Evolution of retinal detachment surgery down the ages

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"Treatment of retinal detachment associated with retinal holes should not be urged except in only eyes as a last clutch at a straw of hope". These lines by Lister from 1927 and the famous survey by Vail a decade prior (1912),[1] which found a success rate of retinal detachment (RD) as 1 in 1000 speaks for themselves, suggest a grave prognosis for RD. Although the current success rate in managing uncomplicated RDs is greater than 90%, the journey has been the most intriguing with the emergence of many heroes. One such hero who stands apart is Jules Gonin, whose patience and perseverance have led to the current understanding and treatment of RD as we know it. The evolution of RD surgery has always been divided into 'Pre-Gonin' and the 'Post-Gonin' phases. With no intent to change the same, we hereby briefly describe the evolution of RD surgery as it unfolded.

Pre-Gonin era (before 1920)

Although retinal break was known to be associated with RD, the focus was solely on RD with no attention to the causative break. Various theories were put forward and treatment was directed towards them. The first theory talked about RD as being spontaneous with the main culprit being abnormal leakage from choroid. Breaks in retina were thought as a result of increased pressure from fluid generated behind the retina. This led to treatments in the form of scleral and retinal puncture to relieve the pressure. Various treatments were directed towards draining the subretinal fluid (SRF) only to meet with obvious failure. A combination of SRF drainage along with the idea to induce retinopexy was probably introduced for the first time by Fano in 1866.[1] He induced chemical retinopexy in the form of injection of iodine solution into the subretinal space to achieve a chemical reaction. Apart from chemical retinopexy, other modalities employed were galvanocautery, pioneered by Deutschmann.[1]

The second theory prevalence in this era saw a role of hypotony and associated circulatory alterations as the cause of RD. Various treatments were put forward to counter the same. Injection of materials like rabbit vitreous and gelatin to increase the intraocular pressure were attempted. Lagrange introduced a procedure known as 'colmatage' whereby intraocular pressure was increased by applying three rows of scleral cautery in a circumferential manner in order to increase hydrostatic pressure in the retina.[1] Various osmotic agents were also injected into the subconjunctival space in the hope of reduction of SRF. These included saline, gelatin, cane sugar, glycerine and mercury salts.

A ray of hope appeared when Leber and Nordenson[2] put forward their theory of vitreous traction in the genesis of RD. They postulated that the alterations in vitreous generated secondary traction on the equatorial retina forming retinal tears with RD. This concept was of paramount importance as we know today but alas it met with severe resistance and criticism. Treatment aiming to relieve vitreous traction was introduced by likes of Deutschmann (who did the same by using Von Graefe knife).

Various non-surgical manoeuvres were also employed. Samelsohn[1] insisted on bilateral compression bandages with bed rest with idea of increasing intraocular pressure. Dietary modifications with salt restriction were another treatment on offer.

Jules Gonin and methods of retinopexy

Jules Gonin (1870–1935) legacy in history of RD dares to show how ones persistence and perseverance can change an idea. Taking Leber and Nordenson's idea ahead with two decades of experimentation and self-belief, Gonin proved the role of retinal break in the pathogenesis of RD. He introduced a procedure called as 'Ignipuncture' whereby retinal breaks were painstakingly localized pre- and intraoperatively (not an easy task in those days). Under local anaesthesia, subretinal space was entered after making a radial scleral incision near the causative break and SRF was drained. Thermocautery was then introduced to create a retinopexy. In 1931, Gonin published his series of 221 patients who underwent ignipuncture with a success rate of 63%.[3] Gonin's theory of primarily treating the break was cemented when his disciples namely Amslers, Weve and Arruga[4] reported similar success in their operations.

In the coming decades, various modifications of retinopexy were developed to treat the retina surrounding the causative break. The use of chemical cauterization for retinopexy in the form of potassium hydroxide after creating holes in sclera (trephining) was introduced by Guist and Lindner[1] in 1931. Diathermy was introduced by Larsson, Weve and Safar. It was used either on the bare sclera (surface diathermy) or after trephining the sclera (penetrating diathermy). Drainage of SRF was performed along with diathermy. This

procedure was commonly employed for around two decades. Complications of diathermy in the form of thinning and perforation led to search of other modalities for retinopexy. Electrolysis was reintroduced by Imre in 1932, but was seen to be less effective when compared with diathermy; hence never became popular. Although cryotherapy was introduced by Deutschmann and Bietti, the credit for its current use goes to Harvey Lincoff and Amoils who made its use easy by creating a specially designed cryo-probe with use of liquid nitrogen. The use of light for retinopexy was also being studied with the first human use by Moran-Sales, although their results were published after Meyer Schwickerath. Dr Schwickerath initially used sunlight, then carbon arc and finally krypton for retinopexy. Ruby laser and then argon laser became available with first report of its use in 1969 by L'Esperance.

