Weight Loss Following Orthognathic Surgery: a Descriptive Prospective Cohort Study

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ABSTRACT

Objectives: The purpose of this prospective cohort study was to assess weight loss in kg following orthognathic surgery focusing on gender, type of surgery, employment, and living arrangements, as effect modifiers.
Material and Methods: Patient weights were measured at four points during their trajectory; two weeks preoperatively, week one, week three, and week eight postoperatively. Additionally, the registered nurse collected the following information: (1) patient age; (2) gender; (3) status of employment; (4) type of surgery; and (5) living arrangement.
Results: Mean weight loss of 3.35 kg (95% CI [confidence interval] = 3.07 to 3.62, P < 0.001), 3.56 kg (95% CI = 3.23 to 3.89, P < 0.001), and 2.79 kg (95% CI = 2.36 to 3.21, P < 0.001) for week 1, 3 and 8. Higher weight loss was observed in males 3.81 kg (95% CI = 3.31 to 4.31) compared with females 3 kg (95% CI = 2.71 to 3.29) at week 1 (P = 0.01). Highest weight loss following bimaxillary surgery was observed at week 1 (P = 0.00) and week 8 (P = 0.04).
Conclusions: Postoperative proportional weight loss is observed in all patients undergoing orthognathic surgery. Being male and having bimaxillary surgery predicts for a higher weight loss. Patients who had bimaxillary procedures showed greater weight loss compared to those who had a single jaw procedure, possibly due to longer surgery times, increased facial swelling and restricted mouth opening. Interestingly, living arrangements seemed to have an effect on weight loss at week 3, suggesting that social support may influence nutritional status.

Keywords: cohort studies; orthognathic surgery; postoperative period; weight loss.

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INTRODUCTION

Dentofacial deformities is a congenital disorder, which primarily affects the masticatory function and the facial appearance [1]. Minor dentofacial deformities are corrected by orthodontic treatment involving brace and alignment of the dentition and occlusion. Extreme dentofacial deformities necessitates orthognathic surgery involving orthodontic treatment combined with single or bimaxillary surgery [2]. Orthognathic surgery can be performed in the mandible involving a bilateral split osteotomy and/or the maxilla with a Le Fort I osteotomy with or without segmentation in early adulthood. Research highlights health benefits for patients following orthognathic surgery in relation to improvements in psychological well-being, and oral-health related quality of life [3]. However, patients undergoing orthognathic surgery experience postoperative side effects involving severe facial swelling, trismus, impaired chewing, and swallowing combined with nausea, pain, and fatigue. These postoperative symptoms increase the patients' risk of malnutrition, and results in loss of body mass, adversely affects wound healing, and increases the risk of postoperative infections [4-6]. Hence preventing deterioration of these patients' nutritional status in the perioperative period is highly desirable.

The estimated bone healing process after orthognathic surgery is two to four months in healthy young people [7]. Patients undergoing orthognathic surgery follow a strict nutritional diet of 6 to 8 weeks postoperatively involving soft diet without chewing or biting. After 6 weeks patients are allowed to start chewing soft diet. Due to facial swelling and restricted mouth-opening, the patients' ability to consume food is limited to a teaspoon at a time. Furthermore, patients' nutritional needs are insufficient covered up to 48 hours preoperatively according to the guidelines for fasting for surgery and postoperatively due to swelling, decreased mouth-opening and nausea [8,9]. Moreover, the surgical procedure also induces catabolism combined with stress metabolism, which significantly affects postoperative recovery [4].

Postoperative weight loss following orthognathic surgery of 3 to 10 kilograms have previously been reported, where the largest weight loss occurs within the first three postoperative weeks [10-12]. Postoperative weight loss has a significantly impact on patient´s functional level and their well-being involving difficulties in eating, chewing, swallowing and decreased mouth opening as their most serious problem up to six to eight weeks after orthognathic surgery [13].

Postoperative weight loss in patients following orthognathic surgery has been of interest within orthognathic surgery since the early 1980s, however despite focus on guidance on sufficient nutrition and the risk of weight loss orthognathic patients still lose weight postoperatively [12,14].

Monitoring of weight loss and nutrition guidelines following orthognathic surgery are therefore essential to improve postoperative outcome, patient well-being, and satisfaction. The aim of this prospective cohort study was to assess weight loss among patients undergoing orthognathic surgery to investigate gender, type of surgery, employment, and living arrangements, as effect modifiers for early weight loss.

