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Return to the Operating Room after Macular Surgery

IRIS Registry Analysis

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Purpose: To investigate the rate of return to the operating room after vitrectomy surgery to treat macular hole or epiretinal membrane.

Design: A retrospective registry cohort.

Participants: Individuals receiving care in ophthalmology practices participating in the Academy IRIS (Intelligent Research in Sight) Registry.

Methods: Data from the IRIS Registry were analyzed for patients who underwent vitrectomy for macular holes or epiretinal membranes. Cases were identified by the combination of International Classification of Diseases, 9th revision code (362.54, 362.56) and a current procedural terminology (CPT) code for vitrectomy surgery between January 1, 2013 and June 30, 2017.

Main Outcome Measures: The eyes that underwent additional eye surgery within 1 year after initial vitrectomy for macular hole or epiretinal membrane were identified, as was the nature of the additional procedures per CPT code.

Results: A total of 41 475 eyes underwent vitrectomy for macular hole and 73 219 eyes underwent vitrectomy for epiretinal membrane during the study period. In the macular hole group, 7573 had a second surgery within 1 year, and 2827 (6.8%) had a second surgery that was not cataract related. In the epiretinal membrane group, 12 433 had a second surgery within 1 year, 4022 (5.5%) of which were not cataract related. In the macular hole group, 4.6% of eyes returned to the operating room for another macular hole repair surgery, and 2.0% returned for retinal detachment repair. In the epiretinal membrane group, 1.4% returned for a second vitrectomy with membrane stripping, and 2.5% returned for retinal detachment repair.

Conclusions: This registry-based study encompassed a large number of patients but was limited by the inaccessibility of some information and the potential for inaccurate medical records or coding, as it obtained data from multiple electronic health records entities. Excluding cataract surgery, approximately 6% of eyes that underwent vitrectomy to address macular hole or epiretinal membrane returned for a second ophthalmic procedure within a year. In the macular hole group, most secondary non-cataract surgeries were for another macular hole repair procedure. For both macular holes and epiretinal membranes, approximately 2% of eyes required retinal detachment repair surgery within 1 year. *Ophthalmology 2018;125:1273-1278 © 2018 by the American Academy of Ophthalmology*

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Macular holes (MH) and epiretinal membranes (ERM) are relatively common macular pathologies that may cause significant vision loss for patients. Both are predominantly treated with vitrectomy surgery, and both are among the most common reasons that vitrectomy is performed. Vitrectomy is considered a generally effective means of improving patients' vision in these cases. In the case of MH, surgical hole closure has been generally reported to improve the best-corrected visual acuity (BCVA) in a majority of patients by 2 to 3 lines, depending on the duration and size of the MH, extent of myopia, presence of comorbid macular pathology, and other factors.[1–8] ERM removal with vitrectomy may improve vision by a mean of 2 to 4 lines, again depending on duration of time that the ERM has been present, preoperative acuity, and other ocular pathology.[9–13]

For MH, surgical success is typically defined by anatomic closure of the hole. A large number of series have reported anatomic success outcomes between 85% and 100% using a variety of surgical techniques, tamponade agents, and postoperative positioning regimens.[14–17] The Australian and New Zealand Society of Retinal Specialists Macular Hole Study Group reported a primary hole closure rate of 95% in 2456 eyes.[18] Other examined means of closing MH include enzymatic vitreolysis, which with ocriplasmin in clinical trials achieved a 30% closure rate on small (<400 μm) MH, and gas injection in the absence of vitrectomy, which has been reported to close up to 66% of small MH in the setting of vitreomacular traction.[19,20] Spontaneous closure of MH has also been reported but is uncommon.[21,22]

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Postoperative complications with vitrectomy for MH repair include endophthalmitis, vitreous and choroidal hemorrhage, iatrogenic macular damage, secondary ERM formation, cystoid macular edema, retinal tear, retinal detachment (RD), and cataract development or progression.[23–25] Intraoperative retinal tear has been reported in up to 6% of vitrectomies for MH, and postoperative retinal tear or RD formation in anywhere from 1% to 14% of eyes.[1,26–33] The majority of postoperative RD and reopening of MH in published series occur in the first year after the vitrectomy.[34–36]

