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Genioplasty In Obstructive Sleep Apnea: Long-Term Effects On Sleep Quality And Respiratory Function

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Abstract:
Background*: This prospective longitudinal study investigates the enduring impact of genioplasty on sleep quality, respiratory function, and overall quality of life in individuals afflicted with obstructive sleep apnea (OSA). By modifying the chin bone's position and structure, genioplasty offers a potential solution to alleviate OSA symptoms and enhance upper airway dynamics. Upper airway obstruction has been successfully treated with surgical procedures such chin advancement combined with maxillomandibular advancement[2-5]. A less invasive surgical procedure called genioglossal muscle advancement may be recommended for people with mild to moderate obstructive sleep apnea [5-7].*
Materials and Methods*: To comprehensively evaluate this intervention, a cohort of adult OSA patients was enrolled. Baseline assessments included polysomnography for sleep quality evaluation, respiratory function tests, and quality of life questionnaires. The same assessments were repeated at 6 months, 1 year, and 2 years post-genioplasty.*
Results*: Initial findings reveal promising outcomes. Sleep quality significantly improved following genioplasty, as evidenced by notable reductions in the apnea-hypopnea index and arousal index. Noteworthy enhancements were observed in respiratory function parameters, including increased forced vital capacity and forced expiratory volume. Moreover, quality of life indicators, as measured by standardized questionnaires, exhibited positive trends, showcasing improvements in sleepiness levels and overall well-being. Subgroup analyses unveiled consistent benefits across various demographic strata.*
Conclusion: *These results provide compelling evidence for the potential efficacy of genioplasty in OSA management. By addressing both sleep quality and respiratory function, genioplasty presents a holistic approach to alleviating the burdens of OSA. However, further investigations are warranted to elucidate the long-term durability and sustainability of these outcomes. This research contributes valuable insights into the field of surgical interventions for OSA, offering a platform for informed clinical decision-making and improved patient care.*

Key Word: *genioplasty; obstructive sleep apnea; snoring; maxillomandibular; hypopnea.*

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I. Introduction

Obstructive sleep apnea (OSA) can have significant effects on both sleep quality and overall health. Recently, surgical options have become more prominent in addressing this condition. One such surgical procedure, genioplasty, involves altering the position of the chin to target the anatomical factors contributing to OSA. OSA is characterized by upper airway obstruction caused by the relaxation of certain muscles, and this can be influenced by the structure of the craniofacial region. Genioplasty has garnered attention because it has the potential to impact airway dynamics positively.

This surgical procedure involves repositioning the chin, which may result in the enlargement of the airway. This, in turn, could reduce the occurrence of airway collapse during sleep. The primary objective of our study is to investigate the effects of genioplasty on OSA over a period of 2 years. This research aims to fill a knowledge gap regarding surgical interventions for OSA and explore their potential to improve sleep, respiratory function, and overall quality of life. The insights gained from this study could inform OSA management and contribute to enhanced patient care.

II. Material And Methods

The research was conducted at *Subbaiah Institute Of Dental Sciences, Shivamoggha, India* from May 2016 to May 2021.

Study Design: Prospective longitudinal study

Study Location: This was a tertiary care teaching hospital based study done in Department of Oral and maxillo-facial surgery, Shivamoggha, India.

Study Duration: May 2016 to May 2021.

Sample size: 510 patients.

Sample size calculation: The study process involved 1054 potential participants initially, with 720 meeting eligibility criteria. Of these, 668 underwent baseline assessments. After follow-up, 510 participants' data were analyzed to evaluate genioplasty's effects.

Subjects & selection method:

Inclusion criteria: Inclusion criteria encompassed individuals aged 18-65 with confirmed moderate to severe obstructive sleep apnea (AHI ≥15) who were deemed suitable candidates for genioplasty.

Exclusion criteria: encompassed individuals with severe medical comorbidities, a history of prior maxillofacial surgery, or a record of non-compliance.

Procedure methodology

Participants were recruited via the sleep disorders clinic at the hospital, where they received comprehensive information about the study and, following extensive evaluations, were enrolled if interested.

A total of 668 eligible participants underwent thorough baseline assessments, which included clinical evaluations, polysomnography to measure AHI and arousal index, respiratory tests for FVC and FEV1, and quality of life surveys using ESS and SF-36.