MATERIAL AND METHODS

A descriptive prospective cohort study was conducted at the Department of Oral and Maxillofacial Surgery, Aalborg University Hospital, Aalborg, Denmark. Data was collected from February 1, 2015 to April 30, 2016. According to the Danish Health Care Act the project is classified as a quality assurance/development study which does not require any additional ethic assessment according to Danish legislation. The study is conducted in compliance with the General Data Protection Regulation and is a part of North Denmark Region's record of processing activities (2016-130).

The study enrolled patients consecutively scheduled for single or bimaxillary surgery. Patients were enrolled during their pre-surgery examination. The STROBE guideline for observational studies was followed [15].

No exclusion criteria were applied. All patients followed the same postoperative diet protocol consisting of cold liquid diet the first 24 hours after surgery, followed by six to eight weeks with soft diet without permission to bite or chew the food. After six weeks the patients are allowed to chew soft food.

Patient weights were measured at four points during their trajectory; two weeks preoperatively, week one, week three, and week eight postoperatively (Figure 1). All weight measures were secured using the same Seca 876 digital scale weight (Seca North America; Chino, California, USA).

The weights were read by registered nurses after receiving instructions verbally and in writing on how to perform the measurements and record patient data.

Additionally, the registered nurse collected the following information: (1) patient age; (2) gender; (3) status of employment (employed, unemployed, attending school, early retirement); (4) type of surgery (bilateral split osteotomy on the mandibula

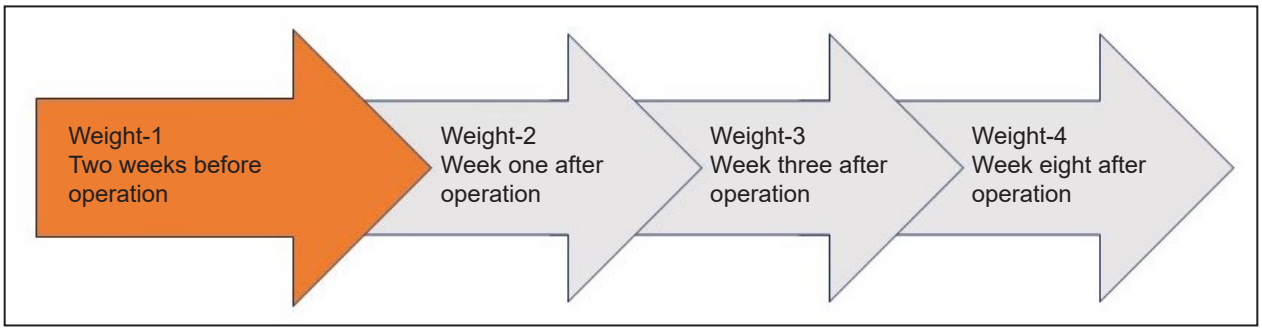

Figure 1. Patient trajectory.

and Le Fort I osteotomy on the maxilla with or without segmentation, bilateral sagittal split osteotomy on the mandibula, or Le Fort I osteotomy on the maxilla with or without segmentation); and (5) living arrangement (cohabiting, living alone).

Statistical analysis

Data management and analyses were conducted using statistical software STATA 18 (StataCorp LP; College Station, TX, USA). Categorical data are presented as counts and percentages, while continuous data are reported as mean and standard deviation. Except for age, it is reported as median, minimum, and maximum. Chi-square test was used to compare categorical data and Kruskal-Wallis test for continuous data comparisons.

Weight loss from baseline was analysed using mixed regression with a random intercept for each participant and robust variance estimation. Weight loss estimates are reported with 95% confidence intervals (CI), along with the P-value indicating if the loss is statistically significant at a significance level of 5%.

RESULTS

A total of 161 patients were initially eligible to participate in this study. However, due to missing baseline weight data for seven patients, the final enrolment comprised 154 patients. Among these, 117 (69.7%) adhered to a complete and conclusive weight control schedule. The remaining 30.1% of patients had incomplete weight control schedules with missing measurements. Data shows that more females than males were treated with orthognathic surgery, with 57.8% and 42.2% respectively. Patients' characteristics on gender and age distribution, status of employment, type of surgery, living arrangements and baseline weight are displayed in Table 1.

