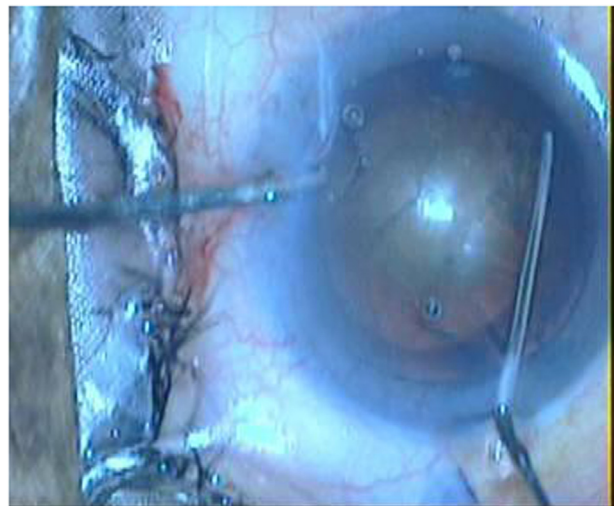


Fig. 2b. Multiquadrant hydrodissection (selection of inferior quadrant).

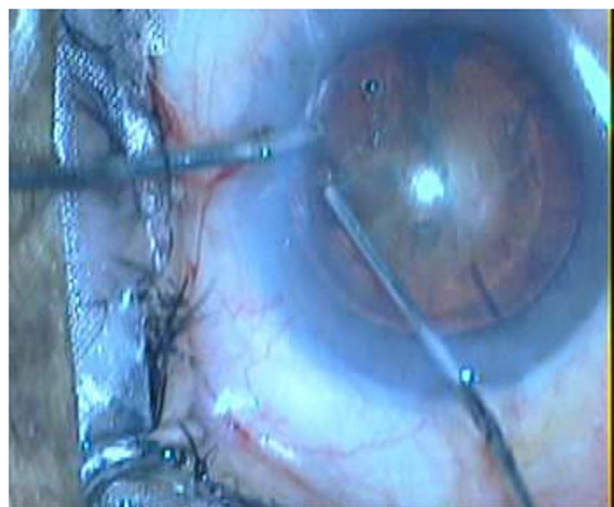


Fig. 2c. Multiquadrant hydrodissection (selection of superior quadrant).

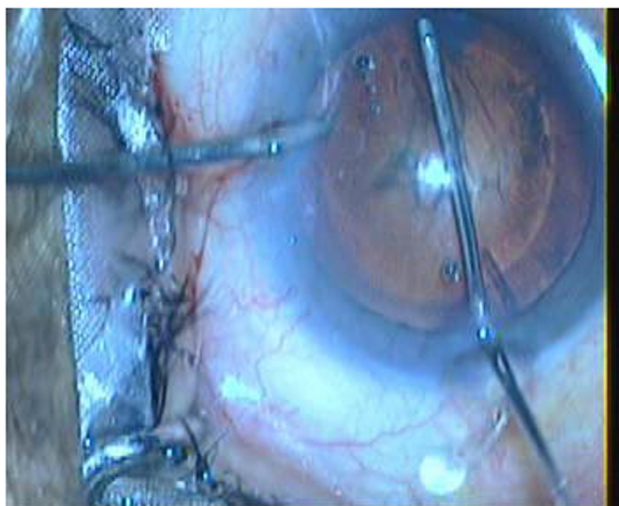
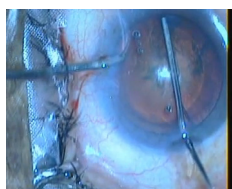


Fig. 2a. Multiquadrant hydrodissection.



Video 2. Multiquadrant hydrodissection.

The eyes with occurrence of golden ring around the nucleus, suggestive of hydrodelineation, were excluded from the study.

The amount of fluid required to complete the hydrodissection was noted at the end of the procedure measuring the residual fluid remaining in the syringe.

In both the studied groups, nucleus was not rotated after the hydrodissection. The nucleus was emulsified with quick chop technique. The settings for nucleus chop were as follows: power 90% (linear), vacuum 350 mm Hg, and aspiration flow rate 34 cc/min (Galaxy-pro phacoemulsifier system, Appasamy Associates, Chennai, India). After the creation of chop, the nucleus was rotated to 90 deg to create further chop. Sharp chopper was used in all the cases. Rotation of the nucleus at the first attempt was considered easy rotation. Rotation of nucleus requiring two or more attempts was considered to be difficult rotation. When the surgeon required removal of phaco probe and repetition of hydrodissection for rotating the nucleus, it was considered a very difficult rotation. Four quadrants were created, and the nucleus was emulsified in the capsular bag. Parameters were kept same for all cases until the last fragment was emulsified. Thorough cortical clean up was accomplished by bi-manual irrigation and aspiration probe with preset vacuum of 375 mm of Hg

and aspiration flow rate of 28 cc/min. Vacuum polishing of anterior and posterior capsule was performed with preset vacuum of 10 mm of Hg and flow rate of 10-cc/min. A single piece hydrophilic lens was implanted in the capsular bag. Stromal hydration of side port and main incision were completed with BSS.

