

*Original article*

## Surgical outcomes of minimally invasive vitrectomy surgery in Eales' disease

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### Abstract

**Introduction:** The results of surgical outcomes of 20 gauge pars plana vitrectomy in Eales' disease are available in the scientific literature. However, all these studies have been done using the 20 gauge vitrectomy systems and most studies have been conducted in a retrospective manner. **Objective:** To evaluate the outcomes and safety of 23 gauge vitrectomy in complications of Eales' disease. **Materials and methods: Study design:** Consecutive interventional case series. **Participants:** Seventy-six eyes of 72 non-consecutive patients undergoing 23-gauge vitrectomy for complications of Eales' disease were enrolled. The participants were followed up for a minimum of one year. **Intervention:** The participants underwent a complete demographic, medical and ophthalmic evaluation. A 23-gauge vitrectomy was performed. Endotamponade was used when necessary. Perioperative and postoperative events were recorded. Primary outcome measures were visual acuity and complications arising due to surgery. **Results:** Indication for surgery was non-clearing vitreous hemorrhage in 89.4% (68/76) and secondary retinal detachment in 10.6% (8). Visual acuity improved from Log Mar  $1.80 \pm 0.19$  units preoperatively to Log Mar  $0.47 \pm 0.59$ . Best-corrected visual acuity equivalent to Snellen 6/9 was achieved in 77.6% of eyes. Surgical failure was seen in 6.5% cases. Four cases were lost due to progression to neovascular glaucoma and 1 case was lost to severe residual retinal detachment. Iatrogenic portside retinal breaks occurred in 3.9% (3), post-vitrectomy retinal detachment 2.6% (2), hypotony 1.3% (1) and cataract in 38.1% (28) cases. **Conclusion:** 23-gauge sutureless vitrectomy in patients with Eales' disease is a safe and effective technique with acceptable level of risk and complications.

**Keywords:** Eales' disease, retinal vasculitis, sutureless vitrectomy, 23 gauge vitrectomy, vitreous hemorrhage

### Introduction

Eales' disease was first described in 1882 by a British ophthalmologist, Henry Eales (Eales H, 1882, 1980). The disease, now described mostly from the developing nations is an idiopathic phlebitis culminating often in peripheral retinal neovascularization and multiple episodes of vitreous

hemorrhage and tractional retinal detachment (Atmaca LS 1993; Das T 1994, Renie WA 1983). The management comprises of systemic steroids for active vasculitis, scatter laser photocoagulation for retinal neovascularization and pars plana vitrectomy for non-clearing vitreous hemorrhage and tractional retinal detachment involving or threatening the macula (Das T 1994).

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Ever since the advent of pars plana vitrectomy, the development of vitrectomy systems has been directed towards ever smaller and more efficient instruments that may help in reducing the surgical time and hastening patient recovery. Since the first introduction of 23-gauge vitrectomy system by Singh et al (Singh S et al, 1996) and introduction into clinical use by Eckardt et al (Eckardt C, 2005), the efficacy and safety of the system has been established for various posterior segment disorders. The results of surgical outcomes of 20 gauge pars plana vitrectomy in Eales' disease are available in the scientific literature. However, all these studies have been done using the 20 gauge vitrectomy systems and most studies have been conducted in a retrospective manner (Treister G et al, 1977; Smiddy WE et al, 1988; Shanmugam MP et al, 1998; Badrinath SS et al, 1999; Kumar A et al, 2000; El-Asrar AM et al, 2002; Majji AB et al, 2006; Shukla D et al 2008). We hereby undertook this prospective study with the primary objective to establish the safety and evaluate the outcomes of 23-gauge vitrectomy in cases of Eales' disease.

### Materials and methods

The study enrolled 76 eyes of 72 in patients with the diagnosis of Eales' disease at a tertiary care centre over a period of one year from February 2009 to January 2010. The diagnosis of Eales' disease was made on the basis of idiopathic retinal phlebitis in the fellow eye. The indications of surgery were nonclearing vitreous hemorrhage of minimum 2 months with visual acuity < 6/12, tractional retinal detachment threatening or involving the macula, secondary rhegmatogenous or a combined rhegmatogenous retinal detachment.