Table 1. Baseline characteristics by gender

Characteristics		Female	Male	Total	P-value
N (%)		89 (57.8)	65 (42.2)	154 (100)	-
Age	15-years, N (%)	27 (30.3)	20 (30.8)	47 (30.5)	-
	20-years, N (%)	41 (46.1)	32 (49.2)	73 (47.4)	-
	30-years, N (%)	21 (23.6)	13 (20)	34 (22.1)	0.86
	Median (min; max)	22 (15; 55)	20 (15; 56)	21 (15; 56)	0.79
Status of employment	Employed, N (%)	26 (29.2)	28 (43.1)	54 (35.1)	-
	Unemployed, N (%)	14 (15.7)	6 (9.2)	20 (13)	-
	Attending school, N (%)	49 (55.1)	29 (44.6)	78 (50.6)	-
	Early retirement, N (%)	0 (0.0)	2 (3.1)	2 (1.3)	0.08
Jaw surgery	Bimaxillary (double), N (%)	74 (83.1)	37 (56.9)	111 (72.1)	-
	Le Fort I osteotomy (maxilla), N (%)	7 (7.9)	14 (21.5)	21 (13.6)	-
	Bilateral sagittal split osteotomy (mandible), N (%)	8 (9)	14 (21.5)	22 (14.3)	0.00[a]
Living arrangement	Cohabiting, N (%)	72 (80.9)	57 (87.7)	129 (83.8)	-
	Living alone, N (%)	17 (19.1)	8 (12.3)	25 (16.2)	0.26
Weight (week 0)	Mean (SD), kg	68.3 (17.6)	81 (16)	73.6 (18)	< 0.001[a]

[a]Statistically significant at level $P < 0.05$ (chi-square test).
N = number; SD = standard deviation.

Table 2. Weight changes from baseline by time

Week	Weight (kg)	Weight loss (%)	95% CI (kg)	P-value
	Mean (SD)			Loss
Baseline	73.64	-	-	-
1	70.29 (3.35)	4.5	3.07; 3.62	< 0.001[a]
3	70.08 (3.56)	4.8	3.23; 3.89	< 0.001[a]
8	70.85 (2.79)	3.8	2.36; 3.21	< 0.001[a]

[a]Statistically significant at level P < 0.05 (Kruskal-Wallis test).
CI = confidence interval; SD = standard deviation.

Table 3. Weight loss from baseline by time and by gender

Week	Gender	Weight loss		95% CI (kg)	P-value	
		Kg	%		Loss	Gender
1	Female	3	4.4	2.71; 3.29	0.00[a]	0.01[a]
	Male	3.81	4.7	3.31; 4.31	0.00[a]	
3	Female	3.38	4.9	3.02; 3.73	0.00[a]	0.23
	Male	3.81	4.7	3.2; 4.42	0.00[a]	
8	Female	2.61	3.8	2.22; 3.01	0.00[a]	0.39
	Male	3.02	3.7	2.17; 3.88	0.00[a]	

[a]Statistically significant at level P < 0.05 (chi-square test).
CI = confidence interval.

Tables 2 to 5 are summaries from mixed regressions as described in the statistical section.

A mean weight loss of 3.35 kg (95% CI = 3.07 to 3.62, P < 0.001), 3.56 kg (95% CI = 3.23 to 3.89, P < 0.001), and 2.79 kg, (95% CI = 2.36 to 3.21, P < 0.001) for week 1, 3 and 8 was observed across genders. The data shows that both males and females experience increased weight loss from week 1 to week 3 compared with their baseline weight, while their weight loss had decreased by their weight at week 8. The weight losses of patients in all postoperative measurements show a statistically significant difference when compared with their baseline measurements (Table 2).

In our dataset, a general higher average weight of males compared to females was observed, which we attribute to anatomical gender differences. Weight loss stratified by gender is displayed in Table 3. A statistically significant higher weight loss in kg was found in males compared with females at week 1, 3.81 kg (95% CI = 3.31 to 4.31), and 3 kg (95% CI = 2.71 to 3.29, P = 0.01). At week 3 and 8 males also had a higher weight loss than females however the differences were not significant. As displayed in Table 2 and 3 the weight changes from week 1 to week 8 were minor. Across genders, a difference of 0.56 kg was observed. Specifically, for females, the difference was 0.39 kg, and for males, it was 0.79 kg.

