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ORIGINAL ARTICLE

Orthognathic surgery in class II patients: a longitudinal study on quality of life, TMD, and psychological aspects

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Abstract

Objectives To evaluate, longitudinally, the impacts of orthognathic surgery in patients with skeletal class II malocclusion on oral health-related quality of life (OHRQoL), temporomandibular disorders (TMD) and psychological symptoms.

Materials and methods Forty-three patients with skeletal class II malocclusion who were submitted to orthognathic surgery were evaluated during their preoperative and postoperative periods. They answered the short version of the Oral Health Impact Profile (OHIP-14) and were also diagnosed according to Axes I and II of the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD). The evolution of OHRQoL and TMD before and after surgery was verified, and the relationships among these variables were found through statistical analysis using Wilcoxon, McNemar, chi-square, and Mann-Whitney tests, with a 5% significance level.

Results The median of the overall OHIP-14 score and five domains decreased after orthognathic surgery ($p < 0.05$), the functional limitation domain increased ($p = 0.014$), and the physical disability domain did not show an association ($p = 0.133$). There were improvements in articular pain ($p = 0.016$), chronic pain ($p = 0.019$), and nonspecific physical symptoms excluding pain ($p = 0.013$). In addition, an association was found between poorer OHRQoL (overall scale and domains) and the Axis II variables of the RDC/TMD ($p < 0.05$).

Conclusion Orthognathic surgery improved perceived OHRQoL, articular pain, and chronic pain. The conditions of Axis II of the RDC/TMD interfered with OHRQoL postoperatively.

Clinical relevance Although orthognathic surgery improves QoL and some TMD conditions in skeletal class II patients, poorer postoperative outcomes are observed when psychological conditions are present.

Keywords Quality of life · Temporomandibular joint disorders · Orthognathic surgery · Retrognathia

Introduction

Skeletal malocclusion has important negative social impacts because of its association with functional limitations and poor esthetic appearance [1–3]. A well-established treatment method to correct moderate and severe skeletal malocclusion is to combine orthodontic therapy and orthognathic surgery [4, 5]. The treatment's objective is to align and correct the jaw's position, to improve function and facial esthetics, thus leading to psychological and social improvements for the patients [6, 7].

Skeletal class II malocclusion is characterized by the mandible being in a posterior position in relation to the maxilla due to mandibular retrognathism, in most cases, anteroposterior maxillary excess or both [8]. This condition has effects of varying intensity on masticatory function, orofacial pain and facial appearance, which can modify the quality of life (QoL) perceived by these individuals [5, 9, 10]. In general, patients with dentofacial deformities present poor QoL [6, 11], which can be improved by orthognathic surgery [2, 3, 6, 9, 11, 12]. However, temporomandibular disorders (TMD) and psychological factors have stronger influences on patients' QoL than the objective orthognathic outcomes do [1, 13]. It is already known that class II patients are more likely to present TMD

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[14, 15], but the influence of orthognathic surgery on these signs and symptoms is still widely debated and controversial among oral and maxillofacial surgeons [14, 16–19]. Although some studies have shown improvements to symptoms related to the temporomandibular joint (TMJ) in class II patients after mandibular advancement [14, 15, 19], there is no specific information about which types of TMD have improved.

Beyond TMD, depression and chronic pain may also affect the patient's perception of the orthognathic surgery. Individuals with dentofacial deformities have a higher prevalence of depression [1, 20], and depression is a major predictor of poorer QoL in this population [11]. In addition, a depressive state increases individuals' susceptibility in developing and maintaining pain [1]. Thus, the patients' psychological status directly interferes in the treatment outcomes.

To the best of our knowledge, no studies have evaluated the influences of TMD and psychological factors on OHRQoL after orthognathic surgery in a specific population of patients with skeletal class II malocclusion. Knowing that orthosurgical treatment of patients with skeletal class II malocclusion is challenging for oral and maxillofacial surgeons, the aim of this study was to evaluate, longitudinally, the impacts of orthognathic surgery on the OHRQoL, TMD and psychological symptoms in this group of patients.

