Seizure Outcomes in Occipital Lobe and Posterior Quadrant Epilepsy Surgery: A Systematic Review and Meta-Analysis

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Abstract

BACKGROUND—Occipital lobe epilepsy (OLE) is an uncommon but debilitating focal epilepsy syndrome with seizures often refractory to medical management. While surgical resection has proven a viable treatment, previous studies examining postoperative seizure freedom rates are limited by small sample size and patient heterogeneity, thus exhibiting significant variability in their results.

OBJECTIVE—To review the medical literature on OLE so as to investigate rates and predictors of both seizure freedom and visual outcomes following surgery.

METHODS—We reviewed manuscripts exploring surgical resection for drug-resistant OLE published between January 1990 and June 2015 on PubMed. Seizure freedom rates were analyzed and potential predictors were evaluated with separate meta-analyses. Postoperative visual outcomes were also examined.

RESULTS—We identified 27 case series comprising 584 patients with greater than 1 yr of follow-up. Postoperative seizure freedom (Engel class I outcome) was observed in 65% of patients, and was significantly predicted by age less than 18 yr (odds ratio [OR] 1.54, 95% confidence interval [CI] 1.13–2.18), focal lesion on pathological analysis (OR 2.08, 95% CI 1.58–2.89), and abnormal preoperative magnetic resonance imaging (OR 3.24, 95% 2.03–6.55). Of these patients, 175 also had visual outcomes reported with 57% demonstrating some degree of visual decline following surgery. We did not find any relationship between postoperative visual and seizure outcomes.

CONCLUSION—Surgical resection for OLE is associated with favorable outcomes with nearly two-thirds of patients achieving postoperative seizure freedom. However, patients must be counseled regarding the risk of visual decline following surgery.

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Keywords

Epilepsy; Extra-temporal; Occipital lobe; Outcome; Resection; Surgery

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Occipital lobe epilepsy (OLE) is relatively uncommon, accounting for 5% to 10% of focal epilepsy cases.[1–3] Causes are wide-ranging and include metabolic, structural, neoplastic, traumatic, infective, and idiopathic etiologies.[1] OLE semiology often involves visual symptoms including hallucinations, blindness, eye blinking, and nystagmus.[4–6] However, OLE can also manifest with altered mental status and generalized tonic-clonic activity, suggesting electrical spread to neighboring cortical regions, and complicating accurate diagnosis and seizure localization.[7] Overall, OLE is often a severely debilitating disorder with significant impact on patient quality of life.

For OLE patients with medically refractory seizures, focal surgical resection has proven a viable therapeutic option, with many studies reporting postoperative seizure freedom in the majority of patients.[3,4,8–11] Despite this reported success, OLE surgery is not without its challenges. While OLE can arise from an identifiable focal lesion, such as a malformation of cortical dysplasia (MCD) or tumor, identifying a seizure focus in many other cases can be challenging, as magnetic resonance imaging (MRI) and ictal electroencephalography (EEG) are not always localizing.[1,3,12,13] Additionally, because of anatomic proximity to the visual cortex, OLE surgery is associated with the risk of postoperative visual decline.[8,13–15]

In previous reports of resective epilepsy surgery, seizure freedom is achieved in approximately 60% to 80% of individuals with temporal lobe epilepsy (TLE) and 40% to 60% of patients with extra-temporal lobe epilepsy (ETLE).[16–18] Compared to other focal epilepsies, OLE is less common and thus relatively understudied. The case studies that are available show significant variability in their results due to their generally small sample size and patient heterogeneity. No randomized-controlled trials or systematic reviews of OLE surgical outcomes have yet been reported. Consequently, specific rates and predictors of both seizure freedom and visual decline following surgery are not known. Such information is critical to improve patient selection for OLE surgery. In this paper, we provide first the systematic review and meta-analysis of outcomes following surgical resection for drug-resistant OLE.

