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Retinal Detachment – An Update of the Disease and Its Epidemiology – A Discussion Based on Research and Clinical Experience at the Prince Charles Eye Unit, Windsor, England

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1. Introduction

Retinal detachment is a potentially blinding condition. It is caused by separation of neurosensory retina from the underlying retinal pigment epithelium. Despite treatment advances, functional results remain poor (with only 42% achieving 6/12 vision and only 28% if the macula is involved). There are three distinct types of retinal detachment: rhegmatogenous (RRD), tractional and exudative. For the purpose of this chapter we will focus on RRD.

RRD demonstrates wide geographical variation with incidence reported between 6.3 and 17.9 per 100, 000[1] with 7300 new cases estimated annually in the UK[29]. Risk factors include myopia, increasing age and certain vitreoretinal conditions. Horseshoe tears, giant tears and round holes have been shown the most common along with lattice degeneration[7].

Vitreoretinal traction is responsible for most RRD. As the vitreous becomes syneretic (liquefied) with age, a posterior vitreous detachment (PVD) occurs. In most cases, the vitreous separates from the retina without any sequelae. However, in certain eyes, strong vitreoretinal adhesions are present and the occurrence of a PVD can lead to a retinal tear; then, fluid from the liquefied vitreous can enter the sub-retinal space through the tear, leading to a retinal detachment.

Several studies have investigated the epidemiology and risk factors associated with RRD. These differ in their methodology making comparison of data difficult [1,2,4,6,11,29]. RRD incidence varies with ethnicity and is strongly associated with increasing age, myopia and certain vitreoretinal degenerations including lattice degeneration and round holes. Abnormal vitreoretinal adhesions, which may be visible or invisible, are present in many eyes. Among the visible ones are lattice degeneration and cystic retinal tufts. When a PVD occurs and encounters such an area, a retinal tear may form. Due to changes in cataract surgery trends, the proportion of pseudophakic retinal detachment presenting to specialised

centres appears to be increasing. The incidence is lower in phacoemulsification than extra and intracapsular cataract extraction.

Fig. 1. Retinal detachment

Obtaining an accurate estimate of rhegmatogenous retinal detachment incidence in England and associated risk factors is essential in understanding the healthcare burden related to this disorder. We investigated the epidemiology of rhegmatogenous retinal detachment and associated clinical features by analysing routinely collected hospital statistics for England, using the Hospital In-patient Enquiry (HIPE) and Hospital Episode Statistics (HES) from 1968 to 2004, and for the Oxford National Health Service Region using the Oxford Record Linkage Study (ORLS) from 1963 to 2004. A literature review is also presented.
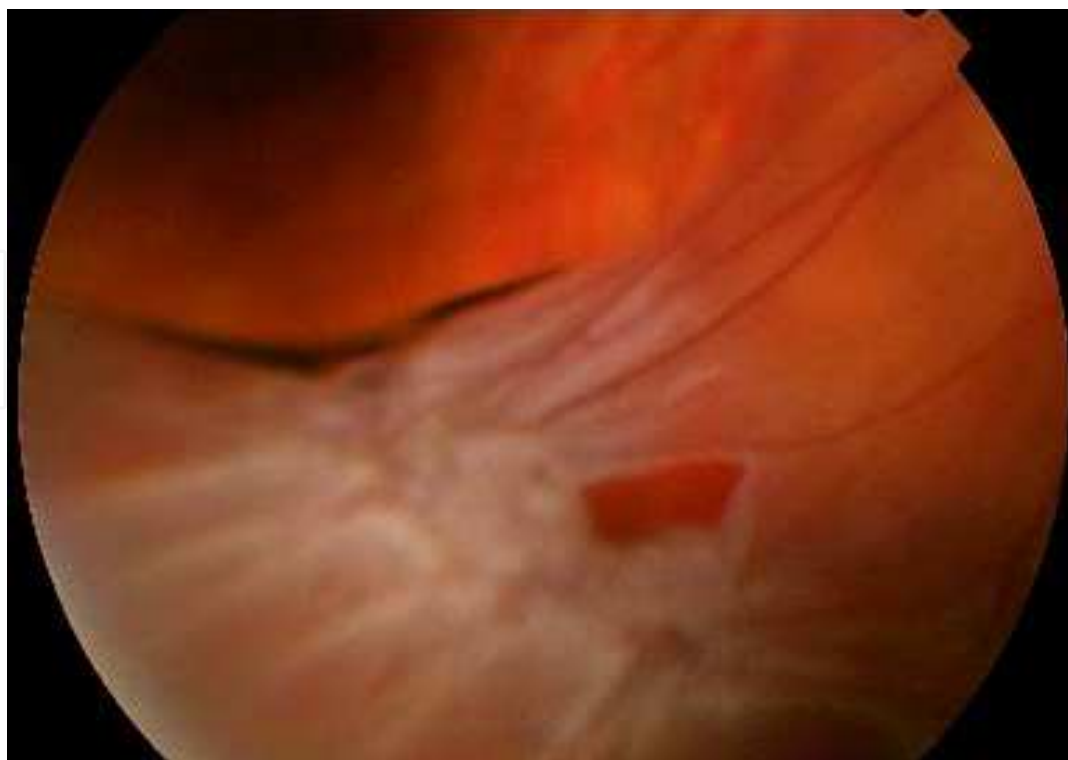
Fig. 2. Retinal break

2. Methods

At the start date for our national analysis, 1968, national hospital statistics for England were collected as the HIPE. This system ceased in 1985 and was replaced, though not until 1989 by HES. Both HIPE and HES are statistical databases of demographic, medical and administrative information about each episode of hospital care. HES include data on all ''day cases'' or office procedures, as well as patients admitted for overnight stay, whereas the HIPE did not include day cases.. The Oxford Record Linkage Study (ORLS) was also used for all patients treated in the Oxford Regional Health Authority area.

The International Classification for Disease (ICD) by the World Health Organisation was used to identify rhegmatogenous retinal detachment. The codes included ICD-7 (1955) code 386, ICD-8 (1965) code 376, ICD-9 (1977) codes 361.0, 361.1, 361.8 and 361.9, ICD-10 (1992) codes H33.0, H33.2, H33.4 and H33.5.

