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Systematic Review

Awake Examination Versus DISE for Surgical Decision Making in Patients With OSA: A Systematic Review

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Objective: Traditionally, upper airway examination is performed while the patient is awake. However, in the past two decades, drug-induced sleep endoscopy (DISE) has been used as a method of tridimensional evaluation of the upper airway during pharmacologically induced sleep. This study aimed to systematically review the evidence regarding the usefulness of DISE compared with that of traditional awake examination for surgical decision making in patients with obstructive sleep apnea (OSA).

Data Sources: Scopus, PubMed, and Cochrane Library databases were searched.

Review Methods: Only studies with a primary objective of evaluating the usefulness of DISE for surgical decision making in patients with OSA were selected. The included studies directly compared awake examination data with DISE outcome data in terms of possible influences on surgical decision making and operation success.

Results: A total of eight studies with 535 patients were included in this review. Overall, the surgical treatment changed after DISE in 50.24% (standard deviation 8.4) cases. These changes were more frequently associated with structures contributing to hypopharyngeal or laryngeal obstruction. However, these differences do not automatically indicate a higher success rate.

Conclusion: This review emphasized the direct impact of DISE compared with that of awake examination on surgical decision making in OSA patients. However, it is also clear that the available published studies lack evidence on the association between this impact and surgical outcomes.

Key Words: DISE, obstructive sleep apnea.

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INTRODUCTION

Sleep-disordered breathing (SDB) is a broad term that encompasses, among others, snoring, upper airway resistance (UAR) syndrome, and obstructive sleep apnea (OSA).

Obstructive sleep apnea syndrome is a common disorder, with a prevalence of 2% to 4 % in the adult population and an increasing rate of morbidity and mortality.[1] Pharyngeal collapse during sleep as a consequence of abnormal structural anatomy and loss of muscle tone during sleep are characteristic of OSA, with snoring being a cardinal sign.[2]

Fundamentally, continuous positive airway pressure (CPAP) therapy remains the gold standard for the conservative treatment of OSA; however, surgery may be indicated to improve compliance and outcomes in patients with poor tolerance to CPAP.[3,4] Increasing recognition of the multilevel nature of anatomical obstruction consequentially indicates the existence of a large variety of differing surgical techniques used in an attempt to address this problem.[5] Currently, there is no consensual gold standard method to determine the level of airway collapse. Traditionally, upper airway examination is performed while the patient is awake. However, in the past two decades, drug-induced sleep endoscopy (DISE) has been used as a method of tridimensional evaluation of the upper airway during pharmacologically induced sleep.[6] Several studies have attempted to demonstrate the usefulness of DISE as a diagnostic approach to sleep apnea, proving that the method is simple, safe, and cost-effective.[7–9] However, data on the comparison of DISE with awake examination in terms of the usefulness for surgical decision making remains sparse.

In this study, we systematically reviewed evidence regarding the usefulness of DISE compared with that of

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traditional awake examination for surgical decision making in patients with OSA.

MATERIALS AND METHODS

Search Strategy

A comprehensive literature search was initially performed in January 2015, followed by an update in May 2015, using the electronic databases of the Cochrane Library, SCOPUS, and PubMed. We combined the following keywords: "Sleep Endoscopy"; "DISE"; "Drug-Induced Sleep Endoscopy"; "Sleep-Disordered Breathing"; and "Sleep Apnea." No language restrictions were applied. Bibliographies of all selected articles and review articles were also reviewed to find any other relevant article. To minimize the risk of missing relevant data, we also searched abstracts and conference proceedings of relevant congresses and scientific forums from 2011 to 2014 by hand.

Selection Criteria, Study Quality Assessment, and Data Analysis

Only studies with a primary objective of evaluating the usefulness of DISE for surgical decision making in patients with OSA were selected. The included studies directly compared awake examination data with DISE outcome data in terms of possible influences on surgical decision making. Studies in which all included patients did not undergo both examinations, those in which the impact on surgical decision making was not clearly stated, and those that focused on pediatric populations were excluded.