Vitrectomy for ERM is typically defined as successful with removal of the ERM from the central or entire macula, with a corresponding improvement in macular anatomy and vision. Visual prognosis is affected by preoperative visual acuity and duration of the macular pathology, similar to MH.[10] The rate of recurrence of symptomatic ERM has been reported to occur up to 5% of the time.[2,4,8–10] Removal of the internal limiting membrane alongside the ERM removal may reduce the risk of recurrence, although this approach is not universal.[35] There is no commonly used alternative to vitrectomy for treatment of ERM at this time.

The complication profile with vitrectomy for ERM is near-identical to that for MH repair. Iatrogenic intraoperative retinal tears may occur in 1% to 6% of cases.[9,10,37–40] Postoperative RD development has been reported in 1% to 7% of eyes after ERM removal.[9–12,28,37,39] Endophthalmitis and choroidal hemorrhage are rare events.[28,41–43]

For this series, the American Academy of Ophthalmology's IRIS (Intelligent Research In Sight) Registry was utilized to examine how often and why patients required additional surgery after vitrectomy for MH or ERM. The IRIS Registry is a clinical data registry of eye care in the United States that began full operation in March of 2014 and is now used by more than 10 000 ophthalmologist members of the American Academy of Ophthalmology and their employed optometrists. Over 100 million patient visits have been logged.[44] The registry's broad pool of real-world patient care data was queried to examine the postoperative course in the context of existing literature regarding MH and ERM repair.

Methods

All cases were identified within the IRIS Registry via a combination of International Classification of Diseases, 9th revision and 10th revision (ICD-9-COM and ICD-10-COM) code and current procedural terminology (CPT) code. The ICD-9-COM codes that were applied to identify patients were 362.54 ("macular hole") and 362.56 ("macular puckering"). The ICD-10-COM codes were H35.349 ("macular hole") and H35.379 ("macular pucker"). The CPT codes were 67041 ("vitrectomy/membrane stripping") and 67042 ("vitrectomy/macular hole repair"). All patients 18 years and older with a combination of 1 each of the above ICD-9-COM and CPT codes in the selected time period (January 1, 2013 to June 30, 2017), were included in the study pool.

It was noted during the initial query that a significant number of eyes had multiple ICD-9-COM or ICD-10-COM codes linked to a surgical procedure. For instance, an eye might have the ERM and the MH ICD-9-COM codes linked to an MH repair CPT code, or the ERM and RD codes linked to an RD repair CPT code. To keep the data clean and eliminate redundancy, ICD-9-COM and ICD-10-COM codes were prioritized, and only the code determined to be of greatest pathology was used. MH was weighed to be of greater priority than ERM but less so than RD or vitreous hemorrhage (VH). ERM was prioritized over 379.24 ("vitreous opacities") and 379.21 ("vitreous degeneration"). Thus a patient with an MH and ERM coded was considered as part of the MH group only, and a patient with ERM and vitreous opacities was put in the ERM group only. A patient with VH or a tractional or rhegmatogenous retinal detachment was excluded from both MH and ERM groups.

Patients' IRIS Registry data for 1 year after the initial MH or ERM surgery was accessed. Any subsequent ophthalmic surgically related CPT codes were analyzed and included in the results, with the exception of standalone intravitreal injections. The presence or absence of additional CPT codes and the nature of the secondary CPT codes was recorded. Intraocular surgery CPT codes were included in this analysis, and codes related to in-office procedures like intravitreal injections or adnexal surgeries were excluded. Final visual acuity and final intraocular pressure (IOP) were obtained at the visit closest to 1 year after the first surgery if there was no second surgery, or closest to 1 year after the second surgery if a second surgery was performed.

All patient data were included or excluded based on the ICD-9-COM and CPT code algorithm mentioned above. The individual treating physicians or practices did not impact the process of case selection or analysis. All patients that were saved in the electronic health records of practices participating in the IRIS Registry were accessible to the investigation.