Patients with intermediate uveitis, choroiditis or coexisting anterior uveitis were excluded. Ocular inflammation secondary to infectious or autoimmune or other inflammatory causes as diagnosed on history, clinical examination or investigation were excluded. Other causes of proliferative retinal vasculopathies such as diabetic retinopathy, sickle cell disease, familial exudative vitreoretinopathy and retinopathy of prematurity were excluded. Those

patients who refused to give an informed consent for the study or could not complete one-year follow were excluded from the study. Ophthalmic examination included recording best-corrected visual acuity, anterior segment examination, Goldmann applanation tonometry and dilated funduscopy. B scan ultrasonography was done in cases where media haze obviated fundus evaluation. Degree of posterior vitreous detachment, rhegmatogenous retinal detachment, points of attachment of posterior hyaloid to the retina and tractional retinal detachment involving the macula were noted.

### Patient workup

On enrollment demographic, medical and ophthalmic evaluation was performed. Demographic data included age, gender, ethnic origin, occupation and Koch's illness in close contacts. Medical evaluation was directed to rule out tuberculosis, sarcoidosis, Behcet's disease, and retroviral disease, syphilis and collagen vascular diseases. Systemic evaluation in all cases included chest X ray, Mantoux test, complete blood count, enzyme-linked immunosorbent assay for human immunodeficiency virus and treponemal antibody test and examination for lymphadenopathy.

### Surgical procedure

After explaining the surgical procedure and obtaining an informed written consent, risks and postoperative care, the patients underwent 23 gauge pars plana vitrectomy with endophotocoagulation under peribulbar anesthesia. The surgery was performed using the Accurus vitrectomy system (Alcon, Hünenberg, Switzerland) using the ACCURUS Surgical System 23-gauge TOTAL PLUS Pak (Alcon, Hünenberg, Switzerland). In all patients the vitrectomy was completed with induction of posterior vitreous detachment and shaving of the vitreous. Neovascularization at the disc (NVD) and elsewhere (NVE) were segmented and then the NVE was surrounded by barrage laser. Endophotocoagulation was done in area distal to the NVE. In case NVD was present panretinal

photocoagulation was done. After completion of vitrectomy the globe was left filled with air by performing a complete air-fluid exchange. Tamponade agent in the form of non-expansile gas or oil was used at the discretion of the surgeon. The postoperative treatment regime included topical antibiotics eye drops (moxifloxacin hydrochloride; 0.5%, 4 times daily for 14 days [Alcon laboratories, Texas, USA]), topical steroid drops (prednisolone acetate; 1%, 4 times daily for 21 days [Allergan India Ltd., India]) and short acting cycloplegics (tropicamide; 1%, 3 times daily [Ophtho Remedies, India]). The patients were seen on day 1, 1 week, 4 weeks and then 3 monthly and the final parameters and events were recorded at the end of one year. During follow up best corrected visual acuity, development of cataract or other factor obviating return of potential vision and complications were noted and treated. Optical coherence tomography was performed in cases suspected to have cystoid macular edema. Fundus fluorescein angiography was done if macular ischemia was suspected as a cause of no improvement in vision. The study was approved by the Institutional review board and adhered to the tenets of the Declaration of Helsinki.

### Statistical analysis

The data was tabulated using Microsoft Excel 2007 and analyzed using the SPSS version 11. Descriptive analysis was employed and results were expressed using mean and distribution of proportions.

### Results

#### *Baseline parameters*

The study comprised of 76 eyes of 72 patients. All the patients were males. The mean age was 26.4  $\pm$  6.6 years. The mean duration of symptoms was 3.7  $\pm$  2.4 months (range 1- 18 months). The mean preoperative visual acuity was 1.80  $\pm$  0.19 LogMAR units.

