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Comparing Current Treatment Modality at an Army Military Treatment Facility for Obstructive Sleep Apnea with an Objective Titration Protocol for Cost Savings Potential

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Comparing Current Treatment Modality at an Army Military Treatment Facility for Obstructive Sleep Apnea with an Objective Titration Protocol for Cost Savings Potential

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ABSTRACT

Purpose. Oral appliance therapy (OAT) titration time has the most significant effect on the cost effectiveness of treatment. The aim of this study was to evaluate the mean titration time and clinical effectiveness of OAT at an Army Military Treatment Facility (MTF). A comparison of the results to the literature and to objective titration protocols for potential cost savings analysis.

Methods. This was a retrospective records review for the treatment year of 2019. Extracted records from the Military Health System Management Analysis and Reporting Tool (MHS MART 2) and reviewed in the Armed Forces Health Longitudinal Technology Application (AHLTA). A further review in the Corporate Dental System (CDS) for patients referred for OAT. Additionally, all patients referred for OAT in 2019 also received review to capture all oral appliance titrations made in 2019. Mean titration times for OAT were calculated and analyzed with an ANOVA test. Clinical effectiveness was calculated for all complete titrations based on AHI reduction to therapeutic levels with the oral appliance.

Results. Mean titration times for all completed titrations was 4.8 months. Clinical effectiveness for all completed titrations was 69%. However, the results showed a significant amount of incomplete titrations that lacked a follow up sleep test. An accurate measure of clinical effectiveness could not be calculated.

Conclusions. This study shows that OAT titration times at an Army MTF are comparable with those found in the literature for multiparametric titrations. Incorporating objective forms of titration can potentially lower titration time even further. Lowering the titration time can increase clinical effectiveness, cost effectiveness, and compliance of OAT.

Keywords. Obstructive sleep apnea, oral appliance therapy, titration, MATRx.

INTRODUCTION

Obstructive Sleep Apnea (OSA) is a significant health concern and studies have shown that untreated OSA, regardless of symptoms, leads to a higher mortality risk[1-5]. Continuous positive airway pressure (CPAP) machines and Oral Appliance Therapy (OAT) have emerged as the two predominant treatment modalities to treat OSA. As such they both have been extensively studied in terms of treatment effectiveness, compliance rates, long term side effects, and cost effectiveness[1, 2, 6-12]. Based on several studies, CPAP is the most effective treatment for OSA. However, compliance rates of CPAP around 50%. Additionally, it is accepted that OAT is an effective treatment for mild and moderate OSA as well as for people who do not tolerate CPAP.

Compliance rates for OAT are between 80-90%, but the clinical efficacy rates are around 50% [6-12]. However, clinical efficacy rates significantly improve when the device is titrated in conjunction with data from a sleep test[13-20].

Analyzing the cost effectiveness of each treatment is more challenging. Multiple studies have demonstrated that both treatments are more cost effective than no treatment. These studies used the Incremental Cost Effective Ratio (ICER), Quality Adjusted Life Year (QALY), and the EQ-5D-3L in their methods of analysis. When comparing the cost effectiveness of OAT vs CPAP the results are mixed. A comprehensive British study concluded that a Mandibular Advancement Device (MAD), a type of OAT, was more cost effective than CPAP in the treatment of mild and moderate OSA, but not for severe OSA. This was especially true when CPAP was not tolerated[8]. An American study showed that OAT was only more cost effective than CPAP when there was a patient intolerance to CPAP[9]. However, this study assumed equal compliance rates between CPAP and OAT (it is generally accepted that compliance rates to CPAP are much lower than OAT[1, 2, 6, 12, 16]), and this study only examined moderate and severe OSA[9]. A Dutch study concluded that CPAP was more cost effective than MAD in the treatment of moderate OSA. However, a limitation on this study was the treatment time was for only 1 year, and maintenance costs on a CPAP increase after 1 year while MAD has very little to no maintenance costs after the first year[7]. Additionally, compliance rates for CPAP decline after 6 months to as low as 17% after 5 years, lowering cost effectiveness even further[6]. A limitation on all 3 studies is that the titration to an effective mandibular position on an MAD was done subjectively[7-9].

