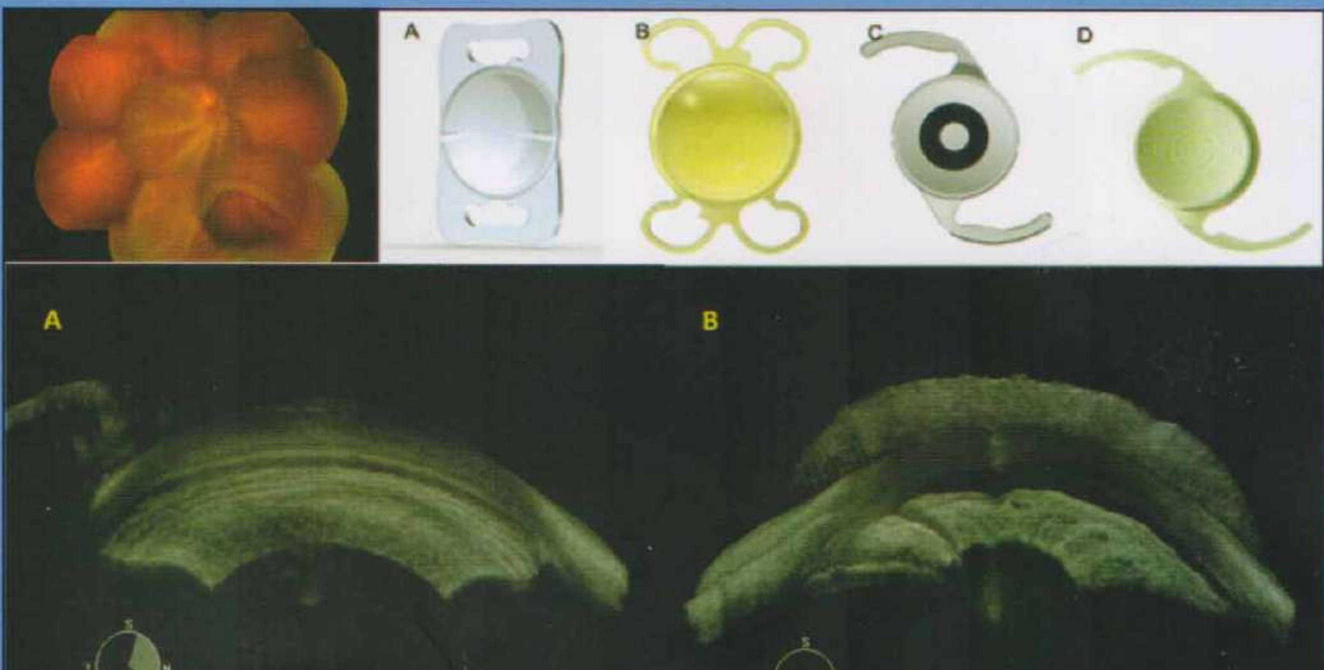
A Handbook of RECENT TRENDS IN OPHTHALMOLOGY

Editors

Rupak Roy, Jayangshu Sengupta

Executive Editor

Subhasish Nag



An Ophthalmological
Society of West Bengal
Presentation

Recent trends in retinal detachment surgery

Manish Nagpal, Navneet Mehrotra, Akansha Sharma, Sham Talati

Recent Trends In Retinal Detachment Surgery

Introduction :

With a frequency of upto 1 in 10,000, retinal detachment is a condition portentous to sight. A higher risk of myopia and a longer axial length in South-eastern Asians results in a higher risk of rhegmatogenous retinal detachments in them compared to the white race individuals[1].

Retinal detachment was a blinding disorder with ambiguous pathogenesis until the early 1900s. To begin with it was believed to constitute an exudative process, arising due to choroidal leakage[2].Through the study of cadaveric eyes,thissphere was restructured by Jules Gonin who acknowledged the role of retinal breaks in causing detachments[3].Surgical techniques to appose the retinal break(s) to the RPE has been the cornerstone for treatment of rhegmatogenous retinal detachments for the past century. The retinal pigment epithelium assiduously eliminates fluid from the subretinal space to the choroid whereabsorption takes place via the choroidal vasculature, once the break is sealed. In 1951, Schepens *et al*[4]introduced extraocular scleral buckling for retinal detachments,uprearing the rate of successful reattachment to 90%. Scleral buckling was the postulated surgical intervention for patients with rhegmatogenous retinal detachmentsfor the next two decades untilin 1970s pars plana vitrectomy was evolved as a revolutionary surgical approach for patients with retinal detachment by Charles and Machemer[5,6]. Norton introduced the use of intraocular tamponade with sulphur hexafluoride gas, expanding the role of intraocular surgery in the management of rhegmatogenous retinal detachment in 1973[7].

