Predicting Changes in AHI Resulting from Mandibular Repositioning Device Therapy

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Introduction: Identification of patients likely to have successful outcomes could increase the use of mandibular repositioning devices (MRD) as the first choice of therapy for obstructive sleep apnea (OSA). One approach suggests patients with positional OSA (supine AHI / non-supine AHI >2) will have better outcomes. Another model does not make predictions when individuals have an AHI < 15. This study investigates predictors associated with successful MRD outcomes.

Methods: One-hundred and twenty-two patients were treated at dental offices in Encinitas, CA (n=70), La Costa, CA (n=38) and Green Bay, WI (n=14) with the Tap II (n=35) and Tap III (n=60) (Airway Management, Inc. Dallas, TX) and Herbst (n=27)(Great Lakes Orthodontics, Tonawanda, NY) oral appliances. ARES in-home sleep studies (Advanced Brain Monitoring, Carlsbad, CA) were obtained and automated algorithms applied to derive apnea/hypopnea indexes equivalent to Medicare criteria (AHI) based on either a 10-sec cessation in airflow (apnea) or a 50% change in tidal volume and a minimum 4% reduction in SpO_2 (hypopnea) and to Chicago Respiratory Disturbance Index criteria (RDI) which includes the AHI events plus hypopneas with a 1% desaturation and resaturation and confirmed with a behavioral arousal based on a change in snoring, head movement or pulse rate. Two-night studies were conducted one- and two-months subsequent to insertion with 63% of the subjects (77/122) obtaining optimal results at month-two. Demographic, anthropomorphic, and sleep studies variables were submitted for analysis by gender with values logged when required to achieve Gaussian distributions (Table 1). Multiple linear regressions were used by and across genders to predict the post-treatment AHI%.

Table 1. Description of participants and pre-treatment sleep study parameters

Mean ± SE	Males N = 84	Females N = 38	p ≤	Mean ± SE	Males N = 84	Females N = 38	p ≤
Age, years	52 ± 1.1	55 ± 1.3	NS	BMI, kg/m2	29 ± 0.5	30 ± 1.0	NS
Epworth	11 ± 0.5	12 ± 0.7	NS	Neck size	43 ± 0.3	38 ± 0.6	0.0001
AHI	20 ± 1.6	10 ± 2.4	NS	RDI	31 ± 1.6	29 ± 2.5	NS
AHI Supine	35 ± 2.4	28 ± 3.7	0.053	RDI Supine	47 ± 2.2	39 ± 3.7	0.05
AHI Non-supine	10 ± 1.2	14 ± 2.6	NS	RDI Non-supine	19 ± 1.6	23 ± 3.0	NS
% time SpO2 <90%	3.9 ± 0.6	5.5 ± 1.3	NS	% time Supine	43 ± 2.9	37 ± 4.2	NS
Snoring < 30 dB	33 ± 1.7	31 ± 3.0	NS	Snoring < 40 dB	23 ± 1.9	24 ± 3.2	NS

Results: The Pearson correlations between the post-treatment AHI and RDI values and pre-treatment values are presented in Table 2. As expected, the correlations between the pre-treatment and post-treatment positional AHI and RDI values are markedly similar by gender. Some interesting findings were noted when significant correlations were compared by variable across gender. The strong correlation between the pre- and post-treatment Supine AHI and RDI for males and lack of correlation in females may be explained by the significantly greater mean Supine AHI and RDI in males (Table 1). The ratio of the supine to non-supine AHI seemed to normalize this discrepancy, and provide an alternative predictor of supine severity for females. Snoring was correlated with the AHI and strongly correlated with the RDI in males but showed no correlation with post-treatment values in females. This finding suggests that reliance on changes in snoring as a subjective measure of MRD outcomes in females may be unreliable. Neck size and the percent time when SpO2 < 90% appear to be very

predictive of post-treatment AHI only in females, suggesting females with larger necks are more likely to have O2 desaturations. The negative correlation between the Epworth sleepiness score and post-treatment AHI and RDI values in females were markedly strong and difficult to explain.