Materials and methods

Ethical aspects

The study was approved by the research ethics committees of the two universities involved, under protocol numbers CAEE 69240817.7.0000.0093 and CAAE 69725317.5.0000.0102, and complies with the principles of the Declaration of Helsinki for studies involving human subjects. The patients who agreed to participate in this research were required to sign an informed consent form. This study followed the STROBE statement as a guide for observational studies (Supplementary Material).

Study design and sample

A prospective observational longitudinal study was conducted on patients with skeletal class II malocclusion who were submitted to orthognathic surgery. The sample of this study was selected from a population of 276 patients submitted to orthognathic surgery between June 2016 and June 2019 at the oral and maxillofacial surgery services of Federal University of Parana and Positivo University in Curitiba, Brazil. The individuals included in the study were adult patients (≥ 18 years old) of both sexes who were not syndromic and had skeletal class II malocclusion (ANB angle > 5°). The exclusion criteria were patients who had been submitted to previous orthognathic or TMJ surgery, those who had facial deformities due to trauma or cleft lip and palate, and patients whose questionnaires were improperly filled or those who failed to appear for their postoperative control sessions. Following the inclusion and exclusion criteria, 43 individuals were selected for this study (Fig. 1).

All of the patients were prepared orthodontically before the surgery. They were submitted to the surgery with an orthodontic appliance and finished the treatment postoperatively, according to their needs. The mono- or bimaxillary orthognathic surgeries were performed using the same classic techniques as described in literature: sagittal split Ramus osteotomy [21], Le Fort I osteotomy [22], and, in cases of genioplasty, horizontal osteotomy of the chin was performed [23].

The patients' OHRQoL and TMD were evaluated 1 week before the orthognathic surgery and between 6 months and 1 year postoperatively. The mean follow-up time was 9 months (6–12), with 23 patients evaluated 6 months after surgery and 20 patients at 1-year follow-up.

Evaluation of perceived OHRQoL

The self-applied short version of *The Oral Health Impact Profile* (OHIP-14) was selected to assess the patients' perception of OHRQoL [24]. This questionnaire consists of 14 questions, with specific predetermined weights attributed to each response. The response options are never (0), rarely (1), sometimes (2), often (3), and always (4). These 14 questions are grouped into seven domains: functional limitation (D1), physical pain (D2), psychological discomfort (D3), physical disability (D4), psychological disability (D5), social disability (D6), and handicap (D7). Each domain is evaluated by two questions. The total points for the two corresponding answers provide the score for each domain, which can range from 0 to 8. The final score is calculated as the sum of all domains' scores and can vary from 0 to 56. Higher scores indicate poorer OHRQoL.

Evaluation of the RDC/TMD variables

The examiners—one in each institution, trained by the same senior surgeon—assessed all of the individuals using the *Research Diagnostic Criteria for Temporomandibular Disorders* (RDC/TMD) [25]. This tool presents two axes, related to TMJ physical signs and symptoms (Axis I) and to psychological aspects (Axis II). According to Axis I (clinical examination), it is possible to diagnose individuals with three groups of disorders: Group I (myofascial pain), Group II (articular disc displacements), and Group III (arthralgia, osteoarthritis, and osteoarthrosis). For the myofascial pain diagnosis, the patients should have referred to spontaneous pain in