METHODS

Article Selection and Data Extraction

A PubMed search was performed for unique entries between January 1990 and June 2015 using the following query guidelines: ((occipital AND(seizure* OR epilepsy))AND(surgery OR surgical OR resection)). We selected 1990 as a starting date because prior to this few papers were published examining OLE surgery outcomes and of those available, many used surgical techniques different from modern therapeutic approaches. Inclusion criteria required that each manuscript be a peer-reviewed clinical investigative study or case series of seizure outcome in surgical treatment of occipital, temporo-occipital, and/or parieto-occipital epilepsy. As such, case reports, review articles, and conference abstracts or papers were not

included. Exclusion criteria included (1) <5 patients with epilepsy involving the occipital lobe (5 being the minimum number of patients needed to limit bias in analysis as we have established in previous systematic reviews[17,19]), (2)<12 mo mean or median follow-up so as to ensure stability of Engel outcomes as previously demonstrated, [20] (3) data redundant with another manuscript, (4) outcomes for epilepsy involving the occipital lobe unable to be separated from non-occipital cases, (5) seizure outcome not reported using the Engel et al[21] or a directly translatable scale, (6) patients treated with disconnective surgery, such as corpus callostomy or multiple subpial transections, and (7) body of manuscript not in English. Studies including resections for epilepsies not involving the occipital lobe were included in part where data could be disaggregated. This article selection process is summarized in Figure 1, with included studies listed in Table 1. Two separate reviewers applied the inclusion criteria to the PubMed search result; there were no disagreements. Three separate reviewers applied the exclusion criteria to the remaining articles. There were 2 instances of disagreement, and in each case, the opinion of the 2 agreeing authors was used. This study was planned and executed in accordance with published Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.[22]

In extracting data from these studies, postoperative seizure outcomes were classified as freedom from disabling seizures (Engel class IA-D outcome) or persistent disabling seizures (Engel II-VI) at 1 yr after surgery. Additionally, postoperative visual outcomes were defined as either no change in vision following surgery or some decline in hemispheric vision compared to a preoperative baseline, as reported in individual studies. Notably, visual decline did not necessarily equate to visual loss.

Statistical Analysis

Data were analyzed as previously described.[23] Specifically, seizure freedom rates and visual outcomes following surgery were determined for all patients. Data were then stratified by potential variables of interest. Preliminary intergroup comparisons were made using Pearson's chi-square tests. Factors identified as associated with seizure freedom were dichotomized and then evaluated using meta-analyses. Meta-analyses were not completed for visual outcomes since no factor met statistical significance following initial analysis. To minimize selection bias, variables selected for meta-analysis had to include at least 80 patients across 5 or more different investigations, with each study comparing at least 2 separation conditions for the variable analyzed. For each meta-analysis performed, the appropriateness of a mixed-effects model was determined with the Cochran Q statistic evaluating heterogeneity between studies. Given limitations of the Q statistic in meta-analyses with a relatively small number of source studies, the I^2 index was also calculated for each meta-analysis to estimate true between-study variance.[24] Individual studies were appropriately aggregated using inverse-variance weighting. Effect size for individual variables across studies was expressed using forest plots with odds ratios (OR) determined using a 95% confidence interval (CI). Differences between groups were explored using the ORs of the pooled proportions. Funnel plots were used to judge publication bias with none being found. All statistical analysis was performed with SPSS version 20 (IBM Inc, Armonk, New York) with statistical significance defined as $P < .05$.

RESULTS

Twenty-seven prospective or retrospective case series reporting postoperative seizure outcomes and associated factors in patients undergoing surgery for drug-resistant OLE were analyzed.[3–5,8–15,25–38] The PubMed search did not identify any usable prospective controlled trials. In total, these studies included 584 patients, with 6 to 52 individuals per report (Table 1). Overall, 65% of OLE patients achieved postoperative seizure freedom (Engel Class I outcome), with rates ranging from 25% to 100% within individual studies and no trend observed across time (Figure 2).

Several factors were examined for potential relationship to postoperative seizure outcomes (Table 2). Among demographic factors, seizure freedom was achieved more often in children and adolescents (age less than 18 yr of age) compared to adults (Table 2, A). Examining epilepsy characteristics, seizure freedom was more often achieved in patients with MCD, tumor, or vascular malformation compared to those with gliosis, normal tissue, and other pathology subtypes (Table 2, B). Additionally, patients with abnormal diagnostic MRIs more often had Engel I outcomes after surgery (Table 2,C). With regard to resection type, quadrantectomy (defined as a multilobe resection of the posterior quadrant including occipital, parietal, and posterior temporal regions) or lesionectomy achieved higher rates of favorable seizure outcomes than corticectomy or lobectomy (Table 3, D). No difference in seizure outcome was noted amongst other factors examined.