OAT does not have a standardized method of titration[13], but setting a therapeutic mandibular position is critical when treating OSA with MAD[13-14, 16-19]. Adjusting the level of mandibular protrusion for an OAT is analogous to adjusting (titrating) the amount of pressure delivered in a CPAP to obtain a therapeutic response[16]. There are three methods of titrating a MAD: subjective titration, objective titration, and multiparametric (combination of subjective and objective) [13]. The most common method of titration is subjective, whereby the patient communicates with the dentist and the sleep physician about their snoring, quality of sleep, day time sleepiness, etc. This process can result in several appointments and take several months in some cases where the dentist continually adjusts the mandibular position to find an effective position that is also comfortable for the patient[13, 17-19]. A longer titration period requires more dental visits, which increases cost and subsequently decreases OAT cost effectiveness. Compliance is also negatively affected by a longer titration period[14]. Secondly, it has also been shown that even after the titration period, the MAD may only be effective in 50% of patients[1, 6, 12-13]. All of these factors negatively affect the cost effectiveness and clinical effectiveness of OAT seen in studies.

This effect is compounded in a military population due to deployments, field training exercises, personnel change of station (physicians, dentists, and patients), and a lack of standardized titration modalities for OAT. Currently, the military utilizes either a subjective or multiparametric method of titrating an oral appliance. At the Carl R. Darnall Army Medical Center (CRDAMC), patients referred for OAT undergo a subjective titration process that may last several weeks to months. After that process is complete the patient is then referred back to the sleep physician for a polysomnography study (PSM) to verify if the device is therapeutic.

However, this treatment process is often interrupted at different points or even halted due to military demands on patient's schedules. A patient may never finish a titration process or follow up to verify if the oral appliance is an effective treatment for their OSA. This effect negatively compounds the clinical and cost effectiveness of MAD treatment in military populations.

Objective forms of OAT titration are a potential solution to improving titration time as well as improving clinical outcome. The MATRx and MATRx plus have been used in several studies and found to be an accurate method of predicting treatment response and therapeutic position[1,2,14, 20]. The MATRx plus is a method of objective titration for determining if a MAD will be effective as well as predicting the mandibular position that will be therapeutic for the patient. This product utilizes custom trays and an actuator to protrude the mandible to various positions during sleep. In conjunction with polysomnography inputs, the mandible is protruded to predict a therapeutic protrusion position. In one study the MATRx predicted if the patient would respond to MAD treatment or not at a 94% for positive prediction (PPV) and 83% for negative prediction (NPV)[1], and in another study PPV of 97% and NPV of 72%[2]. It will also predict the minimal advancement mandibular position for a therapeutic response in those patients that are predicted as positive responders to treatment. This position proved efficacious in 87% and 86% in the two studies[1,2]. The MATRx plus is formulated for a 2 night at home sleep test standardization. A third or fourth night may be required if there is not enough data collected on the prior two nights. For example if a patient did not get 4 hours minimum of sleep than another night may be required. Even counting these extra nights, the titration can be reduced from several months to 2-3 weeks. This also reduces dental visits since the therapeutic position is determined by the MATRx plus and not subjective data from the patient. This has the potential to increase clinical and cost effectiveness as well as compliance.

This retrospective records review evaluated the OSA treatment modality at CRDAMC for the year of 2019. Records were reviewed to determine OAT titration times and rates of clinical effectiveness to comparable results found in the literature. Due to challenges facing a military population, it was hypothesized that the titration time at CRDAMC would be a mean of 6 months, and that clinical efficacy would be less than 50%.

MATERIALS AND METHODS

The Military Health System Management Analysis and Reporting Tool (MHS MART 2) is the data repository for Armed Forces Health Longitudinal Technology Application (AHLTA). It provides individual and claim level data on the health care usage of DoD beneficiaries. For the treatment year 2019, the repository was searched for the following codes: Evaluation and Management (E/M) Code G.47.33 - Obstructive sleep apnea (adult) (pediatric), Current Procedural Terminology (CPT) Code 95810 - Polysomnography With 4+ Add'l Sleep Parameters Age 6 Years Or Older, and 95811 - Polysomnography With PAP titration. Records with these codes were extracted from MHS MART 2 and the patient's medical records were reviewed in AHLTA.

Medical treatment pertaining to OSA was reviewed in AHLTA. Data recorded from treatment included the following: year of OSA diagnosis, first and last appointment related to OSA,

severity of OSA, initial AHI, final AHI, type of treatment, and outcome of treatment. Patients diagnosed with OSA in a different year than 2019, non-active duty patients, patients prescribed a sleep study and found not to have OSA received no further review and data reflected in the results.

Patients that received a dental referral for OAT in AHLTA, were further reviewed in the Corporate Dental System (CDS). Additional data documented on these patients included: initial and final dental visit related to OSA, final AHI after treatment, and potential reasons for inadequate titrations.