One hundred and eleven patients underwent bimaxillary surgery. Bimaxillary surgery was more frequent in females 83.1% compared with males 56.9% (Table 1). Additionally, patients who underwent bimaxillary surgery exhibited a lower baseline weight compared with those who underwent a single procedure. The baseline weights were as follows: for bimaxillary surgery it was 70.8 kg, while for Le Fort I osteotomy and bilateral sagittal split osteotomy separately, it was 76.2 kg and 85.5 kg, respectively. At week 1 and 8, there was a significant difference by jaw surgery (P < 0.001) with patients undergoing bimaxillary surgery having the highest weight loss, respectively 3.65 kg (95% CI = 3.32 to 3.97) and 3.1 kg (95% CI = 2.65 to 3.56) (Table 4).

Patients living alone were advised to consider cohabitation during the first postoperative week to assist with their postoperative care and management of dietary restrictions. The analysis revealed

Table 4. Weight loss from baseline by time and by jaw surgery

Week	Jaw surgery	Weight loss (kg)	95% CI (kg)	P-value	
				Loss	Surgery
1	Bimaxillary (double)	3.65	3.32; 3.97	0.00	< 0.001[a]
	Le Fort I osteotomy (maxilla)	2.81	2.37; 3.24	0.00	
	Bilateral sagittal split osteotomy (mandible)	2.35	1.62; 3.09	0.00	
3	Bimaxillary (double)	3.8	3.44; 4.16	0.00	0.08
	Le Fort I osteotomy (maxilla)	3.21	2.38; 4.04	0.00	
	Bilateral sagittal split osteotomy (mandible)	2.63	1.53; 3.74	0.00	
8	Bimaxillary (double)	3.1	2.65; 3.56	0.00	0.04[a]
	Le Fort I osteotomy (maxilla)	1.56	0.38; 2.74	0.01	
	Bilateral sagittal split osteotomy (mandible)	2.21	0.84; 3.59	0.00	

[a]Statistically significant at level P < 0.05 (chi-square test).
CI = confidence interval.

Table 5. Weight loss from baseline by time and by living arrangements

Week	Living arrangement	Weight loss (kg)	95% CI (kg)	P-value (difference)	P-value (living arrangement)
1	Cohabiting	3.29	3; 3.59	0.00	0.41
	Living alone	3.62	2.9; 4.34	0.00	
3	Cohabiting	3.38	3.04; 3.73	0.00	0.03[a]
	Single	4.46	3.55; 5.36	0.00	
8	Cohabiting	2.67	2.2; 3.14	0.00	0.2
	Living alone	3.39	2.4; 4.37	0.00	

[a]Statistically significant at level $P < 0.05$ (chi-square test).
CI = confidence interval.

no significant difference in weight loss between those living alone and those cohabiting during the first week (P = 0.41) or at week 8 (P = 0.2). However, a statistically significant difference between cohabitation and weight loss was observed at week 3 (P = 0.03) (Table 5).

Furthermore, the study found no significant correlation between various employment statuses (employed, unemployed, attending school, and early retirement) and patients' weight loss following orthognathic surgery.

DISCUSSION

The aim of this prospective cohort study was to assess weight loss among patients undergoing orthognathic surgery to investigate gender, type of surgery, employment, and living arrangements as effect modifiers for early weight loss.

This study's results indicate a consistent pattern of weight loss across the three time points post-surgery. The most substantial weight loss occurred during the initial three weeks following surgery, with a gradually decreasing weight loss in the subsequent weeks. This is consistent with existing literature demonstrating a weight loss following orthognathic surgery of 3 to 10 kilograms, indicating that the most substantial weight loss occurs within the first three postoperative weeks [11,12,16,17]. Therefore, understanding which dietary interventions can mitigate postoperative weight loss in this patient group is especially crucial during the initial three postoperative weeks.

In this study, a higher proportion of females underwent orthognathic surgery. Comparing the number of surgeries performed in 2015, 2017, and 2019, at Aalborg University Hospital, Aalborg, Denmark a consistent gender difference was observed, with approximately 60% of the patients being females. It is worth noting that males may have a relatively lower level of awareness regarding diseases and tend to visit doctors less frequently compared to females [18].