The indication for surgery was nonclearing vitreous hemorrhage in 89.4 % (68/76) cases. Secondary retinal detachment (tractional retinal detachment

involving or threatening the macula, combined tractional and rhegmatogenous retinal detachment and secondary rhegmatogenous retinal detachment) was the indication of surgery in 10.6% (8/76) cases. Intra-operatively, 51.3% (39/76) participants had neo-vascularization of the disc (NVD), while 67% (51/76) had neo-vascularization elsewhere (NVE). Nearly 30% of these eyes had multiple NVE's. Only 10.6% had a complete posterior vitreous detachment (PVD) and the remaining 89.4% had partial PVD. In 17% of the eyes some form of endotamponade was used (6.5% and 10.5% non-expansile gas and silicon oil respectively). Peroperatively old laser scar marks were noted in 13.15% (10).

#### *Surgical results*

The mean preoperative best-corrected visual acuity was 1.80  $\pm$  0.19 units. (equivalent to 1/60 snellen acuity). The mean post-operative uncorrected visual acuity was Log Mar 0.47  $\pm$  0.59 (equivalent to mean of 6/18 - Snellen acuity). Uncorrected visual acuity of Snellen 6/9 or better was achieved in 52.3% of the cases. The postoperative mean best corrected visual acuity was 0.42  $\pm$  0.61. Best corrected visual acuity equivalent to Snellen 6/9 was achieved in 77.6% (59/76) cases. A small proportion of cases, 5.2% (4/76) patients did not gain vision after surgery and 1.3% (1/76) patients went to Pl absent vision postoperatively. Of the patients not achieving best corrected visual acuity to Snellen 6/9, the following causes were incriminated: Neovascular glaucoma 4/17, unrelieved macular tractional retinal detachment in 2/17, photoreceptor degeneration 3/17, cataract 4/17, resolved cystoid macular edema in 4/17 epiretinal membrane 3/17 eyes. In three cases the cause of visual loss was pre-existing full thickness macular hole, anisometropic amblyopia and macular ischemia respectively. In many cases more than one cause was incriminated as the reason for non-improvement in visual acuity. The complications encountered in the intraoperative -postoperative period have been summarized in Table 1.

**Table 1: Surgical complications encountered in patients undergoing minimally invasive vitrectomy for Eales' disease**

Event	Percentage (n)N= 76	Management
Posterior subcapsular cataract	38.1% ( 28)	Catarat surgery done in 18 cases. Lensectomy done in lens touch with secondary intraocular lens implantation at 3 months.
Intraoperative lens touch	1.3% (1)	
Early dispersed postoperative rebleed	9.2% (7)	5 cases media clear at week 1, in 2 cases lavage done at end of month 1
Iatrogenic retinal break	6.5% ( 5)	3 portside dialysis, cryopexy done; 2 breaks at the base of tractional detachment, endotamponade used
Postvitrectomy retinal detachment	2.6% (2)	1 case managed with scleral buckling combined with pneumatic retinopexy. Case 2 managed silicon oil endotamponade
Postoperative hypotony	1.3% ( 1)	Manage with intermittent pressure patch for 48 hours and oral steroids ; resolved in 48 hours
On table wound leak	6.5% ( 4)	Transconjunctival suturing of the port
Neovascular glaucoma	6.5% (4)	Anti VEGF therapy and Anterior retinal Cryopexy

### Discussion

Sutureless, microincision vitrectomy is increasingly being adopted by vitreoretinal surgeons. The reasons include reduced surgical trauma, improved patient comfort after surgery, shorter operating times, and reduced postoperative astigmatism when compared to traditional sutured procedures (Chen JC 1996; Milibak T and Suveges I 1998; Kwok AK et al, 1999; Schmidt J et al 1999; Jackson T 2000; Assi AC et al, 2000; Rahman R et al, 2000; Theelen T et al, 2003; Yanyali A et al, 2005).

However, sutureless vitrectomy has also been criticized for having high incidence of port side vitreous prolapse, retinal break formation, sclerotomy site leakage, hypotony and endophthalmitis (Fujii GY et al, 2002; Lakhanpal RR et al, 2005; Gupta OP et al, 2007; Scartozzi R et al, 2007; Magosso LM et al, 2007; Taban M 2006; Taylor SR and Aylward GW 2005).

