A Multi-center Evaluation of Oral Pressure Therapy for the Treatment of Obstructive Sleep Apnea: sleep architecture effects

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Abstract

OBJECTIVES: This study sought to evaluate laboratory polysomnography measures of sleep architecture and sleep stability in obstructive sleep apnea (OSA) patients while using a new non-invasive oral pressure therapy (OPT) system (Winx(TM), ApniCure). The hypothesis was that improvements in apnea-hypopnea index (AHI) with device use would be associated with a reduction in N1, arousal index and sleep-stage shifts, and increases in REM and N3.

METHODS: Sixty-three eligible subjects at 6 centers, 69.8% male, 53.6+/-9.0 years (mean+/-SD), BMI 32.3+/-4.5 kg/m^2, with mild to severe OSA underwent laboratory polysomnography (PSG) at treatment initiation: one night with (Tx1) and one without (Tx-) treatment in randomized order) and again following 28 nights (Tx28) of treatment. Total AHI and sleep architecture were assessed each night based on blind scoring by a single centralized scorer using AASM criteria. Differences between Tx- (control night) and Tx1 and Tx28 were assessed with paired t-test or signed rank test. Data are presented as (median ± interquartile range).

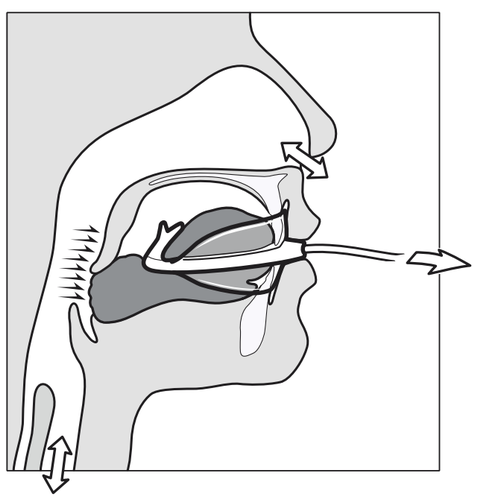
RESULTS: N1% was significantly reduced at Tx1 (17.8 ± 17.1, p =.005) and Tx28 (17.5 ± 14.2, p < .001) relative to Tx- (23.0 ± 21.1). REM% was significantly increased at Tx1 (18.8 ± 8.0 p < .02) and at Tx28 (18.1 ± 9.3, p = .03) relative to Tx- (16.6 ± 9.5). There were no significant changes in N3% (Tx-: 5.6 ± 12.0; Tx1: 5.7±15.0; Tx28: 6.5±11.8). Stage shifts to N1 sleep, overall stage shifts, total awakenings and arousals per hour were all significantly decreased at Tx1 (9.0 ± 6.0, p = .002; 26.0 ± 12.0, p < .001; 34 ± 20, p = .035; 30.6 ± 23.2, p < .001) and at Tx 28 (8.0 ± 5.5, p < .001; 24.0 ± 12.5, p < .001; 29 ± 21, p <.001; 28.7 ± 20.0, p < .001) relative to Tx- (11.0 ± 8.0; 32.0 ± 16.0; 38 ± 27; 41.0 ± 23.5) . The difference in AHI between Tx- and Tx1 was significantly correlated with differences in stage shifts, shifts to stage 1, AI, REM% and stage 1% (all p < .01), The same pattern of correlations was seen for differences between Tx- and Tx28 (all p <.01), with the exception of REM%.

CONCLUSION: Significant improvements in AHI produced by OPT were associated with anticipated changes in PSG measures, including increased sleep stability, decreased time in stage 1 sleep and increased time in REM sleep on both the first night of treatment and again after 28 days of treatment.

SUPPORT: ApniCure, Inc.

Background

- Oral Pressure Therapy (OPT) is a novel approach to treating obstructive sleep apnea (OSA)
- The OPT system (Winx™, ApniCure, Inc., Redwood City, CA) comprises a bedside console, a soft polymer mouthpiece, and a flexible tube connecting the mouthpiece to the console. The console creates vacuum pulling the soft palate anteriorly and stabilizing the tongue to reduce obstruction during sleep.



Methods

Intended study population (Analysis Cohort):
- Adult subjects with mild to severe OSA
- Prior treatment (no surgery) allowed, but not required
- All subjects off all OSA treatment ≥ 2 weeks at randomization
- Exclusions: poor nasal patency, AHI > 60, BMI > 40, inadequate mouthpiece fit

Study Treatment:
- Randomized to single PSG night with OPT(Tx1) versus non-treatment (Tx-) (control)
- Crossed over to opposite treatment
- Subsequent 28-day OPT treatment
- Second PSG on OPT-treatment night 28 (Tx28)

Analysis cohort
- Total sleep time (TST) ≥ 4 hours at Tx- and Tx1

Responder Cohort
- AHI at Tx1 50% or less than AHI at Tx-
- AHI at Tx1 20 events per hour or less
- TST of at least four hours

PSG Data Analysis:
- PSG scored blindly using AASM recommended criteria by one scorer
- Stats: paired T-test; signed-rank test; Spearman's correlation

Objectives

- This study examined the effect of OPT treatment versus non-treatment on the sleep of mild to severe OSA subjects.
- Polysomnographic sleep measures including arousal index, sleep-stage shifts, and duration of sleep stages N1, REM and N3 were evaluated.