Potential predictors of postoperative seizure freedom identified on preliminary analysis were then evaluated with formal meta-analysis (with the exception of resection type given that fewer than 5 manuscripts compared at least 2 different resection types in the same study). As summarized in Figure 3, seizure freedom was achieved significantly more often in patients less than 18 yr of age compared to older individuals (OR 1.54, 95% CI 1.13–2.18), in patients with a focal lesion (MCD, tumor, or vascular malformation) on pathological examination compared to those with nonfocal pathology (OR 2.08, 95% CI 1.58–2.89), and in individuals with abnormal vs normal preoperative MRI (OR 3.24, 95% 2.03–6.55).

Next, rates of change in hemispheric vision following OLE surgery compared to a preoperative baseline, as reported in individual studies, were evaluated. Such data were available from 8 studies totaling 175 patients with 7 to 52 patients per study.[3,8,12–15,26,29] Overall, 57% of patients experienced some degree of hemispheric visual decline after surgery. Several factors were examined for potential association with postoperative visuals outcomes, although no significant relationships were observed (Table 3). Of note, patients with normal vision before surgery were more likely to experience visual decline after surgery (67%) compared to those with preoperative visual deficits (49%) with a trend nearing significance (Table 3B). Rates of visual decline were similar between patients with Engel I (47%) and Engel II to IV (50%) seizure outcomes.

DISCUSSION

In this study, we provide a systematic review and meta-analysis of seizure outcomes following surgery for drug-resistant OLE. Compiling data from 27 unique investigations

with 584 patients, we found that 65% of these patients achieved postoperative seizure freedom which in turn was predicted by younger patient age, an abnormal preoperative MRI, and focal lesion on pathological examination. These findings may aid in both patient selection and outcome prediction in the surgical treatment of OLE.

Historically, successful surgical management of OLE has been hindered by numerous diagnostic and technical challenges.[4,39] One of the foremost difficulties for OLE surgery is precise identification of the epileptic focus. Unlike TLE, scalp EEG has proven to have limited diagnostic utility in both identifying OLE and creating a surgical plan.[25] Several studies have demonstrated that in OLE, the most common EEG finding is not spike activity observed over the occipital lobe, but rather sharp and spike waves over the temporal cortex. [32] One study included here demonstrated that only 17% of known OLE patients examined had scalp EEG showing occipital onset of seizure activity.[35] As such, it is not surprising that OLE patients can be misdiagnosed as having TLE based on "pseudo-occipital" seizures and spikes observed with extracranial EEG data alone.[25] These limitations with scalp EEG for OLE seem to be associated with the anatomic position of the occipital lobe at the base of the cerebrum as well as its multiple connections to adjacent brain regions, which enable exceptionally rapid spread of seizure activity, thereby muddying precise localization of activity onset.[4,28,38]

Due to these limitations associated with scalp EEG, more invasive techniques—including subdural and depth electrodes— are frequently utilized to diagnose and anatomically characterize OLE as evident by the more than 50% of patients reported here receiving invasive monitoring (Table 1).[4,5,25] In one study directly comparing OLE with TLE, 84% of OLE surgical cases utilized invasive recording for precise epileptic focus localization compared to only 14% of TLE cases.[25] Despite their proven utility, intracranial electrodes do not solve all the diagnostic challenges for OLE. Unlike TLE and frontal lobe epilepsy which are more often focal in nature, OLE can commonly be multifocal, crossing not only lobar but also hemispheric boundaries, making not only diagnosis but surgical management very difficult.[5]

For the OLE cases that do seem to arise from a single radiographic lesion, some have asserted that removing this tissue alone may prove inadequate. Specifically, it has been suggested that OLE is not a focal but rather a regional disease in which achieving true seizure freedom requires removing the entire epileptogenic zone—an area that often extends beyond abnormalities seen on imaging.[39] Some have argued that defining this zone requires identifying areas of seizure initiation, spread, and termination[5,35]— information that may require intracranial recordings.

Adding to these diagnostic challenges is the technical challenge of resecting epileptic tissue abutting multiple areas of eloquent cortex. Vision loss is a known risk with surgery in the posterior quadrant due to proximity of the visual cortex—as evident by 57% of patients reported here who experienced postoperative visual decline (Table 3). However, language deficits, alexia, and neglect are also known risks of OLE surgery due to the proximity of key language centers and the parietal lobe to OLE foci.[25] Attempts to preserve these areas of

eloquent cortex while removing epileptic tissue often lead to suboptimal seizure outcomes— a point highlighted by several of the studies included here.[28,29,39,40]

Despite these known obstacles associated with achieving seizure freedom with OLE surgery, our analysis revealed nearly two-thirds of OLE patients undergoing surgery achieving seizure freedom— outcomes more favorable than those typically reported for frontal lobe epilepsy surgery, the most common ETLE syndrome.[21,41–44] Additionally, this seizure freedom rate for OLE surgery lies within the lower range of rates usually observed (60%– 80%) in studies of anterior temporal lobectomy for TLE.[16,45–47] Nevertheless, while surgical outcomes for medically refractory TLE have been validated by randomized-controlled trials, [20,48] no such trial has yet been performed for OLE. A randomized-controlled trial comparing seizure outcomes following surgical vs continued medical therapy for intractable ETLE is still needed.