National HES for England were analysed to produce a geographical profile of hospital admission for retinal detachment by the Local Authority (LA) between 1998 and 2005. The data were used to construct a map showing the person-based admission rate per 100 000 resident population for each LA, expressed as an average annual rate. The LAs were arranged into quintiles: the fifth of LAs with the lowest rates are shown with the lightest colour, and the fifth of LAs with the highest rates are shown with the darkest colour.

The association with affluence was studied using the Index of Multiple Deprivation score for 1998-2005 (n= 57,949) as a measure of deprivation levels. The study population was split into quintiles from least deprived to the most deprived. Standardised admission ratios and 95% confidence intervals were calculated to evaluate statistical significance. Seasonal

variation by monthly analysis was studied for detachment surgery from 1989-2006 (n=169,417).

The datasets were anonymised; approval to analyse them in a programme of research undertaken by the Unit and affiliated University, was obtained through the NHS Central Office for Research Ethics Committees (reference 04/Q2006/176).

3. Incidence

The English National and ORLS admission rates for retinal detachment surgery were just over 10 episodes per 100 000 population in the late 1960s. They rose nationally steadily, but gradually, to around 22 episodes per 100 000 population by 2004.

The ORLS data show rates based on the number of people admitted to hospital for retinal detachment surgery as well as the number of episodes of care for surgery (episodes of separate admission or transfers within an admission, or both). The scale of multiple admissions per person was small, although an increase in multiple recording is evident in recent years as seen in the recent divergence between the rates for episodes and people (figure 3). The figure confirms that the increase in hospital episodes in the 1990s represents an increase in the number of people treated (all RRD admissions were operated). It also shows more accurately than the English figures (which omit data for 1986–8) that the start of rapid increase in surgery was about 1989–90.
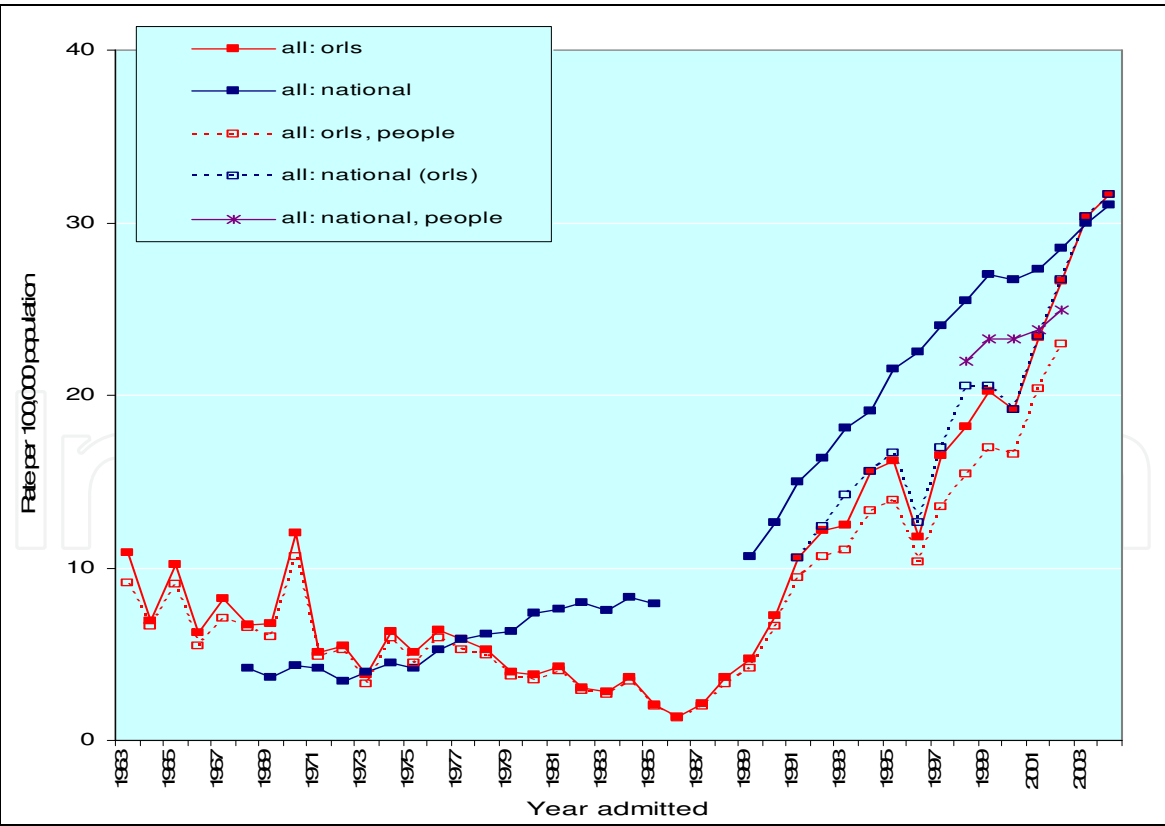

Fig. 3. Hospital admission rates 1963-2004 for Retinal surgery for ORLS and National data measured as episodes and people per year, male and female, all ages, all sources of admission, any mention

The reported annual incidence of rhegamatogenous retinal detachment in other studies around the world varies from 4-17.9 per 100 000 population [1,2,4,8,10,12,13,32,38]. Studies with small sample size, potential for sampling error and varied methodologies underlie these different results.