The entirety of the data in this study was obtained from the IRIS Registry. The latter identifies patient data via a combination of patient-specific identifiers such as social security number, name, and date of birth, and then assigns a unique patient identifier. Thus if a patient receives care with 2 different physicians or 2 different practices that both participate in IRIS, the patient data from both settings should be integrated. However, any care from a provider or health care entity that was not an IRIS Registry participant was not accessible. For research purposes, the IRIS Registry de-identifies all patient data when it extracts it from the electronic health record, so there was no potential for the authors of this study to personally identify any individual patients.

The IRIS Registry maintains internal identifiers for the sake of data integrity. The IRIS Registry data set has been previously qualified as Health Insurance Portability and Accountability Act (HIPAA) compliant.

Statistical analysis was performed with chi-square analyses and *t* tests as dictated by the data groups and comparison format. Visual acuity was typically recorded in Snellen lines and translated to logarithm of the minimum angle of resolution (logMAR) units for quantitative assessments.

Results

In the IRIS Registry between January 1, 2013 and June 30, 2017, 223 205 eyes in 209 915 unique patients underwent vitrectomy for MH, ERM, or vitreous opacities as defined by the prioritization process above (Fig 1). A total of 27 709 (12.4%) of those eyes underwent a second surgery in the same eye within 1 year afterward.

After the formula for prioritizing the diagnoses was applied and redundant codes were addressed (see "Methods"), there were 41 475 eyes that underwent vitrectomy for MH (Table 1). Of these, 7573 (18.3%) eyes received a second surgery within 1 year. Of these secondary surgeries, 2827 (6.8% of the total MH eyes) were non-cataract procedures. The remainder (4746, or 11.4% of the total MH eyes) underwent cataract surgery. The most

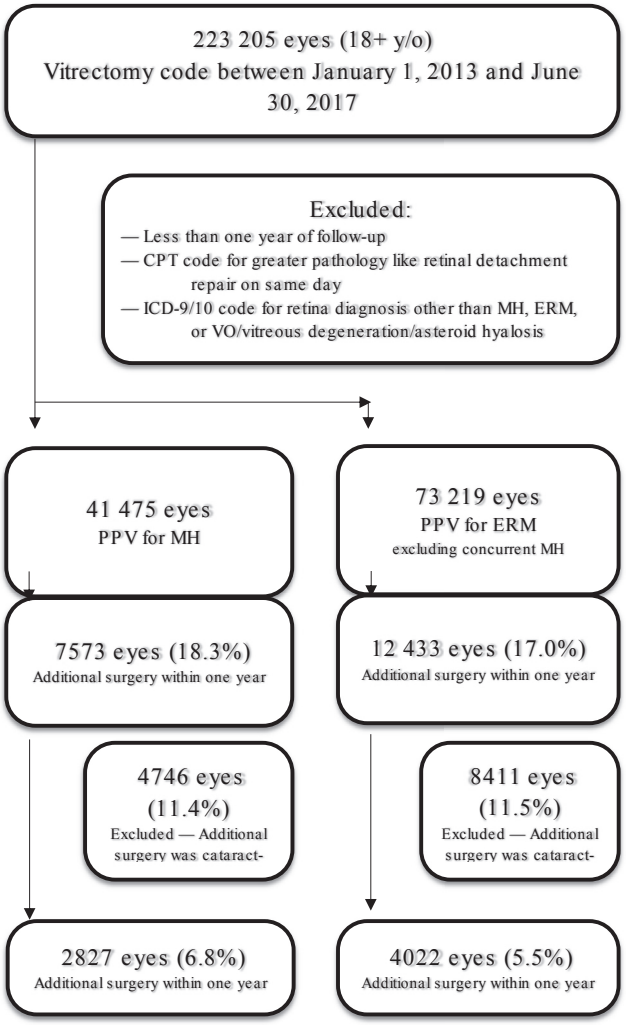

Figure 1. Protocol for identification of macular hole and epiretinal membrane cases. CPT = Current Procedural Terminology; ERM = epiretinal membrane; ICD = International Classification of Diseases; MH = macular hole; PPV = pars plana vitrectomy; VO = vitreous opacities.