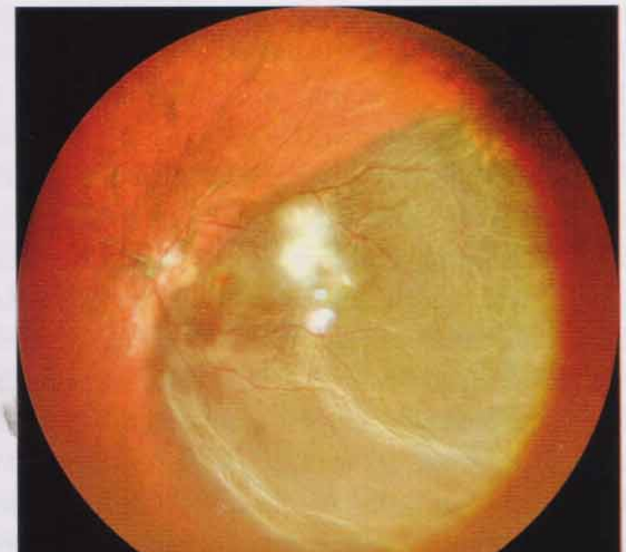


Fig. 1(A): Wide-field colour photo of left eye showing macula involving temporal retinal detachment

Fig. 1(B): Montage of the left eye showing re-attached retina and presence of gas bubble at superiorly.

Pathology :

Largely, retinal attachment is due to two elements, the prime being the retinal pigment epithelium pumping fluid out of the subretinal space in the direction of the choriocapillaris. The inter-photoreceptor matrix glue is the subsequent element sustaining retinal attachment. The existence of vitreous gel plays the ancillary element in holding the retina attached.The vitreous has three main components: water, hyaluronic acid and collagen fibers. The domain of adherence of the vitreous gelcomprise the disk margin, macula, the major retinal vessels, closer to the periphery and at the vitreous base.

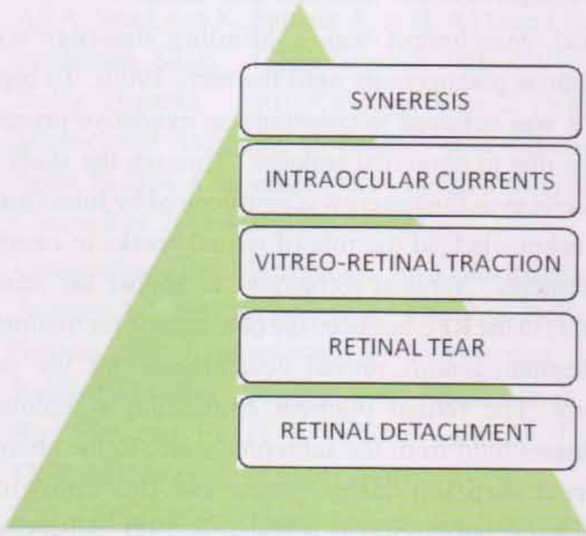
Affiliation :
The Retina Foundation, Ahmedabad, India.
Email-ID: drmanishnagpal@yahoo.com

The most common form of retinal detachmentis rhegmatogenous retinal detachment [FIGURE 2and 3] with an annual incidence of12.4 cases per 1,00,000 population[8], which occurs as a result of a full-thickness retinal break. Genesis of a retinal tear consists of posterior vitreous detachment to be playing a very pivotal role[9]. The rate of retinal detachments been relayed to escalate from 1.5 to 7% if posterior vitreous detachment has occurred and up to a third of eyes with a spontaneous posterior vitreous detachment have been relayed to have a retinal break or detachment[10-13].

Fig. 2: Montage of the right eye shoeing retinal detachment with an inferior tear.

Fig. 3: Montage of the right eye showing superior retinal detachment with a large tear.

