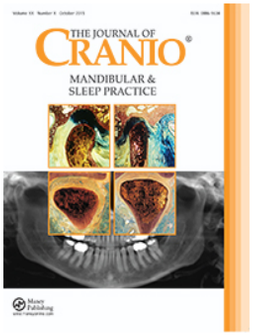

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Facial esthetics and subjective impairment assessed after maxillomandibular advancement surgery for patients with obstructive sleep apnea

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ABSTRACT

Objective: To assess facial esthetics and quality of life (QoL) as measure of success or failure after maxillomandibular advancement (MMA) surgery for obstructive sleep apnea (OSA).
Methods: Visual analog scales (VAS) on facial esthetics and QoL survey, including EQ-5D3L, Epworth Sleepiness Scale (ESS), and Functional Outcome of Sleep Questionnaire (FOSQ) were collected. Outcomes were analyzed for surgical-success/failure after MMA.
Results: Forty-one patients returned completed surveys (response: 66%). Mean VAS on facial esthetics was 57 ± 22 mm preoperative and 51 ± 24 mm postoperative ($p = 0.217$). When MMA was considered a surgical-failure, VAS was significantly more negative (40 ± 22 mm; $p = 0.026$). EQ-5D-3L showed an overall mean score of 73.2 ± 15.7, ESS was 6.3 ± 5.4, and FOSQ was 16.0 ± 3.3.
Conclusion: No significant alteration of facial esthetics were reported after MMA; however, lower QoL was associated with surgical-failure; whereas, in surgical-success, QoL were higher.

KEYWORDS
Maxillomandibular advancement surgery; obstructive sleep apnea; OSA; VAS

Introduction

Obstructive sleep apnea (OSA) is the most common sleep-related breathing disorder. The overall prevalence of OSA is 9–38% in the general adult population, is higher in men, and rises with increasing age [1]. Recently, higher prevalence rates were reported compared to earlier findings: 84% of men vs. 61% of women had OSA, defined as an apnea-hypopnea-index (AHI) > 5, recorded by polysomnography (PSG) [2]. Specifically, the prevalence of moderate and severe OSA (AHI > 15) was estimated at 50% in men and 24% in women [2]. OSA is a chronic disorder characterized by recurrent (partial) closure of the upper airway accompanied by intermittent oxygen desaturation and sympathetic activation [3]. OSA causes neurocognitive problems, resulting in impaired quality of life and excessive daytime sleepiness. It has also been described as an independent risk factor for cardiovascular sequelae [4,5].

Treatment of OSA is usually initiated with conservative therapies consisting of lifestyle changes, improved sleep hygiene, weight reduction, avoidance of alcohol, and supine sleeping position [6]. After these conservative measures, treatment options include oral appliance therapy (OAT), continuous positive airway pressure (CPAP), and surgery [7–9]. The golden standard of OSA therapy is CPAP, but because of disappointing adherence to this treatment, other options are often explored [10]. In the case of CPAP intolerance, oral appliance therapy is often considered and provides satisfactory outcomes on treatment success, especially in patients with mild and moderate OSA (AHI < 30) [7]. In patients with severe OSA (AHI > 30), treatment by OAT is considered but often proves insufficient. Next to OAT and CPAP, different types of surgery for a patient with OSA are available [11]. One promising surgical approach, maxillomandibular advancement surgery (MMA), shows very good results for treating severe OSA [12]. Therapeutic efficacy in surgical procedures for OSA is defined using criteria described by Sher et al., which proposes that therapeutic *success* is achieved when AHI drops more than 50% and there are fewer than 20 events/h postoperatively and defines surgical *cure* as an AHI < 5 after intervention [13]. Based on the aforementioned definitions, MMA results in good surgical outcome with surgical success rates reported as 86% and a cure rate of 43% [11,12,14,15]. MMA can provide an effective and lifelong solution for patients with severe OSA; however, it has a downside because it is highly invasive and can alter facial appearance dramatically.