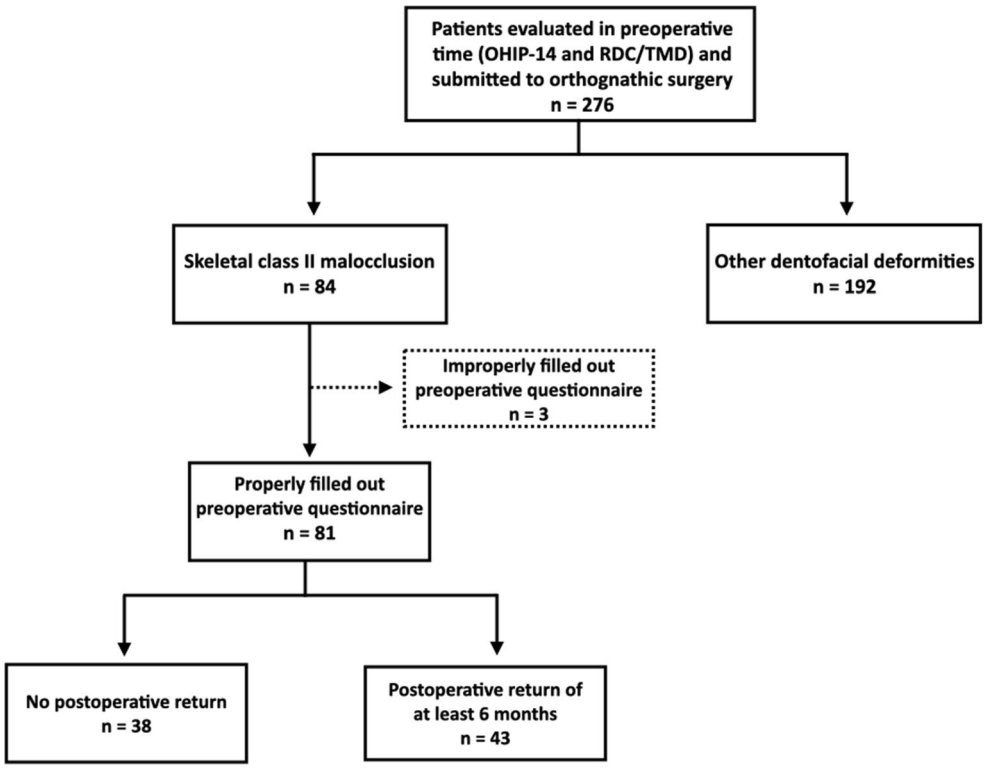

Fig. 1 Flowchart demonstrating the selection of the study sample

their facial muscles, in association with three points of positive palpation and/or mouth opening < 40 mm. For Group II, disc displacement with reduction was diagnosed when there was clicking and disc displacement without reduction, when there were limitations to mouth opening (< 35 mm), deviation in mouth opening, and crepitation. However, for statistical analysis, this variable was dichotomized as the presence or absence of disc displacement, without considering the side and if there was reduction. Thus, Groups I and II of RDC/TMD were considered the presence or absence of some diagnosis, without considering subdiagnoses. Concerning Group III, TMJ was again evaluated and classified as no alterations; arthralgia, when there was reported and palpable pain without crepitation; arthritis, when there were pain and crepitation; or osteoarthrosis, when there was crepitation without pain. For statistical analysis, we dichotomized this variable by the presence or absence of pain in the TMJ, thus grouping the diagnoses of arthralgia and osteoarthritis versus diagnoses of no alterations and osteoarthrosis. Maximum mouth opening was also evaluated before and after the operation. To do so, the patients were instructed to open their mouth to the maximum, even with pain. Thereafter, the distance between the upper central incisor's incisal edge and the lower incisor's incisal edge was measured in millimeters using a digital pachymeter.

Axis II was measured by a questionnaire with 31 self-completed questions, with which the individuals could be diagnosed as having or not having chronic pain, depression, nonspecific physical symptoms including pain (NSPSIP), and nonspecific physical symptoms excluding pain (NSPSEP). Depression, NSPSIP, and NSPSEP could be classified in three degrees: normal, moderate, and severe. In this study, we dichotomized these variables as having (including moderate and severe) or not having (normal) these conditions. Moreover, chronic pain was also evaluated as having or not this diagnosis.

