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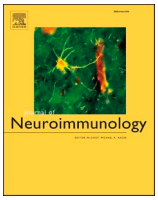

Myelin oligodendrocyte glycoprotein (MOG) antibody-associated disease: Presentation and outcomes of adults at a single center

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A B S T R A C T

Background/Introduction.

Myelin oligodendrocyte glycoprotein antibody-associated disease (MOGAD) is a chronic demyelinating disorder that has been increasingly recognized since the serum antibody became commercially available in 2017. The most common clinical presentation is optic neuritis, and first line acute treatment is intravenous (IV) steroids. However, there are many questions that remain unanswered. For clinicians and patients, the primary question is whether relapses will occur and whether to treat with chronic therapy.

Methods: This retrospective chart review examined characteristics of thirty-three known adult MOGAD cases at a single institute. Data was collected on patient demographics, clinical presentation, objective diagnosis with MRI and serum antibody levels, acute and chronic treatment and disease outcomes.

Results: Our MOGAD cases revealed a slight female to male predominance of 1.5:1. No racial groups were affected disproportionately, and age of symptom onset spanned a large range with a median of 40 years. The most common clinical and radiologic presentation was optic neuritis followed by transverse myelitis and brainstem symptoms/lesions. IV methylprednisolone was used in the vast majority of cases for acute treatment. 83.3% of our patients were treated with chronic therapy at some point during their disease course. Therapies include rituximab, IVIG, ocrelizumab, mycophenolate mofetil and ofatumumab. The majority of our patients were treated with rituximab and we did not see a significant benefit of yearly relapse reduction for rituximab versus other therapies. Our cohort had a higher-than- expected percentage of cases with relapsing disease (56.3%) compared to monophasic (43.8%).

Discussion/Conclusion: Our study confirms prior data regarding the demographics, clinical presentation and radiologic presentation of MOGAD. There is no consensus on whether maintenance therapy should be started for MOGAD cases with a single clinical event. Our cohort showed a higher relapse rate than has been reported previously and all known relapses occurred within one year of diagnosis. More data is necessary to confirm risk of relapse in the years following diagnosis. In addition, further data on biomarkers are needed to predict the disease course could help guide management.

1. Introduction

Myelin oligodendrocyte glycoprotein (MOG) is one of several proteins produced by oligodendrocytes and is expressed in the outer lamella of the myelin sheath. When an anti-MOG antibody is present in the setting of a characteristic clinical presentation, we call the disease state MOG-antibody associated disease (MOGAD). In MOGAD, it is proposed that B cells and plasma cells produce anti-MOG antibodies in the peripheral immune system. These cells and antibodies then cross the blood-brain barrier to gain entry to the central nervous system. Finally, MOG antibodies bind MOG expressed on myelin which causes injury to the myelin sheath and demyelination (Marignier et al., 2021). Clinically and radiologically, MOGAD in adults presents with optic neuritis, longitudinally extensive transverse myelitis, brainstem lesions and non-specific white matter lesions in the brain.

There has been debate about whether MOGAD represents a distinct entity from other central nervous system demyelinating disorders such as MS and neuromyelitis optica spectrum disorder (NMOSD). However, studies have shown that the combination of MS with MOG antibody and the presence of both MOG Ab and aquaporin-4 Ab are rare (Cobo-Calvo et al., 2019; Höftberger et al., 2015). Although MOGAD is a phenotypically heterogeneous disease, it has emerged as a distinct clinical entity based on clinical presentation, serum antibodies and imaging findings. The proposed diagnostic criteria are complicated and include those with monophasic or relapsing course, classic radiologic findings of CNS demyelination in brain or spinal cord or evidence of optic neuritis, cerebrospinal fluid (CSF) pleocytosis without CSF specific oligoclonal bands, histopathology and clinical findings (Jarius et al., 2018). Antibody testing became commercially available in 2017 and has allowed for accurate detection of the MOG antibody due to advancements in testing

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methods.