Data were abstracted by two independent reviewers (R.P. and L.G.) in a blinded manner, and discrepancies were resolved by a third reviewer (V.F.C.). Two authors (M.C. and R.C.) also independently assigned the 14-item Quality Assessment Tool for Diagnostic Accuracy Studies (QUADAS) to each article. Disagreements were resolved by consensus. The primary outcome was evidence regarding the usefulness of DISE compared with that of traditional awake examination for surgical decision making in patients with OSA. The secondary outcome measures included the impact of DISE on surgical outcomes and all other outcomes described in the included studies. Data were reported as mean/standard deviation (SD) (range) values for continuous variables and frequency and percentage values for categorical variables.

RESULTS

Search Results and Quality Assessment

All database searches were performed in January 2015, with an update in May 2015. A flow chart of the process of study identification and inclusion/exclusion is shown in Figure 1.

In total, 393 articles were identified using the search strategy and listed sources. After the titles and abstracts were screened for relevance, 363 articles were excluded (the reasons for exclusion are presented in Fig. 1). The remaining 30 articles were retrieved for more detailed full-article evaluation, and 23 were excluded because of the lack of a direct comparison between awake examination and DISE, or because of the lack of mention to the impact on surgical decision making.[10–32] One study[33] was included after a manual search of references of the included studies. Finally, eight studies were included in this review (Table I).[5,33–39]

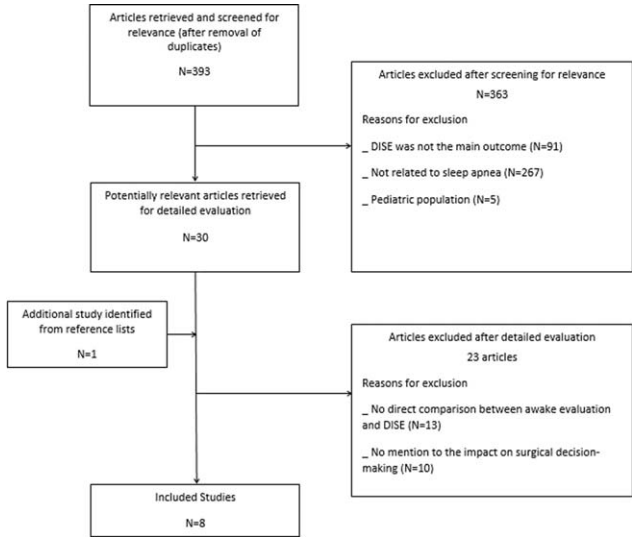

Fig. 1. Flow diagram of study identification and selection.

The QUADAS checklist for the assessment of methodological quality is presented in Table II. Overall, the included studies satisfied seven of the 14 items in the QUADAS checklist, and the primary methodological limitations of the studies were related to poor reporting of items 3, 4, and 13.

Included Studies

A total of eight studies with 535 patients were included in this review. The details and main results of these articles are summarized in Table I. Sleep was induced using intravenous propofol in five studies,[5,34,36,38,39] a combination of propofol and midazolam in two,[33,37] and intravenous midazolam in one.[35]

Five studies[33,35–38] analyzed whether surgical planning after DISE was different from that after awake clinical examination. Overall, the surgical treatment changed after DISE in 50.24% cases (SD 8.4). These changes were more frequently associated with structures contributing to hypopharyngeal or laryngeal obstruction. The frequency of multilevel airways collapse detected by DISE was greater than that detected by awake examination.

Three studies analyzed the correlation between the modality used for surgical planning (awake evaluation or DISE) and surgical outcomes.[5,34,39] Aktas et al.[5] found that the obstruction site defined by DISE was correlated with increased surgical success; specifically, a higher surgical success rate for cases of upper airway obstruction and a lower surgical success rate for cases of lower airway obstruction. There was no correlation between awake examination and surgical outcomes. In contrast, Yilmaz et al.[39] did not find any correlation between DISE and surgical success, despite the higher rate of combined procedures performed in those subjects who underwent DISE when compared with those who underwent only during awake examination (in this case, the Müeller maneuver). However, that study included only patients with retropalatal obstruction. Finally, Blumen et al.[34] analyzed the reliability of DISE by studying OSA

TABLE I.
General Characteristics and Main Outcomes of the Included Studies.