With occurrence of syneresis, there is increased proportion of liquefaction than separation of vitreous from retina[14]. All probable gesticulations of the eye or head deploy a dynamic traction, noticed as flashes by the patient, causing retina to haul which is foiled by the amassed effect of the retinal pigment epithelium, the inner photoreceptor matrix and the retina's tensile strength. The retinatears due to this conveyof the equipoise. Detachment does[15] not necessarily occur due to this retinal tear[16] but the diminutive retinal area to which the vitreous is steadilypulled may tear off (operculum), leaving the surrounding retina not only attached but without any traction. With intraocular currents[17] being present during saccadic eye and normal head movements[18], the retinal tear may also get lifted, resulting in the intravitreal fluid to enter the subretinal space, thereuponcausingdevelopment of retinal detachment once the bulk of incoming fluid transcends the RPE pump's clearance threshold.



Chandelier-assisted Scleral Buckle :

The underlying principle in scleral buckling is approximation of neurosensory retina with the retinal pigment epithelium by compression of the globe wall, thus preventing passage of liquid vitreous into the subretinal space. If the break is properly closed, the retinal pigment epithelium pump actively absorbs subretinal fluid and the retina will spontaneously reattach with no need for subretinal fluid drainage[19].Countermanding the bias of the slumping surgical predilection for scleral buckling, the latter-day inception of chandelier endo-illumination in the course of scleral buckling maximizes on strengthening visualization technology managed by widefield intraoperative viewing systems through the operating microscope. A conventional 360° conjunctival peritomy accompanied by isolation and looping of the rectus muscles involves the primary step of chandelier-assisted scleral buckling surgery where visualization is done by way of the microscope in lieu of by indirect ophthalmoscopy. A trans-scleral cannula is placed to contain the chandelier fiber-optic illumination system and we use the operating microscope with either a widefield contact lens or a non-contact wide-angle visualization system for scleral-depressed examination and treatment of retinal breaks by cryotherapy. The primary retinal break is pronounced to ascertain the location for buckle placement, at which point the chandelier light is removed and the buckle is then sutured in place. The chandelier is reinstated across the cannula for visualization of pulsations at the disc after pulling on the buckle, performance of additional cryotherapy, and assessment of the relation of the retinal breaks to the supporting buckle. Visualization and treatment of retinal breaks during scleral buckling surgery is ameliorated with the wield of a chandelier endo-illumination system. This method also revamps upskilling of the procedure and appears to ameliorate conveyance among the colleagues. In addition, it prospectively decreases stretch of the approach and takes the edge off associated musculoskeletal injuries.

The lighting system should be kept 180° away from the retinal breaks.Plugging the trans-scleral cannula when it is not engaged by the chandelier and decreasing the intraocular pressure with creation of an anterior chamber paracentesis before withdrawal of the chandelier light system can be done to reduce the peril of vitreous prolapse[20].

Supplemental scleral buckle in silicone oil-filled eyescan increase the tamponade effect of SO on the inferior retina, as it creates an area of contact by bringing the peripheral retina closer to the SO bubble, while relieving the traction on the retina circumferentially and supporting the retinal breaks. The surgical technique includes localization of the open retinal breaks and retinopexy with cryotherapy and/or laser photocoagulation, then placement of scleral sutures, external drainage of any significant SRF, and placement of an explant[21].

Vitrectomy:

Vitrectomy techniques used in the present day anticipate on the MIVS platforms. Transconjunctival pars plana vitrectomy system's breakthrough hasdelivered many advantages to patients and surgeons which include lessscarring in conjunctiva and dry eyes occurrence post-operatively; methodical surgery; reduced inflammation post-operatively leading to less pain and more patient comfort; better cosmesis post-surgery; fewer astigmatic changes; and faster visual recovery [FIGURE 4(A) and 4(B)].

A trocar-cannula system utilizing 23 gauge, 25 gauge and 27 gauge is at hand with the recent system. The risk of wound leakage, hypotony, and endophthalmitis is reducedbecause of smaller incisions. Sclerotomy wound contriving tack includes trocar entry made at an oblique angle to lengthen the wound and maximize the chance of wound closure.Suturingof the leaking sclerotomy to reduce complications post-surgery is suggested in any display of leakage. The longer the surgical duration, the more the sclera becomes fatigued leading to less efficient self-sealing of the wound due to inflexibility and rigidity[22]. A relative drawback of 27-gauge vitrectomy systems is the flexibility of the instruments; anterior maneuvers occasionally cause them to bend. Dual-function instruments, such as lighted endolasers and lighted picks, for example, are not available in 27-gauge. Many other instrumentation cardinal for vitrectomy are not available for 27 guagesuch as curved scissors or forceps. Hybrid 27-gauge vitrectomy can be thought of as an augmented 23- or 25-gauge approach to complex cases. It is also a surgeon-friendly technique when one is initially transitioning from 23- and 25-gauge to 27-gauge platforms[23].

