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The Role of Tonsillectomy in the Treatment of Obstructive Sleep Apnea

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ABSTRACT

Background: Obstructive Sleep Apnea (OSA) is caused by a partial or complete obstruction of the upper airway. OSA is a very inconvenient and relatively common disorder with daytime and nocturnal symptoms. The intervention and management of OSR is dependent on the patients' case severity. The aim of this study was to evaluate the role and the optimal choice of Tonsillectomy for treatment of OSR.

Methods: a systematic search in the scientific database (Medline, EMBASE, Google Scholer and Ovid) from 1980 to 2016 was conducted for all relevant retrospective studies including; randomized controlled trials, cohort studies and case–control studies were analyzed and included based on the preset inclusion and exclusion criteria. **Results:** the search has yielded twelve studies to be included in the present SR (n = 206 patients, 34.4 ± 10.0 years and body mass index: 29.3 ± 9.6 kg/m2) met criteria. Tonsils sizes were hypertrophied, large, enlarged, extremely enlarged, or grades 2 to 4. Apnea-Hypopnea Index decreased by 65.2% (from 43.7± 21.7 /hour to 13.7 ± 12.7 /hour) (n = 198). The AHI mean difference (MD) was −30.2 per hour (95% confidence interval [CI] −39.3, −21.1) (P value < 0.00001). The AHI SMD was −1.37 (−1.65, −1.09) (large effect). Lowest oxygen saturation improved from 77.7 ± 11.9% to 85.5 ± 8.2% (n = 186). Lowest oxygen saturation MD was 8.5% (95% CI 5.2, 11.8) (P value < 0.00001). The Epworth Sleepiness Scale decreased from 11.6 ± 3.7 to 6.1 ± 3.9 (n = 125). Individual patient outcomes (n = 52) demonstrated an 85.2% success rate (AHI < 20/hour and ≥ 50% reduction) and a 57.4% cure rate.

Conclusion: tonsillectomy is an effective and safe surgical intervention for treatment of OSA in adults, particularly among carefully selected patients with large tonsils and mild to moderate OSA severity.

Keywords: Tonsillectomy, OSA, sleep apnea syndromes, Tonsillar Hypertrophy.

INTRODUCTION

Obstructive sleep apnea (OSA) is a type of sleep-disordered breathing (SDB) which is a disorder characterized by partial and/or complete upper airway obstruction that affects normal ventilation and hypopneas due to repetitive collapse of the upper airway during sleep [1]. If left untreated, OSA will be most certainly associated with symptoms of excessive daytime sleepiness, impaired daytime function, metabolic dysfunction, and an increased risk of cardiovascular disease and mortality[2] and hence, Decreased quality of life and behavioral, psychiatric, neurocognitive, cardiovascular, metabolic, endocrine, and growth abnormalities[3].

Obstructive sleep apnea (OSA) is estimated to affect 1 to 5% of all children [4] , and its incidence peaks are between 3 and 8 years of age [5]. Multiple components are involved in SDB in children. Anatomical, craniofacial and neuromuscular factors, excess lymphoid tissues and airway inflammation are cited as the most critical components [6]. Snoring is one of the most often reported symptoms of SDB in pediatric populations, and its prevalence ranges from 1.5 to 27.6% for different studies and populations[6].

First-line therapy in most adults, for OSA consists of behavioral modification, including weight loss if appropriate, and positive airway pressure (PAP) therapy [7]. For patients who fail or do not tolerate PAP therapy, treatment options include oral appliances and surgical therapy. The choice among various second-line options depends on the severity of the OSA and the patient's anatomy, risk factors, and preferences.

Several studies repeatedly showed that tonsillar hypertrophy is a major risk factor for OSA in Children, and that tonsillectomy is highly successful in treating those children [8]. The

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situation in adults is not that clear. While some studies reported a high success rate approximating 100%, other studies reported disappointing results [9]. Obviously, factors, such as anatomical characteristics of the patients, might have attributed to this profound discrepancy. The position of the palate with respect to tongue base is one of the key clinical factors in predicting the outcome of treatment of OSA [10]. Theoretically, the position of the palate may be one of the anatomical features that should be considered when we select adult patients with OSA who are likely to benefit from an isolated tonsillectomy operation [11].