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The aim of this study was to assess facial esthetics and quality of life as a measure of success or failure associated with MMA surgery for severe OSA. It was hypothesized that higher quality of life outcomes are associated with successful MMA. Perceived changes in facial esthetics were also assessed since MMA may also yield an undesired effect on facial esthetics, despite MMA surgery's main goal, which is the curative treatment of severe OSA.

Materials and methods

The data for this single-center observational study were obtained from patients admitted between 2011 and 2015 for elective MMA therapy for moderate and severe OSA. The institutional medical ethics review board of the Amsterdam University Medical Centre (location AMC) reviewed the study guidelines and procedures and granted permission to collect data and questionnaires (Project No. W16_006). All participants registered in this investigation's database received a detailed explanation of the study guidelines and procedures, and written informed consent was obtained. This investigation was conducted in accordance with the principles established in the Declaration of Helsinki (Fortaleza, October 2013).

Study participants

Patients with moderate or severe OSA referred to the Department of Oral & Maxillofacial Surgery of the Academic Medical Center of the University of Amsterdam for an elective MMA procedure were eligible for participation in this study. This study is the second part of a large cohort of data derived from patients who participated in a previously reported investigation concerning technical considerations associated with surgical success and failure after the MMA procedure [12].

Questionnaires

All patients were asked to complete three questionnaires after MMA surgery: EQ-5D-3L (for general health quality of life), Epworth Sleepiness Scale (ESS), and the Functional Outcome of Sleep Questionnaire (FOSQ). Specific data of the EQ-5D-3L, ESS, and FOSQ questionnaires before MMA surgery were not available for analysis. The change in facial esthetics was assessed using a visual analog scale (VAS), and data were collected before and after MMA surgery.

EQ-5D-3L

The EQ-5D-3L, developed by the EuroQol Group (EuroQol Research Foundation, Rotterdam, The Netherlands), is a standardized self-administrated questionnaire for general health in five dimensions: mobility, self-care, daily activities, pain/discomfort, and mood consisting of both anxiety and depression. It uses a 3-point rating scale, in which 1 = "no problems," 2 = "moderate problems," and 3 = "extreme problems." The questionnaire also contains a EuroQol-Visual Analogue Scale (EQ-VAS) from 0 (worst imaginable overall health) to 100 (best imaginable overall health) that generates a self-rating general health score. The EuroQol instruments have been extensively validated [16,17].

Epworth Sleepiness Scale (ESS)

The ESS was designed as a subjective method of estimating excessive daytime sleepiness [18]. It consists of eight questions about subjective daytime sleepiness in eight everyday situations (each question scores 0–3, max. of 24). The cut-off to determine excessive sleepiness was set at a score of 10 [19].

Functional Outcomes of Sleep Questionnaire (FOSQ)

To determine the impact of disorder of excessive sleepiness on daily living and quality of life in adults, the FOSQ was used [20]. The FOSQ consists of 30 questions with a 5-point rating scale (0 = always and 4 = never). Factor analysis of the FOSQ yielded five factors: activity level (nine items), vigilance (seven items), intimacy and sexual relationships (four items), general productivity (eight items), and social outcome (two items). Subscale scores were summed up to get a total score with a maximum of 20 points. A low score represents dysfunction of the respondent, due to excessive daytime sleepiness.

Visual Analog Scale (VAS)

Facial appearance was assessed subjectively by the patients by VAS, retrospectively, before and at least 6 months after surgery. Overall satisfaction and treatment recommendation for the MMA procedure was also assessed using VAS. Subjective snoring assessment was evaluated by using VAS pre- and postoperatively, as reported by the study subject. The VAS is a psychometric response scale from 0 to 100 on a 100 mm horizontal line, in which 0 is the worst outcome possible, and 100 is the best achievable result. For example, the VAS on facial esthetics was described as a range from 0 (not pretty/beautiful) to 10 (very pretty/beautiful).

