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Original Article

Short-term and long-term psychological impact and quality of life of patients undergoing orthognathic surgery

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ABSTRACT

Background: Orthognathic Surgery (OGS) is a surgery for patients with dento-facial deformity but not all patients are satisfied with its outcome. The purpose of this study is to find out the short-term and long-term psychological impact and quality-of-life of OGS.

Methods: 77 participants receiving OGS and 32 age and gender-matched controls were enrolled. The data of questionnaires were collected before OGS, one month and 9 months after OGS, including short form of the Derriford-Appearance-Scale (DAS-24), Big-Five-Inventory (BFI), Hospital-Anxiety-and-Depression-Scale (HADS), Pittsburgh-sleep-quality-index (PSQI), and 36-Item Short-Form-Health-Survey (SF-36). Variables were presented as mean ± standard deviation or frequency. Paired t-test, ANOVA and MANOVA were used to evaluate the pre-and post-surgery data.

Results: Short-term and long-term satisfaction of OGS was high. Before OGS, BFI showed the extraversion had significant difference between the male and female OGS subgroups. Several domains of DAS-24 were significantly different between the OGS and the control groups. Both groups had no significant difference in PSQI, HADS and SF-36, except sleep-efficiency. After OGS, many domains of DAS-24 were significantly improved and the improvement persisted to 9 months later. Sleep-latency, physical-function, role-limitations-due-to-physical-health and social-functioning exacerbated after OGS. Sleep-latency, physical-function, and social-functioning were improved 9 months after OGS, but sleep-efficiency and role-limitations-due-to-physical-health were still significantly worse than controls.

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Conclusion: People received OGS for unfavorable appearance and the surgery could decrease their distress of appearance and impact to their daily living. Through long-term assessment, we should pay attention to sleep problems and role-limitations-due-to-physical-health after OGS.

At a glance commentary

Scientific background on the subject

Patients with dentofacial deformity usually suffer from the negative impact of the deformity. After orthognathic surgery, they can have a more pleasing appearance and improved quality of life. Although evidences suggest positive change, the long-term impact of the surgery can be ambiguous.

What this study adds to the field

After surgery, our patients can have decreased negative impact from their appearance and improved sleep latency, physical and social function at the 9-month follow-up. However, sleep efficiency and role limitation due to physical health were worse than controls. Post-surgery evaluation of sleep and role limitations due to physical health is warranted.

Most patients with dentofacial deformity are usually less confident and suffer from the negative impact of the deformity. Not only their physical health such as oral function but also social function and other psychosocial condition can be affected. Low self-esteem and poorer oral health-related quality of life were reported [1], as well as emotion problems including depression and anxiety. Several studies have shown those with dentofacial deformity report more distress and insecurity compared to the control group, regarding their facial appearance [2–4]. Patients tend to exhibit more psychological stress in social situations than those with other jaw deformities [3]. Thus, most people would try to find a way to fix their problem. Among the reasons to receive orthognathic surgery, the aesthetic desire is frequently and mostly reported, and there are other reasons such as functional improvement [5–9].

Dentofacial deformity includes Class II and III malocclusion, poor dental and jaw relation. It can be noted since very young age and influence development in different life stages. Because current medicine pursues both physical and mental health of human beings, more and more people receive Orthognathic surgery (OGS). OGS is a functional and aesthetic treatment with increasing patient population. Orthognathic surgery (OGS) is a functional and aesthetic treatment. After receiving OGS, patients can have improved bite, better sleep quality for those with obstructive sleep apnea (OSA), and a more pleasing appearance and subsequently better confidence. Moreover, the benefits of OGS with regard to quality of life [10] have been reviewed and the improvement in quality of life after surgery is confirmed [1,11]. Other positive effects of OGS on psychosocial status have also been well reported [3,12,13].

However, some patients can be unsatisfied with the outcome of OGS, and some studies showed that patients who had increased distress before OGS could also have more distress postoperatively [3,13]. Besides, although most previous studies showed positive and successful psychosocial outcomes after OGS surgery [11,12,14–18], some authors suggested that the results should be interpreted with caution since there was wide variation in study designs, inconsistent measurement methods of the psychosocial outcome, and reporting biases [10,18,19]. There were few prospective long-term follow-up studies and thus it can be difficult to quantify the extent and duration of the psychosocial influences of OGS. Other studies also mentioned that not only the benefit, but also other unfavorable outcomes and the psychological difficulties after OGS should be further investigated [20,21]. Therefore, although most evidences suggest improvement, the impact of OGS on different patient populations can be ambiguous, and it necessitates further investigation of the both short-term and long-term psychological changes in different psychosocial aspects.