The present study was, therefore, geared at the roles of surgery in the management of OSA.

MATERIALS AND METHODS

Literature search

The present Systematic Review is reported in line with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.

Data Sources: electronic databases were searched: MEDLINE, Book Citation Index–Science (since 2005), Cumulative Index to Nursing and Allied Health, Conference Proceedings Citation Index–Science (since 1990), Embase (from 1980); The Cochrane Library (Evidence-based medicine reviews in OVID) , Google Scholar, PubMed/MEDLINE, Scopus, The Cochrane Library, and Web of Science. Econlit (from 1886).

Search terms included "apnea," "hypersomnia sleep apnea syndrome," "obstructive sleep apnea," "sleep apnea syndromes," and "tonsillectomy."

Study Selection

Study Selection :

Search results were screened by scanning abstracts for the following

Inclusion Criteria

1. Participants Age: 18 years and above
2. Intervention type: only tonsillectomy is considered
3. Comparison: pre- and posttonsillectomy data
4. Outcomes: polysomnography data and quantitative sleepiness data

Exclusion Criteria

1. Patients with mixed or central sleep apnea
2. Individual patient data demonstrating a decrease of ≥ 10% in their body weight.

Data Extraction and Study Quality Assessment

Reviewers independently reviewed studies, abstracted data, and resolved disagreements by consensus. Studies were evaluated for quality. A review protocol was followed throughout. Data collected included Apnea-Hypopnea Index (AHI), Apnea Index (AI), lowest oxygen saturation (LSAT), oxygen desaturation index, respiratory disturbance index (RDI), and quantitative sleepiness data (i.e., Epworth sleepiness scale [ESS], Likert scales, Visual Analog Scales). If studies reported RDI, the study was reviewed to see if RDI scoring criteria were used[12]**.** If so, the plan was to perform a separate analysis for RDI; if not, data was combined with AHI. Studies not reporting sufficient data were contacted at least twice to try to obtain the data. In this study, definitions of postoperative success from the recent publication by Dr. Kezirian and the Sleep Disorders Committee of the American Academy of Otolaryngology–Head and Neck Surgery [13]**.** were applied to the available data; the sub-classifications of surgical success include a postoperative AHI that decreased by ≥ 50% to < 20 events per hour (S20), < 15 events per hour (S15), and < 10 events per hour (S10). Surgical cure was defined as a posttonsillectomy AHI < 5 events per hour (C5). Data with regard to palate positions 1 to 4 (a.k.a. modified Mallampati or Friedman Palate Positions) [14] and Friedman stages [15] 1 to 3 were also evaluated.

We referred to the National Institute for Health and Clinical Excellence (NICE) quality assessment tool for a quality comparison between studies [16] **,** accordingly 8 categories were defined and evaluated in each study and was selected because it allows for quality comparison between studies even for studies with the same level of evidence.

RESULTS

The initial search was on a large scale, any article related to the evaluation of social and behavioral interventions was accepted to ensure a comprehensive view of available work, and generated 764 articles in addition to another 17 publications that were found through manual research. . Preliminary application of study criteria identified 214 potential studies for inclusion that met one or more criteria. Further review of these investigations by two independent reviewers yielded 29 papers full text could not be retrieved and another 89 papers with the same cohort. There were also 68 papers excluded because they did not discuss the present study's relevant endpoint in addition to 38 articles with the same cohort. 12 RCTs that fully met all inclusion criteria. The 12 eligible articles were again closely examined and data extracted using a standard protocol regarding target population, sample size, program provider, program content, intervention components, processes, and outcomes. We followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines in reporting the results **(Figure 1).**