4. Geographic variation

The people rate for the national data is at its peak at 16 per 100,000 in 2004. There is a suggestion that the rate has reached its peak as the rate fluctuated between15-16 per 100,000 from 1998 to 2004. The people rate for the Oxford data continues to show a rise to 20 per 100,000 in 2004. This can be explained by the fact that Oxford remains a tertiary referral centre for retinal detachment and serves patients from outside the region and so the service throughput may not represent the local population. Bilaterality was not investigated but most series support a bilateral rate of retinal detachment of between 5-15%.
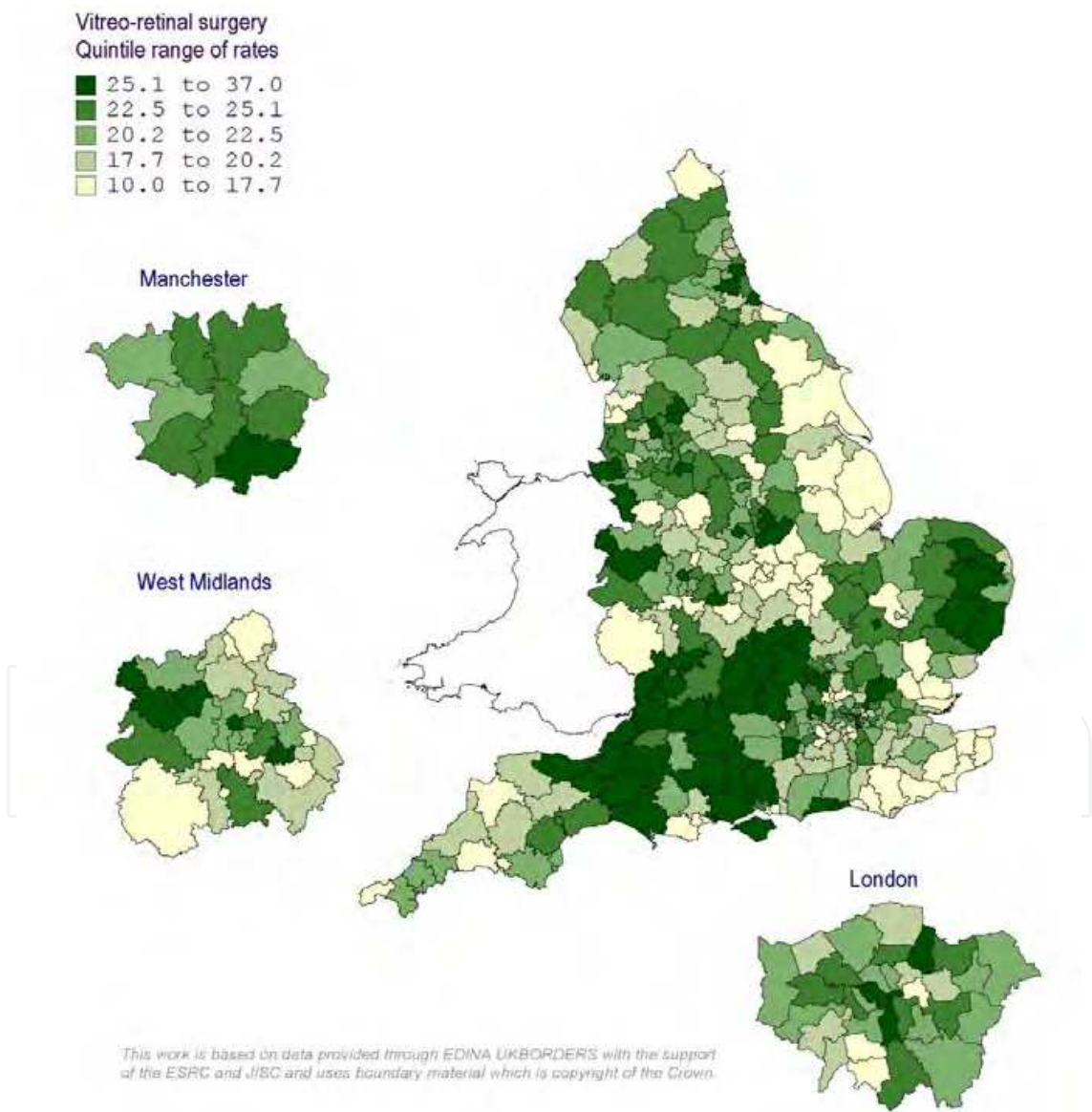

Fig. 4. Vitreo-retinal surgery: males and females indirectly standardised rate per 100 000: each local authority in England any mention of operation: 1998/99 to 2004/05

Figure 4 shows a geographical profile of the annual rate of retinal detachment surgery by LA. LAs showed a wide variation in rates of retinal detachment surgery, ranging from 7 to 23 people per 100 000 population. This reflects the relative infancy of retinal surgery service provision in comparison to cataract surgery for example and highlights the need for more service provision for patients in England.