As only five years have passed since MOG antibody testing became commercially available, there is limited data to confirm whether the majority of MOGAD cases are monophasic or relapsing and how this disease responds to maintenance therapies. Our institution has previously published clinical presentations and initial treatments of 11 MOGAD patients (Brayo et al., 2019). Our current study focuses on broadening our knowledge of 33 known MOGAD at our institution with data on demographics, clinical presentation, diagnosis, treatment and disease course of MOGAD. We also aimed to determine whether rituximab showed benefit in preventing relapses compared with the other chronic therapies.

2. Methods

A retrospective review was performed of all known adult MOGAD cases at our institution. This study was approved by the Duke University IRB, Protocol number: Pro00109575. Providers within the Duke University Neurology Division of Multiple Sclerosis and Neuroimmunology have access to a shared MOGAD patient database on the electronic medical record system. Since the database's creation in May 2018, 35 adult MOGAD patients have been added. This study's inclusion criteria included patients diagnosed with MOGAD by a neuroimmunologist in the department, symptom onset at age 18 or greater and record of a positive MOG antibody in the electronic medical record (EMR). Patients tested at our facility were positive for MOG antibodies by Mayo Clinic's cell-based assay. Those tested from outside hospitals may have been through outside laboratories. Outpatient and inpatient electronic medical records of these 33 patients were reviewed. Patient information was de-identified and data was collected on each patient's demographics, clinical presentation, objective diagnosis, treatment, and disease course.

Descriptive statistics were calculated for patient demographics. For clinical presentation, initial clinical symptoms were grouped into distinct categories to represent optic neuritis, transverse myelitis, brainstem symptoms and other cerebral symptoms. Patients' age in years at occurrence of first symptoms suggesting MOGAD were grouped by decade of life. Age at symptom onset was determined by patient history in the chart as diagnosis was often delayed. History of symptoms lasting >24 h and suggestive of optic neuritis, transverse myelitis or brainstem lesions were included. Patients' first known MRIs following symptom onset were reviewed. MRI findings at diagnosis were also categorized to include combinations of optic neuritis (ON), supratentorial white matter brain lesions, spinal cord lesions and "negative imaging" without evidence of typical lesions. All thirty-three patients had MRI brain data to review. Twenty-six patients had spinal cord MRI in initial workup. These 26 were included in analysis regarding presence of transverse myelitis. Imaging was reviewed if it was available in our chart. Otherwise, reports were reviewed for outside images that were not available to determine location of lesions.

Descriptive statistics for acute treatments used for the first clinical attack were recorded. Chronic treatments following MOGAD diagnosis were investigated for each patient. In addition, changes in chronic therapy were recorded with reasons for switching. Due to the high percentage of patients treated chronically with rituximab, we investigated whether rituximab showed any benefit to prevent relapses compared with the other chronic therapies combined. Using follow up data after diagnosis, we determined whether relapse occurred during each treatment year for each treatment type. The percentage of treatment years with relapse on rituximab was compared to the percentage of treatment years with relapse for the other therapies combined (IVIG, ocrelizumab, mycophenolate mofetil and ofatumumab). The differences in mean number of relapses per year for rituximab compared with other therapies combined and differences between monophasic and relapsing percentages were compared with an unpaired t-test with $p < 0.05$ considered significant. We did the same analysis comparing all B-cell depleting therapies (rituximab, ocrelizumab and ofatumumab) versus the others (IVIG and mycophenolate mofetil).

Finally, we investigated the disease course of MOGAD for our patients. For each patient, it was determined whether they ever had clinical or imaging findings consistent with an inflammatory relapse prior to or following official diagnosis of MOGAD. If clinical or radiologic relapses were identified, the patient's disease course was categorized as relapsing. If only one clinical event was mentioned in the electronic medical record system and repeat imaging showed no new lesions, the patient was labeled as monophasic. Serum MOG antibody titer was tested for association with patient status as monophasic or relapsing. A chi-squared likelihood ratio test was performed to determine if the frequency of a certain age of symptom onset or presenting clinical symptom was different than expected in the monophasic or relapsing groups.