Results

Demographics:
- 63 subjects enrolled (44 male - 69.8%)
- 6 sleep centers
- Age 53.6±8.9 years (range 32-80)
- BMI 32.3±4.5 kg/m^2 (mean±SD)

OPT and AHI:
- AHI (median) significantly reduced; 27.5 to 13.4 at Tx1 & 14.8 at Tx28
- 26/63 subjects (4/15 mild, 10/18 moderate, 12/30 severe) met Clinical Success criteria (defined *a priori* as AHI reduction ≥ 50% and treatment AHI ≤ 20 at Tx1)
- In these 26 subjects, median AHI was reduced from 26.2 to 5.7.

PSG parameters – OPT Tx1 & Tx28 versus non-treatment:
- N1% significantly reduced at Tx1 and Tx28
- REM% significantly increased at Tx1 and Tx28
- Sleep stage shifts to N1 and overall stage shifts significantly decreased at Tx1 & Tx28
- Total awakenings and arousals per hour significantly decreased at Tx1 & Tx28

AHI and sleep interaction:
- The difference in AHI between Tx- and Tx1 was significantly correlated with differences in stage shifts, shifts to stage 1, AI, REM% and stage 1% (all p < .01), The same pattern of correlations was seen for differences between Tx- and Tx28 (all p <.01), with the exception of REM%.

Sleep Architecture: Analysis Cohort (n=63)

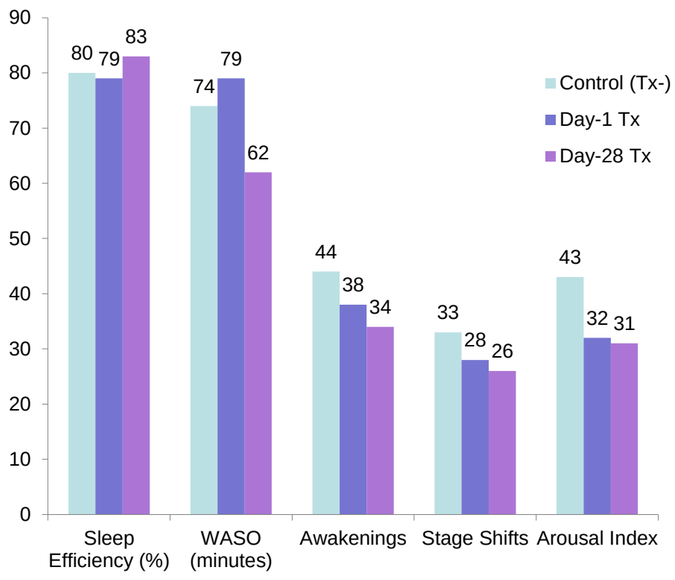
	Baseline	Tx1	Tx28
n	63	63	52
Stage 1 shifts	12.0±6.2	9.5±4.5*	8.7±4.6*
Stage shifts	33.1±12.1	27.6±9.1*	26.3±10.7*
Awakenings	43.5±23.5	37.7±16.1*	33.9±16.7*
Arousal index (/hr)	42.8±18.1	32.4±15.8*	31.4±13.1*
Sleep efficiency (% TST)	79.7±9.1	78.6±8.7	83.2±8.1*
WASO (min)	74.3±41.5	78.5±39.5	61.7±37.7*
% TST in stage 1	27.1±18.0	21.6±12.4*	21.4±13.3*
%TST in stage 2	49.3±12.7	51.3±11.6	52.8±12.5*
%TST in stage 3	7.1±7.0	8.6±8.4	7.6±6.5
%TST in REM	16.5±7.5	18.4±6.5*	18.2±6.9
% TST supine	62.2±35.2	69.3±31.4*	69.2±32.2*

Sleep Architecture: Responder Cohort (n=26)