5. Age distribution

The prevalence of PVD increases with age; occurring in 11% of 60-69 year olds, 46% of 80-89 year olds and occurring earlier in myopes. The highest incidence rate of detachment was found in the 70-74 age group with rates of 60 per 100,000. The incidence rate in under 20 year old females was the lowest noted; <3 per 100,000. The bimodal distribution with a secondary peak in younger ages (24-30 years) reflects the highly myopic group.
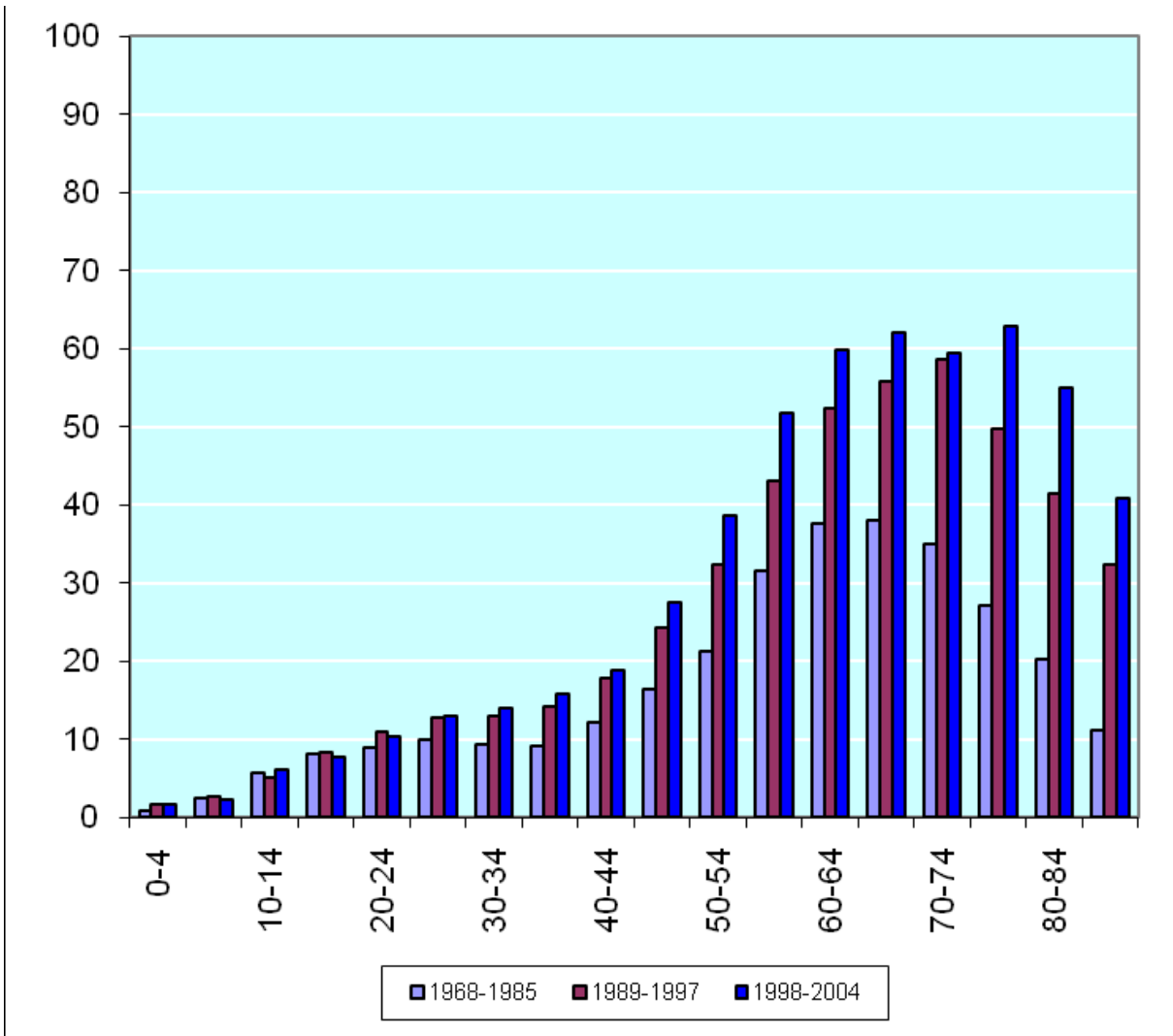

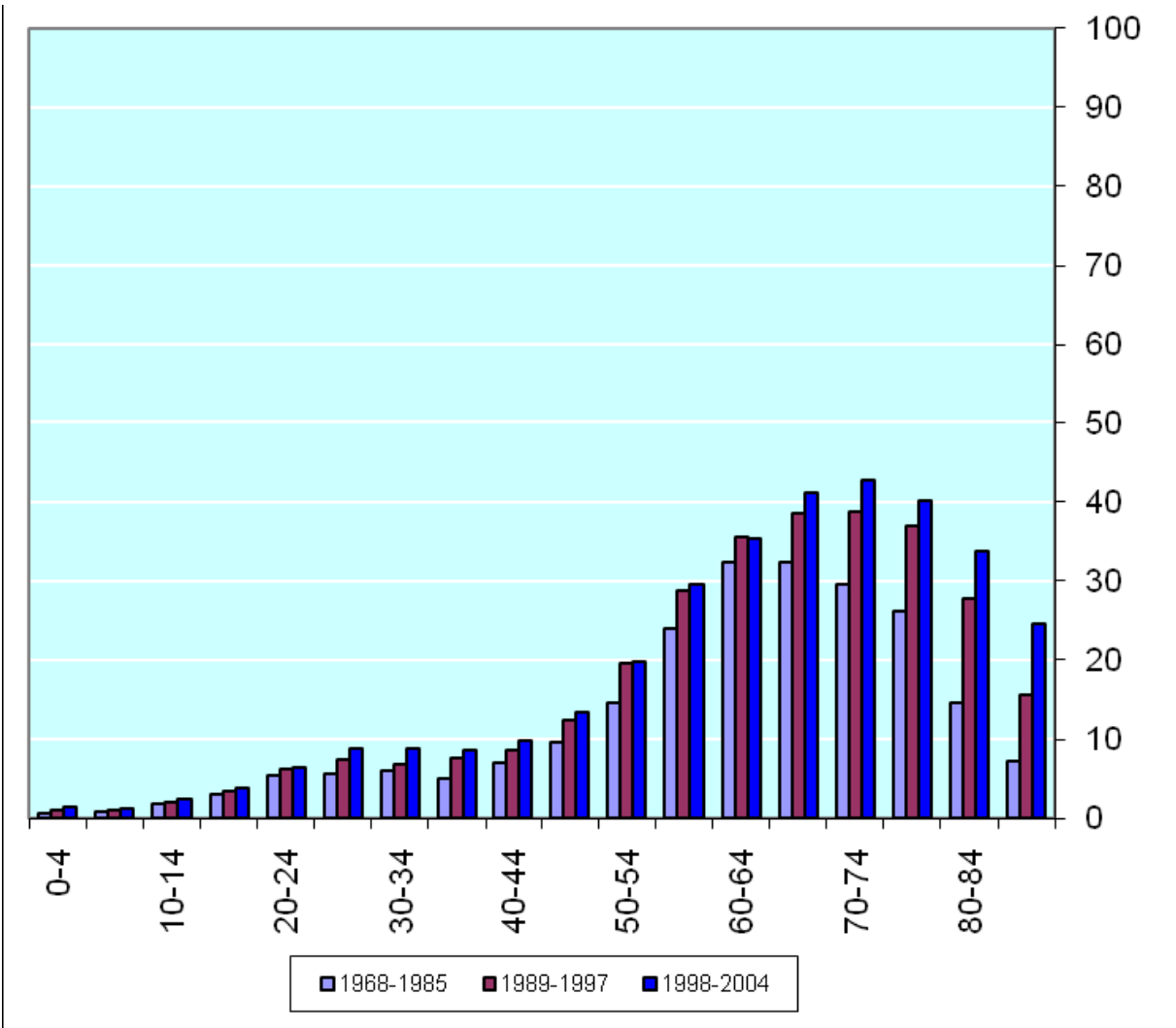Fig. 5. Admission rates for retinal detachment per 100,000 population: all sources, males, National data

Fig. 6. Admission rates for retinal detachment per 100,000 population: all sources, females, National data

6. Gender

Figures 5 and 6 presents national and ORLS admission rates for retinal detachment surgery analysed by age and sex, and over three time periods (1968–1985, 1989–1997 and 1998–2004) for men and women separately. Three contrasting time periods were selected: one relatively long historical period, when rises in rates were fairly modest, and two more recent periods, when rises were more evident. Over these time periods, the rate of retinal detachment surgery shows a bi-modal distribution with peaks at the 24-30 and 70-74 age groups for both men and women. There was a 6 times higher risk in the 70-74 age group for both males and females. The rate of retinal detachment surgery for all age groups shows a 1.5 times male preponderance.