As a secondary source for titration data, all referrals made from CRDAMC Sleep Center from 2018-2020 for OAT were reviewed. This was done to capture all OAT titrations made in 2019 as well as a cross check on data extracted from MHS MART 2. Record breakdown is illustrated in Table 1. Titration breakdown for patients diagnosed with OSA in 2019 and referred for OAT in 2019 is illustrated in Table 2. Titration breakdown for patients diagnosed with OSA in a year other than 2019, but had a referral for OAT in 2019 is illustrated in Table 3.

Mean titration time was calculated for all patients that received a complete titration. Total of 10 completed titrations for patients diagnosed with OSA and referred for OAT in 2019, and 16 for patients diagnosed with OSA in a year other than 2019, but referred for OAT in 2019. For the purposes of this research a complete titration is defined as an appliance that was delivered, monitored for subjective resolution of OSA symptoms by the dentist, and a follow up PSG or AHST administered with the appliance to evaluate clinical efficacy. Additionally, mean titration time was calculated for incomplete titrations that only lacked a follow up PSG or AHST to determine clinical efficacy. For this subset, a total of 14 patients diagnosed with OSA and referred for OAT in 2019, and 14 for patients diagnosed with OSA in a year other than 2019, but referred for OAT in 2019. A combined total of 54 titration times were captured. Titration times were calculated and graphed for the 4 different groups shown in Figure 1 and 2.

Utilizing Statistical Package for Social Sciences (SPSS), an ANOVA test was used to determine if there was a statistically significant difference in mean titration times for the 4 different groups. Results of the ANOVA test are reported in Figure 3.

RESULTS

A total of 842 records were reviewed in AHLTA. The breakdown of these patients are as follows: 568 patients were diagnosed with OSA and did not receive a dental referral, 116 patients were diagnosed with OSA in a year other than 2019, 10 patients were diagnosed with OSA and received no follow up treatment, 37 patients were diagnosed with OSA but were not active duty military, 52 patients received a PSG or AHST but were not diagnosed with OSA, 1 patient diagnosed with OSA refused treatment, and 44 patients were referred for OAT after their OSA diagnosis.

Of the 568 patients diagnosed with OSA without a dental referral, 297 were treated and compliant with CPAP, 104 were non-compliant with CPAP, and 167 received CPAP treatment and did not have a follow up appointment to confirm efficacy or compliance.

Of the 44 patients that received an OSA diagnosis in 2019 and a dental referral, 10 had completed titrations, 28 had incomplete titrations, and 6 did not come in for an OSA related dental appointment. Out of the 10 completed titrations, 5 patients obtained therapeutic success (AHI < 5), 4 patients were therapeutic failures (AHI >5), and 1 patient was unknown due to the AHI of the follow up PSG not documented in AHLTA. Of the 28 incomplete titrations, 14 patients were subjectively titrated by the dentist, but did not receive a follow PSG to determine clinical effectiveness of the appliance.

An additional 48 patients received a referral for OAT in 2019, but had an OSA diagnosis in a year other than 2019. For these patients, 16 had completed titrations, 22 had incomplete titrations, and 10 did not come in for an OSA related dental appointment. For the completed titrations, 13 patients obtained therapeutic success, 2 patients were therapeutic failures, and 1 patient was unknown due to the AHI of the follow up PSG not documented in AHLTA. For the incomplete titrations, 14 patients were subjectively titrated by the dentist, but did not receive a follow PSG to determine clinical effectiveness of the appliance.

There were inconsistencies found between MHS MART 2 extraction data, AHLTA, and the OAT referral records. There were 14 records that were extracted from MHS MART 2, but their AHLTA records showed no OSA related treatment. Additionally, 16 patients that were referred for OAT were not in the MHS MART 2 extraction data.

Completed titrations for patients diagnosed with OSA and referred for OAT in 2019 ranged from 1.8 to 8.7 months with a mean of 4.6 months. Completed titrations for patients diagnosed with OSA in a year other than 2019 but referred for OAT in 2019 ranged from 1.4-14.5 months with a mean of 4.9 months. Incomplete titrations, only missing a follow up PSG, for patients diagnosed and referred for OAT in 2019 ranged from 0.9 to 13.5 months with a mean of 3.9. Incomplete titrations, only missing a follow up PSG, for patients diagnosed with OSA in a year other than 2019 but referred for OAT in 2019 ranged from 1.3 to 11.2 months with a mean of 4.2. The ANOVA test showed a p value of 0.870 indicating no significant difference between the means of the groups.