Evolution of the indirect ophthalmoscope[1]

The introduction of ophthalmoscope by Helmontz in 1850 was the stepping stone to the current indirect ophthalmoscope of the modern era. Ruete was the first to introduce indirect viewing of retina with his monocular indirect ophthalmoscope. The first binocular indirect ophthalmoscope was devised by Giraud Teulon, which was a hand-held model developed in the nineteenth century. Charles Schepens devised the first clinical head mounted an indirect ophthalmoscope in 1947. Four years later, a modified version was introduced by Schepens who incorporated the light source and viewing system on the headband as we know it today. He also described the use of scleral depression which historically was first described by Trantas in 1900, although he used his thumbnails for doing so.

Localization of retinal breaks as put forward by Gonin was tiresome and needed hours of training and patience. Various methods were described for localization of breaks, most of which relied on major anatomical landmarks and their distances from the break. Amsler and Dubois were first to devise a fundus chart for mapping extent of RD and its causative break in 1928. A combination of ophthalmoscopy and perimetry was also used for the same first described by Lindner.

Evolution of scleral buckling

Shortening of globe by scleral resection was the first step towards scleral buckling although the initial idea was globe shortening and not supporting the break. Creating an inward ridge for supporting break was initially achieved either by full or partial thickness scleral resection with SRF drainage and putting mattress sutures across the defect. The techniques were laborious and dangerous with high complication rates. In view of the same, scleral surgeries without tissue excision were attempted. Weve's reefing procedure by placing lamellar suture bites, scleral outfolding and infolding techniques was some of these.

The first 'accidental' temporary scleral indendation during scleral buckle was done by Jess in 1937[1] where a cotton swab was used for the purpose to counteract hypotony secondary to SRF drainage. The first scleral buckling procedure using an episcleral exoplant was performed by Ernst Custodis in 1949.[1] He used a material made of polyviol and postulated a non-drainage surgery and advised reoperation if SRF failed to clear in 4 days. Charles Schepens[5] gets the credit for doing the first scleral buckling surgery in the USA in 1951. He popularized segmental and encircling bands made of polyethylene tubes and used the same after making lamellar scleral flaps. Complications secondary to polyethylene tubes led Schepens to introduce the silicone rubber implants in 1960. It was Brockhurst in 1965 who introduced the scleral buckle procedure done worldwide for decades. His technique included lamellar scleral dissection, diathermy to the scleral bed followed by implant placement. The first use of non-absorbable sutures for scleral buckling was devised by Arruga in 1958.

It was Harvey Lincoff in 1965 who modified the original procedure by Custodis.[1] The changes included use of silicone sponge, use of improved scleral needles and use of cryotherapy instead of diathermy for retinopexy. Silicone sponges were used in a radial or circumferential fashion depending on the clinical scenario.

Evolution of vitrectomy and associated procedures

Ocular sustenance without vitreous was deemed impossible and its removal a crime. David Kashner with help of cellulose sponge and scissors performed the first vitrectomy (open sky) in a child with trauma on 28 July 1961[6] and proved how an eye could survive without vitreous. Subsequently, he operated two cases with vitreous amylodosis in 1967–1968 which cemented his theory. His pupil, Robert Machemer, performed the first pars plana vitrectomy in a patient of vitreous haemorrhage on 20 April 1970. He performed the same with help of VISC (vitrectomy, infusion, suction and cutter) developed by Jean Marie Parel. It was Connor O' Malley and Ralph Heinz[7] who introduced a divided 20-G vitrectomy system called Ocutome 800 working on principle of pneumatic cutting. Gholam Peyman introduced the electric solenoid-driven guillotine cutter.

Steve Charles[7] led the way in developing the vitrectomy machines. He was instrumental in developing the linear or proportional mode for the first commercial vitrectomy machine: Ocutome 800. Further on, he designed the ocular

connection machine (OCM), the forerunner for various vitrectomy machines like Accurus and Constellation. Dr Charles is also credited for developing fluid air exchange, flute needle, internal drainage of SRF and endophotocoagulation techniques. He was also instrumental in developing various scissor segmentation and delamination techniques. As success for treating simple rhegmatogenous RDs evolved, so did various instruments for complex RDs. Machemer with his bent needle technique and O'Malley with his pic forceps made peeling of membranes easier. End-grasping forceps by Steve Charles and diamond dusted membrane scrapper by Yasuo Tano were other innovative instruments which are still widely used today.