Our craniofacial center is one of the world's best craniofacial centers, receiving at least 600 patients for OGS per year. We pursue the surgical success and also emphasize the importance of physical and mental health. In our experience, some people have disproportionate dissatisfaction with the surgical results, and it brings distress to both the patient and the medical team. Subsequent clinic visits and distressing phone calls can be exhausting and demoralizing, and some patients insist on re-operation, which consumes unnecessary time and treatment costs. Therefore, we developed a comprehensive psychological screening and evaluation assessment for screening and monitoring OGS patients before and after surgery.

By using our psychological assessment, we designed a long-term prospective study to explore possible psychological issues before and after OGS and analyzed the short-term and long-term psychological impact and quality of life in patients receiving OGS.

Materials and methods

Patients who were scheduled for OGS due to class II or III malocclusion or an asymmetrical face were recruited prospectively. Patients with craniofacial syndrome, cleft lip and palate, or facial deformities secondary to trauma and tumor resections were excluded. We also enrolled age and gender matched healthy controls without dentofacial deformity as the control group, and those with major physical disease (such as stroke, epilepsy, heart failure, liver cirrhosis, etc.) and psychiatric disorder (such as bipolar disorder, schizophrenia, and mental retardation, etc.) were excluded. The study was

Table 1a Demographic data of all participants.

		OGS group			Control group			P1	P2
		Male (n = 25)	Female (n = 52)	Total (n = 77)	Male (n = 13)	Female (n = 19)	Total (n = 32)		
Gender (%)		32.5%	67.5%		40.6%	59.4%			0.420
Age (Mean ± SD) years		23.04 ± 9.53	22.04 ± 7.18	22.36 ± 7.97	22.69 ± 2.87	21.16 ± 8.39	21.78 ± 6.69	0.866	0.717
Education of participants (%)	Below university	(12.0%)	(21.2%)	(18.2%)	(7.7%)	(15.8%)	(12.5%)	0.361	0.282
	University or above	(88.0%)	(78.8%)	(81.8%)	(92.3%)	(84.2%)	(87.5%)		
Education of father (%)	Below university	(40.0%)	(61.5%)	(54.5%)	(15.4%)	(42.1%)	(31.3%)	0.059	0.289
	University or above	(60%)	(38.5%)	(45.5%)	(84.6%)	(57.9%)	(68.7%)		
Education of mother (%)	Below university	(56.0%)	(61.5%)	(59.7%)	(30.8%)	(42.1%)	(37.5%)	0.125	0.021*
	University or above	(44.0%)	(38.5%)	(40.3%)	(69.2%)	(57.9%)	(62.5%)		
Accompanied by relatives to the clinic (%)	Yes	14 (56.0%)	32 (61.5%)	46 (59.7%)				0.162	
	No	11 (44.0%)	20 (38.5%)	31 (40.3%)					
Does the family agree? (%)	Yes	22 (88.0%)	49 (94.2%)	64 (92.2%)				0.382	
	No	3 (12.0%)	3 (5.8%)	6 (7.8%)					
Physical diseases	Yes	4 (16.0%)	9(17.3%)	13 (16.9%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0.173	0.026*
	No	21 (84.0%)	43 (82.7%)	64 (83.1%)	13 (100.0%)	19 (100.0%)	32 (100.0%)		
Psychological diseases	Yes	1 (4.3%)	7 (14.3%)	8 (11.1%)	0 (0.0%)	1 (5.3%)	1 (4.0%)	0.359	0.291
	No	22 (95.7%)	42 (85.7%)	64 (88.9%)	13 (100.0%)	18 (94.7%)	31 (96.0%)		
Whether or not to take sleeping pills	Yes	1 (4.0%)	0 (0.0%)	1 (1.4%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0.373	1.000
	No	24 (96.0%)	52 (100%)	76(98.7%)	9 (100.0%)	16 (100.0%)	25 (100.0%)		