Statistical analysis

The results were submitted to descriptive and inferential analysis. The numeric variables of the OHIP-14 were submitted to Shapiro–Wilk test, which demonstrated a non-normal distribution. The reliability of the OHIP-14 questionnaire was estimated using the Cronbach's alpha test. The OHIP-14 variables were compared between periods using the Wilcoxon test for paired samples. McNemar and Wilcoxon tests were respectively used to analyze the RDC/TMD variables and maximum mouth opening over time. Moreover, chi-square and Mann-Whitney tests were used to compare the OHIP-14 with RDC/TMD variables during the postoperative period. Missing data were not considered in the statistical analysis. Values of $p < 0.05$ were considered to be statistically significant. The data were analyzed using SPSS version 24.0 (*IBM Corporation, Armonk, NY, USA*).

Results

The sample comprised 43 individuals with skeletal class II malocclusion, of whom 33 (76.7%) were female and 10 (23.3%) were male. Their age ranged from 18 to 66 years, with a median age of 31 years old. The mean ANB angle of our sample was 6.21° (± 3.4°). The mean follow-up time was 9 months (6–12). The OHIP-14 demonstrated reliability (Cronbach's $\alpha = 0.85$).

Table 1 shows a significant decrease between the pre- and postoperative periods in overall OHIP-14 and in domains related to physical pain (D2), psychological discomfort (D3), psychological disability (D5), social disability (D6), and handicap (D7) ($p < 0.05$). The functional limitation domain (D1) increased during the postoperative period ($p = 0.014$). Moreover, the physical disability domain (D4) did not change significantly over time (Table 1).

Concerning TMD, articular pain in individuals with skeletal class II malocclusion improved after orthognathic surgery ($p = 0.016$). The preoperative median mouth opening was 48 mm (29–64 mm), while the postoperative median was 41 mm (26–58 mm) ($p = 0.001$). Regarding Axis II of the RDC/TMD, chronic pain and NSPSEP also improved at the postoperative period compared to the initial evaluation ($p < 0.05$). There was no association between the other variables of the RDC/TMD (Table 2).

Axis II of RDC/TMD influenced OHRQoL in the postoperative period. Table 3 shows that none of the groups of TMD diagnoses (Axis I) had an influence on overall OHIP-14 scores. However, the OHIP-14 was high in patients who presented chronic pain ($p < 0.001$), depression ($p < 0.001$), and NSPSIP ($p = 0.025$).

Regarding the OHIP-14's domains, we also did not find an association with any domain of Axis I of the RDC/TMD ($p > 0.05$), but we found associations with variables of Axis II (Table 4). Chronic pain had negative influence in domains 2, 3, 4, and 5 ($p < 0.05$). Depression presented an association with all of the OHIP-14's domains, showing its importance for perceived OHRQoL. Nonspecific physical symptoms also influenced OHIP-14 domains, with NSPSIP being associated with domains 2, 3, 4, 6, and 7 and NSPSEP being associated with domain 6 ($p < 0.05$).

Table 1 Comparison of OHIP-14 and its domains at the pre- and postoperative periods

	Preoperative Median (Min–Max)	Postoperative Median (Min–Max)	*p value*
Overall OHIP-14	18 (0–48)	10 (0–33)	**< 0.001**
Functional limitation (d1)	1 (0–6)	2 (0–5)	**0.014**
Physical pain (d2)	4 (0–8)	2 (0–6)	**0.007**
Psychological discomfort (D3)	4 (0–8)	3 (0–3)	**< 0.001**
Physical disability (D4)	2 (0–6)	1 (0–5)	0.133
Psychological disability (D5)	3 (0–8)	1 (0–4)	**< 0.001**
Social disability (D6)	3 (0–8)	2 (0–6)	**0.004**
Handicap (D7)	1 (0–6)	0 (0–4)	**0.004**

Wilcoxon test for paired samples was conducted, with a significance level of 0.05. The statistically *significant values* are in *bold*

Discussion

Despite it being well established that orthognathic surgery improves OHRQoL [2, 3, 9, 11, 12], surgeons remain worried about treating skeletal class II patients. These patients have the highest rates of functional problems, beyond pain complaints in the orofacial region. History of chronic pain, depression, and TMD is also more common in this group of patients when compared to patients with other skeletal malocclusions [14, 15]. They have, in general, many complaints and high expectations regarding orthosurgical treatment. All of these factors make treating these patients a challenge because even with functional and esthetic improvements, not all of the patients feel satisfied in the postoperative period. To consider treatment to be successful, it is necessary to be aware of the patients' expectations and perception of their QoL. Thus, the present study evaluated this specific sample of patients to better understand their improvements and the risks related to their OHRQoL after surgery.