Author, Year	N	Mean preoperative AHI	Objective	Awake Evaluation	Anesthesia Protocol	Main Results
Aktas et al., 2015[5]	20	N.R.	Investigate the role of sleep endoscopy in surgical treatment planning in patients with OSA.	Muller's Maneuver and Mallampati classification	Propofol	No statistically significant correlation between modified Mallampati class and operation success, or between the polysomnographic stage of disease and operation success, was identified. A significantly high operation success rate was found in the group with obstruction of the upper airway according to DISE. A significantly low operation success rate was found in the group with obstruction of the lower airway according to DISE. According to the endoscopy results, no significant correlation was identified between modified Mallampati classification and the site of obstruction.
Blumen et al., 2015[34]	24	30.9 (12.4)	Investigate whether the surgical method and success was influenced by the location of the obstruction, as identified by DISE, in contrast to awake clinical evaluation alone.	ENT examination in seated position assessed the oropharynx and nasal cavities and was completed by flexible endoscopy of the retrovelar and hypopharyngeal space and epiglottis.	Propofol	In eight of the 14 patients in the success group, DISE showed an obstruction site not treated by surgery. In six patients of the 10 patients in the failure group, all DISE sites were treated by surgery, which nevertheless was not effective. DISE seems to show additional obstruction sites that do not need to be treated.
Eichler et al., 2013[35]	97	23.0 (20.2)	Detect whether locations of treatment recommendations given after DISE are different to those made after clinical basic ENT examination.	Exploration of pharyngeal and laryngeal structures (webbing, size of uvula, soft palate and tonsil, and laryngoscopic examined size of tongue base, visibility of vallecular, size and shape of epiglottis)	Midazolam	Regarding surgical options only, 63.9% of the examined patients got a different recommendation in at least one of four levels. Subdivided into each type of intervention, the following changes were found in the therapy concept: 24.7% (n = 24/97) soft palate, 12.4% (n = 12/97) tonsils, 33.0% (n = 32/97) tongue base, 27.8% (n = 27/97) epiglottis.
Fernandez-Julian et al., 2014[36]	162	32.1 (18.2)	Examine correlations between surgical recommendations based on either DISE or common awake examination methods in patients with OSA.	Muller's Maneuver and Friedman staging	Propofol	Significant relationship between surgical plans based on DISE and those based on awake techniques for velum/tonsil surgery. However, no significant relationship between plans was found

TABLE I.
(*Continued*)

Author, Year	N	Mean preoperative AHI	Objective	Awake Evaluation	Anesthesia Protocol	Main Results
						for surgeryinvolving tongue base, lateral pharyngeal walls, or epiglottis. DISE changed surgical recommendations concerning structures contributing to hypopharyngeal or laryngeal obstruction in > 40% of patients.
Gillespie et al., 2013[37]	38	N.R.	To determine reliability and validity of DISE for patients undergoing surgery for sleep-disordered breathing.	Muller's Maneuver	Midazolam and propofol	DISE demonstrated more severity of collapse than awake endoscopy. The surgical plan was changed after drug-induced sleep endoscopy in 23 (62%) cases and unchanged in 14 (38%). The majority (73%) had multisegmental airway collapse, with fewer having single-level palatal (16%) or tongue base (11%) collapse.
Hewitt et al., 2009[33]	94	N.R.	Examine and compare the information derived from clinical evaluation with that derived from DISE in a blinded prospective study.	Exploration of oropharynx (inter alia; size of the tonsils, uvula and soft palate; degree of overbite; and nature of dentition) and larynx and pharynx with a combination of flexible nasendoscopy, endoscopy, and direct visualization in combination with Muller's maneuver and simulated snoring techniques	Midazolam and propofol	Overall clinical evaluation predicted that a palatal intervention LAUP was indicated in 74.4% (n = 70) and MAS in 22.3% (n = 21). DISE predicted LAUP in 47.8% (n = 45) and MAS in 41.4% (n = 39) and a choice of modalities in 8.5% (n = 8). Statistical analysis of the predictions from clinical evaluation and DISE when evaluated by Pearson test shows a statistically significant difference between the two groups, with a *P* value of less than 0.001.
Pilaete et al., 2014[38]	61	N.R.	Investigate whether DISE changed the initial treatment plan based on standard clinical evaluation,	Clinical investigation with nasal endoscopy, scoring of Friedman tongue position and tonsil size, evaluation of dental occlusion/chin position and laryngoscopy to evaluate the larynx, epiglottis, tongue base, and tongue tonsil	Propofol	After DISE, initial management plan changed in 41% of patients irrespective of type of initial management plan. The only somewhat accurate initial treatment plan was uvulopalatopharyngoplasty (unchanged in 11/13 patients). Radiofrequency of the palate in six out of 12 patients and radiofrequency of palate and tongue base in five out of 11 patients.