P1 values were calculated by Chi-square test or ANOVA test of 4 subgroups; *$p < 0.05$.
P2 values were calculated by Chi-square test or t-test of 2 groups (the OGS and control groups); *$p < 0.05$.
Abbreviations: OGS: orthognathic surgery; SD standard deviation.
"Physical diseases" include major physical diseases such as heart disease, diabetes mellitus, metabolic or endocrine diseases, cancer, orthopedic or urologic diseases, brain injury, stroke, epilepsy, etc.
"Psychological diseases" include major psychiatric disease such as schizophrenia, bipolar disorder, major depression, obsessive compulsive disorder, intellectual disability, substance use disorder, personality disorder, etc.

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Procedure

(a) Participants were diagnosed as having class II or III malocclusion or an asymmetrical face and scheduled for OGS at the Craniofacial Center of Chang Gung Memorial Hospital. Investigators explained the purpose and process of the study to patients and their families and invited them to join as participants. All participants signed an informed consent.
(b) After they signed the informed consent, they filled questionnaires before they received OGS (the preoperative phase).
(c) After OGS, we followed our participants and they completed the same questionnaires 1 month and 9 months after the surgery, evaluating the short-term and long term impact of OGS and the change of quality of life.

The surgical technique of OGS

Orthognathic surgery (OGS) is a safe and essential procedure to functionally correct malocclusion and esthetically improve facial profile [22,23]. The indication of OGS is for those patients with craniofacial anomaly, acquired dentofacial deformity, and facial asymmetry [24]. OGS mainly consists of two key surgical techniques including Le Fort I osteotomy and bilateral sagittal splitting osteotomy. LFI is used to dysjunction the connection of maxilla to pterygoid plate and zygoma to free the upper jaw. BSSO can separate the proximal and distal segments of mandible to free the lower jaw. Then, based on the guided stent, a new maxillomandibular complex could be repositioned for a better facial profile according to intraoperative esthetic checkpoints [25]. In addition, following the two-jaw surgery, genioplasty is usually performed to optimize the facial harmony at last.

Psychological screening and evaluation assessment

At present, there is no structured tool available to evaluate the psychological status and mental health of patients receiving OGS. Thus, we developed a comprehensive psychological screening and evaluation assessment, exploring 6 domains: (1) Demographic data, (2) Personality, (3) Distress and dysfunction to problems of appearance, (4) Sleep, (5) Emotion, and (6) Quality of life. We also assessed the Satisfaction of the surgery details were shown as follows:

(1) Demographic data: we devised our own questions with the guidance from literature to collect data including gender, age, physical/psychological diseases and family support. Family and social support could correlate to physiological behavior and health [26,27].
(2) Personality: Big Five Inventory (BFI) has 33 questions assessing 5 different personality components. These

components include extraversion, agreeableness, conscientiousness, neuroticism, and openness. Higher scores of a particular component mean more tendency of the specific personality trait [28].

(3) Distress and dysfunction to problems of appearance: we used Derriford Appearance Score (DAS-24) to measure distress and dysfunction to problems of appearance. It could evaluate the distress of patients with different appearance-altering conditions, e.g. burns, cleft lip and palate, etc. [29,30].
(4) Sleep: Pittsburgh Sleep Quality Index (PSQI) Scale was used and its 9 questions can assess eight sleep components, including subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleeping medication, daytime dysfunction and global PSQI score [31]. Higher scores mean worse sleep quality.
(5) Emotion: The Hospital Anxiety and Depression Scale (HADS) with 14 major questions was used to evaluate depression and anxiety. The internal consistency of the Chinese-Cantonese HADS has been published, with Cronbach's alpha 0.86 for the full scale, 0.82 for the depression subscale and 0.77 for the anxiety subscale [32]. Higher scores represent more depression or anxiety.
(6) Quality of life: 36-Item Short Form Health Survey (SF-36) is a widely used tool for quality of life, and its 11 questions assess 8 components. The components assessed by SF-36 include physical functioning, role limitations due to physical health, role limitations due to emotional problems, energy/fatigue, emotional well-being, social functioning, pain, and general health. Higher scores mean better physical or mental functions [33].
(7) Satisfaction: a visual analogy scale from 1 to 10 score was designed and used in the study. The higher scores mean more satisfaction. It was scored 1 month and 9 months after OGS.