While some reports indicate a sex distribution corresponding with that of the general population, most indicate a male preponderance[2-6]. This may be related to an inherent gender risk, though an increased rate of ocular trauma may be contributory. Furthermore, the higher proportion of myopia in young males may partly explain this.

In a prospective study which involved 1130 cases of RRD in Scotland over a 2-year period from 2007-2009, Mitry *et al.*, reported that PVD -associated RRD showed a male preponderance of 61.7% male vs. 38.2% female (P<0.001). Notably, 1 in 10 cases were associated with a recent history of ocular or head trauma.[7] The underlying sex distribution could not account for this gender discrepancy but higher rates of traumatic RRD or an inherent increased risk in men may be influential.[8]

Exclusion of traumatic retinal detachments from analysis may negate or even reverse gender differences in RRD incidence. The Beijing Rhegmatogenous Retinal Detachment Study Group prospectively reviewed 528 patients diagnosed with RRD from October 1999-September 2000. It reported a greater incidence of RRD in males (8.98/100000 population; 95% CI 8.07 – 10.13 in males, and 6.78/100000 population; 95% CI 5.97 – 7.76 in females). However, on subgroup analysis, although there was a greater incidence of traumatic RRD in males, there was no significant difference between males and females in nontraumatic, phakic, aphakic and pseudophakic retinal detachments.[11] A Swedish retrospective study of 590 cases of RRD over a 10-year period from 1971 to 1981 reported a higher incidence of non-traumatic RRD in females.[12] However in another large retrospective case-control study (1032 cases from 1995 to 2001), the male predominance persisted even after excluding trauma-related RRD, with a reported 2.15 odds ratio for male gender.[13]

The sex difference, that is a higher incidence of RRD in men, also appears to apply to retinal detachment incidence after cataract surgery. A small retrospective study from Olmstead County, Minnesota, found that men were 2.9 times more likely to have a retinal detachment after cataract surgery than women (P<0.001; 95%CI 1,8-4.4).[14]

Other possible explanations include increased myopia and axial length in men, as well as gender differences in the anatomy of the vitreoretinal base. [15, 16] Myopia is a well-known risk factor for retinal detachment and an increase in axial length is significantly associated with an increased risk of RRD.[17-19] Axial length is related to height and men tend to be taller than women.[20] Anatomical differences in the vitreoretinal base (with males having larger eyes hence longer vitreous chambers as described in 1912 by Salzmann's Anatomy and Histology of the Human Eyeball) can be in the form of greater migration of the posterior vitreous base towards the retina in males as reported by Wang et al, in their study of donor eyes.[21] This may predispose males to retinal breaks after PVD, either from greater dynamic vitreoretinal traction and/or an increase in vitreoretinal irregularities of the posterior border.

7. Cataract extraction and other ophthalmic operations

Cataract operation is the most common ophthalmic surgical procedure worldwide. Even with the best technique and in healthy eyes this procedure is associated with an increased risk of retinal detachment. There is a higher rate of PVD after cataract extraction and a lower hyaluronic acid concentration causing vitreous collapse **5**. Increased rates of cataract surgery (phacoemulsification, internal and external capsular cataract extraction) and higher life expectancy may also contribute to retinal detachment. The cumulated six year risk of detachment after cataract surgery is increased by a factor of 6 to 8, increasing linearly for 20 years[22].

