

## Abstract

**Objective:** Patients with Down syndrome (DS) commonly have obstructive sleep apnea (OSA). Adenotonsillectomy (T&A) is the primary treatment for OSA, however there is limited data regarding the effects of surgery on polysomnography (PSG) parameters in this patient population. Our aim was to evaluate PSG outcomes following T&A in patients with DS.

**Study Design:** Retrospective case series.

**Methods:** We included all patients with DS who underwent polysomnography both before and after T&A at a tertiary care center from 2003-2013. Non-parametric analysis of variables was carried out.

**Results:** There were 74 patients who met inclusion criteria. The mean age at surgery was 5.1 ± 3.1 years and 40.5% were female. The mean apnea-hypopnea index (AHI) was 10.0 ± 14.3 events/hour before surgery and 4.58 ± 5.1 after surgery. The median obstructive AHI (oAHI) improved 2.85 events/hour [range -26.6-114] (p<0.0001). The mean oxygen nadir improved from 84% to 89% (p=0.001). The mean time with CO<sub>2</sub> >50mmHg improved from 19.9 to 14.0 percent, but was not significant (p=0.09). There were no significant changes in the central index, obstructive apnea index or percentage of rapid eye movement (REM) sleep. After surgery, the obstructive AHI was ≤5 events/hour in 80% and ≤1 event/hour in 27% of patients.

**Conclusion:** T&A improved AHI, hypopnea index, obstructive AHI and saturation nadir in patients with DS. 80% had an oAHI ≤ 5 events/hour after surgery, however 20% had persistent moderate/severe OSA. This supports the recommendation that with children DS and OSA should have a PSG following T&A.

## Background

- Down syndrome is the most common chromosomal abnormality in the US
- OSA affects 40-80% of children with DS vs 1-4% of the general pediatric population
- Polysomnography is recommended to screen children with DS for OSA
- T&A is recommended 1<sup>st</sup> line treatment for children with OSA
- Little is known about the effect of T&A on PSG parameters in DS

## Study Design

- Retrospective chart review
- Children with DS who underwent PSG both before and after T&A at CCHMC between 2003-2013
- PSG outcomes assessed:
  - Apnea hypopnea index (AHI)
  - Obstructive AHI (oAHI)
  - central apnea index
  - O<sub>2</sub> nadir
  - Percent REM
  - Time with CO<sub>2</sub> >50 & maximum end tidal CO<sub>2</sub>
  - Apnea index (obstructive and mixed) & hypopnea index
- Non-parametric analysis of pre-post changes
  - Continuous variables - Wilcoxon Rank Sum test
  - Categorical variable - McNemar's test

## Objectives

### Primary objectives :

- To evaluate PSG outcomes following T&A in children with DS
- To determine if patient age at the time of surgery affected the post operative PSG results in children with DS

**Table 1: Study Population Demographics**

Characteristic	n=74
Age at pre-study, mean (sd) and median [interquartile range (IQR)]	4.9 (3.1) 4.2 [1.1-14.7]
Age at surgery, mean (sd) and median [IQR]	5.1 (3.1-4.5) 4.5 [1.2-14.9]
Age at post-study, mean (sd) and median [IQR]	5.6 (3.0) 4.8 [1.4-15.7]
Age at Surgery	
<3 years, n (%)	17 (23%)
3-6 years, n (%)	39 (52.7%)
>6 years, n (%)	18 (24.3%)
Race – white, n (%)	61 (82.4%)
Sex – Male, n (%)	44 (59.5%)
BMI percentile (n=52), mean %ile (mean BMI) and median %ile [range]	75 <sup>th</sup> (27.6) 88 <sup>th</sup> [2-99]

**Table 2: Polysomnography (PSG) outcomes before and after adenotonsillectomy in children with DS**

	Preoperative PSG	Postoperative PSG	Overall change median	P value*
AHI, mean (sd) and median [range]	10 (14.3) 6.75 [0.8-115.3]	4.58 (5.1) 3 [0.1-34]	2.85 [-26.5-114]	<0.0001
oAHI, mean (sd) and median [range]	8.79 (14.4) 4.95 [0.3-115.3]	3.51 (4.8) 2.05 [0-34]	2.85 [-26.6-114]	<0.0001
O <sub>2</sub> Nadir, mean (sd) and median [range]	0.84 (0.16) 0.88 [0-0.96]	0.89 (0.04) 0.90 [0.76-0.96]	-0.024 [-0.20-0.075]	0.001
Percent REM, mean (sd) and median [range]	22.1% (7%) 23.7 [4.7-34.3]	21% (7%) 21.9 [4.6-32.9]	0.021 [-0.21-0.21]	0.18
Percent Time CO <sub>2</sub> > 50, mean (sd) and median [range]	19.9 (30.2) 2 [0-100]	14 (25.3) 0.45 [0-98]	0.10 [-95-98]	0.09
Obstructive Apnea index, mean (sd) and median [range]	3.12 (3.36) 2.04 [0.54-14.58]	1.56 (3) 0.84 [0-1.308]	1.32 [-10.8-9]	0.58
Hypopnea index, mean (sd) and median [range]	5.52 (5.34) 3.72 [0.18-27]	2.88 (3.54) 1.74 [0.12-20.82]	1.68 [-15.6-25.8]	<0.0001
Maximum ET CO <sub>2</sub> , mean (sd) and median [range]	53.2 (4.8) 53 [44-71.5]	52.9 (4.8) 53 [41.6-66]	0.10 [-95-98]	0.09
Central index, mean (sd) and median [range]	1.19 (1.6) 0.6 [0-8.2]	1.02 (1.45) 0.55 [-0.3-7]	0 [-6.4-7.4]	0.20
Postoperative AHI ≤ 1, n (%)	1 (1.4%)	5 (6.9%)		0.10
Postoperative AHI ≤ 5, n (%)	27 (37.5%)	52 (72.2%)		<0.0001
Postoperative oAHI ≤ 1, n (%)	2 (2.7%)	<b>20 (27%)</b>		
Postoperative oAHI ≤ 5, n (%)	39 (52.7%)	<b>59 (79.7%)</b>		