Statistics

All data were analyzed with SPSS, version-20 (SPSS, Inc., Chicago, IL). Variables were presented as either mean ± standard deviation or frequency. Paired t-test and ANOVA to evaluate the pre-and post-surgery data. Independent t-tests and analysis of variance were used to compare groups according to visibly different/not different, and diagnostic (causal) category within the visibly different group.

To further analyze the changes of DAS-24 in different time points, we grouped the items of DAS-24 into three domains. The first domain is "Subjective distress to appearance," including Distress at reflection, Irritable at home, Feel hurt, Self-consciousness of appearance, and Feel irritable. The second is "Distress of others' views to the appearance," including Distressed at beach, Adopt concealing gestures, Avoid communal changing, Distressed in supermarkets/department, Avoid undressing with partner, Distressed playing sport/games, Distressed at social events, and Distressed at others remarks about appearance. The third domain is "Impact to daily living," including Self consciousness affects work, Misjudged due to appearance, Distressed by clothing limitation, Feel normal, Affects sex life and Avoid

Table 1b The data of BFI of the OGS and control groups.

	OGS			Control group			P1	P2	Post hoc
	Male (n = 23) (mean ± SD)	Female (n = 48) (mean ± SD)	Total (n = 71) (mean ± SD)	Male (n = 13) (mean ± SD)	Female (n = 20) (mean ± SD)	Total (n = 32) (mean ± SD)			
Extraversion	19.50 ± 4.46*	16.53 ± 4.13*	17.45 ± 4.43	18.77 ± 5.17	18.65 ± 4.87	18.71 ± 5.07	0.044*	0.209	OGS: M > F (p = 0.008)
Agreeableness	23.09 ± 3.62	22.94 ± 3.42	22.99 ± 3.46	22.54 ± 2.47	23.60 ± 3.52	23.16 ± 3.23	0.830	0.811	
Conscientiousness	25.13 ± 4.25	24.45 ± 4.45	24.67 ± 4.37	25.38 ± 4.13	26.05 ± 3.95	25.77 ± 3.90	0.551	0.230	
Neuroticism	18.27 ± 4.34	21.10 ± 6.20	20.23 ± 5.81	19.54 ± 4.63	22.55 ± 5.04	21.19 ± 5.10	0.065	0.424	
Openness	22.74 ± 4.21	20.14 ± 3.93	20.97 ± 4.17	21.46 ± 4.37	20.75 ± 4.39	20.84 ± 4.39	0.100	0.884	OGS: M > F (p = 0.013)

P1 values were calculated by Two-way ANOVA of 4 groups; *$p < 0.05$.
P2 values were calculated by t-test of 2 groups (OGS and control groups); *$p < 0.05$.
Post hoc: Scheffe test.
Abbreviations: BFI: the Big Fiver Inventory; F: female; M: male; OGS: orthognathic surgery; SD: standard deviation.

Table 2 Comparison of DAS-24 before OGS and after OGS with the control group.