After the completion of the procedure, the surgeon noted qualitative assessment of the ease of cortical aspiration.

Intraoperative parameters

The intraoperative parameters studied were as follows: amount of fluid needed to accomplish hydrodissection, nucleus emulsification time (beginning of the ultrasonic energy till the emulsification of the last nuclear fragment was taken as a nucleus emulsification time), cortical aspiration time, total amount of fluid required after completion of the procedure, ease of nucleus rotation during emulsification of nucleus (easy, difficult, or very difficult), ease of cortical aspiration (easy, difficult, or very difficult), and intraoperative surgical complications.

Statistical analysis

Preoperative and intraoperative observations were entered in an MS-Excel sheet. Graph pad prism version- 4 was used for the analysis of data. Data were analyzed using the Mann-Whitney and Student t- test.

Differences were considered significant when the p value was less than 0.005.

Results

The average ages of the patients in the single site and multi-quadrant hydrodissection groups were 68.35 years (±13.29) and 65.46 years (±12.83), respectively (p = 0.008). Distribution of eyes according to the grade of cataract is shown in Table 1. Table 2 depicts the intraoperative parameters based on quantitative assessments. The average amount of BSS required to accomplish the hydrodissection in multi-quadrant group (1.71 ml) was more than double the single site hydrodissection (0.71) group (p = 0.001); however, no statistically significant difference was found with other parameters in both the groups. Table 3 shows subjective assessment of the parameters based on surgeon’s observations. In both the groups, almost equal number of patients had easy rotation of the nucleus (single site hydrodissection group:

Table 1. Showing distribution of eyes according to the LOCS III classification.

LOCS Grade of the cataract	Single site hydrodissection group	Multisite hydrodissection group
N03	10	15
NO4	15	10
NO5	30	25
C4	20	25
C5	20	15
P4	05	10
P5	10	10
Total	110	110

NO = Nuclear opalescence, C = Cortical grade, P = Posterior subcapsular.

Table 2. Quantitative assessment of the parameters.

Parameter	Single site hydrodissection group	Multisite hydrodissection group	P value
Mean fluid to accomplish hydrodissection (ml)	0.71(±0.17)	1.7 (±0.9)	0.001
Mean Nucleus emulsification time (sec)	277 (±95.5)	267 (±98.8)	0.379
Mean cortical aspiration time(sec)	75.7 (±31.2)	73.4 (±33.9)	0.301
Mean total fluid used (ml)	154 (±64.9)	157 (±66.4)	0.708

Table 3. Subjective assessments of the parameters.

Parameters	Single site hydrodissection group	Multisite hydrodissection group	P value
<i>Ease of nucleus rotation</i>			
Easy (%)	105(95.45)	103(93.64)	0.551
Difficult (%)	4(3.64)	5(4.55)	
Very difficult (%)	1(0.90)	2(1.81)	
<i>Ease of cortical aspiration</i>			
Easy (%)	102(92.72)	102(92.72)	0.998
Difficult (%)	2(1.81)	6(5.45)	
Very difficult (%)	6(5.45)	2(1.81)	

n = 105, 95.45% and multisite hydrodissection group: n = 103, 93.64%) and cortical aspiration (n = 102, 92.72% for both the groups). Three patients in the multi-quadrant group had posterior capsular rupture during multi-quadrant hydro procedure.

Discussion

Hydrodissection is an integral part of modern cataract surgery. It facilitates nucleus rotation and removal of divided nucleus fragments during phacoemulsification. Multi or single site techniques are commonly performed for hydrodissection. Single site hydrodissection is advocated to prevent blow out of the posterior capsule with luxation of nucleus in the vitreous cavity.^{7,10,11} Multi-quadrant hydrodissection has been shown to make easier the removal of nucleus and cortex during phacoemulsification procedure.⁴

Lin et al. described the novel technique for hydrodissection in which small volume (0.2 cc) of BSS was injected to separate nucleus from the capsule utilizing low hydrostatic pressure and precise kinetic movement of the fluid. They carried out nucleus rotation at the end of hydrodissection and no comparison was done with the other techniques of hydrodissection.¹¹

Tas et al. described minimal water-jet hydrodissection performed with high-speed pulse injection of 0.1 cc of BSS. They further stated high energy obtained by high-speed injection of small amount of fluid ensures highly effective hydrodissection. In this technique as well rotation of the nucleus was performed.¹⁰

To the best of our knowledge, the current study is the first comparative study of these two modes of hydrodissection procedure. Additionally, in contrast to the standard technique, in the two groups of eyes, no rotation of the cataract

was performed after the hydrodissection was made, but the nuclear fracture was performed directly with the quick chop technique.