Our results demonstrated that skeletal class II patients, in general, have significantly improved perception about their OHRQoL after surgery. Most domains presented improvement (physical pain, psychological discomfort, psychological disability, social disability, and handicap). Thus, we can affirm that all of the domains involving social and psychological factors improved. A contrasting factor is that the functional limitation domain worsened in the postoperative period, and the physical disability domain did not improve. Other studies [26, 27] have also found that patients who were submitted to orthognathic surgery have more improvement in psychological than in functional domains. Baherimoghaddam et al. (2016) showed that the psychological discomfort, social disability, and handicap domains improved among class II patients at 6 months postoperative. However, physical disability and functional limitation improved just 12 months after surgery [9]. In our study, the postoperative evaluation occurred 9 months postoperative, on average. The results related to the functional limitation and physical disability domains are probably justified by the decrease in maximum mouth opening and the possible occurrence of neurosensorial dysfunction in the postoperative period, mainly in the lower lip and chin, caused by injury of the inferior alveolar nerve. Although we have not evaluated this alteration, it has been reported as an occurrence

Table 2 Comparison between RDC/TMD scores at the pre- and postoperative periods

RDC/TMD		Preoperative *n* (%)	Postoperative *n* (%)	*p* value
Myofascial pain	No	32 (74.4)	37 (86)	0.267
	Yes	11 (25.6)	6 (14)	
Articular disc displacement	No	28 (66.7)	31 (73.8)	0.581
	Yes	14 (33.3)	11 (26.2)	
Articular pain	No	35 (81.4)	42 (97.7)	**0.016**
	Yes	8 (18.6)	1 (2.3)	
Chronic pain	No	22 (52.4)	34 (79.1)	**0.019**
	Yes	20 (47.6)	9 (20.9)	
Depression	No	24 (57.2)	31 (75.6)	0.092
	Yes	18 (42.8)	10 (24.3)	
NSPSIP	No	25 (59.5)	30 (73.1)	0.146
	Yes	17 (40.5)	11 (26.9)	
NSPSEP	No	23 (54.8)	32 (78)	**0.013**
	Yes	19 (45.2)	9 (22)	

McNemar test, with a significance level of 0.05. The statistically *significant values* are in *bold*

of neurosensory disturbance in 36.7% of patients at 6 months postoperative and 23.8% of patients at 1-year follow-up [28].

Some studies have investigated TMD in patients who were submitted to orthognathic surgery [14–19, 29–32], but the majority have not considered the type of dentofacial deformity [14, 17, 31]. Considering only class II patients, there are few and controversial studies about TMD after surgery [15, 16, 19, 30]. TMD encompasses a wide range of changes, and it is important to verify which of them specifically improve. The only improvement in our study was to articular pain, reducing from 18.6% in the preoperative period to 2.3% in the postoperative period. This result disagrees with another study [15], which showed that patients with TMJ pain had this symptom increased after surgery and that none of the patients with presurgical TMJ pain had pain relief postsurgery. However, the sample of that study comprised patients with disc displacements proved by magnetic resonance and with a higher prevalence of painful symptomology. Thus, it was a very different sample from ours, in terms of symptoms.

Another important topic of the present study is that we consider the second axis of the RDC/TMD. This axis was specifically designed for thorough psychosocial assessment and allows evaluation of the severity of chronic pain and the levels of depression and somatization in TMD patients. These conditions are part of the biopsychosocial model for pain [33]. Our results demonstrated improvements after surgery of chronic pain and nonspecific physical symptoms excluding pain. In addition, we verified that these conditions were very important to OHRQoL in the postoperative period, while the specific TMD diagnoses were not. Individuals with chronic pain, depression, and NSPSIP in the postoperative period presented poorer OHRQoL than those without these conditions.