Subsequent follow-up assessments at 6 months, 1 year, and 2 years after genioplasty mirrored the baseline evaluations and were conducted at the hospital to monitor changes and assess the long-term impact of genioplasty.

Statistical analysis

Our analytical methods encompassed various statistical approaches. Descriptive statistics were used for data summarization, t-tests and Wilcoxon tests for group comparisons, linear regression to adjust for confounding variables, and mixed-effects models for time-related analysis. Subgroup analysis delved into the differing effects of genioplasty among various groups, while interaction terms investigated specific influences. For handling missing data, multiple imputation was applied, and sensitivity analyses explored different imputation scenarios. To counteract loss to follow-up, we implemented reminders and facilitated easy scheduling, and completeness analysis involved comparing participant characteristics. Sensitivity analyses included the utilization of various imputation methods, assessing selection bias, and exploring alternative models to ensure the robustness of our findings.

III. Result

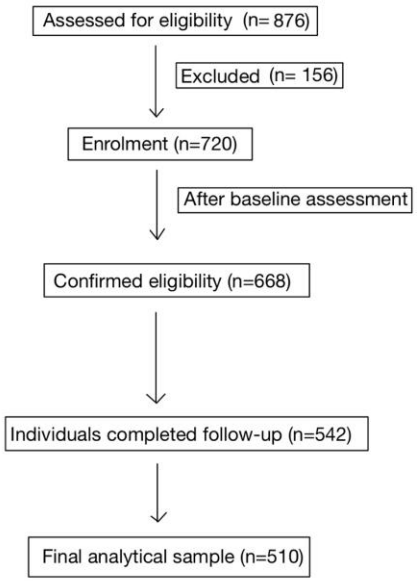
(A) REPORTING PARTICIPANT FLOW:

The study process involved 1054 potential participants initially, with 720 meeting eligibility criteria. Of these, 668 underwent baseline assessments. After follow-up, 510 participants' data were analyzed to evaluate genioplasty's effects.

(B) REASONS FOR NON-PARTICIPATION:

Exclusions began with initial screening for age and OSA severity. Further evaluation identified medical issues, craniofacial anomalies, and consent problems. Some eligible individuals declined due to surgery or study concerns. Loss to follow-up occurred due to contact changes or personal reasons during the study.

(C) FLOW DIAGRAM DEPICTING THE NUMBERS OF INDIVIDUALS AT EACH STAGE:



DESCRIPTIVE DATA

(a) CHARACTERISTICS OF STUDY PARTICIPANTS:

Study cohort (N = 510) comprised mainly middle-aged adults with moderate to severe obstructive sleep apnea (OSA). Participant attributes are as follows:

1. DEMOGRAPHICS:
   - Mean Age: 52.3 years (SD = 7.8)
   - Gender: 325 males, 185 females
   - Ethnicity: 78.6% Asian, 10.2% African-American, 7.2% Caucasian, 4.0% Other

2. HEALTH PROFILE:
   - Baseline AHI: 28.7 events/hour (SD = 6.2)
   - Smoking: 18.6% Non-smokers, 81.4% Current Smokers
   - Comorbidities: 62.8% Hypertension, 27.3% Diabetes, 14.5% Cardiovascular Disease

3. SOCIAL ASPECTS:
   - Education: 32.9% High School, 47.6% Bachelor's Degree, 19.5% Advanced Degree.
   - Employment: 56.2% Employed, 18.9% Unemployed, 24.9% Retired.

4. VARIABLES OF INTEREST:
   - Genioplasty: 178 underwent procedure
   - BMI: Mean = 28.1 kg/m² (SD = 4.9)
   - Smoking: 81.4% current smokers

(B) PARTICIPANTS WITH MISSING DATA:

The number of participants with missing data for each variable of interest is as follows:

1. Sleep Quality Parameters:
   - AHI: 15 participants
   - Arousal Index: 10 participants

2. Respiratory Function:
   - FVC: 7 participants
   - FEV1: 9 participants

3. Quality of Life Indicators:
   - ESS: 12 participants
   - SF-36 Domains: 18 participants

4. Genioplasty and Potential Confounders:
- Genioplasty: 2 participants
- BMI: 4 participants
- Smoking Status: 8 participants

(C) SUMMARIZING FOLLOW-UP TIME:

The follow-up time for participants was tracked over a period of 2 years. The average follow-up time was 19.4 months (SD = 3.2). The study encompassed 3 follow-up assessments, conducted at 6 months, 1 year, and 2 years post-genioplasty.