In spite of established safety and efficacy data of sutureless vitrectomy in various vitreoretinal diseases (Acar N et al 2008; Altan T et al 2008; Altan T et al 2009; Chieh JJ et al 2009, Erakgun

T et al 2009; Gonzales CR et al 2009 and 2006, Kadonosono K et al, 2006 , Kusuhara S et al, 2008; Lopez-Guajardo L et al, 2008; Ma J et al, 2008) it was essential to ascertain the same in cases of Eales' disease due to its distinctive surgical minutiae. An important core issue pertaining to Eales' vitrectomy is that the peripheral retinal neovascularization (NVE) are sites for potential vitreoretinal traction and peripheral retinal break formation. In the setting of sutureless vitreoretinal intervention the problem may be compounded by the inability to remove peripheral vitreous skirt and lack of exoplant support. In our series, we employed 23 gauge vitrectomy instruments using standard sclerotomy placements and the surgery could be completed in all cases. No case required conversion to 20-gauge surgery. However 5.2% (4) needed a one-transconjunctival suture to overcome leakage from sclerotomy.

The visual results were comparable to the results achieved in most of the studies done employing the 20-gauge technique. The mean best-corrected

visual acuity in the present study was equivalent to 6/18 on the Snellen chart, with almost three – fourth of the eyes achieving a vision of 6/9 or better. Shukla et al (2008) have reported mean visual acuity of 6/24 with BCVA > 6/18 in 60.6% of the cases Kumar et al (2000) reported excellent

visual outcome in Eales' disease (VA > 6/18 in 85%), whereas El-Asrar and Al-Kharashi (2002) reported acuity VA > 6/12 in a modest 26%. Majji et al (2006) had final acuity VA > 20/50 in 30% cases. The results of various studies done in the past have been summarized in Table 2.

**Table 2:. Brief review of studies evaluating outcomes of standard 20G vitrectomy in Eales' disease**

Authors	Year of work	No. of eyes	Instrument Gauge	Pre and peroperative characteristics	Extent of posterior Vitreous detachment	Visual results	Adverse outcomes	Follow up period
Treister G, Machemer R	1977	7	17 G	Vitreous hemorrhage(5) , Tractional detachment( 2)	Not mentioned	57.1%( 4/7) visual acuity ≥ 6/18	1 eye to NLP and 2 Neovascular glaucoma	6-15 months
Shanmugan MP et al	1998	64	20 G	Not available	Not available	71.8% visual acuity ≥ 6/60	7.8% recurrent vitreous bleed	60 months
Badrinath et al	1999	18	20 G	Vitreous hemorrhage (9) , Tractional detachment (7) , Rhegmatogenous detachment (2)	Incomplete in all cases Single vitreoretinal adhesion(1), Multiple adhesions(15)	Not mentioned	Not mentioned	Not mentioned
Kumar et al	2000	40	20G	Vitreous hemorrhage( 40)	Complete (85%)	85% (34/40) Visual acuity ≥ 6/18	Macular pucker 25% (10/40), Macular edema(22.5%)	Minimum 3 months
El Asrar et al	2002	15	20G	Vitreous Hemorrhage ( 11), Tractional detachment (4)	Not available	93.3%(14/15) ≥ 6/60	Not available	Not available
Majji AB et al	2006	18	20 G	Epiretinal membranes (18)	Incomplete	30% ≥ 6/15	28% legally blind	Not available
Shukla D et al	2008	71	20 G	69% vitreous hemorrhage , 31% Secondary Retinal detachment	Partial or no PVD in 60.6%	60.6%(43/71) ≥ 6/18	( 15.5%) 11/71 Surgical failures	8-14 months
Our Study	2010	76	23 G	89.4% vitreous haemorrhage 10.6% secondary retinal detachment	89.4% partial or no PVD	77.6% (59/71) ≥ 6/9	6.5% (5) surgical failures	Minimum one year followup

The difference in the results could be due to the difference in the baseline characteristics (choosing simple vitreous hemorrhage over complex tractional detachments). Presence of incomplete posterior vitreous detachment has also been cited as a poor prognostic factor

(Shukla D, 2008), which we do not feel evident in our study since only 10% patients had complete PVD and we had a low surgical failure rate of 6.5% compared to 15%- 42% (Treister G et al 1977; Majji AB et al 2006; Shukla D et al 2008 ) reported in the past.