3. Results

Thirty-three patients met inclusion criteria and were therefore included in our analysis. Two were not included; one due to pediatric onset MOGAD and one due to lack of positive MOG antibody in the electronic medical record system.

3.1. Demographics

Patient demographics including sex and race are reported in Table 1.

3.2. Clinical presentation

Age at onset of symptoms suggesting MOGAD were reported by

Table 1
Patient demographics including sex, race, age and disease characteristics.

Demographics of patients presenting with MOGAD	
Patient Characteristics	
Sex, N (%)	
Male	13 (39.4)
Female	20 (60.6)
Race, N (%)	
Caucasian/white	22 (66.7)
African American/black	8 (24.2)
Hispanic	2 (6.1)
Not reported	1 (3.0)
Age at first symptoms in years, N (%)	
18–29	9 (27.3)
30–39	7 (21.2)
40–49	8 (24.2)
50–59	7 (21.2)
≥ 60	2 (6.1)
Median	40.0
MOG antibody titer, N (%)	
1:20	4 (12.1)
1:32 or 1:40	8 (24.2)
1:100	14 (42.4)
1:1000	6 (18.2)
1:10000	1 (3.0)
Initial presentation, N (%)	
Optic neuritis only	23 (69.7)
Optic neuritis plus other	3 (9.1)
Transverse myelitis	4 (12.1)
Brainstem symptoms	3 (9.1)
Disease course, N (%)	
Monophasic	14 (42.4)
Relapsing	18 (54.55)
Unknown	1 (3.0)

decade of life: 9 (27.3%) were between 18 and 29 years old, 7 (21.2%) were 30–39 years old, 8 (24.2%) were 40–49 years old, 7 (21.2) were 50–59 years old and 2 (6.1%) were 60 years old or older. There was no statistically significant difference in patient distribution for each of these age categories. Median age at onset was 40 (Table 1). The majority of cases, 26 patients (78.8%) had their first presentation suggestive of optic neuritis. Five of these patients (19.2%) had bilateral optic neuritis at onset. Three of the optic neuritis patients (9.1%) also had other accompanying symptoms. These included facial paresthesias, bladder dysfunction, quadriparesis and paresthesias. The remaining patients presented with symptoms suggestive of transverse myelitis (n = 4, 12.1%) or symptoms suggestive of brainstem lesions (n = 3, 9.1%) (Table 1). Symptoms of brainstem lesions included combinations of internuclear ophthalmoplegia, facial paresthesias, vertigo, imbalance, nystagmus and hemiparesis.

3.3. Objective diagnosis

The most common initial MRI finding was unilateral or bilateral optic nerve edema and/or enhancement suggestive of optic neuritis in 23 (79.3%). Of those with optic neuritis, 12 (52.1%) had only optic neuritis on MRI, nine (39.1%) had optic neuritis plus white matter lesions in the brain, and two (8.6%) had a combination of optic neuritis, white matter lesions in the brain and spinal cord lesions. Twenty-six of the patients had MRI imaging of the spinal cord at time of initial workup, five of which (19.2%) had transverse myelitis. All five patients with transverse myelitis also had white matter lesions in the brain and two also had optic neuritis as stated previously. Three of the total patients (9.1%) had only white matter lesions in the brain. Four of the total patients (12.1%) had negative MRI imaging of the brain and spinal cord with lack of optic neuritis, white matter lesions in the brain and transverse myelitis. Of the four with negative imaging, three patients had clinical signs of optic neuritis at onset while one had symptoms of transverse myelitis. None were on immunosuppression at time of first imaging. MOG antibody titers for those with negative imaging included 1:40 (1), 1:100 (2) and 1:1000 (1). All 4 developed abnormalities on follow up imaging. No patients had imaging findings in the absence of clinical symptoms though three patients had additional incidental findings consistent with MOGAD including optic neuritis (2) and cervical cord lesions (1).