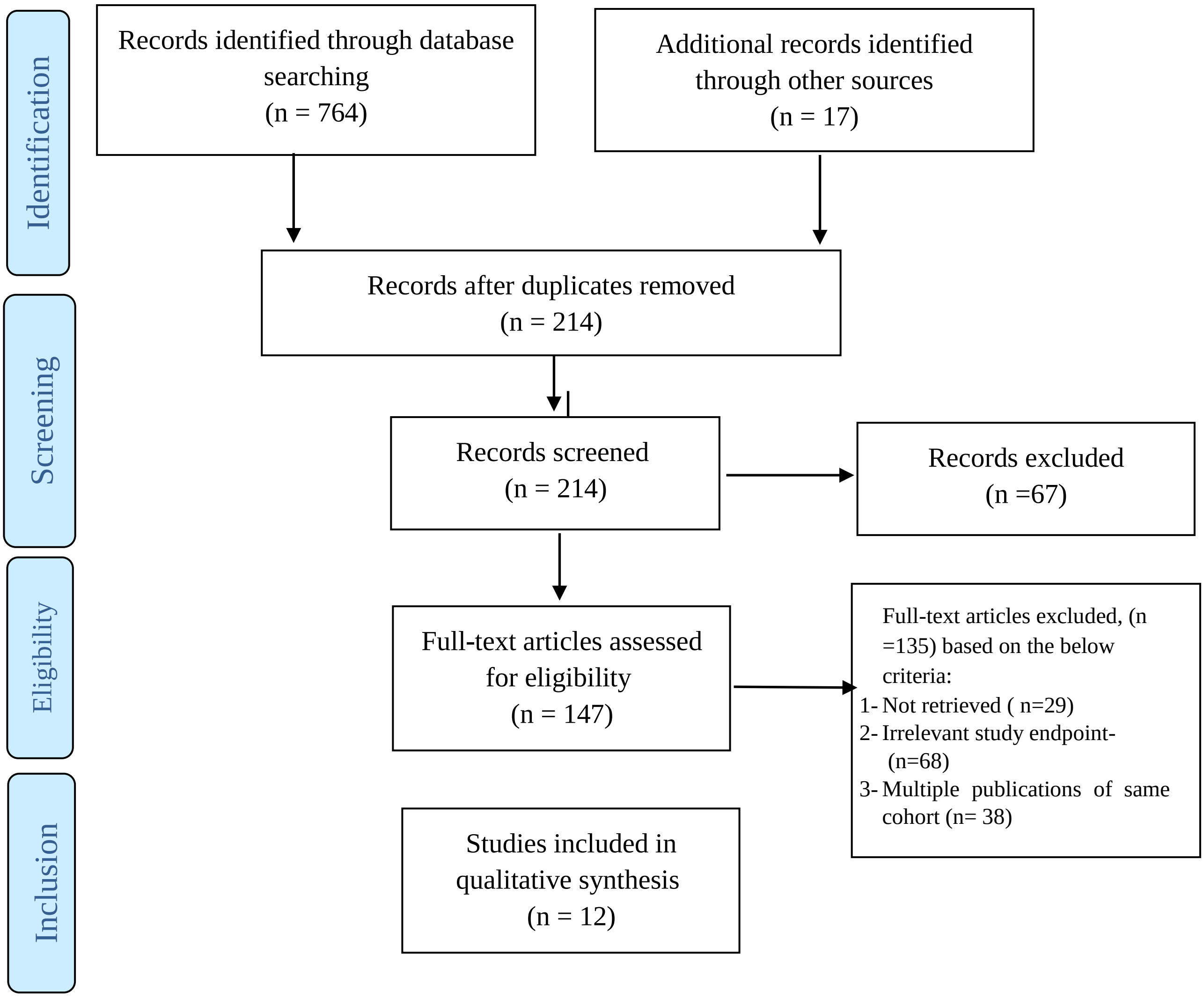

Figure 1: PRISMA flow diagram showing the selection process and steps of the literature search.

Main findings and Outcomes

1. **Obstructive Sleep Apnea Polysomnography)**

- The overall analysis of the 12 studies included demonstrated that isolated tonsillectomy reduced AHI (198 patients) from a mean ± SD of 43.7 ± 21.66 to 13.7 ± 12.68 events per hour (68.6% decrease), see Table 1.
- The pooled M ± SD data for AI (114 patients) decreased from 36.8 ± 24.1 to 7.2 ± 11.7 events per hour (80.4% decrease), Table 1.
- The lowest oxygen saturation (184 patients) improved from 78.2 ± 10.3% to 86.1 ± 7.1%; (10% increase), Table 2.

