OBJECTIVE: To evaluate the efficacies of transcutaneous stimulation of genioglossus on remaining mild-to-moderate obstructive sleep apnea syndrome (OSAS) after uvulopalatopharyngoplasty (UPPP).

METHODS: A total of 22 patients diagnosed with mild-to-moderate OSAS by polysomnography (PSG) after UPPP were recruited from Sleep Center of First Affiliated Hospital, Nanjing Medical University from February 2013 to October 2013 and underwent transcutaneous stimulation of genioglossus therapy at night. Prior to and during treatment overnight polysomnography examination was performed. Moreover, the sleepiness of patients was assessed according to the Epworth sleepiness scale (ESS) before and after treatment. Comparison was made to observe the effects of treatment on PSG parameters and daytime ESS.

RESULTS: Compared with pre-treatment, nocturnal apnea hypopnea index (AHI) (9.3 ± 4.2 vs 18.3 ± 6.8), microarousal index (MAI) (6.5 ± 3.8 vs 11.2 ± 4.8), radio of duration pulse oxygen saturation (SpO2) < 90% to total sleep time (T90) ((5.1 ± 4.0)% vs (9.5 ± 4.0)%) and score of daytime ESS (8.8 ± 3.3 vs 9.4 ± 3.1) all significantly decreased (all P < 0.01) while mean SpO2 ((95.5 ± 1.0)% vs (94.4 ± 1.1)% and minimal SpO2 ((88.6 ± 2.9)% vs (84.9 ± 4.6)% were both significantly elevated (both P < 0.001). None of them experienced obvious discomforts during treatment.

CONCLUSION: Submental transcutaneous electrical stimulation of genioglossus is an effective treatment for remaining mild-to-moderate OSAS after UPPP surgery.

PMID: 25151904 [PubMed - indexed for MEDLINE]
2. **Continuous transcutaneous submental electrical stimulation in obstructive sleep apnea: a feasibility study.**

Steier J, Seymour J, Rafferty GF, Jolley CJ, Solomon E, Luo Y, Man WD, Polkey MI, Moxham J.

**Author information**

**Abstract**

**BACKGROUND:** The therapeutic value of *transcutaneous* electrical *stimulation* of the genioglossus muscle in patients with obstructive sleep apnea (OSA) to reduce sleep-disordered breathing is unclear.

**METHODS:** Contraction of the genioglossus muscles during *transcutaneous stimulation* was investigated using ultrasonography in 11 healthy subjects (seven men, mean [SD] age 30 [6] years; BMI, 24.2 [3.5] kg/m(2)). Esophageal and gastric pressures were measured with balloon catheters, and transesophageal diaphragm electromyogram (EMGdi) was recorded during polysomnography in 11 patients with OSA (eight men, aged 51 [16] years; BMI, 42.0 [9.7] kg/m(2)) while *transcutaneous* electrical *stimulation* of the genioglossus was applied in non-rapid eye movement sleep (stage N2).

**RESULTS:** Ultrasonography measurements showed a significant increase in tongue diameter during *stimulation* (sagittal: 10.0% [2.8%]; coronal: 9.4 % [3.7%]). The measurements were reproducible and repeatable. In patients with OSA, snoring decreased during *stimulation* (P < .001) and oxygenation improved (P = .001); the respiratory disturbance index (RDI) fell from 28.1 (26.3) to 10.2 (10.2) events per hour during *stimulation* (P = .002), returning to 26.6 (26.0) events per hour after *stimulation* was stopped. Transdiaphragmatic pressure swing decreased from 24.1 (13.5) cm H(2)O to 19.7 (7.1) cm H(2)O (P = .022), increasing to 24.2 (10.8) cm H(2)O afterward, and EMGdi fell from 23.8% max (12.6% max) to 15.7% max (6.4% max) (P < .001), rising to 22.6% max (10.4% max) post *stimulation*.

**CONCLUSIONS:** Continuous *transcutaneous* electrical *stimulation* of the genioglossus contracts the genioglossus muscle and reduces ventilatory load and neural respiratory drive in patients with OSA.