In OLE patients with an abnormal preoperative MRI, we observed a rate of postoperative seizure freedom more than double that seen in individuals without remarkable neuroimaging. This finding is consistent with several previous investigations of OLE surgery.[8,13,35,37,40] As has been shown in other focal epilepsy syndromes, abnormalities on neuroimaging help target surgical resection and often suggest a focal pathological lesion. [41,44,49] With respect to pathology, OLE patients with focal lesions on pathological analysis —including MCD, tumor, or vascular malformation—achieved higher rates of Engel class I outcomes than those with nonfocal findings—such as gliosis or normal appearing tissue. Improved postsurgical outcomes with focal lesions has similarly been described in OLE[5,9,30,35,50] as well as TLE[51,52] and other forms of ETLE.[41,47,53] Furthermore, in patients with focal lesions, gross-total lesionectomy has previously been associated with dramatically increased rates of postoperative seizure freedom compared to subtotal resection.[4,8,9,14,35] Notably, while there is significant overlap between neuroimaging and pathological findings as outcome predictors, not all resections involving an abnormal MRI uncover a focal lesion on pathological analysis, and not all focal pathological lesions are detected on preoperative MRI. Therefore, neither the lack of MRI abnormality nor focal lesion necessarily precludes surgery in patients with otherwise clear and strongly concordant electrographic and semiological data.

With regard to patient demographics, postoperative seizure freedom rates were nearly 50% higher in patients younger than 18 yr of age. This may suggest earlier intervention is warranted in children with clearly refractory OLE who are otherwise favorable surgical candidates.

Finally, visual outcome data were available in a minority of studies examined, and suggested that greater than 50% of individuals experience some visual decline after surgery compared to preoperative baseline. However, given the paucity of data available, and the lack of standardization with regard to visual outcome reporting across studies, this finding should be interpreted with caution. In addition, insufficient data were available to examine potential predictors of visual outcome. Because of the impact of vision on quality of life, further studies including detailed, formal visual field examination both before and after OLE surgery are critically needed.[54]

Limitations

There are several limitations to consider in this investigation, including the innate shortcomings of meta-analysis technique in neurosurgical studies previously outlined by Sampson and Barker.[55] Specifically, in this meta-analysis, data were aggregated from multiple studies to generate a larger patient study group. While this does enhance detection of statistically significant correlations between various variables, the validity of the findings depends on the data quality collected by others and is thus susceptible to selection bias. Additionally, the power of the analysis may be limited by the relatively few studies contributing to each meta-analysis. However, the use of both Cochran Q statistic and I^2 index to evaluate study heterogeneity suggests that our applied statistical model was appropriate.[24] Next, the methods used to characterize visual loss following surgery were not always defined or differed between individual investigations, which may contribute to further bias with regard to visual outcome data. Data regarding the use and type of electrographic monitoring were also limited in the source studies, which limits our ability to ascertain the potential effect of invasive recordings on seizure outcome. Furthermore, in a systematic review, variables of interest cannot be disaggregated and as such, it is impossible to perform a multivariate analysis looking for interactions across variables. Finally, even though measures to ensure selection of dependable sources were utilized, the systematic review approach largely depends on appropriately aggregating high volumes of patients (over 500) across time. Replicating such numbers with a prospective case series, even if multi-institutional, would be quite challenging. Additionally, PRISMA guidelines were utilized to improve the quality of the present analysis and findings reported.[22]

CONCLUSION

Drug-resistant OLE is a relatively uncommon but debilitating focal epilepsy syndrome. Nearly two-thirds of patients achieved seizure freedom after surgery with pediatric age group, focal lesion on pathological analysis, and abnormal preoperative MRI predicting favorable seizure outcomes. These findings may help guide outcome prediction and patient counseling in the surgical treatment of OLE. While some visual decline was reported in greater than half of individuals after surgery, further study of visual outcomes in OLE surgery will be critical, given the paucity of data currently available and the influence of visual outcome on quality of life. A randomized-controlled trial of surgical therapy for ETLE, including OLE, has not yet been performed and remains an important goal.