Patients' first MOG antibody serum titer levels were reviewed. Four patients (12.1%) had the lowest reported titer level of 1:20; eight patients (24.2%) had titer of 1:32 or 1:40; 14 patients (42.4%) had a titer of 1:100; six patients (18.2%) had a titer of 1:1000 and only one (3.0%) had a titer of 1:10000. Those patients with low titers (1:40 or less) were included based on the combination of clinical and objective findings that suggested MOGAD. The majority with low titers had unilateral optic neuritis (6) or bilateral optic neuritis (1). The remaining had clinical and objective evidence of brainstem lesions (1), transverse myelitis lesions (1) or both (3). Only one patient had a second serum MOG antibody titer level reported in our electronic medical record system. This patient's first level was 1:40 two months following initial symptoms. The titer was reduced to 1:20 five months after the first level was drawn and after treatment with oral prednisone taper and mycophenolate mofetil. Diagnosis was made within one month of first symptom onset in 30.3% of subjects. Diagnosis was delayed by at least one year in 45.5% of subjects with 21.1% of total subjects having ten years or greater delay in diagnosis.

3.4. Treatment

Acute treatment was given to 28 (84.9%) of the 33 patients at time of first symptoms suggesting demyelination (Table 2). Of those 28, 24 (85.7%) were treated with IV methylprednisolone 1000 mg for 3–5 days. One of these patients had evidence of optic neuritis, a pontine lesion and spinal cord lesions. While the MOG antibody had not returned, they were treated with both IV steroids and plasmapheresis concurrently due to clinical and radiologic severity of presentation. Three patients who received treatment (10.7%) were given oral steroids only at varying doses <1000 mg methylprednisolone daily. In the five patients who were not treated acutely at time of first symptoms, the diagnosis of MOGAD had not yet been made. Twenty-six (83.3%) were treated with maintenance therapy at some point in their disease course. The first maintenance therapy used was rituximab in 18 (69.2%), IVIG in three (11.5%), ocrelizumab in two (7.7%), mycophenolate mofetil in two (7.7%) and ofatumumab in one (3.9%). Of these 26 patients who were started on maintenance therapy for MOGAD, 10 (38.5%) were started after a first clinicoradiologic event while 16 (61.5%) had at least two events at the time of maintenance treatment initiation.

Of the 26 patients who were initially started on maintenance therapy, there were six patients (18.2%) who required a single change in therapy and one (3.9%) that required two changes in therapy (Table 3). Five of the patients requiring change in therapy were on rituximab which was discontinued due to: breakthrough disease (1), persistent symptoms (2), financial reasons (1) and unknown reasons (1). One patient was switched from IVIG due to determination that they no longer required maintenance therapy. One patient was changed from mycophenolate mofetil due to side effects. The final patient was switched from ocrelizumab to rituximab when the phenotype was determined to represent MOGAD rather than multiple sclerosis. The most common medication chosen for the second or third option was IVIG in three (50.0%) followed by rituximab in two (25.0%) and mycophenolate mofetil in two (25.0%). Because the majority of patients were treated with rituximab, we compared relapse rate with rituximab compared to relapse prevalence with other therapies. Of the 22 treatment-years on rituximab, there were two treatment-years with relapse (9.1% relapse

Table 2
Acute treatment of MOGAD at time of first symptoms.

Acute treatment at time of first symptoms	
Acute treatment used, N (%)	
Yes	28 (84.9)
No	5 (15.2)
Acute treatments used, N (%)	
IV steroids alone	24 (85.7)
IV steroids + plasmapheresis	1 (3.6)
Oral steroids	3 (10.7)

Table 3
Chronic therapy used for MOGAD.