The risk is increased if there are complications during cataract surgery. There is a statistically significant higher incidence of RRD after posterior capsule rupture and anterior vitrectomy than after uncomplicated phacoemulsification, 16% versus 0.75% according to one study[23].The estimated risk of retinal detachment after cataract surgery is 5 to 16 per 1000 uncomplicated cataract operations[24].The risk may be much higher in those who are highly myopic, with a frequency of 7% reported in one study[25].Young age at cataract removal further increased risk in this study. A vitreo-retinal centre in London analysed cases of rhegmatogenous retinal detachment in 1980 and again in 1999 finding that pseudophakia rose from 0.8% to 24%. This may explain the steady rise in retinal detachment we found as shown in figure 7 in England over the last 4 decades. Most series report that about 50% of RRD occur during the first year following cataract surgery. Long term risk of retinal detachment after extracapsular and phacoemulsification cataract surgery at 2, 5, and 10 years was estimated in one study to be 0.36%, 0.77%, and 1.29%, respectively[26].
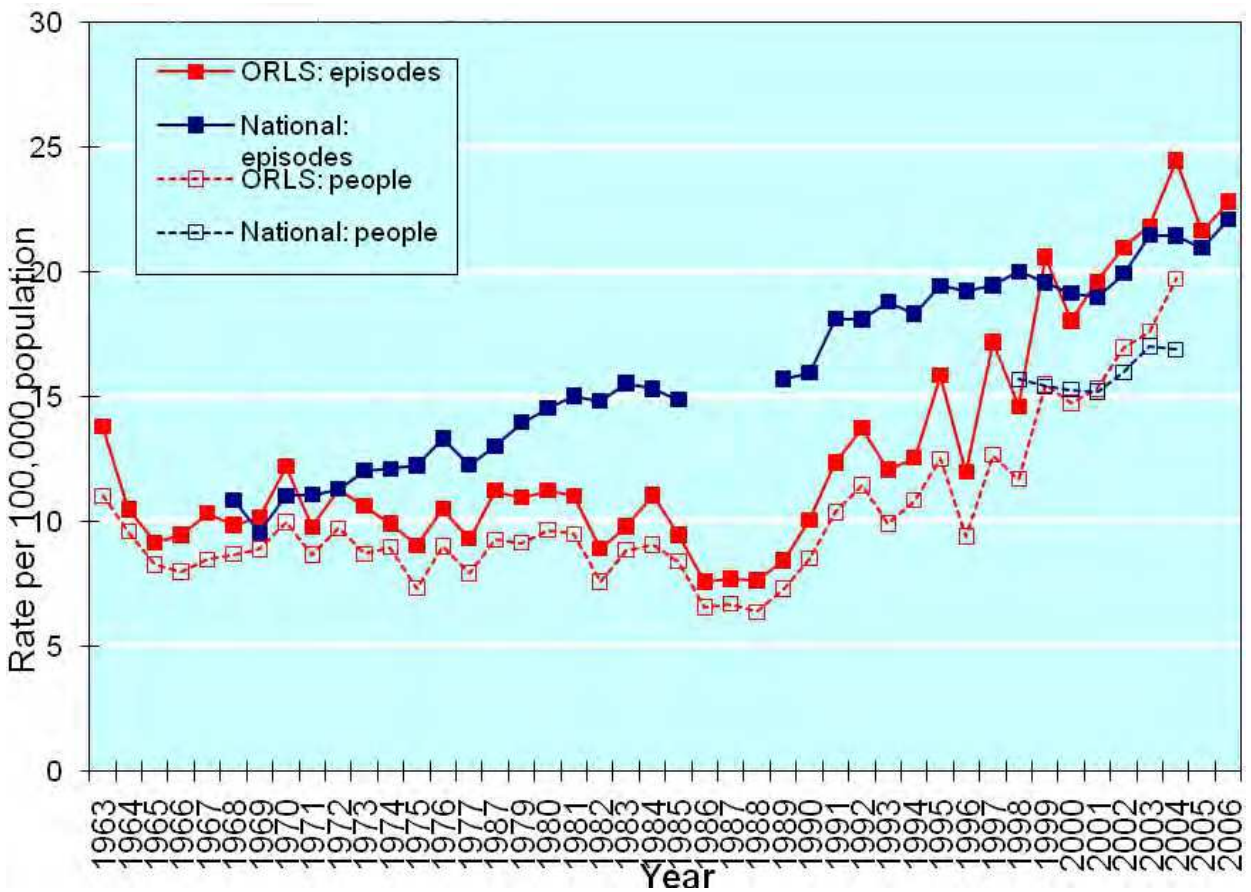

Fig. 7. Hospital admission rates (per 100,000 population) for retinal detachment: National & ORLS data 1963-2004(06) measured as episodes and people per year, all ages, males and females, all sources, any mention

The exact mechanism contributing to retinal detachment related to cataract surgery is not fully known, however several hypothesis have been postulated. It is well known that

cataract extraction alters the physiology of the eye. Removal of a larger cataractous lens in aphakia or its replacement with a smaller lens implant in pseudophakia is responsible for the anterior shift of the iris lens diaphragm resulting in a relative increase in volume of the vitreous cavity. The removal of the lens and its anterior capsule also disturbs the diffusion barriers and results in a more liquefied vitreous with a reduced hyaluronic acid content . This is associated with a higher rate of PVD. Direct evidence between cataract surgery and PVD comes from a recently published study from New Zealand [33]. The study showed that among 149 patients aged 50 to 60 years who underwent unilateral cataract surgery, the incidence of PVD after five years was 51 per cent in the treated eyes, compared to only 21 per cent in their unoperated fellow eyes. Other possible mechanisms leading to a retinal detachment have been implicated to be the inflammatory vitreoretinal adhesions and retinal breaks caused by surgical trauma.

ND:Yag capsulotomy following cataract operation carries a potential to induce PVD, and thereby cause a retinal detachment [23]. The risk factors include myopia, lattice degeneration and retinal detachment in the fellow eye. No relationship has been established between energy application and incidence of retinal detachment. According to one study the incidence of RD following Nd:YAG laser capsulotomy was 0.82% , with a mean time of 32 months between cataract surgery and capsulotomy and 13.5 months between capsulotomy and RD.[23]

The incidence of retinal detachment following penetrating keratoplasty is variable, dependent on whether the eye is phakic or pseuphakic or whether the procedure has involved vitreous manipulation. Several series report 2.4-6.8% of cases with RRD[28]

Intravitreal injections have entered the therapeutic arena recently and remain a potential threat to causation of a rhegmatogenous retinal detachment. Iaterogenic retinal tears and rips due to misdirected needles can cause retinal detachment, however most studies have documented that this risk is low. A consecutive, interventional, multicenter case series measured the incidence of RD in patients receiving intravitreal anti-vascular endothelial growth factor. During 36 consecutive months the incidence rate of RRD was 0.013% (5/35 942) (1 per 7188 injections)[29] .

8. Affluence

Socio-economic deprivation plays a major role in health and disease, but its role in retinal detachment in England has not been studied. Figure 8 shows the study population being split by Index of Multiple Deprivation (IMD) scores into quintiles from the least deprived (group 1) to the most deprived (group 5). As shown by the standardised admission ratio (with lower and upper 95% CIs) there is a gradient with deprivation score showing a significant relationship, though not strong, between affluence (least deprived) and retinal detachment surgery. There's about a 10% difference between the least deprived quintile and the most deprived (n= 57,949).

The Scottish Retinal Detachment Study Group, based on 12 months prospective research between 1 November 2007 and 31 October 2008, assessed 572 patients diagnosed with primary retinal detachment[29]. They came to the conclusion that retinal detachment is twice as common among the more affluent than those living in areas of deprivation. This might be as those in poorer areas may present later if at all to medical services and the more affluent tend to have greater myopic prevalence.

IMD Group	Index of Multiple Deprivation Score	No. of LA's	Observed	Expected	o/e	SAR	Confidence Interval (Lower)	Confidence Interval (Upper)
1 Least Deprived	8,36	71	9924	9150,1	1,08	108,5	106,3	110,6
2	12,68	70	9807	9615,1	1,02	102,0	100,0	104,0
3	17,13	70	9585	9793,4	0,98	97,9	95,9	99,9
4	22,92	70	11701	11903,7	0,98	98,3	96,5	100,1
5 Most Deprived	33,35	71	16932	17486,6	0,97	96,8	95,4	98,3
Total			57949	57949,0		100,0		

Fig. 8.