Reduction in amount of leakage of fluid during instrument swap, decreasing the possibility for vitreous/retina incarceration, eluding risk of suprachoroidal hemorrhage reducing the prospectof bleeding during diabetic dissection and intraocular pressure alternations during surgery is achieved by addition of valves in the trocar systems due to formation of closed systems. Surgical efficacy has been upgraded by theadvancement of the cutter designs. Vitreous removal has been quickened by the use of vitreous cutters with faster cut rates.Soaring of the speed of the cutter has been made through diverse processes which decreases the size of each individual morsel of vitreous, therebyreducing the cutter-induced vitreoretinal traction during vitrectomy in turn minimizing the risk of iatrogenic retinal breaks.

Unfettered of the cut rate, duty cycle is an additional variable that mentions the percentage of time the cutter port remains open during each cutting cycle, and the surgeon may choose between open or closed bias. The closed bias reduces the prospect of tissue incarceration with surgery in close vicinity to the retina which in the open biased mode would admit a pronounced flow of fluid[22].

The main vitrectomy probe, during the 1990s and 2000s, is made with spring-driven pneumatic cutting mechanism up to 2500 cpm[24]. In these systems, pneumatic pulses push the cutter to one direction, and the passive recoil of a spring returns the blade to its original position. The limitation of this design is in higher cutting rates; the speed of the spring recoil is not enough to return the blade. For these cutters, when cutting rates approach 2500 cpm, the blade could not fully return to the initial position that the vitrector port is open, so a higher proportion of a cutting cycle is spent with the port closed. Duty cycle of vitrectomy cutter refers to proportion of one cutting cycle in which the vitrectomy port is open. This is important because active removal of vitreous only occurs only when the port is open. Current-generation vitrectomy systems can achieve upto 10,000 cpm, but with a traditional spring-driven pneumatic cutter, vitreous removal efficiency may not necessarily proportionally increase with higher cut rates. There are currently two strategies to improve this limitation. A dual-pneumatic-driven cutting mechanism uses separate air lines to control opening and closing of the cutter. In this system, duty cycle is not dependent on the passive recoil of springs and also can be set individually. The other strategy is using a two-dimensional cutter approach in which a double-sided blade cuts in both the forward and reverse directions to achieve an effective cut rate of 20,000 cpm with higher duty cycle[25]. The high duty cycle is achieved because the port is nearly always open as the blade moves back and forth. In dual-pneumatic systems, however, duty cycle can be controlled independent of the cut rate. A new mechanism using ultrasound to liquefy vitreous has been developed. The ultrasound harmonic vitrector liquefies the vitreous before being aspirated and has been shown to be safe on cadaveric eyes. These vitrectomy probes have the potential advantage of creating almost no traction during vitrectomy[26,27].

Guillotine vitrector performance is dependent on cut rate, vacuum and gauge. Performance of the hypersonic vitrector is dependent only on vacuum and flow for both fluids and ultrasonic power for vitreous flow, therefore allowing for the use of smaller gauges and port sizes, as well as providing less variation in flow and consequently more stable infusion pressures. The hypersonic vitrector is capable of operating with port openings as small as 200 to 250 μm compared to 500 to 600 μm with guillotine vitrectors[24].

The two focal elements put up to upgradation in visualization that include better viewing systems and improved lighting. With optics homogenous to indirect ophthalmoscopy, the new-fangled non-contact wide-angle viewing systems gives a panoramic view extending more than 100 degrees of field of view, admitting the visualization of peripheral retina and vitreous with the slightest demand to rotate or tilt the eye during vitrectomy surgery. To recompense for the lower proportion of light channeled through smaller-gauge instruments, higher lumen light sources have been evolved that can be merged with special filters to reduce the prospect of retinal phototoxicity from shorter wavelength light. Peripheral vitreous shaving unaccompanied by an assistant and bimanual dissection techniques in compounddiabetic or proliferative vitreoretinopathy patients can be performed easily aschandelier light systems have absolved the hands of surgeons. Chandelier lights could be pitched effortlessly irradiate different regions of the globe.