Chronic therapy	
Chronic therapy used, N (%)	
Yes	26 (78.8)
No	7 (21.2)
First chronic therapy used, N (%)	
Rituximab	18 (69.2)
IVIG	3 (11.5)
Ocrelizumab	2 (7.7)
Mycophenolate mofetil	2 (7.7)
Ofatumumab	1 (3.9)
Required change in therapy, N (%)	
No	20 (76.9)
Yes, once	5 (19.2)
Yes, twice	1 (3.8)
Second and third chronic therapy used, N (%)	
IVIG	3 (50.0)
Rituximab	2 (25.0)
Mycophenolate mofetil	2 (25.0)

rate per year). Of the 14 treatment-years on other therapies, there was one treatment-year with relapse (7.1% relapse rate per year). There were 10 treatment-years off maintenance therapy with 2 total relapses (20.0% relapse rate per year). There was no statistically significant difference in relapse rates between the patients treated with rituximab compared with the other therapies ($p = 0.68$). There was also no statistically significant difference in relapse rates between patients treated with B-cell depleting therapies compared with the other therapies ($p = 0.76$).

Seven patients had not been treated with ongoing maintenance therapy for MOGAD at the time of this publication. Five of those patients had a monophasic course and were being watched clinically with plans to initiate therapy if disease became relapsing. One patient was offered treatment for a relapsing course but declined due to clinical stability. The remaining patient was offered therapy but was lost to follow up.

3.5. Disease course

Follow up clinical data was available for 25 patients (75.8%) at 1-year post-diagnosis, 17 patients (51.5%) at 2 years post-diagnosis and four patients (12.1%) at 3 years post-diagnosis. Median follow up for our cohort was 1 year with an average of 1.52 years. One patient was lost to follow up with an unknown disease course. In the remaining 32 patients, 18 (56.3%) had a relapsing course and 14 (43.8%) had a monophasic course at the time of analysis (Table 1). The relapsing group includes those with relapse(s) prior to MOGAD diagnosis and/or treatment. MOG antibody titer levels were analyzed in relation to disease course. When comparing low antibody titer level $\leq$ 1:40 compared to those with titers >1:40, there was no significant difference in monophasic or relapsing disease course ($p = 0.58$). Six (50.0%) of those with low titers had a monophasic course compared to 6 (50.0%) of low titers having a relapsing course. Eight (40%) of those with high titers had monophasic course compared to 12 (60%) of high titers having relapsing course. One patient with repeat MOG antibody titer and persistent positive level had a relapsing course.

There was no difference in the numbers of patients with relapsing or monophasic disease courses based on age of onset ($p = 0.07$, Chi squared = 8.6, likelihood ratio test). There was also no difference in the numbers of patients with relapsing or monophasic disease courses based on initial clinical symptoms ($p = 0.28$, Chi squared = 5.0, Likelihood ratio test). When analyzing follow up data after time of diagnosis, all of the known clinical or radiologic relapses occurred within the first year of diagnosis. There were five known relapses in year one with none in years two or three following diagnosis. Those five relapses represented 20.0% of total patients with follow up data of at least one year. Of 14 patients with a monophasic disease course, nine (64.3%) were treated with maintenance therapy.

4. Discussion

Our cohort reported demographics, clinical presentation at symptom onset, objective findings at diagnosis including MOG antibody titer and MRI imaging, acute and chronic treatments used as well as disease course of MOGAD. Our cohort demographics showed a slight female predominance of 1.5:1. This is in contrast to older data presented in 2014 which reported a higher proportion of male than female patients with MOGAD (Sato et al., 2014). The racial composition of our cohort was similar to the expected distribution for the North Carolina population at large. The 2020 North Carolina Census quoted 60% of the population as white with 66.7% of our MOGAD cases being Caucasian/white. The Census reported 20% black or African American while our cohort had 24.2% of MOGAD cases being African American/black. Eleven percent of the North Carolina population by Census is reported as Hispanic or Latinx while 6.1% of our MOGAD cases were Hispanic.