Clinical efficacy for complete titrations was also calculated. Patients diagnosed with OSA and referred for OAT in 2019 had a 50% clinical efficacy rate. Patients diagnosed with OSA in a year other than 2019 and referred for OAT in 2019 had a clinical efficacy rate of 81%. For all completed titrations in 2019, a combined clinical efficacy rate of 69%. Results are shown in Table 4.

DISCUSSION

This retrospective records review calculated mean titration times for OAT at CRDAMC and compared them to titration times found in the literature. Additionally, clinical efficacy rates were calculated and referred to the efficacy found in the literature.

HYPOTHESES

The first hypothesis for this project was that OAT titration times would be a mean of 6 months at CRDAMC. This was chosen based on multiparametric titration times of 2.1, 3, and 5.8 months

found in the literature[17-19]. It was thought that barriers to care in a military population would cause delays in treatment leading to increased titration times. Results did not support this hypothesis based on mean titration times of 4.5 and 4.9 months for completed titrations. Data from this project suggest that the OAT titration times are efficient and on par with civilian institutions.

The second hypothesis was that OAT clinical efficacy rates would be lower than 50%. This was chosen based on overall efficacy rate of 50% found in the literature[6-12]. It was thought that barriers to care in a military population would degrade efficacy. Results did not support this hypothesis based on combined clinical efficacy of 69% for all completed titrations. However, due to the high amount of incomplete titrations, the data is unable to determine clinical efficacy rates conclusively.

LIMITATIONS

This project is significantly limited by selection bias as the population is active duty military at a military treatment facility (MTF) and not necessarily representative of broader society. In an attempt to mitigate this bias, a treatment period of 2019 was chosen for analysis.

Incomplete titrations represented a significant amount of the referrals made for OAT in 2019. This led to a small sample size for completed titrations for study. While clinical titration time is not significantly altered without the follow up PSG, the clinical effectiveness is impossible to determine without it. The amount of incomplete titrations with missing PSG data made it impossible to report clinical effectiveness accurately or confidently at CRDAMC for OAT in 2019.

Finally, COVID-19 influenced the data. The treatment year 2019 was chosen to limit or avoid COVID-19 influence, but some of the titrations took place during the height of the pandemic. Although the ANOVA test showed no significant difference in mean titrations times, COVID-19 negatively influenced some individual titrations causing extended times. It is possible the mean titration times are even lower than the reported data indicate.

CONCLUSIONS

OAT titration time at CRDAMC is efficient and comparable with titration times found in the literature. With an average titration time of 4.8 months for all complete titrations in 2019, OAT treatment workflow is comparable with 2.1, 3 and 5.8 months respectively from other studies[17-19]. This is especially true considering two of these studies are prospective studies with rigid clinical treatment protocols and follow up appointments[18, 19]. The retrospective study with an average titration time of 5.8 months is potentially more indicative of actual titrations in a dental office setting and more comparable with titration times found at CRDAMC[17].

Data on this project suggest that clinical efficacy of OAT is comparable to results found in the literature with a 69% clinical efficacy for all complete titrations. However, more data is required to make a confident and accurate conclusion on clinical efficacy. Only 26 completed titrations were available for analysis. Contrast that with 28 incomplete titrations missing a follow up PSG. Data from the potential follow up PSG could significantly alter the clinical efficacy results.

Incorporating objective forms of OAT titration has the potential to reduce the titration time further. A multiparametric titration is efficient, clinically effective, and cost effective. However, objective titrations like those utilizing the MATRx plus can decrease the titration time from 4 months to 4 weeks[1, 2, 20]. This has the potential to increase clinical effectiveness, cost effectiveness, and compliance significantly.

APPENDIX A: Tables

OSA diagnosed in 2019 with no Dental Referral	568	[redacted]
OSA diagnosed in a different year	116	[redacted]
Patients that were not seen for OSA*	14	*MHS MART 2 Error
OSA diagnosed in 2019 but not treated*	10	*No treatment mentioned after diagnosis
OSA diagnosed in 2019 but not active duty	37	[redacted]
PSG in 2019 but OSA not diagnosed*	52	*AHI < 5 on PSG
OSA diagnosed in 2019 but refused treatment	1	[redacted]
OSA diagnosed in 2019 and referred for OAT	44	[redacted]
Total AHLTA Records Screened	**842**	[redacted]

Table 1. Records extracted from MHS MART 2 and reviewed in AHLTA.