common CPT code for a secondary, non-cataract procedure was 67042 ("vitrectomy/macular hole repair"), in 1899 eyes (4.6% of the total MH eye group). Other common CPT codes for the second surgery were 67108 ("retinal detachment repair") in 432 eyes (1.0%), 67113 ("complex RD repair") in 418 eyes (1.0%), 67041 ("vitrectomy/membrane stripping") in 217 eyes (0.5%), 67040 ("vitrectomy/panretinal laser") in 84 eyes (0.2%), and 67039 ("vitrectomy/focal laser") in 47 eyes (0.1%).

Regarding ERM, 73 219 eyes received vitrectomy for ERM using the same prioritization method, and 12 433 eyes (17.0%) underwent a subsequent ophthalmic surgery within 1 year (Table 2). Of those secondary procedures, 8411 (11.5% of total ERM eyes) were cataract related. Thus, 4022 eyes (5.5% of the total ERM eyes) required a secondary procedure that was not cataract related. For the second surgery in the ERM group, the most common CPT codes were 67041 ("vitrectomy/membrane stripping") in 1049 eyes (1.4%), 67113 ("complex retinal detachment repair") in 1048 eyes (1.4%), 67042 ("vitrectomy/

Table 1. Reasons for Additional Procedure after Macular Hole Repair

Procedure (CPT Code)	Number of Eyes (N = 41 475)*	% of Eyes that Underwent Initial MH Repair
Vitrectomy/MH repair (67042)	1899	4.6
Retinal detachment repair (67108)	432	1.0
Complex retinal detachment repair (67113)	418	1.0
Vitrectomy/membrane stripping (67041)	217	0.5
Vitrectomy/panretinal laser (67040)	84	0.2
Vitrectomy/focal laser (67039)	47	0.1

CPT = Current Procedural Terminology; MH = macular hole.
*Eyes that underwent second surgeries may have had more than 1 procedure code associated with the second surgery, so the sum of eyes with each CPT code exceeds the total number of second surgeries.

macular hole repair") in 944 eyes (1.3%), 67108 ("retinal detachment repair") in 820 eyes (1.1%), 67040 ("vitrectomy/panretinal laser") in 524 eyes (0.7%), and 67039 ("vitrectomy/focal laser") in 131 eyes (0.2%).

The effect of the second surgery on visual acuity and IOP was analyzed. Eyes that underwent MH or ERM repair and then did not require a second, non-cataract-related surgery had a mean final BCVA of 0.51 with a standard deviation of 0.61. Eyes that did require a second, non-cataract-related surgery had a mean final BCVA of 0.62 and standard deviation of 0.75. This difference between the final BCVA of those that did and did not undergo secondary surgery was statistically significant ($P < 0.001$). Eyes were not included in the visual acuity analysis if the visual acuity was listed as "uncorrected" or "unspecified." The mean IOP decreased from the preoperative visit to the final postoperative visit, regardless of whether a second surgery was performed or not. In those eyes that did not require a second surgery, the IOP decreased by a mean of 0.6 mmHg after the surgery. In those eyes that did undergo the additional procedure, the IOP decreased by a mean of 0.6 mmHg. The *P* value was not significant.

Discussion

Just under 5% of eyes that underwent MH repair returned to the operating room for another MH repair in the same eye in this study. Most of the large series in the existing literature over the last decade indicate a primary hole closure rate of 85% to 95%. Translating this study's 5% rate of MH eyes subsequently requiring another vitrectomy for MH repair into an estimate of primary surgery hole closure rate is problematic, though. On the one hand, the IRIS Registry data included all MH types and sizes and was probably much more inclusive of difficult or complex cases than some published series. On the other hand, many eyes that did not achieve anatomic closure after the first surgery may not have gone to a second surgery in the first year, or at all, or may have had additional surgery with an ophthalmologist who was not an IRIS Registry participant (as discussed later). Nonetheless, the IRIS Registry data indicate that at least 5% of eyes that undergo MH repair will require additional MH repair, specifically in the first 12 months afterward.