The age of symptom onset was represented by a wide spectrum of ages with the highest proportion between 18 and 29 years old, relatively equal distribution among those in the third, fourth and fifth decades and the smallest percentage over age 60. There were no statistically significant differences to suggest a predilection for the young or old. Our cohort had a slightly higher median age of 40 compared to early to mid-thirties quoted in other studies (Denève et al., 2019). Presenting clinical features of MOGAD can vary and appear to be age dependent. Children tend to have more brain involvement with an acute disseminated encephalomyelitis (ADEM) presentation. As described in prior reports of MOGAD (Rempe et al., 2021), the most common clinical and radiographic presentation in our adult cohort was optic neuritis representing 78.8% of our patients. This was followed by transverse myelitis and brainstem lesions.

MRI findings can also be helpful to raise suspicion of MOGAD when optic neuritis, white matter lesions of the brain and/or spinal cord lesions are present. However, normal imaging at time of presentation was also seen in 12.1% of our patients. MRI imaging can also help to distinguish MOGAD from multiple sclerosis (MS). MOGAD is characterized by extensive anterior optic neuritis with enhancement of the peri-optic nerve sheath, longitudinally extensive transverse myelitis crossing at least three vertebral body segments and non-specific supratentorial subcortical or deep white matter lesions (Denève et al., 2019). MOGAD lesions are also more likely to be poorly demarcated with higher numbers of brainstem and infratentorial lesions compared to MS (Jarius et al., 2018). With the high proportion of patients presenting with clinical and radiological optic neuritis in our cohort, we suggest consideration of serum MOG antibody levels in any patient presenting with atypical optic neuritis (longitudinally extensive, involving the optic nerve sheath or when significant optic disc edema is present).

High clinical suspicion for MOGAD can help to avoid delays in treatment and any patient presenting with classic history and objective evidence of demyelination should be treated in the acute setting. Treatment should not be delayed while waiting on antibody test results. The most common acute treatment in our cohort was IV methylprednisolone 1000 mg daily for 3–5 days. For severe cases, treatment can be escalated to include plasmapheresis and/or IVIG (Jarius et al., 2016). Plasmapheresis was added to IV methylprednisolone for one of our patients who had clinically and radiographically severe disease involving the optic nerve and spinal cord.

Whether to treat with long-term treatment is still under debate and should be determined on a case- by-case basis. Considerations should include age at onset, severity of attack, response to treatment with IV steroids, risk of disability and potential risks of maintenance therapy. Maintenance treatment options that have been explored include IVIG, mycophenolate mofetil, azathioprine and rituximab. The six largest retrospective studies on MOGAD with descriptive statistics and treatment response were summarized in one publication (Marignier et al., 2021). In the aforementioned study, at 9–16 months of treatment, the highest percentage of relapse free patients had been treated with IVIG (69%) followed by rituximab (50%), mycophenolate mofetil (47%) and azathioprine (39%). Our cohort patients were most commonly treated with rituximab (69.2%) as initial maintenance therapy. We suspect that some of our institute's high rate of rituximab use could be related to the ease of initiation and approval compared to other agents. In addition, our institute is in an academic tertiary center in a large population center allowing access to infusion therapies. This may not be the case in more rural areas. On evaluation of rituximab, we did not see a statistically significant benefit of rituximab for preventing relapses compared to the other therapies as a group, however our study was not sufficiently powered to test for differences in relapse rates by therapy.