OSA diagnosed in 2019 and referred for OAT: 44 Total Patients		
Completed Titrations	10	5 Treated Effectively (AHI<5) 4 Treatment Ineffective 1 Unknown: No AHI recorded after follow up PSG
Incomplete Titrations	34	14 No follow up PSG 5 Delivered without titration 4 Appliances not delivered 2 Titration ongoing 2 Patients required dental work 1 Patient ETS then came to dental 6 Referred but did not come in for dental appointment

Table 2. Records of patients diagnosed and referred for OAT in 2019 and the outcomes.

OSA diagnosed in a year other than 2019 and referred for Oral Appliance in 2019: 48 Total Patients		
Completed Titrations	16	13 Treated Effectively (AHI<5) 2 Treatment Ineffective 1 Unknown: No AHI recorded after follow up PSG
Incomplete Titrations	32	14 No follow up PSG 2 Titration ongoing 2 OAT non-compliant 1 Declined appliance 1 Severe gag reflex 1 Deployed 1 Mistake referral, patient already on OAT 10 Referred but did not come in for dental appointment

Table 3. Records of patients diagnosed in a year other than 2019 but referred for OAT in 2019 and the outcomes.

Clinical Effectiveness: AHI < 5 with Oral Appliance		
Completed Titrations Patients Diagnosed and Referred in 2019	5/10	50%
Completed Titrations Patients Diagnosed in a year other than 2019 but Referred in 2019	13/16	81%
Total Completed Titrations in 2019	18/26	69%
Incomplete Titrations with no PSG follow up	Unknown out of 28	Unknown

Table 4. Clinical outcome of OAT based on PSG data.