High myopia is one of the risk factors in patients with retinal detachment. It was documented that there is an association of short sightedness with intelligence quotient (IQ) and thus higher income and socio-economic status[31,32]. Saw et al. report the association between retinal detachment and educational achievement in a study of 1204 school children aged 10 to 12 in Singapore. Using the nonverbal Raven Standard Progressive Matrix test Intelligence Quotient they concluded that non-verbal IQ is a strong risk factor for myopia[32]. Higher prevalence of myopia in the most affluent quartile could explain the increased incidence in this group.

However, we cannot exclude the possibility that affluence is associated with some other, hitherto undefined, risk factor such as genetic factors. The latest evaluation by the Scottish Retinal Detachment Study Group investigated the influence of genetic predilection on primary RRD in 2011. They show a doubled risk of the condition in those having an affected sibling[33]. Whilst ethnicity could not be studied we know that the incidence of retinal detachment is lower in Asians and in Blacks[34].

As the risk of retinal detachment has direct connection with the most affluent group of population, there are implications for service planning, as there is likely to be a greater need for vitreoretinal services in wealthier areas.

9. Seasonality

Seasonal variation in RRD incidence has been widely reported. Most studies describe a summer peak and winter trough; others vice versa and some no seasonal variation at all[35-39]. This is likely attributed to increased sun exposure and outdoor activities in summer[36].

Figure 9 shows that the rate of retinal detachment surgery is higher in summer peaking in July with the lowest rates being in January-February. This pattern is most striking in males under

40 in whom there is relatively lower presentation in winter (lower incidence in December-February). The association with season was statistically significant at the level of p=0.01.
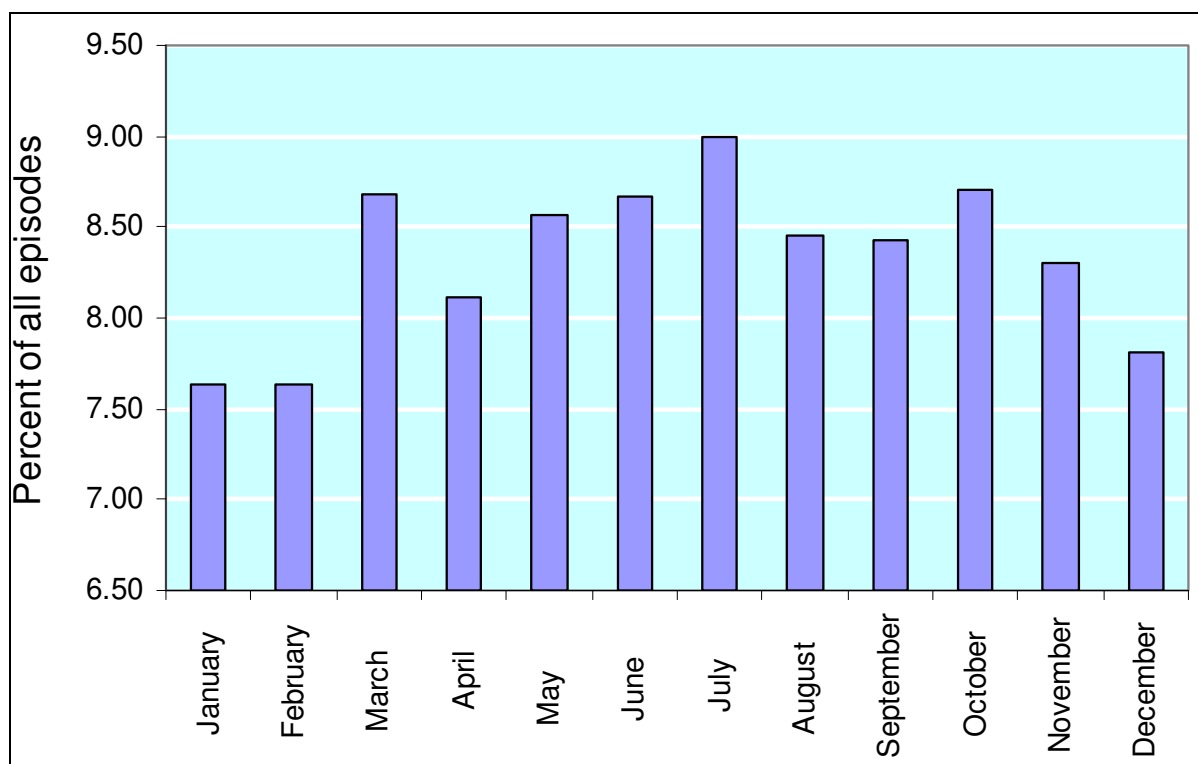

Fig. 9. Retinal detachment: monthly percentages of all FCEs, National data, male and females, any mention 1989-2006

We found a statistically significant summer peak and winter trough at the level of p=0.01 (n=115,450). The effect of light and temperature on the vitreous has been implicated. This study showed that the seasonal variation was most striking in younger males suggesting another association other than the season itself. Could this subgroup of patient be more active during the summer months and be more likely to experience trauma and PVD formation?

In a large retrospective review of 2314 patients with primary RRD in Germany, Thelen *et al.* (1997) reported a significant mid-summer peak incidence (n in July = 228) and winter trough (mean n December to January = 161) with a difference of 36% between the two periods. They noted a close correlation between seasonal incidence of RRD and seasonal incidence of light hours per day and considered a potential role of light-induced changes on vitreoretinal adhesion.[35]

Mansour *et al.* (2009) retrospectively reviewed the charts of 211 patients undergoing idiopathic RRD repair in one referral centre in Lebanon over a 13-year period. They reported a significant (P<0.05) increase in RRD in spring and summer compared to autumn and winter (56% vs. 44%). Interestingly, there was a significantly younger age of onset of RRD in the warmer months (47 vs. 54, P= 0.007).[36]

In contrast, a retrospective evaluation of RRD in Kuwait from 1981 to 1987 reported a peak incidence in winter (with the highest level in November) and a trough in the summer months.[38] These findings have not been replicated elsewhere.