New digitally assisted vitreoretinal surgery systems allow surgeons to maintain a heads-up position instead of having to look down through the microscope oculars. 3D high-dynamic-range cameras mounted in place of the microscope oculars, which are connected to a central processing unit, finally project live feed onto screen. Reported advantages of this system include high magnification; improved ergonomics for the surgeon; a decrease in required endo-illumination through enhanced digital signal processing; improved depth of field; ability to overlay diagnostic studies, including intraoperative OCT data; and enhanced teaching and observation capabilities[28,29]. Endoscopic vitrectomy provides direct visualization of the posterior segment with a directional camera, allowing surgeons to bypass compromised anterior segments, opacified corneas, and media opacities. Additionally, the ability to direct the visualization from the pars plana allows surgeons a method to visualize the anterior retina, ciliary body, and posterior iris surface in their natural anatomic configuration[30]. In retinal detachment surgery, microscope-integrated intraoperative optical coherence tomography aids in detection of residual subretinal fluid, small retinal breaks, and proliferative vitreoretinopathy membranes and can assist in completion of fluid-air exchange.

The silicone study showed that chronic postoperative elevated intraocular pressure (IOP) was seen in both the gas and silicone oil groups[31]. While removal of silicone oil is associated with an increased risk of redetachment, chronic retention leads to emulsification, increased rate of cataract formation and corneal changes. Moreover, retinal support with both forms of tamponade is usually insufficient in cases with inferior retinal breaks, even with strict postoperative positioning[32-34]. Proper positioning itself is challenging in the elderly and in patients with spinal disorders and gas tamponades [FIGURE 1(A) and 1(B)] can also lead to restriction in air travel[35,36]. Fibrin glue emerged as the likely candidate since its efficacy and safety as an ocular tissue sealant had been established not only in ocular surface procedures, but also in scleral fixation of intraocular lenses and even in surgeries for optic disc pit associated macular detachments[37-41].

Eyes at high risk for proliferative vitreoretinopathy development due to a history of prior proliferative vitreoretinopathy or intraocular inflammation had a low incidence of proliferative vitreoretinopathy following intravitreal methotrexate injection at the time of pars plana vitrectomy and later for retinal detachment repair. Methotrexate is a commonly used antineoplastic agent since it is a potent competitive inhibitor of enzymes requiring folate as a cofactor, including those critical for the nucleotide biosynthesis necessary for the DNA synthesis required for cell proliferation[42]. Methotrexate has the potential to block many aspects of proliferative vitreoretinopathy simultaneously including aberrant cell proliferation, inflammation, and fibrosis.

Focus of recent vitreous substitute research has been on polymeric hydrogels. Hydrogels are hydrophilic polymers that form a gel network when crosslinked and are capable of absorbing several times their weight in water and swell[43]. The result is typically a clear viscoelastic gel that strongly resembles the natural vitreous humor. Hydrogels are more favorable vitreous substitutes because they are clear, tend to be biocompatible and can act as a viscoelastic dampener, much like the natural vitreous. Polyvinyl alcohol - methacrylate (PVA-MA) is a hydrogel which is injected in aqueous form, containing a photo-initiator that can form a hydrogel in situ when irradiated with the proper wavelength of UV radiation[44]. Others like co-polyacrylamide gel are first made soluble by reducing disulfide cross-linked bridges and then soluble gel can then be injected which undergoes gelation in situ upon exposure to oxidation by air[45]. A relatively newer hydrogel, known as smart hydrogel, are stimuli-sensitive and can respond to a variety of signals including pH, temperature, light, pressure, electric fields, or chemicals[46]. Another experimental agent WTG-127 (Wakamoto Pharmaceutical, Tokyo, Japan) is a type of thermo-setting gel that can gelate at 360 degree celcius and retains transparency upon gelation[47].

Implantable devices may be able to support the retina and control intraocular pressure without the need of a potentially reactive and biodegradable intravitreally injected solution. Foldable capsular vitreous bodies are a thin, vitreous-shaped capsule made of a silicone rubber elastomer with a silicone tube valve system filled with a physiologically balanced solution or silicone oil[48].