TABLE I.
(Continued)

Author, Year	N	Mean preoperative AHI	Objective	Awake Evaluation	Anesthesia Protocol	Main Results
Yilmaz et al., 2015[39]	39	Group 1 (DISE plus MM): 20.4 (95% CI: 7.0–70.1) Group 2 (only MM): 20.1 (95% CI: 7.1–62.8)	Investigate whether the surgical method was influenced by the location of the obstruction, as identified by DISE, in contrast to Müller Maneuver alone.	Muller's maneuver	Propofol	The postoperative improvements between the groups were not statistically different. Although the DISE resulted in more changes in the surgical treatment plan and higher rate of combined treatment compared to MM, authors determined that this difference did not result in a significant difference in treatment success.

CI = confidence interval; DISE = drug-induced sleep endoscopy; ENT = ears, nose, and throat; LAUP = laser-assisted uvulopalatoplasty; MAS = mandibular advancement splint/device; MM = Muller maneuver; NR = not reported; OSA = and obstructive sleep apnea.

patients with surgical indications identified during awake examination; DISE before surgery identified obstruction sites that were either the same as or different from those found during awake examination. Therefore, the surgical procedures based on the latter were either complete or partial when the DISE findings were considered. The proportion of concentric retropalatal obstruction and retrolingual obstruction cases was higher in the failure group, indicating that DISE could have some utility in predicting bad surgical outcomes. However, the success group included cases in which DISE had identified retrolingual or epiglottic obstruction sites that were not operated, although the treatment was still effective, suggesting that DISE may show collapse sites that may not be relevant to individual patients.

DISCUSSION

Polysomnography is the gold standard diagnostic tool for SDB and is essential for the evaluation of OSA severity. However, it cannot localize the sites and patterns of upper airway obstruction. Awake upper airway evaluation is a routine procedure, but its role is frequently controversial because it is performed in the awake state wherein an increased muscle tone can confound the results. In 1991, Croft and Pringle[40] introduced the technique of sleep endoscopy wherein the upper airway was examined during midazolam-induced sleep. The possible obstruction sites could be visualized using a flexible camera inserted through the nasal cavity in an anesthetic-induced sleep state, and surgery was planed according to the findings.

Several studies[27,28] have reported a discrepancy between obstruction sites detected during awake examination and those detected during sleep endoscopy. However, few studies have investigated the actual impact of these discrepancies on surgical decision making.

The primary conclusion of the present review is that surgical planning performed according to the findings of awake examination can change markedly after DISE (> 50% cases), and the differences are most frequently associated with the hypopharyngeal and laryngeal structures. However, these differences do not automatically indicate a higher success rate. Very few studies considered the actual implications of DISE for surgical success, and the results of these studies are heterogeneous. Therefore, a solid consensus could not be reached by analyzing the literature. Furthermore, Blumen et al.[34] showed that the treatment of all obstructed sites detected by DISE is not a guarantee of success, and additional sites detected by DISE indeed may lead to unnecessary procedures. High-drug doses and prolonged examination, oversensitive observation, misunderstanding of the correlation between the DISE image and considerably decreased airflow, and induction of secondary obstruction sites by the primary sites may account for these potentially artificial additional sites.