2. **Outcomes for Sleepiness**

- All four of the studies that reported sleepiness outcomes pre- and posttonsillectomy reported the Epworth sleepiness scale.[70] Overall, the ESS was reported for 125 patients and decreased from 11.8 ± 3.9 to 6.3 ± 4 (46.6% decrease), Table 2.

Table 1. Demographic, Polysomnographic, pre and post apnea outcomes.

Publication	Year	N	Age	BMI	Pre-T AHI	Post-T AHI	Pre-T AI	Post-T AI
Orr *et al.*[18]	1981	3	33.3 ± 21.6	29.6 ± 3.6	–	–	55.7 ± 25.8	12.3 ± 16.3
Moser *et al.*[19]	1987	5	37.6 ± 8.7	31.5 ± 6.1	–	–	14.2 ± 8.8	9.1 ± 16.2
Miyazaki *et al.*[20]	1998	10	39	24.8	14.4 ± 19.9	2.9 ± 4.3	–	–
Verse *et al.*[21]	2000	11	43.5 ± 14.0	30.9 ± 4.4	39.5 ± 28.6	8.2 ± 12.8	29.8 ± 26.8	3.7 ± 8.0
Martinho *et al.*[22]	2006	5	36 ± 10	36.6 ± 6.3	86.8 ± 29.0	27.2 ± 20.3	–	–
Nakata *et al.*[23]	2006	30	33.2 ± 6.8	30.7 ± 6.0	69.0 ± 28.4	30.1 ± 24.0	59.3 ± 31.7	14.7 ± 22.1
Kikuchi *et al.*[24]	2006	11	32.2 ± 7.2	30.4 ± 3.0	51.2 ± 27.7	12.2 ± 8.3	37.0 ± 29.3	1.6 ± 1.5
Nakata *et al.*[25]	2007	20	32.9 ± 6.3	27.9 ± 5.0	55.7 ± 22.5	21.2 ± 14.2	36.6 ± 25.0	4.1 ± 4.7
Chen *et al.*[26]	2012	56	35.9 ± 9.3	24.7 ± 2.9	23.8 ± 15.3	10.8 ± 7.8	–	–
Stow *et al.*[27]	2012	2	44 ± 1.4	24.8 ± 1.0	36.3 ± 6.2	7.7 ± 8.0	–	–
Tan *et al.*[28]	2014	34	31.7 ± 10.8	30.6 ± 6.0	42.2 ± 25.6	13.1 ± 21.7	24.9 ± 21.0	4.6 ± 13.3
Senchak *et al.*[29]	2015	19	27.9 ± 10.1	29.6 ± 6.0	18.0 ± 13.4	3.2 ± 5.4	–	–
Totals		***206***	***35.6*± 9.6**	***29.3*± 6.3**	***43.7*± 21.7**	***13.7* ± 12.7**	***36.8*± 24.1**	***7.2* ± 11.7**

AHI = Apnea-Hypopnea Index; AI = Apnea Index; BMI = body mass index in kg/m^2.

Table 2. Demographic, Polysomnographic and Sleepiness Data Pre- and Posttonsillectomy.