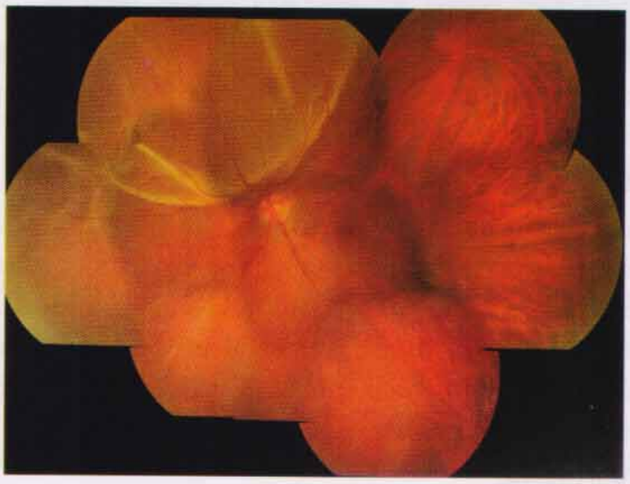


Fig. 4(A): Montage of the left eye showing retinal detachment super-nasally.

Fig. 4(B): Montage of the left eye showing re-attached retina post vitrectomy.

Vitrectomy With Encircling Band:

Scleral buckling can also play an important adjunctive role to pars plana vitrectomy in the management of more complex rhegmatogenous retinal detachment associated with multiple or large retinal breaks, proliferative vitreoretinopathy, retinoschisis and phakic young patients.

Vitrectomy and gas alone may be analogous with discouraging resultswhen used for treating retinal detachments with inferior breaks or multiple breaks due to decreased support of the inferior breaks by the endo-tamponade.

Suprachoroidal Buckle:

In this method, a lighted catheter is inserted into the suprachoroidal space and placed to any desired area over the breaks; there, an enduring hyaluronic acid filler can be injected to create choroidal indentation. This can be performed with or without pars plana vitrectomy and has been reported effective for the treatment of patients with retinal detachment[49,50].

Macular Surgeries

Inverted internal limiting membrane (ILM) flap technique has been reported to improve the closure rates of large and persistent macular holes[51]. This technique has recently been suggested for the treatment of macular retinal detachment due to macular holes in highly myopic eyes in which macular holes are relatively difficult to close[52].

Conclusion:

Rhegmatogenous retinal detachment yet is one of the stereotypical and complex entity in the outpatient department with anatomical reduction being secured after treatment without a good post-operative visual acuityalways guaranteed. Hence, the option of a satisfactory surgical procedure is exceptionally necessary. Each procedure has merits and demerits, and each patient has its parallel attestations, needing that the apt surgical procedure be adoptedduly.Hence, an elementary, pliant, prudent and effective method is demanded, and one should select the most appropriate treatment in the opinion of the situations encountered.

References :

1. Chandra A, Banerjee P, Davis D, Charteris D. Ethnic variation in rhegmatogenous retinal detachments. Eye (Lond). 2015 Jun;29(6):803-7.
2. 2. Gloor BP, Marmor MF. Controversy over the etiology and therapy of retinal detachment: the struggles of Jules Gonin. Surv Ophthalmol 2013;58:184–95.
3. Fine SL, Goldberg MF, Tasman W. Historical perspectives on the management of macular degeneration, diabetic retinopathy, and retinal detachment: personal reminiscences. Ophthalmology 2016;123: S64–77.
4. Schepens CL, Okamura ID, Brockhurst RJ. The scleral buckling procedures. I. surgical techniques and management. AMA Arch Ophthalmol 1957;58:797–811.
5. Machemer R, Parel JM, Buettner H. A new concept for vitreous surgery. I. instrumentation. Am J Ophthalmol 1972;73:1–7.
6. Charles SCJ, Wood B. Vitreous microsurgery. 5th edn. Philadelphia, Lippincott: Williams & Wilkins, 2010.
7. Sabates WI, Abrams GW, Swanson DE, et al. The use of intraocular gases. The results of sulfur hexafluoride gas in retinal detachment surgery. Ophthalmology 1981;88:447–54.
8. M H Haimann, T C Burton, C K Brown. Epidemiology of retinal detachment. Arch Ophthalmol. 1982 Feb;100(2):289-92.
9. Bradbury M, Landers MI: Pathogenetic mechanisms of retinal detachment; in Ryan S, Wilkinson C (eds): Retina. St Louis, Mosby, 2001, p 1987.