ABBREVIATIONS

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CI	confidence interval
EEG	electroencephalography
ETLE	extra-temporal lobe epilepsy
MCD	malformation of cortical dysplasia
MRI	magnetic resonance imaging
OLE	occipital lobe epilepsy

OR odds ratio

TLE temporal lobe epilepsy

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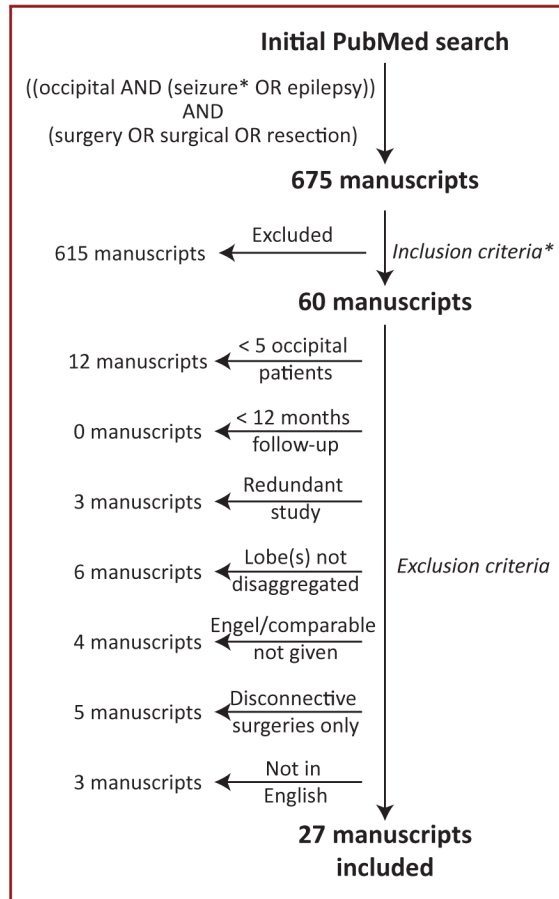
FIGURE 1.