Maxillomandibular advancement (MMA) procedure

A Le Fort I osteotomy and a bilateral sagittal-split osteotomy were performed to advance the maxillary and mandibular facial skeletons, respectively. The maxilla was advanced to the preoperatively planned position (~8–10 mm anteriorly), and an intermediate splint was inserted to immobilize the advanced maxilla. After fixation of the maxilla with osteosynthesis, the mandible was repositioned in the planned position using a final splint and fixated with osteosynthesis. Elastics were used postoperatively for guiding maxillomandibular occlusion.

Statistical analysis

All datasets were analyzed with SPSS® (IBM® SPSS® Statistics version 25, IBM Corp. Armonk, NY, USA). Descriptive statistics were assessed on normality and were analyzed and expressed as median (interquartile range) or mean ± standard deviation. Presented variables were tested for differences between postoperative surgical success or failure using the Fisher's exact test for categorical variables and the Mann–Whitney U test for continuous variables. Associations were described between continuous variables using Spearman's Rho correlation. Strength of correlation was categorized as either being absent (< 0.20), poor (0.20–0.34), moderate (0.35–0.50), or strong (> 0.50) [21]. A p-value < 0.05 was considered statistically significant.

Results

Overall outcome measures

A total of 62 patients had MMA surgery for severe OSA, of whom, eventually, 41 patients were included in the study population (response rate of 66%). The study population had a mean age of 55 ± 10 years, and 35 patients were male (85%). All demographic parameters of the study population are presented in Table 1 (including details regarding non-responders). No differences between responders and non-responders were noticed, indicating that the current cohort sample may be a good representation of MMA-treated severe OSA patients.

The EQ-5D-3L showed a lower overall score in overall health, which was also reflected by the EQ-VAS and in every other domain of the questionnaire compared to the normal scores of the general population in the Netherlands (Table 2). Postoperatively, the ESS had a mean of 6.3 ± 5.4 and the FOSQ a mean of 16.0 ± 3.3. When patients were selected for MMA success or failure (criteria defined by AHI decrease of > 50% and AHI < 20), the FOSQ and EQ-VAS showed a significantly better result in favor of the success-group (p = 0.003 and p = 0.028, respectively). However, the ESS remained < 10 for both groups and showed no significant difference (Table 3).

The mean VAS outcome for subjective assessment regarding facial esthetics was 58 ± 22 mm at preoperative and 51 ± 23 mm at postoperative and showed no

Table 1. Characteristics of the study population. Data are presented as mean (± SD).

	Patients (N = 41)	%	Missing patients (N = 21)	%	p-value
Gender [M:F]	35:6	85:15	19:2	90:10	.577
Age [years]	55 (±10)		50 (±10)		.056
BMI [m^2/kg]	30 (±4)		31 (±5)		.243
Neck circumference [cm][a]	42 (±4)		44 (±3)		.135
AHI preoperative	54 (±22)		50 (±18)		.550
AHI postoperative	18 (±17)		13 (±14)		.274
MMA success [yes/no][b]	27/14	66/34	17/4	81/19	.222
ASA score [I/II/III]	11/25/5	27/61/12	8/10/3		.598

[a]Data is based on 31 patients because of missing data; [b]Success/failure based on the Sher criteria: postoperative AHI changes > 50% and < 20 events/h.

ASA: American Society of Anesthesiologists; BMI: body mass index, AHI: Apnea-hypopnea-index; MMA: maxillomandibular advancement; SD: standard deviation.

Table 2. OSA patient health-related quality of life using EQ-5D-3L compared with the general reference population in the Netherlands. This table presents an overview of the mean EQ-VAS ratings and the proportions of reported problems on each of the five EQ-5D dimensions.

	Patients (N = 41)	MMA success (N = 27)	MMA failure (N = 14)	Standardized EQ-5D-3L results NL
Mobility	0.22	0.11	0.43	0.04
Self-care	0.00	0.00	0.00	0.03
Daily activity	0.19	0.15	0.29	0.15
Pain	0.58	0.52	0.71	0.31
Mood	0.29	0.22	0.43	0.17
EQ-VAS (0–100) Mean ratings	73.2	77.6	65.4	81.4

OSA: Obstructive sleep apnea; MMA: Maxillomandibular advancement, NL: the Netherlands.