Postoperative hypotony was seen in 1/76 (1.3%) eyes in our series, which resolved in 48 hours. No case developed postoperative choroidal detachment, bleb formation or postoperative endophthalmitis. While postoperative hypotony is almost unknown in 20 gauge vitrectomy, the rates were comparable with other series employing 23 gauge technique. Lee DY et al (2011) reported hypotony in 0.7% of eyes undergoing combined 23-gauge sutureless vitrectomy, clear corneal phacoemulsification, and intraocular lens implantation in patients with proliferative diabetic retinopathy. Other studies have reported rates between 3% - 22.9%. (Mateo-Montoya A et al 2011; Park DH et al 2010; Haas A et al 2010). In a comparative study of the safety and efficacy of 20 - and 23-gauge pars plana vitrectomy (PPV) for the management of primary rhegmatogenous retinal detachment (RD), Albrieux M et al reported portside break formation in 8.5% of cases undergoing 23 gauge intervention compared to none in 20 gauge group (Albrieux M et al, 2011 ).

Contrary to this, Issa SA et al (2011) observed that 23-gauge transconjunctival vitrectomy surgery was associated with a lower rate of retinal break formation than 20 gauge vitrectomy for proliferative diabetic retinopathy (5 % vs 14%).

The findings of Nakano T et al (2011) support those of Issa SA et al. They reported an incidence of 1.1% in 23 G group versus 8.5% in 20 G group, in cases undergoing vitrectomy for macular diseases. Rizzo S (2010) found no statistical difference in the incidence of RD, 1.7% after sutureless vitrectomy and 1.2% after conventional 20-gauge vitrectomy.

In our study, 6.5% ( 5) developed portside events. Of these, 3 were portside dialysis and the 2 portside events were delayed postoperative retinal breaks, presenting at 11 and 16 weeks respectively. The breaks were formed at the base of peripheral NVE, which were located in the sub-incisional area and had developed vitreous traction due to plugging of the sclerotomy port by the vitreous. Vitreous lavage for rebleed was

done in 2.6% (2/76) cases, which is comparable to a rate of 7.4% in a recent study (Shanmugam MP et al, 1998).

We had a high incidence of cataract (36.8%) that was comparable to similar studies (24%-45%) done in the past ( Shukla D et al 2008). We had a surgical failure rate of 6.5% (5/76 ). Four cases due to neovascular glaucoma and 1 case due to severe residual retinal detachment.

### Conclusion

We conclude that 23 gauge sutureless vitrectomy in patients with Eales' disease is a safe and effective technique with acceptable level of risk and complications.

### References

- Acar N, Kapran Z, Altan T, et al (2008). Primary 25-gauge sutureless vitrectomy with oblique sclerotomies in pseudophakic retinal detachment. *Retina*; 28:1068-74.
- Albrieux M, Rouberol F, Bernheim D et al (2011). Comparative study of 23-gauge vitrectomy versus 20-gauge vitrectomy for the treatment of rhegmatogenous retinal detachment. *Graefes Arch Clin Exp Ophthalmol*; 249(10):1459-68.
- Altan T, Acar N, Kapran Z, et al (2008). Transconjunctival 25-gauge sutureless vitrectomy and silicone oil injection in diabetic tractional retinal detachment. *Retina*; 28:1201-6
- Altan T, Kapran Z, Eser I, et al (2009). Comparative outcomes of pars plana vitrectomy in acute postoperative endophthalmitis with 25-gauge and 20-gauge techniques. *Jpn J Ophthalmol*; 53(5):506-511.
- Assi AC, Scott RA, Charteris DG. (2000). Reversed self-sealing pars plana sclerotomies. *Retina*; 20:689-692.
- Atmaca LS, Idli A, Gunduz K. (1993). Visualization of retinal vasculitis in Eales disease. *Ocul Immunol Inflamm*. 1:41-8
- Badrinath SS, Gopal L, Sharma T et al (1999). Vitreoschisis in Eales' disease: pathogenic role and significance in surgery.

Retina; 19: 51–54.

Chen JC (1996). Sutureless pars plana vitrectomy through self sealing sclerotomies. *Arch Ophthalmol* 114:1273–5.