AHI: apnea hypopnea index, oAHI: obstructive AHI, O<sub>2</sub>: oxygen, REM: rapid eye movement, CO<sub>2</sub>: carbon dioxide, OA: obstructive apnea, MA: mixed apnea, ET: end tidal  
 Reported as mean with standard deviation in parentheses and median with min-max in brackets

## Results

- Mean AHI improved from 10.0 ± 14.3 to 4.58 ± 5.1 events/hr
- Median AHI improvement was 2.9 events/hour (p<0.0001)
- Change in AHI ranged from an improvement of 114 events/hour to a worsening by 26 events/hour (7, 9.4% with worsening)
- Mean oAHI improved from 9.0 ± 14.4 to 3.5 ± 4.8 events/hour
- Median oAHI improvement was 2.9 events/hour (p <0.0001)
- Mean oxygen nadir improved from 84% to 89% (p=0.001)
- Mean time with CO<sub>2</sub> >50mmHg improved from 19.9 to 14.0 minutes but was not significant (p=0.09)
- Mean hypopnea index improved from 5.5 to 2.88 (p<0.0001)
- No changes in the central AHI, or obstructive AI were seen
- The post-op oAHI was ≤5 in 79.7% and ≤1 in 27%
- Stratification by age did not affect results (Table 3)

**Table 3: Changes in PSG outcomes before and after adenotonsillectomy, for children with DS with OSA, stratified age.**

	Changes in outcomes for children <3 years (N=17)	Changes in outcomes for 3-6 year olds (N=39)	Changes in outcomes for children >6 years (N=18)	P value
AHI, median [range]	3.8 [-8-23.3]	2.9 [-26.5-114]	1.6 [-7.5-12.3]	0.09
oAHI, median [range]	3.6 [-5.3-23.9]	2.6 [-26.6-114]	1.6 [-7.8-11.8]	0.12
O <sub>2</sub> Nadir, median [range]	-0.039 [-0.195-0.01] N=9	-0.02 [-0.2-0.075] N=27	-0.015 [-0.08-0.02] N=12	0.18
Percent REM, % [range]	0.039 [-0.13-0.21]	0.02 [-0.18-0.21]	0.012 (-0.21-0.10)	0.29
Percent Time CO <sub>2</sub> > 50, mean (sd) and median [range]	0.80 [-56.3-74.2]	0.40 [-95-98.0]	-0.89 [-0.50-3-96.64]	0.22
Obstructive Apnea index, median [range]	0.03 [0.022-0.038]	0.027 [-0.18-0.148]	-0.0005	---
Hypopnea index, median [range]	0.044 [-0.021-0.39]	0.023 [-0.26-0.43]	0.019 [-0.034-0.155]	0.14
Max ET CO <sub>2</sub> , median [range]	1.4 [-6.0-13.9]	0 [-15-9]	-1.0 [-12-6.9]	0.30
Central index, median [range]	-0.20 [-2.7-2.5]	0.1 [-2.8-7.4]	0 [-6.4-3.1]	0.69
Postoperative AHI ≤ 1, n (%)	1 (6.3%)	4 (10.5%)	0	0.41*
Postoperative AHI ≤ 5, n (%)	11 (68.8%)	29 (76.3%)	12 (66.7%)	0.71

## Discussion, Conclusions, and Implications

- T&A significantly improved AHI, oAHI, hypopnea index and O<sub>2</sub> nadir in children with DS and OSA
- Persistent moderate/severe disease (AHI>5) in 20%
- Stratifying by age did not affect the results
- This supports the recommendation that PSG is indicated following T&A in all patients with DS and OSA
- For patients with DS and OSA, we agree with T&A as 1<sup>st</sup> line treatment followed by PSG at 8-12 weeks post-op
- We recommend that persistent OSA be managed in a multidisciplinary fashion with either medical and/or surgical therapies, depending on the severity of persistent disease and patient specific factors