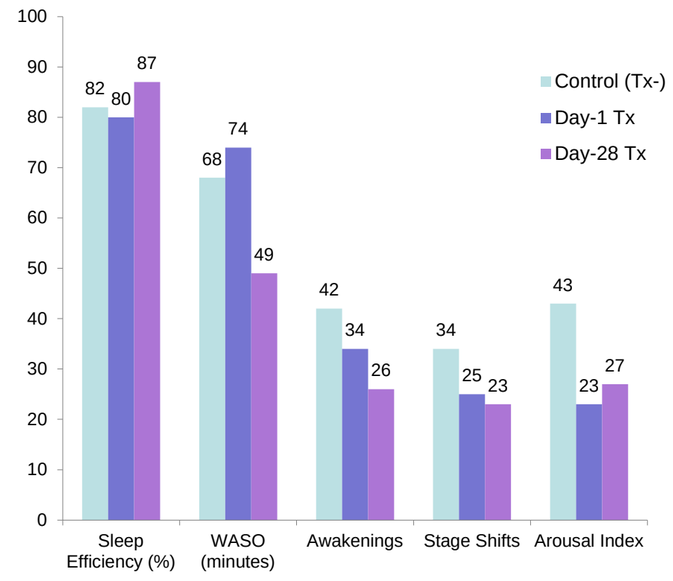
	Baseline	Tx1	Tx28
n	26	26	20
Stage 1 shifts	11.9±5.4	7.8±3.0*	6.8±3.1*
Stage shifts	33.6±11.1	24.8±5.8*	22.6±7.3*
Awakenings	42.0±17.2	33.8±12.7*	25.5±10.7*
Arousal index (/hr)	42.9±17.5	23.2±10.8*	26.8±10.8*
Sleep efficiency (% TST)	81.7±8.1	80.1±8.9	86.8±6.8*
WASO (min)	68.0±35.7	73.6±41.0	49.1±33.9*
% TST in stage 1	25.4±12.7	17.7±10.5*	16.5±9.5*
%TST in stage 2	51.1±9.6	52.9±10.0	54.9±8.1*
%TST in stage 3	7.0±6.1	10.0±7.8*	9.6±6.0
%TST in REM	16.5±7.1	19.4±6.1*	19.0±5.4*
% TST supine	60.1±37.0	57.8±35.7	63.0±35.0

mean±SD, * p<0.05 vs. baseline

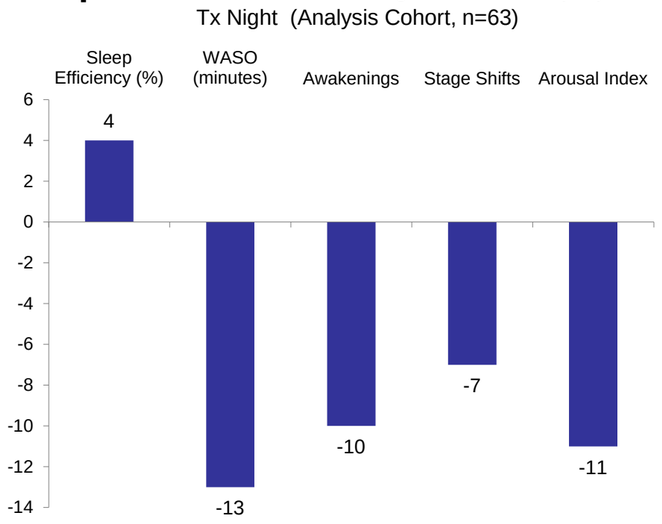
Sleep Architecture: Analysis Cohort (n=63)



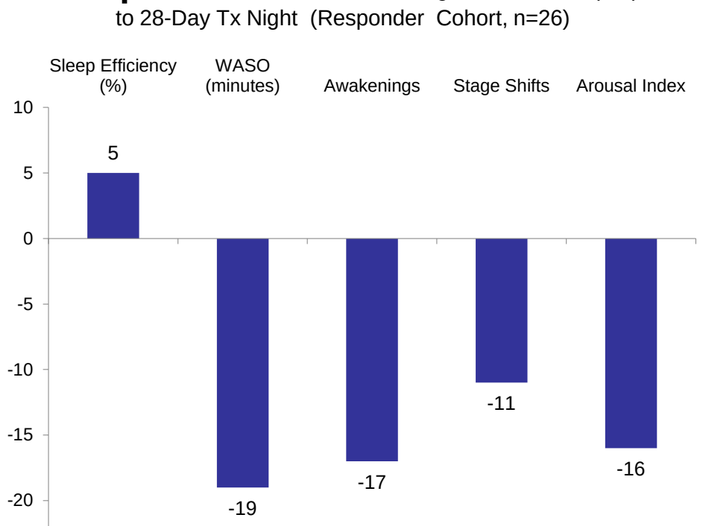
Sleep Architecture: Responder Cohort (n=26)



Sleep Architecture: Change from Control (Tx-) to 28-Day Tx Night (Analysis Cohort, n=63)



Sleep Architecture: Change from Control (Tx-) to 28-Day Tx Night (Responder Cohort, n=26)



Conclusions

- OPT significantly reduces AHI
- OPT is associated with improvement in sleep stability and decreased number of arousals and awakenings at Tx1 and Tx28
- OPT is associated with increased sleep efficiency and decreased WASO at Tx28
- OPT is associated with decreased stage 1 sleep and increased REM sleep at Tx1 and Tx28
- OPT effects on AHI are correlated with changes in sleep quality

Relationship between change in AHI and change in number of sleep stage shifts between Control (Tx-) and Tx1 (Responder Cohort)