	Control group (N = 32) (M ± SD)	OGS group			P1	P2
		Before OGS (N = 77) (M ± SD)	1 month after OGS (N = 77) (M ± SD)	9 months after OGS (N = 28) (M ± SD)		
Distress at reflection	1.90 ± 0.65	2.58 ± 0.91	2.03 ± 0.73	2.00 ± 0.94	0.018*	Pc1: 0.000*; Pc2: 0.469; Pc3: 0.633
Irritable at home	1.00 ± 0.81	1.56 ± 0.99	1.30 ± 0.88	1.34 ± 0.84	0.247	Pc1: 0.007*; Pc2: 0.156; Pc3: 0.098
Feel hurt	1.61 ± 0.67	2.46 ± 1.01	1.95 ± 0.85	1.91 ± 0.92	0.011*	Pc1: 0.000*; Pc2: 0.081; Pc3: 0.137
Self consciousness affects work	1.06 ± 0.68	1.47 ± 0.87	1.14 ± 0.75	1.09 ± 0.78	0.040*	Pc1: 0.013*; Pc2: 0.688; Pc3: 0.907
Distressed at beach	1.10 ± 0.94	0.96 ± 0.91	0.73 ± 0.80	0.80 ± 0.96	0.846	Pc1: 0.485; Pc2: 0.088; Pc3: 0.212
Misjudged due to appearance	1.29 ± 0.78	1.39 ± 0.90	1.16 ± 0.80	1.14 ± 0.84	0.380	Pc1: 0.597; Pc2: 0.509; Pc3: 0.467
Self-conscious of appearance	1.71 ± 1.00	2.53 ± 1.10	2.06 ± 0.98	2.20 ± 1.08	0.001*	Pc1: 0.001*; Pc2: 0.161; Pc3: 0.062
Feel irritable	1.68 ± 0.65	2.33 ± 1.02	1.81 ± 0.74	1.79 ± 0.88	0.002*	Pc1: 0.000*; Pc2: 0.437; Pc3: 0.549
Adopt concealing gestures	1.81 ± 0.94	2.03 ± 0.85	1.49 ± 0.61	1.71 ± 0.68	0.004*	Pc1: 0.246; Pc2: 0.096; Pc3: 0.646
Avoid communal changing	1.84 ± 1.29	1.36 ± 1.24	1.22 ± 0.7	1.15 ± 1.06	0.717	Pc1: 0.079; Pc2: 0.027*; Pc3: 0.023*
Distressed in supermarkets/ department	1.23 ± 0.88	1.48 ± 0.97	1.05 ± 0.81	1.11 ± 0.87	0.141	Pc1: 0.216; Pc2: 0.408; Pc3: 0.607
Avoid undressing with partner	0.53 ± 0.51	0.68 ± 0.95	0.46 ± 0.65	0.34 ± 0.48	0.504	Pc1: 0.331; Pc2: 0.612; Pc3: 0.126
Distressed playing sport/ games	1.19 ± 0.83	1.31 ± 1.05	1.24 ± 0.95	1.14 ± 1.14	0.857	Pc1: 0.552; Pc2: 0.822; Pc3: 0.836
Distressed by clothing limitations	2.26 ± 1.03	1.75 ± 1.37	1.73 ± 1.22	1.89 ± 1.43	0.497	Pc1: 0.051; Pc2: 0.061; Pc3: 0.226
Distressed at social events	1.97 ± 1.08	1.91 ± 1.03	1.59 ± 0.86	1.57 ± 0.95	0.140	Pc1: 0.813; Pc2: 0.118; Pc3: 0.117
Feel normal	2.26 ± 1.09	2.41 ± 0.87	2.35 ± 0.82	2.26 ± 0.90	0.018*	Pc1: 0.447; Pc2: 0.697; Pc3: 0.979
Affects sex life	1.00 ± 0.89	0.89 ± 1.09	0.65 ± 0.86	0.46 ± 0.66	0.104	Pc1: 0.587; Pc2: 0.104; Pc3: 0.006**
Distressed at others remarks about appearance	1.94 ± 1.06	2.54 ± 1.16	1.84 ± 1.18	2.14 ± 0.88	0.115	Pc1: 0.015*; Pc2: 0.722; Pc3: 0.389
Avoid pubs/restaurants	1.10 ± 0.94	0.87 ± 0.69	0.81 ± 0.78	0.62 ± 0.60	0.165	Pc1: 0.185; Pc2: 0.173; Pc3: 0.017*

P1 values were calculated by repeat measure test of the OGS groups.
P2 values were calculated by Chi-square test or t-test of 2 groups (the OGS and control groups).
Pc1, *p* value of before OGS and the control group; Pc2, *p* value of 1 months after OGS and the control group; Pc3, *p* value of 9 months after OGS and the control group; * = *p* value < 0.05.
Abbreviations: DAS: Derriford Appearance Scale; OGS: orthognathic surgery; M: mean; SD: standard deviation.

pubs/restaurants. We used MANOVA to evaluate the 3 domains of DAS-24 in different time points.

A *p*-value of less than 0.05 was considered significant.

Results

Total 77 participants (male = 32.5%, mean age = 22.36 ± 7.97 years) were recruited in the OGS group, and the control group consisted of 32 age and gender matched healthy controls (male = 40.6%, mean age = 21.78 ± 6.69 years). Table 1a showed there was no significant difference in demographic data between the OGS group and the control group, except for the physical illness ($p = 0.026$) and education of mother ($p = 0.021$). We divided the OGS group and the control group into 4 subgroups by gender and all variables of collected demographic data had no significant difference between the 4 subgroups. Short-term and long-term satisfaction after OGS was high, one month after OGS (8.54 ± 1.79) and 9 months after OGS (8.70 ± 1.25). Table 1b showed the results of BFI before OGS. There was no significant difference between the OGS and control group. The only difference between the 4 subgroups was in the Extraversion ($p = 0.044$). The male OGS subgroup was more extroverted (mean ± SD = 19.50 ± 4.46) and the female OGS subgroup was more introverted (mean ± SD = 16.53 ± 4.13).