10. Byer N: Peripheral retinal lesions related to rhegmatogenous retinal detachment; in Guyer D, Yannuzzi L, Chang S, Shields J, Green W (eds): Retina, Vitreous, Macula. Philadelphia, WB Saunders, 1999, pp 1219-1247.

11. Byer NE: Long-term natural history of lattice degeneration of the retina. Ophthalmology 1989;96:1396-1401.

12. Boldrey EE: Risk of retinal tears in patients with vitreous floaters. Am J Ophthalmol 1983;96:783-787.

13. 13.Jaffe NS: Complications of acute posterior vitreous detachment. Arch Ophthalmol 1968;79:568-571.

14. Sebag J: Anomalous posterior vitreous detachment: a unifying concept in vitreo-retinal disease. Graefes Arch Clin Exp Ophthalmol 2004;242:690-698.

15. Kuhn F, Aylward B. Rhegmatogenous Retinal Detachment: A Reappraisal of Its Pathophysiology and Treatment. Ophthalmic Res 2014;51:15-31.

16. Byer NE: Prognosis of asymptomatic retinal breaks. Arch Ophthalmol 1974;92:208-210.

17. Machemer R: The importance of fluid absorption, traction, intraocular currents, and chorioretinal scars in the therapy of rhegmatogenous retinal detachments. XLI Edward Jackson memorial lecture. Am J Ophthalmol 1984;98:681-693.

18. Angunawela RI, Azarbadegan A, Aylward GW, Eames I: Intraocular fluid dynamics and retinal shear stress after vitrectomy and gas tamponade. Invest Ophthalmol Vis Sci 2011;52:7046-7051.

19. Nagpal M,Bhardwaj S, Mehrotra N. Throwing New Light on Buckling Surgery. Retina 2013:48-52.

20. Mitry D., Williams L., Charteris D.G., Fleck B.W., Wright A.F. and Campbell H. (2011) Population-based estimate of the sibling recurrence risk ratio for rhegmatogenous retinal detachment. *Invest. Ophthalmol. Vis. Sci.*, 52, 2551–2555.

21. Nagpal M, Chaudhary P, Wachasundar S, Eltayib A, Raihan A. Management of recurrent rhegmatogenous retinal detachment. Indian J Ophthalmol 2018;66:1763-71.

22. McClintock M, Rezaei K. Recent Advances in Vitreoretinal Surgery [Internet]. Review of Ophthalmology. (2015). Available from: https://www.reviewofophthalmology.com/article/recent-advances-in-vitreoretinal-surgery.

23. Papakostas T, Yonekawa Y. Hybrid 27-Gauge Vitrectomy. Sometimes the best approach requires a winning combination. Retina. 2017: 52-54.

24. Mitsui K, Kogo J, Takeda H, Shiono A, Sasaki H, Munemasa Y, et al. Comparative study of 27-gauge vs. 25-gauge vitrectomy for epiretinal membrane. Eye. 2016;30:538-544.

25. Chaves de Oliveira PR, Berger AR, Chow DR. Vitreoretinal instruments: Vitrectomy cutters, endoillumination and wide-angle viewing systems. International Journal of Retina and Vitreous. 2016;2:28.

26. Pastor S, Bonshek R, Luciane I, Zambrano I, Carlin P, Stanga PE. New prototype of ultrasound harmonics vitrector (UHV) histopathological findings: First report. Investigative Ophthalmology and Visual Science. 2015;56:394.

27. Stanga PE, Pastor S, Zambrano I, Carlin P. New prototype of ultrasound harmonics vitrector (UHV) fluidics analysis: First report. Investigative Ophthalmology and Visual Science. 2015;56:385.

28. Eckardt C, Paulo EB. Heads-up surgery for vitreoretinal procedures: An experimental and clinical study. Retina. 2016;36:137-147

29. Kinner CS, Riemann CD. "Heads up" digitally assisted surgical viewing for retinal detachment repair in a patient with severe kyphosis. Retinal Cases and Brief Reports. 2018;12:257-259

30. Marra KV, Yonekawa Y, Papakostas TD. Indications and techniques of endoscope assisted vitrectomy. Journal of Ophthalmic & Vision Research. 2013;8:282-290.

31. Barr CC, Lai MY, Lean JS, Linton KL, Trese M, Abrams G, et al. Postoperative intraocular pressure abnormalities in the silicone study. Silicone study report 4. Ophthalmology. 1993;100:1629–35.