Table 2. Reasons for Additional Procedure after Epiretinal Membrane Repair

Procedure (CPT Code)	Number of Eyes (N = 73 219)*	% of Eyes that Underwent Initial ERM repair
Vitrectomy/membrane stripping (67041)	1049	1.4
Complex retinal detachment repair (67113)	1048	1.4
Vitrectomy/macular hole repair (67042)	944	1.3
Retinal detachment repair (67108)	820	1.1
Vitrectomy/panretinal laser (67040)	524	0.7
Vitrectomy/focal laser (67039)	131	0.2

CPT = Current Procedural Terminology; ERM = epiretinal membrane.
*Eyes that underwent second surgeries may have had more than 1 procedure code associated with the second surgery, so the sum of eyes with each CPT code exceeds the total number of second surgeries.

The rate of RD repair after vitrectomy for MH was 2% when combining the numbers for the "retinal detachment repair" and "complex retinal detachment repair" codes. For ERM, the combined rate of secondary surgery for the 2 RD CPT codes was 2.5%. These RD rates are relatively in line with recent literature.[6,9–12,26–33,35,39] Most RD after surgery for macular pathology probably occur within the first year, but late RD have certainly been reported, and this data series would not reflect those cases.[6,34,36] Because RD frequently require emergent or urgent surgery, the initial surgeon may have been inaccessible to some patients. If the second surgeon was not an IRIS Registry participant, the second surgery would have been absent in the data. We did not include in-office laser retinopexy for retinal tears in this analysis. It is also possible that some of the second surgeries that were coded as "vitrectomy/panretinal laser" or "vitrectomy/focal laser" were for retinal tears or retinal detachments, perhaps in the setting of VH.

Cataract surgery after vitrectomy for MH or ERM was not analyzed in depth for this study. Approximately 11.5% of eyes undergoing surgery for either MH or ERM received cataract surgery within 1 year. This likely underestimates the actual rate of cataract extraction in that time period. Unlike additional retina surgery, which would have a high likelihood of occurring within the same practice, cataract surgery would be much more likely to occur in a different practice than that of the original vitrectomy. It was believed that the data loss from those cataract surgeries occurring with ophthalmologists who were non-participants in the IRIS Registry would have been higher. The chart data on the presence or absence and grading of cataract were also frequently inaccessible or lacking. The effect of multiple vitrectomies on cataract extraction was not analyzed, nor was the effect of lens status on the rate of secondary vitrectomy surgery.

The BCVA trended lower in the group that required a second, non–cataract-related surgery after the first vitrectomy. This is also consistent with existing, smaller series. D'Souza et al[45] reported some limited improvement in final acuity in 55 MH cases that required secondary hole repair, even with successful anatomic closure after the second surgery. Grewing and Mester[46] reported a series of recurrent ERM in 42 cases after a primary surgery to remove an ERM, and indicated that visual gain after the second surgery was limited. However, in this study the visual acuity data should be interpreted with caution, considering that the testing method was not standardized and often not evident in the patient data. The logMAR conversion, comparison, and statistical analysis in this setting of uncontrolled Snellen line data is problematic and limits the conclusions that can be made.

Some data were inaccessible to us during this investigation. The most relevant, perhaps, was the surgical record, as it was not uniformly inserted into the clinical electronic health record. Thus surgical details such as the gauge of vitrectomy instrumentation, the extent of peripheral vitreous removal, and the approach to internal limiting membrane removal or tamponade were not available. It can be presumed from external surveys that as this study period was 2013–2017, the majority of cases were performed with small-gauge instrumentation and the majority of MH cases involved internal limiting membrane removal, but the exact numbers are not known (American Society of Retina Specialists PAT Survey 2014).[47]

Some other limitations to this study are common to clinical registry investigations. The data come directly and exclusively from the IRIS Registry, and are dependent on the accuracy of the information that the treating physicians input into their electronic health records. The ERM and MH cases in this study were identified based on ICD-9-COM, ICD-10-COM, and CPT codes, so miscoded diagnoses or procedures—done either intentionally or unintentionally—may have incorrectly excluded or included some eyes. Patient charts were not reviewed individually for this study, as the cases are de-identified to researchers. Our method of prioritizing certain diagnoses, such as MH over ERM, undoubtedly eliminated some cases from consideration and incorrectly included others, but was an attempt to keep the data as clean and unfettered as possible.