Publication	Year	N	Age	BMI	Pre-T Low O2	Post-T Low O2	Pre-T ESS	Post-T ESS
Orr *et al.*[18]	1981	3	33.3 ± 21.6	29.6 ± 3.6	78.7 ± 5.1	90.7 ± 3.1	–	–
Moser *et al.*[19]	1987	5	37.6 ± 8.7	31.5 ± 6.1	70.1 ± 14.2	81.5 ± 14.0	–	–
Miyazaki *et al.*[20]	1998	10	39	24.8	88.1 ± 10.6	90.9 ± 5.8	–	–
Verse *et al.*[21]	2000	11	43.5 ± 14.0	30.9 ± 4.4	–	–	–	–
Martinho *et al.*[22]	2006	5	36 ± 10	36.6 ± 6.3	67.8 ± 15.0	82.2 ± 2.4	–	–
Nakata *et al.*[23]	2006	30	33.2 ± 6.8	30.7 ± 6.0	81.4 ± 9.1	93.4 ± 6.4	12.1 ± 4.3	4.8 ± 3.7
Kikuchi *et al.*[24]	2006	11	32.2 ± 7.2	30.4 ± 3.0	–	–	–	–
Nakata *et al.*[25]	2007	20	32.9 ± 6.3	27.9 ± 5.0	74.0 ± 9.8	83.9 ± 7.0	11.5 ± 4.3	5.4 ± 4.3
Chen *et al.*[26]	2012	56	35.9 ± 9.3	24.7 ± 2.9	78.6 ± 7.0	81.5 ± 6.0	11.0 ± 3.2	6.2 ± 2.8
Stow *et al.*[27]	2012	2	44 ± 1.4	24.8 ± 1.0	85.0 ± 9.9	84.0 ± 11.3	–	–
Tan *et al.*[28]	2014	34	31.7 ± 10.8	30.6 ± 6.0	73.3 ± 13.7	83.9 ± 8.6	–	–
Senchak *et al.*[29]	2015	19	27.9 ± 10.1	29.6 ± 6.0	84.3 ± 8.2	89.2 ± 6.7	12.5 ± 3.7	8.8 ± 5.2
Totals		***206***	***35.6*± 9.6**	***29.3*± 6.3**	***78.2*± 10.3**	***86.1* ± 7.1**	***11.8*± 3.9**	**6.3 ± 4**

RCS = retrospective cohort study; T = tonsillectomy, low O2 = lowest oxygen saturation.N = number; ESS = Epworth Sleepiness Scale. PCS = prospective cohort study.

Factors Predicting Failures to Successfully Treating OSA

Results were somehow controversial on the severity on the success rate in profoundly obese patients yet there was an agreement on the inversely proportional relationship between weight and surgery success rate. Tan et al. reported a failure in an overweight patient with mild OSA and also had a lower success rate (58.3%) in overweight patients with severe OSA; however, the two patients who were morbidly obese and had severe OSA both had successful treatment with tonsillectomy alone [28]. Kikuchi et al[24]. found that three of eight patients (37.5%) with severe OSA were not successfully treated after surgery. Martinho et al [22]. reported that three of five patients (60%) were not successfully treated; however, all patients were morbidly obese and all had severe OSA preoperatively. The remaining studies did not specify the sources, factors, or predictors of failures

Analysis of Pooled data

A total of 52 patients had individual patient data available for evaluation. The baseline M ± SD for age: 34.2 ± 11.5 years, BMI: 30.0 ± 5.1 kg/m2, and AHI: 40.6 ± 30.0 events per hour. Posttonsillectomy success, as defined by a decrease by ≥ 50% and a total AHI < 20 events per hour, was observed in 46 out of 54 patients, with an M ± SD for age: 33.5 ± 11.5 years, BMI: 29.4 ± 4.8 kg/m2, and a preoperative AHI: 34.8 ± 27.2 events per hour. Posttonsillectomy AHI decreased by ≥ 50% and had a total < 15 events per hour or < 10 events per hour in 81.4% and 72.2%, respectively (see Table 3). Posttonsillectomy cure was observed in 31 out of 54 patients (57.4%). Baseline values for the 31 cured patients included an M ± SD age of 31.0 ± 10.1 years, BMI of 29.0 ± 5.4 kg/m2, and preoperative AHI of 26.1 events per hour.

