Comparison of Ngenuity and Traditional Microscope in Vitreoretinal Surgeries from Surgeon's Perspective

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Abstract

Purpose: To compare Ngenuity with traditional microscope in vitreoretinal surgeries from surgeon's perspective

Methods: In this retrospective study, we recruited patients who have underwent vitreoretinal (VR) surgeries from 1st August 2017 to 30th August 2017. Patient's clinical parameters were extracted from electronic medical records (EMR), and also video recordings of the surgeries using the Ngenuity 3D visualization system were analysed. The surgeons were asked to compare Ngenuity 3D visualization system and traditional microscope during each step of the surgery. We administered a questionnaire to compare the two modalities in each step during the surgery in terms of the preferred system, comfort, ergonomic and visual parameters.

Results: Out of 31 eyes, primary rhegmatogenous retinal detachment (RRD) was 35% (11 eyes), complex recurrent RRD was 13% (4 eyes) and diabetic TRD was 16% (3 eyes). The educational value, upper body comfort and image resolution was found to be better with Ngenuity than microscope. The depth of perception, field of view and the lower body comfort was graded as similar and time lag was experienced more with Ngenuity. On comparison of the preference of traditional microscope and Ngenuity during surgical steps, preference for Ngenuity was significantly more for posterior segment steps like the truncation of cone ($p = <0.00001$), PVD induction ($p = 0.0001$), Endo laser ($p = 0.0001$), Fluid gas exchange ($p = 0.0005$) and tamponade injection ($p = <0.00001$).

Conclusions: Ngenuity provided improved neck and upper body comfort, greater field of view and was more preferred for posterior segment procedures than anterior segment during VR surgeries.

Introduction

The intraoperative visualization systems are the integral part of vitreoretinal (VR) surgeries which is mainly relied upon optical microscopes for years. Microscopes have been improvised with wide-angle visualizations, but few basic components and the surgical experience remain unaltered [1]. Eckardt introduced the heads up three-dimensional (3D) viewing system [2], they provide better digital video quality, necessary stereopsis, greater pixel count, resolution, frame rate, dynamic range, and latency for all VR surgeries [1]. The known advantages of 3D systems were improved ergonomics, lower illumination levels, enhancing filters, reduced retinal phototoxicity, increased depth of field and digital image amplification [2]. Few reports show surgeons experience between Ngenuity and optical microscope during anterior segment surgeries, but there are only limited studies which compare each surgical step during vitreoretinal surgeries from surgeon's point of view. This study aims to compare the traditional microscope and Ngenuity 3D visualizations in each step of the VR surgeries from surgeon's perspective.

Methods

We recruited 31 eyes of patients who underwent VR surgeries using Ngenuity 3D system (Alcon, Fort Worth, Texas, USA). The data was collected from 1st august 2017 to 30th august 2017 at a tertiary eye care centre in South India. This study followed the tenets of the declaration of Helsinki. The protocol was approved by the Institutional Review Board of Medical Research Foundation. The electronic medical records (EMR) were retrieved to collect demographic data, preoperative findings, indications for surgery and intraoperative surgical notes.

The surgeons were administered with a questionnaire after 2 weeks of the surgery, they were asked to compare the two viewing systems (Ngenuity and traditional microscope) for each step of the surgery, in terms of image quality, comfort, technical difficulty, and educational value. The questionnaire was built on a scale from 1 to 10, 1 = vastly inferior to traditional microscopy, 5 = equivalent, and 10 = vastly superior. The surgeons were also asked to state the time estimation for each step using Ngenuity system compared to the microscope as more, same and less time. The recorded surgical videos were retrieved and the time for each step was noted. All cases were performed using a standard technique, scleral buckle or MIVS (microincision vitrectomy surgery) with Endo laser and gas/silicone oil tamponade with an additional procedure. The surgical technique did not differ from previous surgeries performed using a traditional viewing system.

Ngenuity 3D visualization system

Ngenuity visualization system, has a high dynamic range 3D camera that provides greater resolution, depth perception, stereopsis which allows delineation of the retinal microlayers. The 55-inch immersive 3D display renders real time images with 4K organic light emitting diode (OLED) ultra-high definition (UHD; 3,840×2,160-pixel resolution) technology. During surgery, the surgeons wore passive 3-D polarized glasses and were positioned approximately 1.5 meters from the display.