The ideal anesthetic for use during DISE is another controversial issue. Although propofol and/or midazolam have been the drugs of choice in the included studies, the search persists for a drug that alters sleep

TABLE II.
Assessment of the Methodological Quality of the Studies Included According to the 14-item QUADAS Checklist.*

Author, year, reference	Question													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Aktas et al., 2015[5]	Yes	Yes	Unclear	Unclear	Yes	Yes	Yes	Yes	Yes	Unclear	Unclear	Yes	Unclear	N.A.
Blumen et al., 2015[34]	Yes	Yes	Unclear	Yes	Yes	Yes	Yes	Yes	Yes	Unclear	Unclear	Yes	Unclear	N.A.
Eichler et al., 2013[35]	Yes	Yes	Unclear	Unclear	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Unclear	Yes
Fernandez-Julian et al., 2014[36]	Yes	Yes	Unclear	Unclear	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Unclear	Yes
Gillespie ate al., 2013[37]	Yes	Yes	Unclear	Unclear	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Unclear	N.A.
Hewitt et al., 2009[33]	Yes	Yes	Unclear	Unclear	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Unclear	N.A.
Pilaete et al., 2014[38]	Yes	Yes	Unclear	Unclear	Yes	Yes	Yes	Yes	Yes	Unclear	Unclear	Yes	Unclear	N.A.
Yilmaz et al., 2015[39]	No	Yes	Unclear	Unclear	Yes	Yes	Yes	Yes	Yes	Unclear	Unclear	Yes	Unclear	N.A.

*QUADAS checklist: 1) Was the spectrum of patients representative of the patients who will receive the test in practice? 2) Were selection criteria clearly described? 3) Is the reference standard likely to classify the target condition correctly? 4) Is the period between reference standard and index test short enough to be reasonably sure that the target condition did not change between the two tests? 5) Did a whole sample or random selection of the sample receive verification using a reference standard? 6) Did patients receive the same reference standard regardless of the index test result? 7) Was the reference standard independent of the index test (i.e., the index test did not form part of the reference standard)? 8) Was the execution of the index test described in sufficient detail to permit replication of the test? 9) Was the execution of the reference standard described in sufficient detail to permit its replication? 10) Were the index test results interpreted without knowledge of the results of the reference standard? 11) Were the reference standard results interpreted without knowledge of the results of the index test? 12) Were the same clinical data available when test results were interpreted as would be available when the test is used in practice? 13) Were uninterpretable/intermediate test results reported? 14) Were withdrawals from the study explained?

N.A. = not applicable; QUADAS = Quality Assessment of Diagnostic Accuracy Studies.

architecture to a lesser degree. Recently, dexmedetomidine was advocated as a safer and better choice for DISE.[41] Dexmedetomidine is a highly selective alpha-2 adrenoreceptor agonist with analgesic and sedative effects and little effect on ventilation. In addition, it is considered to show both cardioprotective and neuroprotective properties. However, despite good preliminary studies, robust evidence supporting its use as a consistent alternative for sleep endoscopy is lacking.

The large heterogeneity in awake examination and DISE procedures in the included studies is a limitation of this review. The low level of evidence in the majority of studies did not allow us to reach firm conclusions regarding several aspects of DISE, thus necessitating more high-level evidence studies. Also, due to the pervasive heterogeneity in multiple areas of the available data, we did not conduct a pooled analysis, and the results of our statistical analysis should be interpreted with caution.

Even without performing a meta-analysis, however, decisions regarding the optimal categorization and analysis of such disparate data necessarily introduce some degree of subjectivity into our analysis.

Because several variables are different between OSA patients (i.e., age, body mass index, prior surgeries, cephalometric variables, sex, race), which contribute to heterogeneity, future studies could consider a randomized block design with a matched pairs analysis. Compared to a completely randomized design, this type of study reduces variability and potential confounding, producing a better estimate of treatment effects in each group. This type of high-level study could assess specifically whether DISE findings are truly related to treatment outcomes.

CONCLUSION

This review emphasized the direct impact of DISE compared with that of awake examination on surgical decision making in OSA patients and demonstrated that more than 50% of the surgical planning could be modified after DISE. However, it is also clear that the available published studies lack evidence on the association between this impact and surgical outcomes. Accordingly, it can be concluded that DISE may emerge as an objective tool to anatomically and functionally assess the upper airway in potential surgical OSA patients. However, high-quality evidence level studies with statistically appropriate sample sizes and clinical cross-validations are necessary to determine the role of DISE in the assessment of treatment outcomes.

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