PMID: 21454399 [PubMed - indexed for MEDLINE]
Abstract
Apneic patients have hypotonia of the lingual and supra-hyoid muscles. The dysfunction of these muscles leading to a collapse of the upper airway is responsible for the apnea. The goal of this study, designed as a before-after trial, is to determine the effect of lingual and supra-hyoid muscle strengthening on obstructive sleep apnea. Thirty-four patients with obstructive sleep apnea were included (consecutive sample). Only 16 patients completed the study. The treatment consisted of 30 sessions of transcutaneous neuromuscular stimulation administered to the submental region associated with muscular exercises. The effect on apneic events was analyzed with a polysomnography before and after the treatment. Thirteen patients could be analyzed for the statistical studies. The mean apnea-hypopnea index (AHI) decreased from 32.9 to 20.6 (Wilcoxon rank test: P = 0.017). Seven patients ended the study with an AHI of less than 10, and three more patients decreased their AHI by more than 50%. This treatment significantly decreased the AHI in most of the patients. A larger study with more patients and with a long-term follow-up is necessary to determine the place of physiotherapy in the treatment of obstructive sleep apnea.

PMID: 15625609 [PubMed - indexed for MEDLINE]

MeSH Terms

4. [Submental transcutaneous electrical stimulation for obstructive sleep apnea].

[Article in German]
Verse T¹, Schwalb J, Hörmann K, Stuck BA, Maurer JT.

Author information

Abstract
BACKGROUND: Transcutaneous electrical stimulation while asleep has been used to treat obstructive sleep apnea (OSA), although without convincing results. Modern strategies consist of electrical muscle training for a number of weeks during wakefulness rather than stimulation during sleep.

OBJECTIVE: The purpose of this study was to assess the practicability, safety, and efficacy of a new device, SilentOne (Imperpuls, Chemnitz, Germany).

PATIENTS AND METHODS: Fifteen patients with various degrees of OSA used transcutaneous submental electrical stimulation therapy for 4-5 weeks every day, day and night. A patient's diary recorded practicability and potential adverse events. Respiratory parameters were recorded by fully attended polysomnography in the sleep lab. Daytime sleepiness and snoring were assessed by questionnaires.

RESULTS: The apnea-hypopnea-index decreased from 29.2 before to 21.2 after therapy
(P<0.05). Daytime sleepiness improved significantly (P<0.01) as did snoring (P<0.005).

CONCLUSIONS. **Transcutaneous electrical stimulation** therapy using SilentOne proved to be safe, easy to use, and potent. However, therapy showed a limited cure rate.

PMID: 14647925 [PubMed - indexed for MEDLINE]

5. **[The position of submaxillary transcutaneous electrical stimulation for obstructive sleep apnea syndrome].**

[Article in Chinese]
Yang H, Meng X, Zhu Y.

**Author information**

**Abstract**

**OBJECTIVE:** To investigate the effective position of submaxillary **transcutaneous electrical stimulation** for obstructive sleep apnea syndrome (OSAS).

**METHODS:** With fixed provocative locus of genioglossus and its controlling nerve, 11 normal healthy men and 9 patients with OSAS during awakening were studied to disclose the effect of submaxillary constant-current **stimulation** under different stimulative radius or intensity and thickness of submaxillary skin. The effects of electric **stimulation** in 9 OSAS patients with narrowing of the retrotongue-base-pharynx level were compared with the control during sleep.

**RESULTS:** The **submental** and internal side of mandibular angle was effective loci for stimulating genioglossus. Stimulative radius and intensity of both loci were not significantly different (P < 0.05) and no influence of the skin thickness was found. During sleep, indices of breath disorder (P < 0.05), oxygen saturation (P < 0.05) and clinical symptoms had significantly improved.

**CONCLUSION:** Submaxillary electrical **stimulation** with fixed provocative locus is effective for the treatment of OSAS. The mechanism is perhaps **stimulation** of genioglossus pushes the tongue ahead and opens the pharyngeal cavity.

PMID: 12768693 [PubMed - indexed for MEDLINE]

6. **[The effects of transcutaneous electrical stimulation during sleep on obstructive sleep apnea].**
OBJECTIVE: To study the effects of transcutaneous electrical stimulation during sleep on obstructive sleep apnea syndrome (OSAS).