Our cohort was too small to accurately report relapse rate by each individual therapy, but this information can be found in the provided Supplemental Index 1. IVIG was used in a smaller proportion as first line but more commonly chosen for second or third line therapy perhaps due to publications citing its effectiveness in later years (Marignier et al., 2021; Chen et al., 2022). Ocrelizumab was chosen first in two cases, both of which had been diagnosed with multiple sclerosis before MOG

antibody was checked in serum. Mycophenolate mofetil and ofatumumab were also chosen in small percentages of cases. It is unclear from current data whether patients with a single clinical event and positive MOG antibody level should be treated with maintenance therapy. At our institute, 64.3% of patients with a single clinical event were started on maintenance therapy. 35.7% of monophasic cases are being watched clinically with plans to initiate maintenance therapy if a relapse occurs.

The disease course and prognosis are varied in MOGAD. Two large studies with 4 and 5 years follow up have quoted relapse rates of 31.7% and 40% in adult MOGAD patients (Marignier et al., 2021) (Satukijchai et al., 2022). In our 32 patients who followed up for long-term management of MOGAD, a higher-than-expected percentage (56.3%) had a relapsing course. Our data may be limited by a referral bias since our patients represent a tertiary referral center. For this reason, it may have higher representation of relapsing cases that were referred for consideration of chronic treatment. However, relapse rate was reported regardless of maintenance therapy use. Since the majority of our patients were treated with maintenance therapy, there was likely a reduced propensity for relapse in the years following diagnosis. Additional cases may have been naturally relapsing but controlled with therapy. Our data may also underestimate the cases which will become relapsing due to lack of long term follow up data in many cases which is a limitation of this study. 24.2% of our patients were lacking follow up data at one year or greater.

Our data suggests that relapses may be more likely to occur in the first year following diagnosis compared to years two and three. This could be in part due to higher disease activity in the early stages of disease or related to ineffectiveness of the first line immunomodulation treatment chosen. Further data on disease courses in the absence of treatment effect could be helpful to distinguish the two. One patient in our study had rituximab maintenance therapy discontinued at one year following diagnosis and did not experience a relapse during follow-up for two years off of therapy. Sustained seropositivity and titer levels have not been shown to correlate with clinical outcomes (Cobo-Calvo et al., 2019). Nor did high versus low antibody titers in our study. Age of symptom onset and presenting symptoms also did not seem to predict a monophasic or relapsing course in our cohort.

5. Conclusion

In a cohort study of 33 adult patients with MOGAD treated at our institute, we found that there is a slight female predominance, fairly equal distribution of age at onset, and no clear disproportionate effect by race. Consistent with prior publications, the most common clinical and radiologic presentation was unilateral or bilateral optic neuritis. First choice for acute therapy was IV methylprednisolone in the majority of cases. First choice for maintenance therapy was rituximab while the first choice for second line was IVIG. There is still no consensus on whether maintenance therapy should be started in MOGAD cases after a single clinical event. However, our data suggests a higher relapse rate or more active disease might be seen among academic or tertiary care centers. All recorded relapses after diagnosis also occurred within one year of diagnosis in our cohort. This raises the question of whether MOGAD should be treated with chronic therapy at time of diagnosis for a limited duration. More data is needed regarding long term follow up for MOGAD patients to verify the percentage of cases which will be relapsing. In addition, data is needed on biomarkers that can be used to predict the disease course and guide decisions on who may benefit from maintenance therapy.

Declaration of Competing Interest

The authors: Paige Sutton MD, F. Lee Hartsell MD, N. Troy Tagg MD and Nicholas M. Hudak, MPA, MSEd, PA-C, have no declarations of interest.

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Data availability

Data will be made available on request.

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Paige Sutton gathered and analyzed data and drafted the manuscript. Michael Lutz provided statistical analysis and helped draft the manuscript. F. Lee Hartsell, Dorlan Kimbrough, N. Troy Tagg, Mark Skeen, Nicholas Hudak and Christopher Eckstein added patients to the subject cohort and edited the manuscript. Suma Shah provided the concept, edited the manuscript and supervised the research. All authors provided final approval before submission.

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