APPENDIX B: Figures

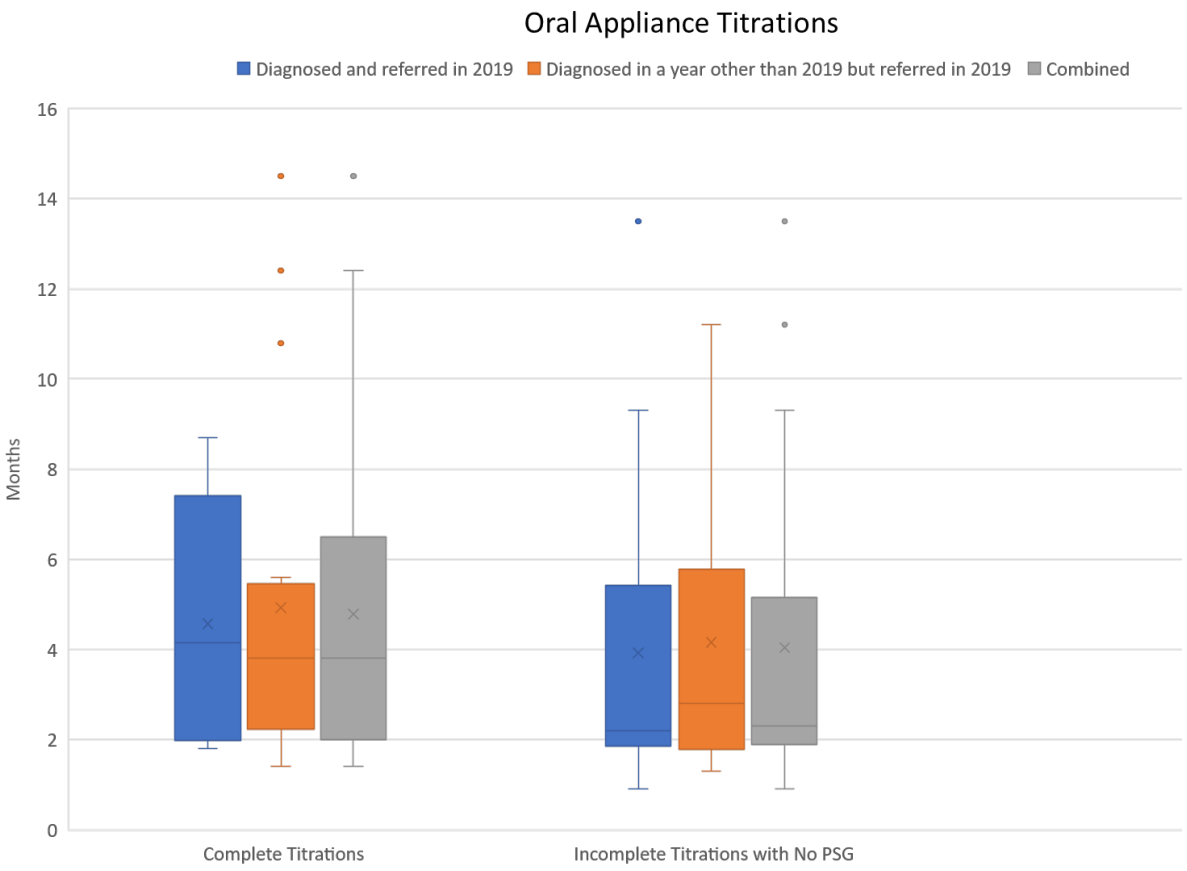

Figure 1. Range of titration times for completed titrations and for incomplete titrations that only lacked a follow up PSG.

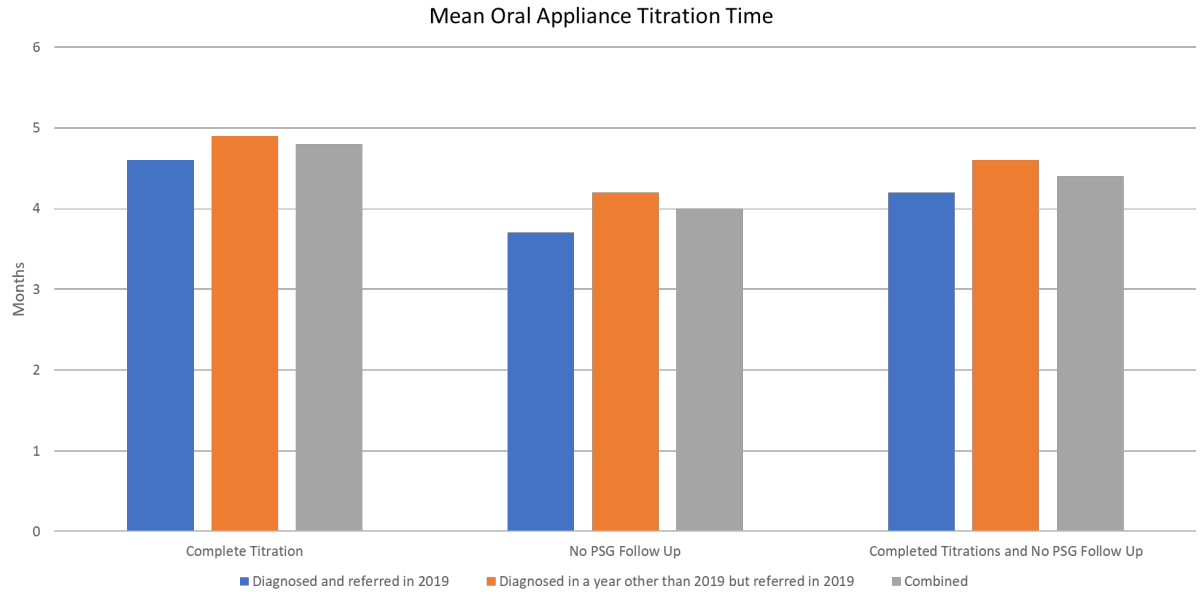

Figure 2. Mean titration times for all referred patients for 2019 with complete titrations and incomplete titrations that only lacked a follow up PSG.

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Diagnosed and referred in 2019	10	4.570	2.6862	.8495	2.648	6.492	1.8	8.7
Diagnosed in other years and referred in 2019	16	4.925	4.0291	1.0073	2.778	7.072	1.4	14.5
No PSG 2019	14	3.921	3.5612	.9518	1.865	5.978	.9	13.5
No PSG other years	14	4.157	3.2842	.8777	2.261	6.053	1.3	11.2
Total	54	4.400	3.4265	.4663	3.465	5.335	.9	14.5

Tests of Homogeneity of Variances

		Levene Statistic	df1	df2	Sig.
Months	Based on Mean	.195	3	50	.899
	Based on Median	.064	3	50	.979
	Based on Median and with adjusted df	.064	3	42.186	.979
	Based on trimmed mean	.119	3	50	.948

ANOVA

Months

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	8.731	3	2.910	.237	.870
Within Groups	613.529	50	12.271		
Total	622.260	53			

Figure 3. Statistical analysis of mean titration times calculated. P value of 0.870 suggesting no statistical significance between the groups.

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