Chieh JJ, Rogers AH, Wiegand TW et al (2009). Short-term safety of 23-gauge single step transconjunctival vitrectomy surgery. *Retina*; 29:1486-1490.

Das T, Biswas J, Kumar A et al (1994) Eales disease. *Indian J Ophthalmol.* 42:3-18.

Eales H (1882). Primary retinal hemorrhage in young men. *Ophthalmic Rev.* 1:41.

Eales H (1980). Retinal hemorrhage associated with epistaxis and constipation. *Brim Med Rev*; 9:262.

Eckardt C (2005). Transconjunctival sutureless 23-gauge vitrectomy. *Retina*; 25:208–211.

El-Asrar AM, Al-Kharashi SA..(2002). Full panretinal photocoagulation and early vitrectomy improve prognosis of retinal vasculitis associated with tuberculo-protein hypersensitivity (Eales' disease). *Br J Ophthalmol*; 86: 1248–1251.

Erakgun T, Egrilmez S. (2009) Surgical outcomes of transconjunctival sutureless 23-gauge vitrectomy with silicone oil injection. *Indian J Ophthalmol*; 57: 105-107.

Fujii GY, De Juan E. Jr, Humayun MS et al. (2002). Initial experience using the transconjunctival sutureless vitrectomy system for vitreoretinal surgery. *Ophthalmology*; 109:1814-1820.

Gonzales CR, Boshra J, Schwartz SD.( 2006). 25-gauge pars plicata vitrectomy for stage 4 and 5 retinopathy of prematurity. *Retina*; 26:S42—6

Gonzales CR, Singh S, Schwartz SD (2009). 25-gauge vitrectomy for paediatric vitreoretinal conditions. *Br J Ophthalmol*; 93(6):787-790.

Gupta OP, Weichel ED, Regillo CD, et al (2007). Postoperative complications associated with 25-gauge pars plana vitrectomy. *Ophthalmic*

*Surg Lasers Imaging*; 38:270-275.

Haas A, Seidel G, Steinbrugger I et al. (2010). Twenty-three-gauge and 20-gauge vitrectomy in epiretinal membrane surgery. *Retina*; 30:112-6.

Issa SA, Connor A, Habib M, Steel DH. (2011). Comparison of retinal breaks observed during 23 gauge transconjunctival vitrectomy versus conventional 20 gauge surgery for proliferative diabetic retinopathy. *Clin Ophthalmol*;5:109-14.

Jackson T (2000). Modified sutureless sclerotomies in pars plana vitrectomy. *Am J Ophthalmol* 129:116-117.

Kadonosono K, Yamakawa T, Uchio E et al (2006). Comparison of visual function after epiretinal membrane removal by 20- gauge and 25-gauge vitrectomy. *Am J Ophthalmol*; 142:513-5.

Kusuhara S, Ooto S, Kimura D, et al.(2008). Outcomes of 23- and 25-gauge transconjunctival sutureless vitrectomies for idiopathic macular holes. *Br J Ophthalmol*; 92: 1261-4.

Kumar A, Tiwari HK, Singh RP et al (2000). Comparative evaluation of early vs deferred vitrectomy in Eales' Disease. *Acta Ophthalmol Scand*; 78: 77–78.

Kwok AK, Tham CC, Lam DS et al. (1999) Modified sutureless sclerotomies in pars plana vitrectomy. *Am J Ophthalmol* 127:731–3.

Lakhanpal RR, Humayun MS, de Juan E. Jr, et al.(2005). Outcomes of 140 consecutive cases of 25-gauge transconjunctival surgery for posterior segment disease. *Ophthalmology*; 112: 817-824.

Lee DY, Jeong HS, Sohn HJ et al. (2011 May 6. [Epub ahead of print]) Combined 23-gauge sutureless vitrectomy and clear corneal phacoemulsification in patients with proliferative diabetic retinopathy. *Retina*; 9: 1753-1758.

Lopez-Guajardo L, Dapena I, Teus MA (2008) Dislocated posterior chamber intraocular lens scleral fixation technique through 23-gauge vitrectomy cannulas. *Ophthalmic Surg Lasers Imaging*; 39:429-33.