32. Toklu Y, Cakmak HB, Ergun SB, Yorgun MA, Simsek S. Time course of silicone oil emulsification. Retina. 2012;32:2039–44.

33. Abrams GW, Azen SP, Barr CC, Lai MY, Hutton WL, Trese MT, et al. The incidence of corneal abnormalities in the Silicone study. Silicone study report 7. Arch Ophthalmol. 1995;113:764–9.

34. Federman JL, Schubert HD. Complications associated with the use of silicone oil in 150 eyes after retina-vitreous surgery. Ophthalmology. 1988;95:870–87.

35. Fawcett IM, Williams RL, Wong D. Contact angles of substances used for internal tamponade in retinal detachment surgery. Graefes Arch Clin Exp Ophthalmol. 1994;232:438–44.

36. Williams R, Wong D. The influence of explants on the physical efficiency of tamponade agents. Graefes Arch Clin Exp Ophthalmol. 1999;237:870–4.

37. Al Sabti K, Kumar N, Chow DR, Kapusta MA. Management of optic disc pit-associated macular detachment with tisseel® fibrin sealant. Retin Cases Brief Rep. 2008;2:274–7

38. 46(new)38. Kumar N, Al Sabti K. Optic disc pit maculopathy treated with vitrectomy, internal limiting membrane peeling, and gas tamponade: A report of two cases. Eur J Ophthalmol. 2009;19:897–72.

39. 47(new) 39. Coleman DJ, Lucas BC, Fleischman JA, Dennis PH, Jr, Chang S, Iwamoto T, et al. A biologic tissue adhesive for vitreoretinal surgery. Retina. 1988;8:250–6.

40. 48(new).40. Balakrishnan D, Mukundaprasad V, Jalali S, Pappuru RR. Comparative Study on surgical outcomes of glued intraocular lens and sutured scleral fixated intraocular lens implantation. Semin Ophthalmol. 2018;33:576–80.

41. 49(new) 41. Basu S, Surekha SP, Shanbhag SS, Kethri AR, Singh V, Sangwan VS. Simple limbal epithelial transplantation: Long-term clinical outcomes in 125 cases of unilateral chronic ocular surface burns. Ophthalmology. 2016;123:1000–10.

42. Sirotnak FM, Moccio DM. Pharmacokinetic basis for differences in methotrexate sensitivity of normal proliferative tissues in the mouse. *Cancer Res.* 1980;40(4):1230–1234.

43. Kopecek J. Polymer chemistry: swell gels. Nature 2002; 417:388-91.

44. Cavalieri F, Miano F, D'Antona P, et al. Study of gelling behavior of poly-methacrylate for potential utilizations in tissue replacement and drug delivery. Biomacromolecules 2004; 5:2439-46.

45. Swindle-Reilly KE, Shah M, Hamilton PD, et al. Rabbit study of an in situ forming hydrogel vitreous substitute. Invest Ophthalmol Vis Sci 2009; 50:4840-6.

46. Chaterji S, Kwon IK, Park K. Smart polymeric gels: redefining the limits of biomedical devices. Prog Polym Sci 2007; 32:1083-122.

47. Katagiri Y, Iwasaki T, Ishikawa T, et al. Application of thermo-setting gel as artificial vitreous. Jpn J Ophthalmol 2005; 49:491-6.

48. Gao Q, Mou S, Ge J, et al. A new strategy to replace the natural vitreous by a novel capsular artificial vitreous body with pressure-control valve. Eye 2008; 22:461-8.

49. El Rayes EN, Oshima Y. Suprachoroidal buckling for retinal detachment. Retina. 2013;33:1073-1075

50. El Rayes EN, Mikhail M, El Cheweiky H, Elsawah K, Maia A. Suprachoroidal buckling for the management of rhegmatogenous retinal detachments secondary to peripheral retinal breaks. Retina. 2016;4:622-629.

51. Michalewska Z, Michalewski J, Adelman RA, Nawrocki J. Inverted internal limiting membrane flap technique for large macular holes. Ophthalmology. 2010;117:2018-2025.

52. Okuda T, Higashide T, Kobayashi K, Ikuno Y, Sugiyama K. Macular hole closure over residual subretinal fluid by an inverted internal limiting membrane flap technique in patients with macular hole retinal detachment in high myopia. Retinal Cases and Brief Reports. 2016;10:140-144.

Acknowledgement- Nil
Conflicts of Interest - Nil
Financial Disclosures - Nil