METHOD: Sixteen patients with OSAS were studied by polysomnography during all-night sleep with and without submental transcutaneous electrical stimulation (TES) of the genioglossus.

RESULT: Fourteen of the 16 patients (87%) who accepted the TES were treated successfully (reduction of Al > 50%). The average apnea index showed a decrease of 29 events per hour when the TES were performed (P < 0.001). The average apnea time decreased from 22 to 7 sec (P < 0.001). The apnea time/TST decreased from 27% +/- 11% to 7% +/- 3%. The lowest SaO2 increased from 71% to 87% (P < 0.001). TES did not cause arousal. The sleep stages of SWS, and REM sleep effect (SE) increased significantly.

CONCLUSION: TES is a conservative but effective treatment in patients with obstructive sleep apnea syndrome, although it failed to improve central sleep apnea.

PMID: 11360522 [PubMed - indexed for MEDLINE]

Abstract

During sleep, diminished activity of upper airway dilator muscles (UADMs) is believed to increase upper airway (UAW) resistance and ultimately cause collapse of the UAW. In anesthetized dogs, electrically induced UADM contraction reduces UAW resistance and collapsibility. In this study, we measured the effects of electrically induced contraction of UADMs on pharyngeal resistance (Rph) in seven awake healthy subjects. UAW partial occlusion was achieved by applying external pressure to the submental hyoid region, leading to increased Rph. Transmucosal electrical stimulation (ES) of the base of the tongue was used to preferentially stimulate the genioglossus muscle. Transcutaneous ES using submental and paralaryngeal electrodes were used to preferentially stimulate the geniohyoid and the sternohyoid and sternothyroid muscles, respectively. During the unobstructed state, Rph averaged 6.11 +/- 0.48 cmH2O.l-1.s, and ES produced minimal resistance changes for all stimulation sites tested. In contrast, during the application of external pressure, when Rph...
was raised to an average of 190 +/- 14% of the baseline value, sublingual ES reduced resistance from 11.67 +/- 1.90 to 6.77 +/- 1.30 cmH2O.l-1.s (P < 0.01). ES at the other sites during the raised Rph state produced only minor statistically insignificant changes in Rph, even when combined submental and paralaryngeal ES was applied. Likewise, only sublingual ES produced measurable anterior movement of the tongue. We conclude that when Rph is raised by exogenous means, sublingual transmucosal ES effectively reduces Rph in awake humans.

PMID: 7649934 [PubMed - indexed for MEDLINE]

Publication Types, MeSH Terms


**The effects of transcutaneous electrical stimulation during wakefulness and sleep in patients with obstructive sleep apnea.**

Edmonds LC¹, Daniels BK, Stanson AW, Sheedy PF 3rd, Shepard JW Jr.

Author information

Abstract

Upper airway (UA) collapse in obstructive sleep apnea (OSA) is considered in part to result from the decrease in UA dilator muscle tone that occurs during sleep. We hypothesized that augmentation of UA muscle function by transcutaneous electrical stimulation (TES) might function to enlarge UA size during wakefulness and/or prevent UA collapse during sleep in patients with OSA. Eight male patients with OSA were studied both awake and asleep, with TES administered to the submental region in two patients and to both the submental and subhyoid regions in six patients. Fast-CT scans obtained at FRC and end-inspiration (VTei) demonstrated increased UA size with tidal breathing, p less than or equal to 0.05. The active generation of -10 cm H2O pressure at FRC substantially decreased UA size, p less than or equal to 0.001. However, no changes in UA size were detected at either FRC or VTei with TES applied at 50 and 100% of the maximal tolerated intensity. The collapsibility of the UA in response to the generation of -10 cm H2O pressure was also unchanged by TES. In contrast to the lack of effect of TES on UA size, voluntary protrusion of the tongue increased cross-sectional area (CSA) of the orohypopharyngeal (OHP) segment of the UA, p less than 0.05, and to a lesser extent the CSA of the distal velopharyngeal segment, p = 0.06. When applied during sleep, TES failed to prevent or improve either sleep-disordered breathing or sleep architecture. (ABSTRACT TRUNCATED AT 250 WORDS)

PMID: 1416392 [PubMed - indexed for MEDLINE]