Table 2 showed that at baseline, several domains of DAS-24 had significantly differences between the OGS group and the control group, including distress at reflection ($p = 0.000$), irritable at home ($p = 0.007$), feel hurt ($p = 0.000$), self consciousness affects work ($p = 0.013$), self-conscious of appearance ($p = 0.001$), feel irritable ($p = 0.000$) and distressed at others remarks about appearance ($p = 0.015$). Many domains were improved significantly after OGS, including distress at reflection ($p = 0.018$), feel hurt ($p = 0.011$), self consciousness affects work ($p = 0.040$), self-conscious of appearance ($p = 0.001$), feel irritable ($p = 0.002$), adopt concealing gestures ($p = 0.004$), and feel normal ($p = 0.018$). Persistent improvement 9 month after OGS (Pc2 and Pc3 ≧ 0.05, indicating no significant difference between the control group and the OGS group 1 month and 9 month after OGS) was noted in distress at reflection, feel hurt, self consciousness affects work, self-conscious of appearance, feel irritable, adopt concealing gestures and feel normal. The improvement of adopt concealing gestures after OGS was even better than the control group, though non-significantly. The results of MANOVA showed that there were significant differences in the first domain (Wilks' Lambda = 3.651, $p < 0.001$) and the third domain (Wilks' Lambda = 3.075, $p = 0.001$), but not the second domain.

Tables 3 and 4 showed the results of PSQI, HADS and SF-36 before and after OGS. Before OGS, the OGS and control groups had no significant difference, except the habitual sleep efficiency of PSQI (Pc1 = 0.001). However, sleep latency

Table 3 Comparison of PSQI and HADS before OGS and after OGS with the control group.

	Control group (N = 32) (M ± SD)	OGS group			P1	P2
		Before OGS (N = 77) (M ± SD)	1 month after OGS (N = 77) (M ± SD)	9 months after OGS (N = 28) (M ± SD)		
PSQI-Subjective sleep quality	1.03 ± 0.72	1.04 ± 0.70	1.00 ± 0.68	1.19 ± 0.46	0.846	Pc1: 0.957; Pc2: 0.849; Pc3: 0.277
PSQI-Sleep latency	1.10 ± 0.70	1.21 ± 0.92	2.26 ± 0.92	1.25 ± 0.87	0.001*	Pc1: 0.495; Pc2: 0.001*; Pc3: 0.436
PSQI-Sleep duration	0.74 ± 0.45	0.63 ± 0.76	0.66 ± 0.97	0.92 ± 0.84	0.886	Pc1: 0.381; Pc2: 0.666; Pc3: 0.297
PSQI-Habitual sleep efficiency	0.17 ± 0.46	0.75 ± 1.27	0.53 ± 0.70	0.61 ± 0.84	0.368	Pc1: 0.001*; Pc2: 0.017*; Pc3: 0.009*
PSQI-Sleep disturbances	1.13 ± 0.50	0.91 ± 0.63	0.86 ± 0.60	1.11 ± 0.57	0.549	Pc1: 0.098; Pc2: 0.052; Pc3: 0.893
PSQI-Use of sleeping medication	0.00 ± 0.00	0.13 ± 0.56	0.11 ± 0.53	0.25 ± 0.73	0.135	Pc1: 0.060; Pc2: 0.211; Pc3: 0.051
PSQI-Daytime dysfunction	0.83 ± 0.39	0.61 ± 0.64	0.51 ± 0.56	0.74 ± 0.61	0.105	Pc1: 0.056; Pc2: 0.015*; Pc3: 0.528
Global PSQI Score	5.36 ± 1.90	5.35 ± 3.36	6.00 ± 3.01	6.03 ± 2.83	0.459	Pc1: 0.981; Pc2: 0.326; Pc3: 0.282
HADS-Depression	4.32 ± 1.49	4.18 ± 3.12	3.47 ± 2.61	4.47 ± 3.13	0.368	Pc1: 0.769; Pc2: 0.114; Pc3: 0.801
HADS -Anxiety	5.76 ± 2.35	5.89 ± 4.16	4.75 ± 4.03	5.22 ± 4.48	0.799	Pc1: 0.859; Pc2: 0.277; Pc3: 0.557