We have found out, single quadrant hydrodissection technique is as effective as multiquadrant hydrodissection technique in terms of intraoperative performance of phacoemulsification. This was supported by the nucleus emulsification time (NET), which was almost equally distributed in both the groups (single quadrant group: 277 s, multiquadrant group: 267 s). For the multiquadrant hydrodissection technique, Vasavada et al.⁴ reported nucleus removal time as 355 s, which is longer than the time observed for single site hydrodissection group in our study. This could be due to using quick chop technique in our study compared to the step-by-step chop in situ and lateral separation technique advocated by Vasavada et al. for nucleus management.⁴

In the present study, the mean BSS required to accomplish procedure in single site (0.71 ml) was less than multiquadrant mode (1.7 ml) of hydrodissection. An increase in intraocular pressure is observed during hydrodissection, which depends on inflow and outflow of the fluid.¹² As the amount of fluid injected in single quadrant hydro procedure is minimal there are less chances of rise in the intraocular pressure and subsequent complications. After hydrodissection gentle tap on the central portion of the nucleus draws out fluid between the nucleus and posterior capsule. In single quadrant hydro a one or two taps are sufficient. However, in multiquadrant hydro after injection of BSS for hydro procedure in every quadrant a tap is needed on the nucleus to decompress the fluid. It is very difficult to judge after each tap, amount of fluid remaining behind the nucleus. With multiquadrant accumulated fluid behind the nucleus may push the nucleus up to block capsulorhexis opening (intraoperative capsular block syndrome),^{7,13} which in turn can cause posterior capsule blowout, like in fact, happened in three cases (2.7%) of the patients in that group in the present study. On the other hand none of the patients in single quadrant group had capsular block or posterior capsular rupture. While three patients in multiquadrant group had posterior capsular rupture subsequent to hydrodissection. One of these three patients had posterior subcapsular and two patients had nuclear opalescence grade 5 cataract. However, reason for posterior capsular rupture in these two cases could not be ascertained.

The ingress of fluid in the vitreous cavity and pupil becoming small confirmed the posterior capsular rupture. Some alternatives have been suggested to avoid hydrodissection related complications, like the mechanical cortical cleaving dissection technique for phacoemulsification.^{11,14,15} This technique, however, seems technically more challenging than manual hydrodissection, and might be risky in patients with zonular dehiscence.

Hydrodissection has added safety during phacoemulsification as rotation of the nucleus has become easy. In the present study no rotation of the nucleus was done after hydro in both the groups. The rotation of the nucleus was performed after the creation of the first nuclear chop. Two patients (1.81%) in multisite group had difficult nucleus rotation; this could be due to the firm preexisting capsulocortical adhesions. These two patients had very difficult cortical aspiration.

Cortical-cleaving hydrodissection performed by creating cleavage between cortex and capsule allows through cortical

cleanup. This causes less stress on the zonular apparatus during irrigation and aspiration procedure. Multiquadrant hydrodissection by breaking the corticocapsular adhesions facilitates the cortex aspiration. This observation was substantiated by the less cortex removal time observed in multi-quadrant group (73.4 s) than single site hydrodissection group (75.7 s). However, there was no statistically significant difference between two groups ($p = 0.301$). Mean cortex aspiration time reported by Vasavada et al. for multiquadrant hydrodissection group (79 s) is in agreement with our study. Six patients (5.45%) in single site group had very difficult cortical aspiration. Vasavada et al. has shown very difficult cortex aspiration in 10.52% cases where they performed only hydrodelineation and not hydrodissection.⁴ Hydrodelineation by separating nucleus from epinucleus leaves sheet of cortex. In an attempt to remove cortical sheet attached to the posterior capsule there is a possibility of posterior capsular tear. A pull on the cortical sheet from the periphery to the center can cause bag pull and cause zonular dehiscence. None of the patients in the present study group developed zonular dehiscence and posterior capsular tear during cortex aspiration.

Recent phacoemulsification technique uses small incisions.¹⁶ With reduction in the size of incision hydrodissection related complications can occur less frequently. Injected fluid may accumulate between the posterior capsule and nucleus leading to iris prolapse and blow out of the posterior capsule.³ Excessive viscoelastic material in the anterior chamber can increase resistance to the egress of BSS.⁴ Single site hydrodissection with less amount of fluid has an ability to avoid it.

Increase in endocapsular pressure is another factor related to the hydrodissection related complications, which depends on amount of fluid required for the hydrodissection and the type of viscoelastic used to form the anterior chamber. Use of minimal fluid can avoid hydrodissection related complications.

A single surgeon was involved in the study, which omits the comparison in skills and the surgical technique. We recommend comparative evaluation of studied parameters between two or more surgeons with different surgical techniques.

Conclusions

Based on the above findings, we conclude that the single site hydrodissection is as effective as multiquadrant hydrodissection technique. It does not compromise the ability to easily rotate the nucleus, nucleus emulsification time and cortical aspiration.

Single site technique has an ability to potential to avoid hydro related complications. Our study also demonstrated that the nucleus rotation immediately after hydrodissection is not required.

Declaration of Competing Interest

The authors declare that there is no conflict of interest.

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