Flow chart summarizing the manuscript selection process. Overall, 675 manuscripts were examined, 60 met inclusion criteria, and 27 met both inclusion and exclusion criteria. *Inclusion criteria are listed in the Methods.
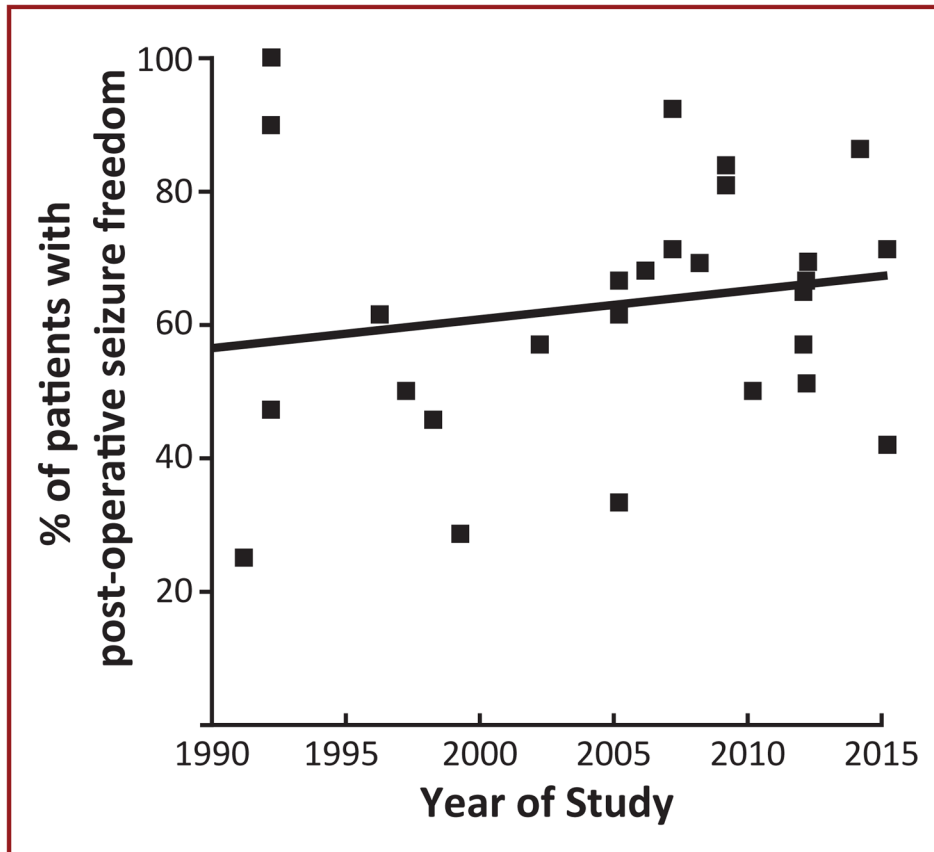
FIGURE 2.
Postoperative seizure freedom rate across all studies by publication date. Each data point represents a single study, with rate of postoperative seizure freedom (Engel class I outcome) plotted against year of study publication. A line of best fit is provided. No significant trend is observed (r = 0.16, P = .43).
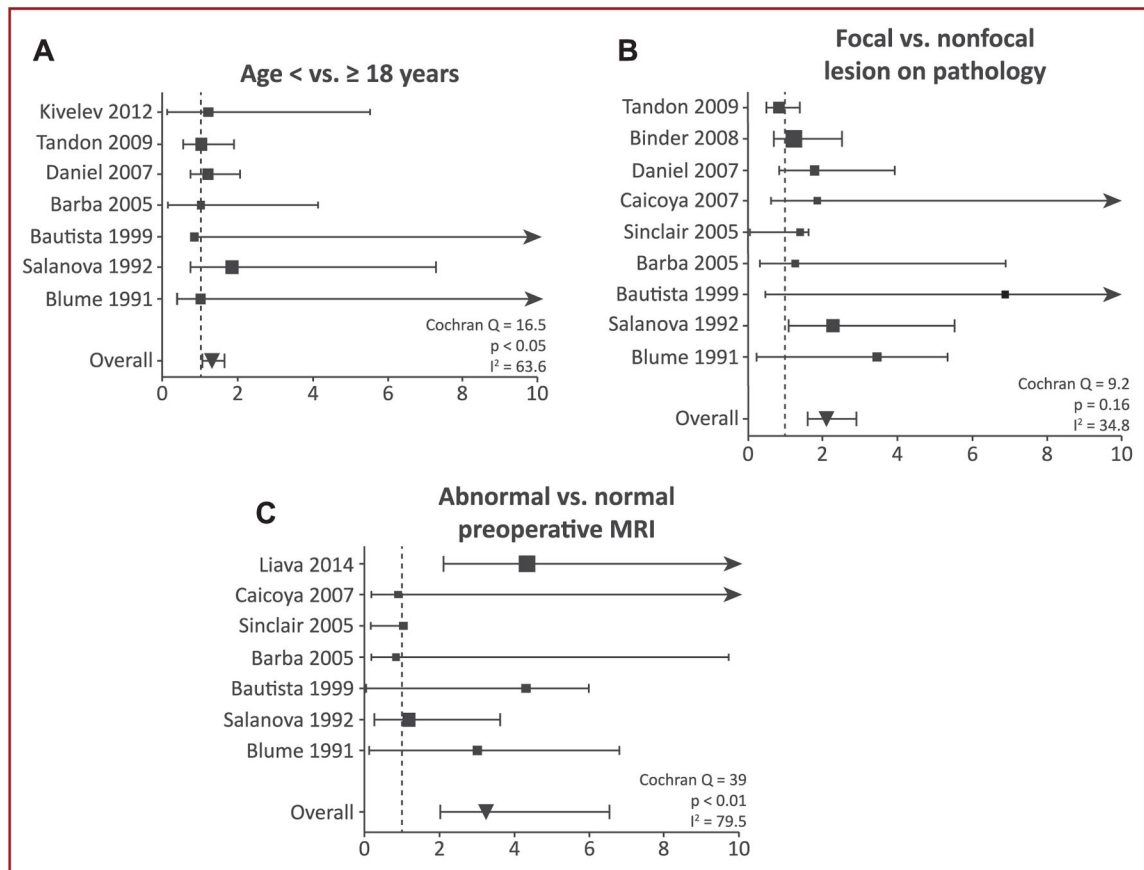
FIGURE 3.
Meta-analyses examining factors associated with seizure freedom after occipital lobe and posterior quadrant epilepsy surgery. Statistically significant predictors of postoperative seizure freedom included **A** age < 18 (vs 18) yr (Cochran Q = 16.5, P < .05, I^2 = 63.6), **B** focal (vs nonfocal) lesion on pathological examination (Q = 9.2, P = .16, I^2 = 34.8), and **C** abnormal (vs normal) preoperative MRI (Q = 39, P < .01, I^2 = 79.5). The effect size for each study is represented as OR of factors associated with seizure freedom (larger OR indicates greater likelihood of seizure freedom), with proportional study weight estimated by the size of each point. Error bars represent 95% CI, with arrowheads indicating an upper limit off of the scale. The size of each point estimates proportional study weight, and the vertical dashed line represents OR = 1.