P1 values were calculated by repeat measure test of OGS groups.
P2 values were calculated by Chi-square test or t-test of 2 groups (the OGS and control groups).
Pc1, p value of before OGS and the control group; Pc2, p value of 1 months after OGS and the control group; Pc3, p value of 9 months after OGS and the control group; * = p value < 0.05.
Abbreviations: PSQI: Pittsburgh Sleep Quality Index; HADS: Hospital Anxiety and Depression Scale; OGS: orthognathic surgery; M: mean; SD: standard deviation.

Table 4 Comparison of SF-36 before OGS and after OGS with the control group.

	Control group (N = 32) (M ± SD)	OGS group			P1	P2
		Before OGS (N = 77) (M ± SD)	1 month after OGS (N = 77) (M ± SD)	9 months after OGS (N = 28) (M ± SD)		
Physical function	91.29 ± 15.91	94.64 ± 13.78	89.44 ± 12.46	93.75 ± 13.06	0.030*	Pc1: 0.287; Pc2: 0.597; Pc3: 0.490
Role limitations due to physical health	95.97 ± 11.36	90.71 ± 24.51	68.06 ± 39.46	82.64 ± 34.23	0.008*	Pc1: 0.144; Pc2: 0.001*; Pc3: 0.033*
Role limitations due to emotional problems	75.27 ± 35.45	84.76 ± 29.86	79.63 ± 34.07	82.41 ± 35.17	0.244	Pc1: 0.168; Pc2: 0.610; Pc3: 0.412
Energy/Fatigue	61.83 ± 15.62	63.84 ± 19.96	63.19 ± 19.50	58.61 ± 19.95	0.250	Pc1: 0.626; Pc2: 0.759; Pc3: 0.474
Mental health	67.87 ± 13.14	69.51 ± 19.40	68.89 ± 16.78	66.11 ± 18.92	0.408	Pc1: 0.674; Pc2: 0.787; Pc3: 0.669
Social functioning	86.29 ± 16.88	82.97 ± 21.43	77.43 ± 22.12	80.90 ± 22.85	0.021*	Pc1: 0.448; Pc2: 0.073; Pc3: 0.273
Body pain	89.92 ± 15.24	92.07 ± 12.52	84.86 ± 17.19	87.22 ± 16.31	0.227	Pc1: 0.461; Pc2: 0.210; Pc3: 0.489
General health	71.45 ± 16.08	70.29 ± 21.29	70.28 ± 20.28	68.19 ± 18.86	0.819	Pc1: 0.786; Pc2: 0.796; Pc3: 0.454

P1 values were calculated by repeat measure test of OGS groups.
P2 values were calculated by Chi-square test or t-test of 2 groups (the OGS and control groups).
Pc1, p value of before OGS and the control group; Pc2, p value of 1 months after OGS and the control group; Pc3, p value of 9 months after OGS and the control group; * = p value < 0.05.
Abbreviations: SF36: 36-Item Short Form Health Survey; OGS: orthognathic surgery; M: mean; SD: standard deviation.

(P1 = 0.001), physical function (P1 = 0.03), role limitations due to physical health (P1 = 0.008) and social functioning (P1 = 0.021) exacerbated after OGS. Sleep latency was improved 9 months after OGS (PC2 = 0.001, PC3 = 0.436), but role limitations due to physical health was still significantly worse than the control group (p = 0.033). Habitual sleep efficiency (p = 0.009) was not significantly changed after OGS, and daytime dysfunction 1 month after OGS was significantly better than the control group (p = 0.015).