Table 2. Correlations between Post-Treatment AHI and Pre-treatment Variables

	Post-treatment AHI				Post-treatment RDI			
	Males		Females		Males		Females	
	Pearson r	p ≤	Pearson r	p ≤	Pearson r	p ≤	Pearson r	p ≤
AHI	0.53	0.0001	0.42	0.01	0.46	0.0001	0.45	0.01
RDI	0.55	0.0001	0.40	0.05	0.58	0.0001	0.47	0.01
AHI Supine	0.48	0.0001	0.10	NS	0.47	0.0001	0.11	NS
RDI Supine	0.42	0.0001	0.08	NS	0.51	0.0001	0.12	NS
AHI Non-supine (l)	0.52	0.0001	0.53	0.001	0.54	0.0001	0.57	0.001
RDI Non-supine (l)	0.46	0.0001	0.53	0.001	0.57	0.0001	0.64	0.0001
AHI Sup/Non-Sup ratio (l)	-0.19	NS	-0.40	0.05	-0.13	NS	-0.39	0.05
% time SpO2 < 90%	0.39	0.001	0.48	0.01	0.29	0.01	0.43	0.01
Snoring > 30 dB	0.30	0.01	0.19	NS	0.40	0.001	0.23	NS
Snoring > 40 dB	0.27	0.05	0.20	NS	0.39	0.001	0.14	NS
BMI (l)	0.29	0.01	0.43	0.01	0.30	0.01	0.39	0.05
Neck size	0.19	NS	0.44	0.01	0.28	0.01	0.47	0.01
Epworth	0.15	NS	-0.39	0.05	0.04	NA	-0.41	0.01

(l) = logged

A simple linear regression model: Predicted Post-treatment AHI4 = 2 + (0.20*Pre-treatment-AHI) accurately predicted 66% of the cases within ± 3 events/hr and 89% within ± 6 events/hr. Only 3% of the cases had predicted errors > ±10 events/hr (Figures 3 and 4).

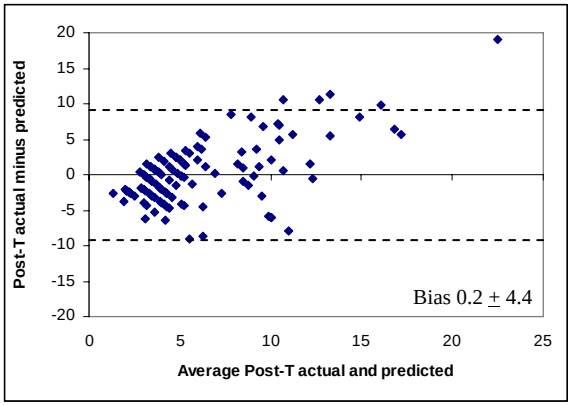

Figure 1: Bland-Altman plot (+/- 2 SD) of differences between actual post-treatment AHI and predicted post-treatment AHI

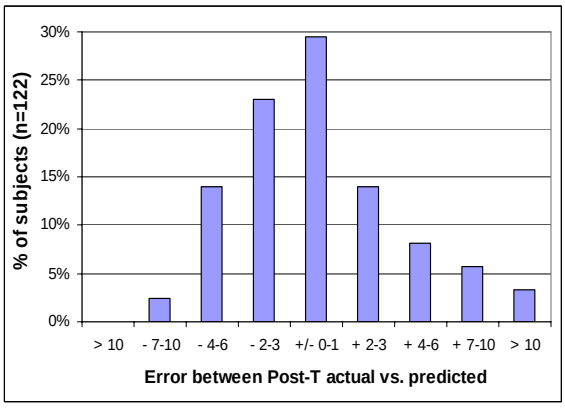

Figure 2: Distribution of the error between the actual post-treatment AHI and the predicted post-treatment AHI using the simple linear regression equation.

Conclusions: There is a strong positional component in the association between MRD outcomes and sleep study data. Several of the factors which predict outcomes are unique to males vs. females. A simple linear regression may be useful in predicting MRD outcomes. Further studies need to be conducted to determine if the post-treatment AHI can be accurately predicted using the formula [Pre-treatment AHI / 5 + 2 events], and whether this formula is applicable when data are obtained with other sleep study equipment.

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