Several specific coding-related scenarios bear mentioning. The first is the case of lamellar MH. The vitrectomy for these can be coded for either MH, ERM, or both. We did not have an effective means of separating the lamellar holes into a separate study group. Lamellar holes are distinct clinically and surgically, and it would be helpful to analyze them separately in the future. The second scenario is that of an eye undergoing vitrectomy predominantly for vitreous opacities, but in whom a membrane was removed and the surgery coded as vitrectomy with membrane stripping, with ERM as the diagnosis coded. The primary pathology would in reality be vitreous opacities rather than ERM, which may well have a different risk profile with vitrectomy. It is unclear how often this occurred, and we did not have the capacity to remove these cases from the ERM group.

We also do not know how many patients were lost to follow-up, and whether that was inadvertent or owing to a transfer of care or release from clinic per the treating physician. It should be emphasized that if patients received care from providers who are not in the registry, that clinical

data would be inaccessible to the IRIS Registry. A significant minority of practicing ophthalmologists, including many in academic centers, are not participants in the IRIS Registry, so any subsequent surgeries that were referred to those practitioners would not be reflected in the data. The overall effect of this data loss might be an underestimation of the reoperation rate. The rate at which patients sought initial care with an IRIS Registry participant and subsequent care with a non-participant is not known.

By the nature of this type of study, the causative link between the initial vitrectomy and subsequent surgery cannot be confirmed. It should also be emphasized that the rate of return to the operating room does not encompass the entirety of the surgical risk or postoperative complications that can occur, and that this study lacks the granular data that a single-center or multicenter retrospective chart review offers. A retrospective series with a limited number of physicians and detailed chart review can include surgical details and information on patients lost to follow-up or referred elsewhere. Considering that this study's analysis was dependent on physician coding for patient identification and only included data from a portion of American ophthalmologists (those participating in the IRIS Registry), one could suspect that the rate of additional surgery was in fact higher than this study's results indicate.

If the IRIS Registry continues to expand in patient numbers and in the sophistication of its data acquisition and organization, the capacity to perform increasingly detailed analyses may, we hope, grow. This study was an initial attempt to characterize the risk for additional surgery after vitrectomy for relatively common elective indications. The real-world rate of return to the operating room within 1 year after MH or ERM repair and the rate of retinal detachment was not insubstantial and was generally consistent with recent literature, although limitations with a registry investigation like this one remain significant. Further investigation and more accurate means of acquiring and analyzing patient data will, ideally, allow us to better identify, stratify, and manage this risk.

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HUMAN SUBJECTS: Human subjects were part of this study protocol. The IRIS Registry de-identifies all patient data when it extracts it from the electronic health record, so there was no potential for the authors of this study to personally identify any individual patients. The IRIS Registry maintains internal identifiers for the sake of data integrity. The IRIS Registry data set has been previously qualified as Health Insurance Portability and Accountability Act (HIPAA) compliant. The IRIS Registry maintains internal identifiers for the sake of data integrity.

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Author Contributions:

Conception and design: Parke, Lum

Data collection: Parke, Lum

Analysis and interpretation: Parke, Lum

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Abbreviations and Acronyms:
BCVA = best-corrected visual acuity; **CPT** = current procedural terminology; **ERM** = epiretinal membrane; **ICD** = international classification of diseases; **IOP** = intraocular pressure; **logMAR** = logarithm of the minimum angle of resolution; **MH** = macular hole; **RD** = retinal detachment; **VH** = vitreous hemorrhage.

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