Statistical analysis

Statistical analysis was performed with SPSS V.22.0 (Continuous variables were represented by mean and standard deviation, and categorical variables were represented as proportions),

P-value of <0.05 (5%) was considered statistically significant. If the preference of viewing system chosen by the surgeon was either of the two, then they were added equally to both (Microscope and Ngenuity), to evaluate the difference between the two variables chi-square test was applied.

Results

Out 31 eyes, primary RRD was 35.4% (11 eyes) n (%), complex recurrent RRD was 12.9% (4 eyes), diabetic total retinal detachment (TRD) was 16.1% (5 eyes), Silicone oil removal (SOR) with cataract surgery was 9.7% (3 eyes), SOR was 6.5% (2 eyes) retinoblastoma was 3.2% (1 eye), intraocular foreign body (IOFB) was 3.2% (1 eye) (Table 1). Nineteen experienced vitreoretinal surgeons answered the questionnaire. The subjective analysis of ergonomic parameters indicated that the surgeons found better educational value

with Ngenuity, image resolution was comparatively superior, improved depth perception, greater field of view, upper body comfort and lower body comfort was graded as similar. However, time lag was perceived to be more with Ngenuity by the surgeons (Fig. 1). Comparison of time consumption for different surgical steps showed that for steps involving anterior segment like conjunctival opening and suturing, scleral tunnel for belt and intraocular lens (IOL) and 240 belt buckle placements was estimated to be more than the microscope by the surgeons.

Table 1
Indications for surgery and procedures performed

Indication of surgery	Procedure	N (%)
RD with PVR	V + MP + RR + EL + SOI	4 (12.9)
Traumatic Dislocation of lens	V + SFIOL	4 (12.9)
Rhegmatogenous RD	V+/-BB + EL + SOI	10 (32.2)
Status post Vit + SOI with cataract	PE + IOL + SOR	3 (9.7)
Diabetic Tractional retinal detachment	V + MP + EL	5 (16.1)
Retinoblastoma	I-125 Plaque insertion	1 (3.2)
Rhegmatogenous RD	SB	1 (3.2)
Status post Vit + SOI	SOR	2 (6.5)
IOFB	V + BB + IOFB removal + EL + SOI	1 (3.2)
<i>N-Total number of cases, RD: Retinal detachment, PVR: Proliferative vitreoretinopathy, V: Vitrectomy, MP: Membrane peeling, RR: relaxing retinotomy, EL: endo laser, SOI: Silicone oil injection, PE: phacoemulsification, IOL: Intraocular lens, SOR: silicone oil removal, SB: scleral buckling, IOFB: Intraocular foreign body, BB: belt buckle</i>		

The estimated time was perceived as less for truncation of cone, vitreous base excision and Endo laser, other steps were estimated as same for both viewing systems (Fig. 2). On comparing the difference between the mostly preferred system for each step, two steps were found to be most preferred with microscope namely scleral tunnel for buckle ($p = 0.04$) and conjunctival opening ($p = 0.0003$). The preference for Ngenuity was more for major posterior segment steps like truncation of cone ($p = < 0.00001$), posterior vitreous detachment (PVD) induction ($p = 0.0001$), endo laser ($p = 0.0001$), fluid gas exchange ($p = 0.0005$) and tamponade injection ($p = < 0.00001$). IOL related steps like scleral tunnel, IOL placement and IOL dialling surgeons preferred microscope more than the Ngenuity (Table 2).

Table 2

Comparison of preferred equipment for visualization during various steps of vitreoretinal surgery