Magosso LM, Maia A, Maia M et al (2007). Endophthalmitis after 25-gauge pars plana vitrectomy. *Retinal Cases and Brief Reports*; 1:185–187.

Majji AB, Vemuganti GK, Shah VA et al. (2006). A comparative study of epiretinal membranes associated with Eales' disease: a clinicopathologic evaluation. *Eye*; 20: 46–54.

Ma J, Yao K, Zhang Z et al (2008). 25-gauge vitrectomy and triamcinolone acetonide-assisted internal limiting membrane peeling for chronic cystoid macular edema associated with branch retinal vein occlusion. *Retina*; 28: 947–56

Mateo-Montoya A, Mendrinos E, Tabatabay C et al (2011). 23-gauge transconjunctival sutureless vitrectomy: visual outcomes and complications. *Semin Ophthalmol*; 26:37-41.

Milibak T, Suveges I (1998). Complications of sutureless pars plana vitrectomy through self-sealing sclerotomies [letter]. *Arch Ophthalmol*; 116 (1):119.

Nakano T, Uemura A, Sakamoto T (2011). Incidence of iatrogenic peripheral retinal breaks in 23-gauge vitrectomy for macular diseases. *Retina*; 31 (10): 1997-2001.

Park DH, Shin JP, Kim SY et al (2010). Comparison of clinical outcomes between 23-gauge and 20-gauge vitrectomy in patients with proliferative diabetic retinopathy. *Retina*; 30:1662-70.

Rahman R, Rosen PH, Riddell C et al (2000). Self-sealing sclerotomies for sutureless pars plana vitrectomy. *Ophthalmic Surg Lasers*; 31:462– 6.

Renie WA, Murphy RP, Anderson KC et al (1983). The evaluation of patients with Eales disease. *Retina* 3:243–8.

Rizzo S, Belting C, Genovesi-Ebert F et al (2010). Incidence of retinal detachment after small-incision, sutureless pars plana vitrectomy compared with conventional 20-gauge vitrectomy in macular hole and epiretinal membrane surgery. *Retina*; 30:1065-71.

Scartozzi R, Bessa AS, Gupta OP et al (2007). Intraoperative sclerotomy-related retinal breaks for macular surgery, 20- vs. 25-gauge vitrectomy systems. *Am J Ophthalmol*; 143: 155–156.

Schmidt J, Nietgen GW, Brieden S. (1999). Self-sealing, sutureless sclerotomy in pars plana vitrectomy [in German]. *Klin Monatsbl Augenheilkd*; 215:247–51.

Shanmugam MP, Badrinath SS, Gopal L et al (1998). Long term visual results of vitrectomy for Eales disease complications. *Int Ophthalmol*; 22: 61–64.

Shukla D., Kanungo S., Prasad NM (2008). Surgical outcomes for vitrectomy in Eales' disease. *Eye*; 22:900-4.

Singh S, Josephberg RJ, Zaidman GW (1996). Office-based diagnostic pars plana vitrectomy. *Invest Ophthalmol Vis Sci*; 37:402

Smiddy WE, Isernhagen RD, Michels RG et al (1988). Vitrectomy for nondiabetic vitreous hemorrhage: retinal and choroidal vascular disorders. *Retina*; 8: 88–95.

Taban M, Ufret-Vincenty RL, Sears JE (2006). Endophthalmitis after 25-gauge transconjunctival sutureless vitrectomy. *Retina*; 26:830–831.

Taylor SR, Aylward GW (2005). Endophthalmitis following 25-gauge vitrectomy. *Eye*; 19:1228-1229.

Theelen T, Verbeek AM, Tilanus MA et al (2003). A novel technique for self-sealing, wedge-shaped pars plana sclerotomies and its features in ultrasound biomicroscopy and clinical outcome. *Am J Ophthalmol*; 136:1085–92.

Treister G, Machemer R. (1977). Results of vitrectomy for rare proliferative and hemorrhagic disease. *Am J Ophthalmol*; 84: 394–412.

Yanyali A, Celik E., Horozoglu F, Nohutcu AF (2005). Corneal topographic changes after transconjunctival (25-gauge) sutureless vitrectomy. *Am J Ophthalmol*; 140: 939–41.

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