Studies reporting no apparent seasonal variation in RRD incidence include the large prospective population-based study by the Beijing Rhegmatogenous Retinal Detachment Study Group. There were no seasonal differences in incidence even after further classification of retinal detachments into blunt traumatic, aphakic and pseudophakic and non-traumatic phakic.[39]

Possible explanations for seasonal variation in RRD incidence include: variations in light and temperature affecting vitreous structure, and increased outdoor activity and consequent trauma during periods of longer daylight hours and warmer weather [35].

Posterior vitreous detachment (PVD) is widely accepted as a contributory factor in RRD. Mitry *et al.* (2011) found that more than 85% of RRDs are associated with PVD and associated tractional retinal tears.[40] The influence of climatic variables namely seasonality, air temperature, solar radiation and humidity on PVD rates was elegantly evaluated by Rahman *et al.* (2002).[41] They retrospectively reviewed 567 patient records diagnostically coded as PVD in the Oxford Eye Casualty over a 2-year period. They excluded cases with a precipitating cause for PVD such as blunt trauma, retinal vascular disease and diabetes, and looked for a correlation between ambient temperatures, humidity and solar radiance and PVD incidence. Interestingly, they found no statistically significant difference in the total numbers of new patients attending the Eye casualty over the summer months compared to winter (912 from April to September vs. 839 October to March). They did however note a strong association (P= 0.035) between weekly average air temperatures and PVD incidence. Air temperatures of the previous week also correlated positively with PVD incidence (P = 0.028). The higher the average air temperature the higher the weekly rate of PVD. As such, increased physical activity and dehydration associated with higher ambient temperatures may alter vitreous structure and thereby increase the incidence of PVD and, in turn, RRD. Further investigation into the role of increased temperature on the biochemical structure of the vitreous and retinal detachment rates is needed.

10. Conclusion

The data on overall incidence of RRD worldwide has been inconsistent. The incidence varies with the population studied and is limited by study design and inclusion criteria. Few recent estimates of incidence have used large samples sizes. These studies show national data and provides longitudinal information, a more inclusive estimate of incidence and its' variation over time.

The highest annual incidence of RRD in England is in the 70-74 year age group with a secondary peak in young myopes and a higher overall incidence in males. Retinal detachment is correlated with affluence and season in England and there is geographic variation. This data sheds light into understanding the epidemiology of RRD in England. This would be particularly useful in designing and developing vitreo-retinal services to meet local needs.

11. Clinical features and management summary

Patients perceive flashing lights and floaters acutely. It probably arises from the mechanical stimulation of vitreoretinal traction on the retina. Floaters are opacities in the vitreous cavity that cast a shadow in the patient's visual field. Cobwebs are caused by condensation of the collagen fibers. Floaters can also indicate fresh blood due to the rupture of a retinal vessel

during an acute PVD. Patients often describe a black curtain (visual field defect) once the subretinal fluid accumalates. When the macula becomes detached (ie, extension of subretinal fluid into the macula), the patient experiences a drop in central vision.

Cell and flare may be seen in the anterior chamber and the intraocular pressure is usually lower in the affected eye. Pigment in the anterior vitreous ('tobacco dusting' or a Shaffer sign) is usually present and this represents release of retinal pigment epithelium through the retinal break. Once the retina becomes detached, it assumes a slightly opaque color secondary to intraretinal edema. It has a corrugated appearance and undulates freely with eye movements unless severe proliferative vitreoretinopathy is present.

Patients with a RRD should be referred to a vitreoretinal specialist immediately. Regardless of the surgical technique chosen, the surgical goals are to identify and close all the breaks with minimum iatrogenic damage. Closure of the breaks occurs when the edges of the retinal break are brought into contact with the underlying RPE. This is accomplished either by bringing the eye wall closer to the detached retina (using a scleral buckle) or by pushing the detached retina toward the eye wall (intraocular tamponade with a gas bubble or silicone oil). Sealing of the breaks is accomplished by creating a strong chorioretinal adhesion around the breaks; this may be completed with cryotherapy or laser photocoagulation.

Scleral buckles usually are made of solid silicone and silicone sponges. Indirect ophthalmoscopy is used to localize all the breaks. Once the breaks are localized, they are usually treated with cryotherapy. A buckling element is chosen and sutured over the breaks. The drainage of the subretinal fluid is a controversial topic among vitreoretinal specialists. The retina can be reattached by either technique and the technical details are outside the remit of this chapter.

Currently, many surgeons use pars plana vitrectomy surgery (PPV) to treat primary uncomplicated retinal detachments. A central core vitrectomy and removal of the vitreous from the margins of the breaks is the next step. Drainage of subretinal fluid through a break internally is then performed. Intraocular tamponade with either gas or silicone oil is chosen according to the surgeon's preference. The advantages of gas are that it has a higher surface tension than silicone oil and it dissipates on its own. The disadvantage is that it expands with changing atmospheric pressure. Patients with an intraocular gas bubble should not fly. Transconjunctival and suture-less small-gauge vitrectomy has gained popularity in the past few years. 23 and 25 gauge systems have several potential advantages over traditional 20-gauge vitrectomy including improved patient comfort, faster wound healing, decreased inflammation, less conjunctival scarring, and a decrease in surgical time in opening and closing.

More than 90% of RRD cases can expect anatomical success with reattachment following one operation. Further surgery is required in the failed cases.

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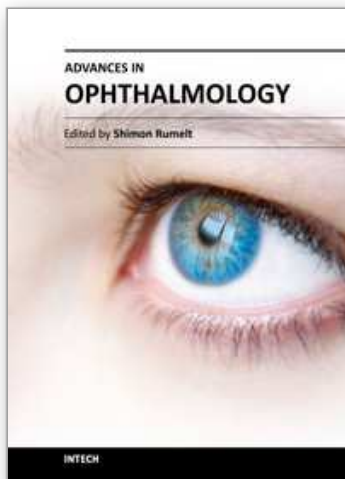
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