Table 3. Disease-specific quality of life (ESS, FOSQ, OHIP-14, MFIQ, EQ-VAS).

	Total population (N = 41)		MMA success (N = 27)		MMA failure (N = 14)		
	Mean	SD	Mean	SD	Mean	SD	*p*-value
ESS	6.3	5.4	5.1	4.1	8.6	7.0	0.102
FOSQ	16.9	3.3	18.2	2.2	14.5	3.8	**0.003**
EQ-VAS	73.2	15.7	77.6	12.0	65.4	18.7	**0.028**

Bold *p*-value (< 0.05) indicates significant difference.
EQ-VAS of the EQ-5D-3L questionnaire; ESS: Epworth Sleepiness Scale; FOSQ: Functional Outcome of Sleep Questionnaire; MMA: Maxillomandibular Advancement; SD: Standard Deviation.

significant difference (p = 0.217). Nineteen patients (51%) perceived their postoperative facial esthetics as negative, 14 patients (38%) rated their change as positive after surgery, and 8 patients (11%) were indifferent. When comparing the differences in VAS on facial esthetics after MMA, the success-group (57 ± 21) reported a significantly better result in comparison to the MMA failure-group (40 ± 22) (p = 0.026).

The outcome on snoring using VAS showed a significant decrease in snoring postoperatively, from 83 ± 21 to 20 ± 21 (p < 0.001). The snoring outcome after MMA did not show significant differences when comparing patients with success and failed MMA on polysomnographic parameters (AHI) (Table 4). Overall satisfaction was good after MMA (65 ± 29 mm), but in patients with MMA failure, satisfaction was negatively experienced (55 ± 34 mm) (Table 4).

Correlations between questionnaires

In this OSA patient population, the satisfaction after MMA surgery was correlated with the outcome of the ESS, the FOSQ, and the EQ-VAS: −0.368 (p = 0.027), 0.620 (p < 0.001), and 0.537 (p < 0.001), respectively. The EQ-VAS showed a correlation with the ESS and FOSQ: 0.326 (p = 0.043) and 0.599 (p < 0.001), respectively.

Discussion

The main research objectives were to evaluate the subjective outcomes after MMA surgery based on results of the EQ-5D-3L, ESS, FOSQ, and subjective assessment of perceived facial esthetics using VAS. The results on general health, expressed by the overall quality of life (EQ-VAS) and daily function related to sleep problems (FOSQ), demonstrate good outcome yields associated with MMA. The overall outcome measurements based on sleepiness (ESS), snoring, and facial esthetics (VAS) indicated that OSA patients were less sleepy and experienced reductions in snoring with no differences in perceived facial esthetics pre- and postoperatively, following MMA.

The results of the EQ-5D-3L showed higher scores in all domains in OSA patients who were successfully treated by MMA surgery. In comparison to the healthy reference population in the Netherlands, OSA patients after MMA surgery reported a lower EQ-VAS [17]. This could be explained by other possible confounding factors, such as gender, age, BMI, and existing medical co-morbidities. At present, this is the first report concerning MMA surgery that illustrates the level of general quality of life after the MMA procedure and that compares OSA patient satisfaction as either success or failure of MMA on the basis of perceived facial esthetics. EQ-VAS scores were higher in patients who were successfully treated by MMA surgery compared to those with an inadequate response in AHI. Patients with moderate-severe OSA who were treated with CPAP had already shown good response using EQ-5D [22]. Unfortunately, CPAP is a medical device with poor patient adherence, which is necessary for achieving desired therapeutic results [9,10]. In treating patients using MMA surgery, it is recommended to use questionnaires assessing general quality of life in addition to specific sleep quality of life questionnaires because of the influence of OSA on daily function, mental state, and overall wellbeing. The impact of OSA is not limited to excessive daytime sleepiness but significantly contributes to the impairment of all domains of general health quality of life, e.g., mobility, mood, and pain.

Excessive daytime sleepiness was evaluated using the ESS and showed an overall score of <10 for both MMA success and failure groups. No difference was observed

Table 4. VAS snoring and assessment of facial change. Data are presented as mean (± SD). Differences between MMA success and failure are presented, including *p*-values.