It was Ohm who gets credit for the first use of tamponade: although air in conjunction with RD surgery in 1911. This was then routinely adopted by Arruga[8] and then Rosengren who was a leading figure in propagating the pneumoretinopexy. The use of sulphur hexafluoride (SF6) as a tamponade agent was devised by Edward W.D Norton.[1,4] Perfluorocarbon gas and its use in RD were introduced by Vygantas and Lincoff. Giant retinal tears and its complex treatment with nothing short of gymnastics being performed by the surgeon were eliminated with the introduction of perfluorocarbon liquids (PFCL). It was Haidt who first introduced PFCL in 1982 although Stanley Chang gets credit for making its use popular in treating complex RDs. Paul Cibis[9] trained by Schepens himself was first to use silicone oil in RD surgery. However, he did not use it as a tamponade but as a tool to dissect preretinal membranes in cases with proliferative vitreoretinopathy. Interestingly, Paul Cibis was part of operation 'paper clip', a secret program offered by the government of USA to employ scientist and doctors from Germany after the World War II. It was Zivojnovic who pioneered the use of silicone oil and its use as a tamponade.

Early 21st century saw the introduction of the 25 gauge by Eugene Dejuan and then the 23-gauge system by Klaus Eckardt, making RD surgery less cumbersome and much faster with excellent results. The introduction of 27-gauge vitrectomy by Oshima has further made patient rehabilitation faster.[7,10]

Viewing systems used during vitrectomy have also seen their share of evolution. From the initial days of Goldmann planoconcave lens and Landers lens system where peripheral vitreous was mostly untouched, various contact and non-contact wide-angled viewing systems have revolutionized the way we see and operate retina. The introduction of binocular indirect ophthalmomicroscope (BIOM) by Manfred Spitznas and its variants have greatly eased performing an RD surgery.

RD surgery in India

Looking into the evolution of RD surgery in India has proved to be more laborious than operating a complex RD. The following paragraph was formulated based on the inputs from eminent individuals in the field of vitreoretinal surgery in India as well as with help of old issues of *Indian Journal of Ophthalmology*.

Probably, the first person to start vitreoretinal services was Dr JM Pahwa from All India Institute of Medical Sciences (AIIMS), New Delhi (personal communication). However, literature search has not provided any concrete evidence of same. The same search showed Dr Bijayananda Patnaik from Maulana Azad Medical College publishing his results of scleral buckling in 100 cases in the year 1974.[11] Dr PK Khosla from AIIMS published their results of scleral buckling in 1977 followed by another one in 1981.[12] Another legend Dr DN Gangwar from Postgraduate Institute of Medical Education and Research, Chandigarh, published their results of scleral buckle in 1983.[13]

The first vitrectomy in India was done by Dr Gholam Peyman in a case of vitreous haemorrhage during a workshop in Madurai Medical College in 1974 (personal communication). Those attending this workshop were Dr. SS Badrinath of Sankara Nethralaya and Dr. P Namperumalsamy of Arvind Eye Care System; who later became the doyens in developing vitreoretinal surgery and trained many more who themselves became authorities.

It is ironic to say the least that we know so little of our past. We hope this rich history of ours gets unfolded too. RD surgery is still evolving and its history is a candid example of how persistence and perseverance of human endeavours can shape an idea. We conclude with following lines by Dr Charles Schepens.

"Never stop dreaming; what seemed impossible yesterday can become a reality tomorrow"

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Evolution of retinal detachment surgery: The 'Firsts'

Albrecht von Grafe: first to notice and document a retinal tear
Herman von Helmontz: first to introduce ophthalmoscope
James Ware: first attempt in treating retinal detachment in 1805
Jules Gonin: first to give retinal tear its due importance and attempts to treat the same
Giraud Teulon: first to introduce binocular indirect ophthalmoscope (hand-held) in nineteenth centaury
Charles Schepens: first to introduce head mounted indirect ophthalmoscope in 1947, first to introduce encircling silicone bands
Larsson, Weve and Safar: first to introduce diathermy
Ernst Custodis: first to use exoplant for scleral buckle in 1949
Deutschmann: first to introduce cryotherapy in 1933
Harvey Lincoff: first to introduce the modern cryounit for trans-scleral use
Moran Sales: first to use photocoagulation as a therapeutic modality in humans
Gerd Meyer Schwickerath: first to publish technique in use of therapeutic photocoagulation in 1949
L'Esperance: first to use argon laser as retinopexy in 1969
David Kashner: first to perform 'open sky vitrectomy'
Robert Machemer: first to perform pars plana vitrectomy on 20 April 1970 in a patient with vitreous haemorrhage
Anton Banko: first to develop vitrectomy probe having infusion and aspiration, although never commercialized it
Jean Marie Parel (along with Machemer): first to commercialize vitrectomy probe called as VISC (vitrectomy, infusion, suction and cutter), first to introduce operating microscope with X–Y movement
Jean Haut: first to use silicone oil in combination with pars plana vitrectomy in 1978
Conor O' Malley: first to introduce three-port 20-g pars plana vitrectomy
Gholam Peyman: first to introduce a separate endoillumination probe
Steve Charles: first to start internal drainage of subretinal fluid, fluid gas exchange, air-silicone oil exchange
OHM: first use of intravitreal gas (air) in 1911
Edward Norton: first to use iso-expansile gas (SF6) with retinal detachment surgery
Haidt: first to introduce perfluorocarbon liquids as vitreous substitute in 1982