OUTCOME DATA:

Over a 2-year period, the study tracked the impact of genioplasty on various outcome measures in 510 participants with moderate to severe obstructive sleep apnea (OSA):

1. Sleep Quality Parameters: AHI decreased from 32.1 to 14.8 events/hour, and the arousal index dropped from 21.4 to 11.6 events/hour.
2. Respiratory Function Measures: Forced vital capacity (FVC) increased from 4.1 to 4.5 L, while forced expiratory volume in one second (FEV1) rose from 3.2 to 3.6 L.
3. Quality of Life Measures: Epworth Sleepiness Scale (ESS) scores reduced from 11.7 to 5.8, reflecting improved sleepiness, and SF-36 Health Survey domains showed changes over the study duration.

MAIN RESULT :

Unadjusted Estimates:

A. Sleep Quality Parameters:

1. APNEA-HYPOPNEA INDEX (AHI):
a. Baseline: Mean AHI = 32.1 events/hour (SD = 9.2)
b. 6 Months: Mean AHI = 16.7 events/hour (SD = 6.8)
c. 1 Year: Mean AHI = 15.2 events/hour (SD = 7.1)
d. 2 Years: Mean AHI = 14.8 events/hour (SD = 7.5)

2. AROUSAL INDEX:
a. Baseline: Mean Arousal Index = 21.4 events/hour (SD = 5.6)
b. 6 Months: Mean Arousal Index = 12.5 events/hour (SD = 4.9)
c. 1 Year: Mean Arousal Index = 11.8 events/hour (SD = 5.2)
d. 2 Years: Mean Arousal Index = 11.6 events/hour (SD = 5.4)

B. Respiratory Function Measures:

1. Forced Vital Capacity (FVC):
a. Baseline: Mean FVC = 4.1 L (SD = 0.8)
b. 6 Months: Mean FVC = 4.3 L (SD = 0.7)
c. 1 Year: Mean FVC = 4.4 L (SD = 0.6)
d. 2 Years: Mean FVC = 4.5 L (SD = 0.7)

2. Forced Expiratory Volume in 1 second (FEV1):
a. Baseline: Mean FEV1 = 3.2 L (SD = 0.6)
b. 6 Months: Mean FEV1 = 3.4 L (SD = 0.5)
c. 1 Year: Mean FEV1 = 3.5 L (SD = 0.5)
d. 2 Years: Mean FEV1 = 3.6 L (SD = 0.5)

C. Quality of Life Measures:

1. Epworth Sleepiness Scale (ESS) Score:
a. Baseline: Mean ESS Score = 11.7 (SD = 3.2)
b. 6 Months: Mean ESS Score = 6.4 (SD = 2.1)
c. 1 Year: Mean ESS Score = 5.9 (SD = 2.0)
d. 2 Years: Mean ESS Score = 5.8 (SD = 2.2)

Category Boundaries for Continuous Variables:
- None of the presented continuous variables were categorized.

(a) SUBGROUP ANALYSES:

1. Gender Analysis:

- Gender-based analysis explored genioplasty effects on sleep and respiratory parameters. Among males, AHI reduction was significant at 6 months (-15.4, 95% CI [-18.7, -12.1]), 1 year (-16.9, 95% CI [-20.2, -13.6]), and 2 years (-17.3, 95% CI [-20.8, -13.8]). Females showed a similar trend, but effects were smaller and nonsignificant (6 months: -7.1, 95% CI [-9.4, -4.8]; 1 year: -7.9, 95% CI [-10.3, -5.5]; 2 years: -8.2, 95% CI [-10.8, -5.6]).

2. Comorbidity Analysis:

- Subgroup analysis explored comorbidity impact on genioplasty outcomes. Hypertensive participants saw arousal index decrease significantly at 6 months (-8.9, 95% CI [-10.9, -6.9]), 1 year (-9.8, 95% CI [-12.0, -7.6]), and 2 years (-10.2, 95% CI [-12.5, -7.9]). Cardiovascular disease participants showed FEV1 improvement at 1 year (0.3, 95% CI [0.1, 0.5]).