	Patients (N = 37)	MMA success (N = 24)	MMA failure (N = 13)	*p*-value
VAS esthetics preop (0–100 mm)	58 (± 22)	62 (± 19)	51 (± 27)	.200
VAS esthetics postop (0–100 mm)	51 (± 23)	57 (± 21)	40 (± 22)	**.026**
VAS snoring preop (0–100 mm)	83 (± 21)	84 (± 18)	80 (± 26)	.998
VAS snoring postop (0–100 mm)	20 (± 21)	19 (± 19)	20 (± 24)	.868
VAS satisfaction (0–100 mm)	65 (± 29)	71 (± 25)	55 (± 34)	.107
VAS recommendation (0–100 mm)	66 (± 33)	68 (± 31)	63 (± 37)	.649

Bold *p*-value (< 0.05) indicates significant difference.
VAS: Visual Analog Scale; MMA: Maxillomandibular Advancement; SD: Standard Deviation.

between either success or failure group, which suggests that patients were not reporting excessive daytime sleepiness after MMA regardless of the outcome on AHI. Patients who were treated successfully by the MMA procedure had a significantly better daily functioning, represented by the FOSQ. Previous studies addressed disease-specific quality of life by using ESS, FOSQ, and OSA-Q and showed good beneficial effects after MMA [23–27]. The current OSA patient data showed similar results on ESS and FOSQ postoperative assessments, supporting the conclusion that MMA is a procedure that results in improved quality of life outcomes. In patients with inadequate AHI-reduction, the ESS still showed a positive response (<10); however, other results (FOSQ) indicated that these patients had problems with daytime functioning and sleepiness because of persistent sleep impairment.

On snoring and esthetics

OSA patients reported no significant alteration regarding perceived facial esthetics after MMA in pre- and postoperative assessments. However, the authors' OSA patients were less positive about the facial esthetic changes (38%) compared to the studies by Li et al. (55%) and Islam et al. (54%) [26,28]. A possible explanation for this difference could be patient selection and the inherent subjectivity associated with questionnaires. It is noteworthy to mention that MMA procedures were not refused to severe OSA patients in whom it was thought that the procedure could potentially alter their face intensely; yet, these severe OSA patients persisted with the notion of getting an effective treatment for OSA and accepted facial alterations. OSA patients perceived their facial esthetics as being more negative when MMA failed to strongly reduce AHI in comparison to the patients whose operations were successful (strong reduction in AHI) in treating their OSA. OSA patients treated by MMA reported less snoring after MMA in both success and failure cases.

Recommendations for future research

This investigation only reported the postoperative subjective response from OSA patients and the differences associated with success and failed MMA procedures. Future research on MMA should explore the variables that were used in this study to evaluate longitudinal outcomes over time, but for assessing causal effect on quality of life, pre- and postoperative measurements are necessary. Overall, the current OSA study population was relatively small, and a larger patient sample would place the current observations into a more robust clinical perspective. MMA is not the first treatment of choice for OSA, and because of its highly invasive nature, it remains a less popular therapeutic option in general.

The use of the EQ-5D-3L in moderate to severe OSA patients remains interesting regarding its utility and because of the absence of validity in OSA patients. Jenkinson et al. showed that the EQ-5D-3L had limited responsiveness in OSA patients [29]; yet, the EQ-5D-3L is a clear and easy-to-use short questionnaire. When using the EQ-5D-3L in combination with the ESS or FOSQ, a greater perspective is gained from each individual OSA patient and study population.

Conclusion

In this study, patients generally reported no significant alteration in their perceived facial esthetics before or after the MMA procedure. If postoperative esthetics were negatively perceived by the patient, MMA was considered a surgical-failure. Interestingly, EQ-5D-3L assessments showed a negative overall score postoperatively across all domains when compared to the scores of the general reference population in the Netherlands. When patients achieve surgical-success after MMA, the results on quality of life are close to outcomes of the healthy reference population in the Netherlands.

Disclosure statement

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