Steps performed during VR surgery	Preferred equipment		
	Microscope	Ngenuity	P Value*
Scleral tunnel (for IOL Surgery) (N = 8)	5 (62.5%)	3(37.5%)	0.90
Scleral tunnel for buckle, N = 7	6 (85.7%)	1 (14.3%)	0.040
Capsulotomy, N = 4	2 (50%)	2 (50%)	1.00
Phacofragmentation, N = 3	2 (66.6%)	1 (33.4%)	1.00
IOL placement, N = 6	4 (66.6%)	2 (33.4%)	1.00
IOL dialing, N = 5	3(60%)	2 (40%)	1.00
Conjunctival opening, N = 11	10 (90.9%)	1 (9.1%)	0.0003
Muscle tagging, N = 14	9 (64.2%)	5 (35.8%)	0.130
240 # silicone band placement, N = 9	4 (44.4%)	5 (55.6%)	0.637
Mattress suture placement for buckle, N = 1	1 (100%)	0	1.00
Buckle placement, N = 2	1 (50%)	1 (50%)	1.00
External SRF drainage, N = 1	1 (100%)	0	1.00
Conjunctival suturing, N = 10	9 (90%)	1 (10%)	0.097
Making of sclerotomy ports, N = 45	18 (40%)	27(60%)	0.057
Truncation of cone, N = 18	2 (11.1%)	16 (88.9%)	< 0.00001
Vitreous Base excision, N = 22	10 (45.45%)	12 (54.54%)	0.546
PVD induction, N = 31	8 (25.8%)	23 (74.1%)	0.0001
Membrane peeling, N = 17	7 (41.1%)	10 (58.9%)	0.303
ILM peeling, N = 3	2 (66.7%)	1 (33.3%)	1.00
Endocautery, N = 17	8 (47.0%)	9 (52.9%)	0.731
Endolaser, N = 26	6 (23.1%)	20 (76.9%)	0.0001
Making relaxing retinotomy, N = 6	3 (50%)	3 (50%)	1.00
Fluid gas exchange, N = 19	4 (21.1%%)	15 (78.9%)	0.0005
Tamponade injection, N = 17	2 (11.7%)	15 (88.3%)	< 0.00001
Scleral fixated IOL, N = 4	2 (50%)	2 (50%)	1.00

Steps performed during VR surgery	Preferred equipment
<i>*Chi square test-Comparison of the between microscope and Ngenuity 3D visualization system to study the difference in the preference between the two systems, N: No of eyes, Sx: surgery, IOL: Intraocular lens, SRF: sub retinal fluid, PVD: Posterior vitreous detachment, ILM: Internal limiting membrane</i>	

Discussion

In the present era of technology revolt better innovations are rapidly growing to bridge the demands created by the older types of equipment, and this also changes the conventional methods of practising. Our study compared the traditional optical microscope with modern Ngenuity 3D visualization in VR surgeries. We highlighted the surgeon’s preference between the two, advantages, and difficulties faced in each step of the procedure. Ngenuity 3D Visualization System was developed in collaboration with True Vision, it provides a unique integrated 3D, high-definition approach for digitally assisted vitreoretinal surgery [3]. It mainly concentrates over the ergonomic aspects, superior depth perception, stereopsis, adaptive illumination, and digital image amplification (1–3).

On comparing the ergonomic parameters Ngenuity provided better upper and lower body comfort, and educational value over the microscope, the surgeons were able to make a better neck and body movements to the extent which facilized upper body comfort. Improved depth perceptions, field of view and resolution added on to the comfort, but the estimated time lag was more for anterior segment procedures than posterior segment steps. The mean score was > 7 for educational value and upper body comfort. Parameters like depth perception and time lag had a mean score of < 6. Similarly, In a recent study Ngenuity and microscope was compared for macular hole surgery in 50 eyes, they reported that comfort and the educational value was improved with Ngenuity, and the visual acuity, total surgery time, internal limiting membrane peel time (ILM), number of flap initiations and macular hole closure was same between the two systems [3]. Another study reported that the 3D system had 80 milliseconds of time lag than standard microscope during vitrectomy plus endolaser and gas or silicone oil for retinal detachment repair [4].

Some studies have reported discomforts such as headache nausea and visual disturbances with Ngenuity. These symptoms are assumed to be associated with constant flickering light which is a disruptive visual stimulation that affects vestibular and proprioceptive systems [5], but such symptoms and side effects were not reported by the surgeons in our study. In our study majority of surgeons felt that the field of view was bigger with Ngenuity than the microscope. Similarly, a recent study stated that three fourth of the surgeons (N = 23) felt DAVS provided a wider field of view [4]. The depth of field, resolution, zooming, focusing, speed and ease of operation was observed to be similar between the analogue microscope and digitally assisted vitreoretinal surgery systems (DAVS) [5]. DAVS provides higher resolution than analogue microscope at all magnifications and better depth of field only with 5x magnification, 13x and 18x was found to be similar with both the systems [6].