	Pretonsillectomy	**Posttonsillectomy**	***P* Value**
Characteristics			
Age in years (n = 49/52)	31.5 ± 12.3	NA	NA
Male gender	38/57 (86.3%)	NA	NA
BMI (kg/m2) (n = 48/52)	31.6 ± 5.7	NA	NA
Tonsil sizeb (n = 31/52)	3.6 ± 0.7	NA	NA
Polysomnography			
AHI (events/hour) (n = 52/52)	40.7 ± 30.5	8.3 ± 11.5	< 0.001
Percent reduction AHI	NA	79 ± 17.2%	NA
SpO2 nadir (%)c (n = 29/52)	77.1 ± 18.2	85.91 ± 8.43	< 0.001
Epworth Sleepiness Scale (n = 17/52)	11.9 ± 3.3	8.3 ± 4.9	0.0021
Surgical success			
AHI < 20 surgical success (%)	NA	45/52 (86.5%)	NA
AHI < 15 surgical success (%)	NA	43/52 (80.8%)	NA
AHI < 10 surgical success (%)	NA	37/52 (71.2%)	NA
Surgical cured			
AHI < 5 surgical cure (%)	NA	30/52 (57.7%)	NA

a ± values are mean (or percent) ± standard deviation.
b Tonsil size is graded on a scale from 0–4.
c The SpO_2 nadir is the lowest oxyhemoglobin saturation measured during sleep.
Surgical cure defined an AHI < 5 events/hour posttonsillectomy. Surgical success defined as the percent of subjects with an AHI < 20, 15, or 10/hour and a ≥ 50% reduction in the AHI posttonsillectomy.
AHI = Apnea-Hypopnea index; BMI = body mass index; CI = confidence interval; kg/m^2 = kilograms per meter squared; n = number of patients in which the outcome was reported out of 52 total patients with individual data; NA = not applicable; spO2 = saturation of oxygen.

DISCUSSION

This systematic review and meta-analysis has four main findings. First, the currently published studies in the international literature demonstrate that tonsillectomy can have a high success and cure rate in select patients as treatment for adult OSA. When combining data for studies reporting posttonsillectomy outcomes as an isolated procedure, there was a 65.2% reduction in AHI, a 79% reduction in AI, a 7.8 point improvement in lowest oxygen saturation, and a 5.5 point improvement in the Epworth Sleepiness Scale. The SMDs for AHI, AI, lowest oxygen saturation, and ESS demonstrated a large magnitude of effect (> 0.8 in all cases). It must be pointed out, however, that the patients selected for tonsillectomy in these studies had hypertrophied[19] , large[9] , enlarged [18] , extremely enlarged [30] , grades 2 to 4 [23,29] , or grades 3 to 4 tonsils [25,26,27,28] Therefore, because none of the studies evaluated patients with small, nonhypertrophied, or grade 1 tonsils, the findings cannot be generalized to all adult patients. Only two studies reported outcomes for patients with grade 2 tonsils: Nakata et al. [23] (3 of 7 patients were successfully treated) and Senchak *et al*.[29] , in which two of two patients were cured, as demonstrated by their pre- and posttonsillectomy

AHI of 17 and 1.7 events per hour (first patient) and 6.3 and 0.6 events per hour (second patient). Because some adults have grade 1 tonsils, which are endophytic and extend deep to the tonsillar pillars, in some cases the removed tonsils may be the same weight as those of another adult with grades 3 or 4 tonsils. In the individual patient meta-analysis, tonsil size was not a predictor of success; M ± SD was grade 3.4 ± 0.6 in the successful group and 3.5 ± 0.7 in the unsuccessful group (*P* value = 0.79) (see Table 4). In order to further evaluate the contribution of tonsillar grade in adults with OSA undergoing tonsillectomies, future studies could consistently include patients with grades 1 and 2 tonsils (along with grades 3 and 4), with measurement of tonsillar weights, volumes, and sizes (length, width, and height). For patients who did not have success or cure, other anatomical areas have been demonstrated to obstruct the upper airway, such as the palate, tongue base [31] , and epiglottis [32]; thus, performing a tonsillectomy in isolation may not be enough to relieve their OSA.

CONCLUSION

Isolated tonsillectomy can be successful as treatment for adult OSA, especially among patients with large tonsils and mild to moderate OSA (AHI < 30/hour). Additional prospective isolated tonsillectomy studies are needed, especially for adult OSA patients with small tonsils.

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