TABLE 1

Included Studies

First author	Year	No.	Age group	Invasive monitoring (no.)[a]	% Seizure freedom
Appel[25]	2015	19	Adults	Yes (16)	42.1
Aykut-Bingol[5]	1998	35	Mixed	Yes (19)	45.7
Barba[26]	2005	9	Mixed	Yes (2)	66.7
Battaglia[14]	2012	7	Pediatric	No	57.1
Bautista[27]	1999	7	Mixed	Yes (13)	28.6
Bidzi ski[11]	1992	11	Mixed	No	91.0
Binder[13]	2008	52	Mixed	Yes (22)	69.2
Blume[28]	1991	16	Mixed	Yes (5)	25.0
Caicoya[29]	2007	7	Adult	Yes (6)	71.4
Daniel[10]	2007	13	Mixed	No	92.3
Davis[30]	2012	43	Mixed	No	51.2
Hong[31]	2002	7	Mixed	No	57.1
Ibrahim[32]	2012	40	Pediatric	Yes (23)	65.0
Jehi[9]	2009	25	Mixed	Yes (24)	84.0
Jobst[33]	2010	12	Mixed	Yes (14)	50.0
Kivelev[15]	2012	9	Mixed	No	66.7
Kuzniecky[34]	1997	6	Pediatric	Yes (5)	50.0
Lee[12]	2005	26	Mixed	Yes (26)	61.5
Liava[8]	2014	51	Pediatric	Yes (24)	86.3
Salanova[35]	1992	36	Mixed	Yes (6)	47.2
Sarkis[36]	2012	36	Mixed	Yes (34)	69.4
Sinclair[37]	2005	6	Pediatric	Yes (6)	33.3
Tandon[3]	2009	21	Mixed	Yes (8)	81.0
Williamson[4]	1992	20	Mixed	Yes (17)	90.0
Yang[38]	2015	35	Mixed	Yes (30)	71.4

First author	Year	No.	Age group	Invasive monitoring (no.)[a]	% Seizure freedom
Yun[40]	2006	22	Mixed	No	68.2
Zentner[39]	1996	13	Mixed	Yes (30)	61.5
Total		584		330	

[a]Subdural strip, subdural grid, or intracranial depth electrodes or a combination of the 3.

TABLE 2

Postoperative Seizure Outcomes Stratified by Patient Characteristics

			Engel I	Engel II–IV	P value	Studies
(A) Demographics	Age	<18 yr	81 (74)	28 (26)	<.001*	3, 8, 14, 15, 24, 26, 28, 34, 36, 55
		18 yr	46 (50)	46 (50)		
	Gender	Female	21 (58)	15 (42)	.25	3, 14, 15, 25, 26, 28, 33, 36
		Male	36 (72)	14 (28)		
	Side	Left	62 (62)	38 (38)	.54	3, 8, 10, 14, 15, 25–28, 33, 34, 36
		Right	57 (67)	28 (33)		
(B) Epilepsy characteristics	Pathology	MCD	61 (71)	25 (29)	<.001*	3–5, 8, 10, 13–15, 25–28, 33, 34, 36
		Tumor	44 (82)	10 (18)		
		Vascular malformation	18 (72)	7 (28)		
		Gliosis only or normal	25 (53)	22 (47)		
		Other	5 (25)	15 (75)		
	Seizure type	Partial only	31 (59)	22 (41)	.26	3, 5, 14, 25–28, 33, 36
		Generalized	27 (47)	31 (53)		
	Preoperative visual deficit	Yes	304 (64)	174 (36)	.62	3, 8, 14, 15, 25, 28, 29, 34
		No	57 (67)	28 (33)		
	Visual aura	Yes	32 (46)	38 (54)	.06	3, 26–28, 32–34
		No	17 (71)	7 (29)		
	Duration of epilepsy	<5 yr	29 (67)	14 (33)	.10	8, 27, 28, 34
		5–10 yr	24 (62)	15 (38)		
		10–20 yr	11 (48)	12 (52)		
		> 20 yr	6 (35)	11 (65)		
(C) Diagnostics	Ictal EEG	Localized	72 (62)	45 (38)	.99	3, 5, 8, 12, 25–28, 34, 36
		Not localized	49 (62)	30 (38)		
	Interictal EEG	Localized	55 (58)	40 (42)	.64	3, 5, 8, 12, 25–28, 34, 36
		Not localized	49 (62)	30 (38)		
	MRI	Abnormal	86 (74)	30 (26)	<.001*	3, 8, 15, 25–28, 34, 36