We compared the surgeon's preference for each step during the surgery for 31 eyes, the microscope was preferred for the scleral tunnel for buckle and Conjunctival opening. Ngenuity was preferred for truncation of the cone, PVD induction, Endo laser, Fluid gas exchange and tamponade injection. IOL related steps like the scleral tunnel, IOL placement and IOL dialling surgeons preferred microscope more than the Ngenuity. Steps like scleral IOL fixation, tamponade injection, posterior vitreous detachment induction had mean grading score of > 4 (on a scale of 1–5). While conjunctival suturing, external subretinal fluid drainage, suture placement for the buckle and the conjunctival opening had meaning grading score of < 3 . This difference in the preference may be due to the image latency period that had a more definite effect in the anterior procedures. This preference between the steps might change over the learning curve and many studies emphasize that surgeons felt more comfortable with Ngenuity in both anterior and posterior procedures after 3 or 4 surgeries which was considered to a short period [7, 8].

The identified downsides in our study were, parameters like discomforts like asthenopia symptoms were not looked onto. Direct comparison between Ngenuity and traditional microscope was not made, which will give a better comprehension about this comparison. The learning curve period of the surgeons to perform the procedures comfortably was not reported. Adding these points to future studies would establish a better understanding of the surgeon's needs and satisfaction with Ngenuity. The identified drawbacks of the 3D system from our study were, it's a high-cost technology, time lag was reported by most of the surgeons and performing anterior segment procedures was uncomfortable.

Conclusion

Ngenuity 3D visualization systems is a better alternative for the traditional microscope, surgeons had improved neck and upper body comfort and it provided a greater field of view, but was more preferred for posterior segment procedures than the anterior segment during VR surgeries. Improvements involving the surgeon's comfort and accessibility for all procedures should be considered in the future.

Declarations

Conflicts of interests: The authors declare no conflicts of interest

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Ethics approval: Approval to conduct the study was obtained from the Research Ethics of Medical Research Foundation.

Availability of data and material: The datasets used during the current study are available from the corresponding author on responsible request

Author contribution:

1. Niharika Singh- Data collection, data analysis and manuscript writing
2. Swathi Priya M. N- Data analysis, manuscript writing and preparation
3. Haard Shah- Data collection and analysis
4. Rajiv Raman- Manuscript writing and approval

References

1. Agranat JS, Miller JB, Douglas VP et al (2019) The Scope of Three-Dimensional Digital Visualization Systems in Vitreoretinal Surgery. *Clin Ophthalmol* 13:2093–2096. doi:10.2147/OPTH.S213834
2. Eckardt C, Paulo Eb (2016) Heads-Up Surgery for Vitreoretinal Procedures: An Experimental And Clinical Study. *Retina* 36(1):137–147. doi:10.1097/lae.0000000000000689
3. Kumar A, Hasan N, Kakkar P et al. Comparison of clinical outcomes between "heads-up" 3D viewing system and conventional microscope in macular hole surgeries: A pilot study 2018: *Indian J Ophthalmol* 66:1816–1819. doi: 10.4103/ijo.IJO_59_18
4. Coppola M, La Spina C, Rabiolo A et al (2017) Heads-up 3D vision system for retinal detachment surgery. *Int J Retina Vitreous* 3:46. doi:10.1186/s40942-017-0099-2
5. Zhang Z, Wang L, Wei Y et al (2019) The Preliminary Experiences with Three-Dimensional Heads-Up Display Viewing System for Vitreoretinal Surgery under Various Status. *Curr Eye Res* 44:102–109. doi:10.1080/02713683.2018.1526305
6. Freeman WR, Chen KC, Ho J et al (2019) Resolution, depth of field, and physician satisfaction during digitally assisted vitreoretinal surgery. *Retina* 39:1768–1771. doi:10.1097/IAE.0000000000002236
7. Berquet F, Henry A, Barbe C et al (2020) Comparing Heads-Up versus Binocular Microscope visualization systems in anterior and posterior segment surgeries: a retrospective study. *Ophthalmologica* 243:347–354. doi:10.1159/000507088
8. Palácios RM, de Carvalho ACM (2019) An experimental and clinical study on the initial experiences of Brazilian vitreoretinal surgeons with heads-up surgery. *Graefes Arch Clin Exp Ophthalmol* 257:473–483. doi:10.1007/s00417-019-04246-w

Figures

Figures are not available in this version.