In this study males had a higher average baseline weight and significant higher weight loss than females at week one which may be argued due to anatomical gender differences. Males often have greater muscle mass than females and therefore also a naturally higher metabolism [19]. Although males continued to show higher weight losses in the following weeks, the differences were not significant. However, these results must be interpreted in the context of their clinical relevance, as the observed weight changes were relatively minor across genders. Though research on weight loss and gender differences following orthognathic surgery are contradictory. A recent systematic review by Williams et al. [17] reported that males generally experience greater weight loss compared with females. A large cohort study revealed that significantly more females experienced weight loss than men [20]. In contrast, no gender-based differences in weight loss or weight gain after bimaxillary surgery have been revealed in other studies [21,22].

Most patients in this study underwent bimaxillary surgery. Patients undergoing bimaxillary surgery experienced significantly higher weight loss compared with patients undergoing single jaw surgery. This difference was statistically significant at week 1 and week 8, but not consistently across all three weeks.

Several studies [12,22-24] have explored the relationship between orthognathic surgery and amount of weight loss. All studies demonstrated that both single- and bimaxillary surgery leads to weight loss, however, no significant difference was disclosed in outcomes between single or bimaxillary orthognathic surgery at all evaluated time points. Though bimaxillary surgery is known to be associated with significantly more postoperative morbidity compared with single jaw surgery involving higher pain score, increase facial swelling, and restricted mouth opening. All factors that significantly may influence

postoperative weight loss [9]. Additionally, the greater weight loss observed among patients undergoing bimaxillary surgery in this study could be related to the length of the surgery. It has been reported that for every additional 30 minutes of surgery, body weight decreased postoperatively by 3.3% [24].

It is noteworthy that patients in this study undergoing bimaxillary surgery had a lower baseline weight compared with those undergoing a single procedure. Patients' body mass index (BMI) was not measured in this study. However, several studies have investigated the association between BMI and weight loss following orthognathic surgery. For instance, a higher preoperative BMI was found to be correlated with higher postoperative weight loss [16]. Another study reported that patients with a higher BMI experienced increased swelling and faster recovery during the initial weeks post-surgery. In contrast, patients with a lower BMI tended to have reduced postoperative swelling and a slower rate of reduction at all time points [9]

In view of the difference between cohabitation and weight loss observed at week 3, it is reasonable to consider that patients who temporarily resided with family or friends during the first postoperative week may have a faster recovery compared with those patients, who returned to living alone. The support and assistance they received in the first week could have a positive effect on their nutritional status. When they returned to living alone, they may have experienced a change in their ability to maintain the same nutritional support which could have explained the change in their weight loss pattern at week 3. None of the identified research literature has focused on the significance of living arrangements for orthognathic patients' postoperative weight loss. Hence, this observation underscores the importance of social support and the influence of the environment on patients' postoperative recovery, highlighting the need for further investigation of these factors in future studies.

This pilot study highlights how orthognathic patients struggle to maintain their nutritional status, resulting in postoperative weight loss. In this study, as well as in other research, there has been a focus on weight loss measured in kilograms among patients. However, we do not know whether it is fat mass, fat-free mass, or fluids that patients are losing, nor whether there is a connection between their weight loss and overall well-being and recovery. We therefore argue for the need for further research to investigate these factors.

Limitations

This study has some limitations. There was an overrepresentation of patients undergoing bimaxillary surgery compared to single-jaw procedures, reflecting the natural distribution. A more balanced sample might have yielded different results. Le Fort I osteotomy was not divided into en bloc or segmented types, though most underwent segmented osteotomy, with similar postoperative restrictions.

Baseline weight was measured two weeks pre-surgery, but clinical experience suggests patients gain weight due to nutritional guidance during this period. As a result, actual weight loss by week 8 may have been underestimated.

Additionally, data was collected in 2016, but to our knowledge, no other studies on this topic have been published since.

CONCLUSIONS

The results revealed a consistent pattern of weight loss across the three post-surgery time points, with the most significant weight loss occurring in the initial weeks. Gender differences were observed, with males experiencing higher weight loss than females in the first week, though not consistently significant in subsequent weeks. Patients undergoing bimaxillary procedures showed greater weight loss compared to a single jaw procedure, possibly due to longer surgery times and increased facial swelling and restricted mouth opening. Interestingly, a correlation was found between living arrangements and weight loss at week 3, suggesting the influence of social support on nutritional status. Additional research is required to investigate the factors influencing weight loss after orthognathic surgery to establish optimal postoperative care strategies as well as examine the weight loss more in detail.

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