		Engel I	Engel II–IV	*P* value	Studies
(D) Surgical factors	Resection extent				
	Normal	14 (33)	29 (67)		
	Occipital only	78 (67)	38 (33)	.75	3, 4, 8, 13, 14, 25–27, 32–34, 36
	Temporo-occipital	32 (68)	15 (32)		
	Parieto-occipital	18 (62)	11 (38)		
	Temporo-parieto-occipital	19 (76)	6 (24)		
Resection type	Lesionectomy	56 (70)	24 (30)	.02	3–5, 14, 15, 25, 32, 34
	Corticectomy	5 (50)	5 (50)		
	Lobectomy	21 (51)	20 (49)		
	Quandrantectomy	12 (92)	1 (8)		
Total		379 (65)	205 (35)		

EEG = electroencephalography; MRI = magnetic resonance imaging.

*
Statistically significant value (P   .05).

TABLE 3

Postoperative Visual Outcomes Stratified by Patient Characteristics

			No change	Decline	P value	Studies
(A) Demographics	Age	<18 yr	22 (56)	17 (44)	.47	3, 8, 14
		18 yr	14 (47)	16 (53)		
	Gender	Female	10 (53)	9 (47)	.99	3, 14, 15, 25, 28
		Male	15 (56)	12 (44)		
	Side	Left	18 (53)	16 (47)		
		Right	17 (52)	16 (48)	.99	3, 14, 15, 25, 28
(B) Epilepsy characteristics	Pathology	MCD	10 (39)	16 (61)	.06	3, 14, 15, 25, 28
		Tumor	13 (77)	4 (23)		
		Vascular malformation	4 (36)	7 (64)		
		Gliosis only or normal	5 (50)	5 (50)		
		Other	2 (100)	0 (0)		
	Seizure type	Partial only	13 (59)	9 (41)	.99	3, 14, 25, 28
		Generalized	8 (62)	5 (38)		
	Preoperative visual deficit	Yes	19 (51)	18 (49)	.07	3, 8, 12–15, 25, 28
		No	31 (33)	64 (67)		
	Visual aura	Yes	6 (55)	5 (45)	.99	3, 28
		No	3 (43)	4 (56)		
	Duration of epilepsy	<5 yr	5 (36)	9 (64)	.21	8, 25, 28
		5–10 yr	10 (71)	4 (29)		
		10–20 yr	3 (60)	2 (40)		
		>20 yr	2 (33)	4 (67)		
(C) Diagnostics	Ictal EEG	Localized	17 (47)	19 (53)	.54	3, 8, 25, 28
		Not localized	9 (60)	6 (40)		
	Interictal EEG	Localized	14 (47)	16 (53)	.57	3, 8, 25, 28
		Not localized	12 (57)	9 (43)		
	MRI	Abnormal	30 (50)	30 (50)	.16	3, 8, 15, 25, 28
		Normal	0 (0)	2 (100)		

(D) Surgical factors			No change	Decline	*P* value	Studies
	Resection extent	Occipital only	11 (52)	10 (48)	.23	3, 8, 14, 25
		Temporo-occipital	4 (36)	7 (64)		
		Parieto-occipital	6 (86)	1 (14)		
		Temporo-parieto-occipital	3 (60)	2 (40)		
	Resection type	Lesionectomy	16 (55)	13 (45)	.64	3, 14, 15, 25
		Corticectomy	4 (67)	2 (33)		
		Lobectomy	1 (33)	2 (67)		
		Quandrantectomy	0 (0)	0 (0)		
Total			76 (43)	99 (57)		

EEG = electroencephalography; MRI = magnetic resonance imaging.