Discussion

There are some limitations of this study. First, the sample size is not large. Second, we used questionnaires to evaluate the impact of OGS, and these were all subjective reports rather than objective measurements. No polysomnography (PSG) or actigraphy was used to evaluate sleep. However, to evaluate psychological aspects such as distress or mood, subjective measurements are still the best methods so far. Third, the results of PSQI and HADS of the OGS group were still within normal range, meaning the sleep and mental conditions of the patients were not too different from the controls. These questionnaires possibly are not sensitive enough to detect the differences between the 2 groups and the changes after OGS. Investigation of patients with psychiatric or sleep disorders can help to clarify the impact of OGS in different patient populations. Fourth, our study is not a randomized trial, but we included a healthy control group to increase the trustworthiness. Fifth, because this is a long-term clinical study,

the drop-out rate is high. We followed drop-out subjects through phone calls, but most of them didn't want to keep participating the study since their problem is fixed, and no further treatment or medication is needed. Last, we didn't analyze the differences between patients with Class II and III deformity and the correlation with sleep disorders such as OSA in this paper, which will be further analyzed in the future.

The satisfaction of our OGS patients was high, consistent with most previous studies [11,12,14–18]. Besides the satisfaction, in this study, we used several psychometric assessments and statistic methods to evaluate and analyze the short-term and long-term psychological impacts of OGS. At baseline, several domains of DAS-24 had significantly differences between the OGS group and the control group, and many were improved significantly after OGS. Persistent improvements 9 month after OGS were also noted. The results of the three domains of DAS-24 by MANOVA also revealed that the first and the third domains of DAS-24 were significantly improved, indicating self-reported improvement in subjective distress of appearance and decreased impact to daily living. Similar to our results, a systematic review article using MEDLINE and Web of Science showed that orthognathic patients experience benefits as a result of OGS. They had more self-confidence, better body and facial image, and social adjustment [10,11,19,20]. The improvement of adopt concealing gestures was even better than the control group in our study and could represent substantial improvement physically and mentally after OGS.

Another finding is the differences of personality of the OGS group. Males in the OGS group were more extroverted while females in the OGS groups were more introverted. Most previous studies focus on the positive impact of OGS on personality trait, but a previous research reported high percentage of personality disorder in their participants, 14 of 33 were suggestive to have borderline, compulsive, antisocial, or passive-aggressive disorders, although the study didn't aim at evaluating the prevalence [34]. Dentofacial deformities can impact patients' growth and development and their personality in adulthood can influence the outcome of OGS and future adjustment. The personality of patients with dentofacial abnormalities is worthy investigating, as well as the gender differences.

The sleep efficiency of the OGS group was significantly worse than the control group. After OGS, sleep latency exacerbated and then was improved 9 months after OGS. Interestingly, daytime dysfunction 1 month after OGS was significantly better than the control group. Craniofacial deformity is a risk factor for OSA, which has huge impact on sleep quality. Besides, postoperative pain can be the acute trigger for prolonged sleep latency. Sleep and pain could be highly correlated with postoperative satisfaction and surgical success [35] and appropriate pain and sleep management is suggested in OGS patients. The utility of OGS in the treatment of obstructive sleep apnea worths further exploring in future research. Objective measurements such as PSG and actigraphy can help us understand the actual impact of OGS on sleep and treat sleep comorbidities such as OSA.

Different from previous studies, our results of SF-36 indicated that after OGS, the quality of life of the OGS group didn't have improvement in either short-term or long-term follow-up. Physical function, role limitations due to physical health and social functioning even exacerbated after OGS. Only role limitations due to physical health was still significantly worse than the control group 9 months after the surgery. The major concern of patients receiving OGS is still the physical appearance, and relates more with the psychological domains of SF-36. Our findings of worsening of role limitations due to physical health can relate to longer recovery period from the surgery in some patients. Although there were consistent findings in the improvement of the distress of appearance after OGS, other psychosocial outcome such as mood and quality of life can be different. A previous longitudinal study also revealed different outcome trajectory classes, and 15% of the patients exhibited a chronic distress pattern [36]. Our findings pointed out the importance of psychosocial evaluation and intervention before and after OGS.

Conclusion

Our study replicated findings of previous studies, showing that patients could have less distress of appearance after OGS and less impact to their daily living. However, not all psychological aspects and quality of life were improved and even some deterioration in sleep and role-limitations-due-to-physical-health was noted after OGS. Proper psychosocial evaluation and intervention before and after OGS can be important in order to promote surgical success and outcome. Further investigation of risk factors for the unfavorable outcome is warranted.

Conflicts of interest

The authors declare that they have no competing interests.

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