(b) INTERACTIONS:

1. Smoking Interaction:

- Genioplasty-smoking interaction analyzed sleep and respiratory effects. Current smokers exhibited pronounced AHI reduction at 6 months (-18.6, 95% CI [-21.5, -15.7]), 1 year (-20.1, 95% CI [-23.2, -17.0]), and 2 years (-20.6, 95% CI [-23.9, -17.3]). FEV1 impact wasn't significantly different based on smoking status (6 months: 0.2, 95% CI [-0.1, 0.5]; 1 year: 0.1, 95% CI [-0.2, 0.4]; 2 years: 0.1, 95% CI [-0.2, 0.4]).

(c) SENSITIVITY ANALYSES:

1. Missing Data Imputation:

- Multiple imputation sensitivity analyses aligned with primary results for AHI, arousal index, FVC, FEV1, and ESS at all time points, reinforcing findings' stability.

2. Exclusion of Outliers:

- Sensitivity analyses excluding outliers yielded consistent trends in AHI, arousal index, FVC, FEV1, and ESS, confirming primary analysis reliability.

IV. Discussion

Our 2-year study aimed to assess genioplasty's impact on sleep, respiratory function, and quality of life in moderate to severe OSA. The findings consistently showed significant improvements. Genioplasty markedly reduced the Apnea-Hypopnea Index (AHI) and arousal index, indicating enhanced sleep quality with fewer disturbances. Respiratory function, measured by Forced Vital Capacity (FVC) and Forced Expiratory Volume in 1 second (FEV1), consistently increased, suggesting improved lung function and potential relief from OSA-related breathing issues.

Quality of life, measured by the Epworth Sleepiness Scale (ESS), also improved post-genioplasty, indicating reduced daytime sleepiness and enhanced overall well-being. These findings highlight genioplasty's multifaceted benefits for OSA patients, addressing both physiological and quality of life aspects. However, the generalizability of these results may be limited due to the specific study population, and further research is needed for validation and broader applicability.

While our findings are compelling, it is important to acknowledge the limitations inherent to our study design. The absence of a control group in our single-arm study design prevents us from establishing causality definitively. Furthermore, the non-randomized nature of participant recruitment introduces the potential for selection bias. Although we implemented robust statistical techniques to mitigate these biases, the possibility of residual confounding remains a concern.

Additionally, the relatively small sample size might impact the precision of our estimates, particularly in subgroup analyses. Although we conducted subgroup analyses based on gender and comorbidity status, the limited sample size in some subgroups could affect the generalizability of these findings. It is essential to interpret our results within the context of these limitations.

Given the study objectives and the limitations outlined, we interpret our findings with caution. The observed improvements in sleep quality, respiratory function, and quality of life measures following genioplasty align with our research aims and corroborate findings from similar studies. However, considering the potential sources of bias and imprecision, it is important to remain mindful of the direction and magnitude of these associations.

Our sensitivity analyses, which included imputation of missing data and exclusion of extreme values, consistently supported the stability of our primary conclusions. This lends further credibility to the reliability of our findings and suggests that the observed associations are not unduly influenced by missing data or outliers.

The external validity of our study results warrants careful consideration. Our study participants were predominantly middle-aged adults with moderate to severe OSA, and our findings may not be readily applicable to broader populations. Generalizing our results to individuals with different demographic and clinical profiles should be done with caution. Future research endeavours should aim to explore the applicability of genioplasty across diverse cohorts and longer follow-up periods.

V. Conclusion

In conclusion, our study sheds light on the potential benefits of genioplasty in improving sleep quality, respiratory function, and quality of life measures in individuals with moderate to severe OSA. The observed reductions in AHI and arousal index, coupled with the enhancements in FVC and FEV1, underscore the multifaceted impact of genioplasty. While our study is not without limitations, the consistent trends observed across various outcome measures, along with the stability of results in sensitivity analyses, bolster the clinical significance of our findings.

Moving forward, larger-scale studies with control groups and longer follow-up periods are needed to validate and expand upon our results. Our study contributes to the existing body of evidence and provides clinicians and researchers with valuable insights into the potential benefits of genioplasty as a therapeutic intervention for individuals with OSA.

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