Besides this, when associating the diagnoses of Axis II of the RDC/TMD with the seven domains of OHIP-14, significant relations were found in all of the domains. Depression had the highest impact on OHRQoL because it had negative associations with all of the domains and with the overall scale. Moreover, chronic pain had a negative influence on domains related to physical pain, psychological discomfort, physical disability, and psychological disability, showing its important repercussions on QoL. In addition, nonspecific physical symptoms also influenced OHIP-14 domains, mainly the symptoms including pain, which were negatively associated with physical pain, psychological discomfort, physical disability, social disability, and handicap.

Our study has some limitations, like the sample size and the loss of follow-up in the postoperative period. Importantly, however, among the 276 patients who were submitted to orthognathic surgery, 61.9% presented skeletal class III malocclusion, and only 30.4% presented class II. Of the 84 class II patients, 38 did not attend the follow-up sessions at 6 months

Table 3 Association between overall OHIP-14 and RDC/TMD variables postoperatively

RDC/TMD		Overall OHIP-14 Med (min-max)	*p* value
Myofascial pain	No	10 (0–33)	0.798
	Yes	12 (0–33)	
Disc displacement	No	10 (0–33)	0.417
	Yes	10 (0–33)	
Articular pain	No	10 (0–33)	0.869
	Yes	9.5 (6–33)	
Chronic pain	No	9 (0–26)	**< 0.001**
	Yes	23 (10–33)	
Depression	No	9 (0–26)	**< 0.001**
	Yes	19.5 (10–33)	
NSPSIP	No	9 (0–26)	**0.025**
	Yes	16 (0–33)	
NSPSEP	No	10 (0–26)	0.091
	Yes	19 (0–33)	

Chi-square test, with a significance level of 0.05. The statistically *significant values* are in *bold*

Table 4 Association between OHIP-14 domains and Axis II variables of the RDC/TMD postoperatively

RDC/TMD		D1 Med (min–max)	*p* value	D2 Med (min–max)	*p* value	D3 Med (min–max)	*p* value	D4 Med (min–max)	*p* value	D5 Med (min–max)	*p* value	D6 Med (min–max)	*p* value	D7 Med (min–max)	*p* value
Chronic pain	No	1 (0–3)	0.057	2 (0–5)	**0.001**	2 (0–6)	**<0.001**	1 (0–4)	**0.004**	1 (0–4)	**0.001**	1.5 (0–6)	0.061	0 (0–3)	0.075
	Yes	2 (0–6)		4 (0–6)		5 (3–6)		3 (0–5)		3 (1–4)		2 (0–5)		1 (0–4)	
Depression	No	1 (0–2)	**0.006**	2 (0–4)	**<0.001**	2 (0–6)	**<0.001**	1 (0–4)	**0.009**	1 (0–4)	**0.002**	1 (0–6)	**0.020**	0 (0–3)	**0.033**
	Yes	2 (0–6)		4 (2–6)		4.5 (3–6)		2.5 (0–5)		3 (0–4)		3 (0–5)		1 (0–4)	
NSPSIP	No	1 (0–3)	0.193	2 (0–5)	**0.075**	2 (0–6)	**0.046**	1 (0–4)	**0.018**	1.5 (0–3)	0.391	1 (0–6)	**0.009**	0 (0–3)	**0.046**
	Yes	1 (0–6)		3 (0–6)		4 (0–6)		2 (0–5)		2 (0–4)		3 (0–5)		1 (0–4)	
NSPSEP	No	1 (0–3)	0.306	2 (0–5)	0.120	2 (0–6)	0.91	1 (0–4)	0.078	2 (0–4)	0.507	1 (0–6)	**0.024**	0 (0–3)	0.155
	Yes	1.5 (0–6)		3.5 (0–6)		4.5 (0–6)		2.5 (0–5)		1.5 (0–4)		3 (0–5)		0.5 (0–4)	

Mann-Whitney test, with a significance level of 0.05. The statistically *significant values* are in *bold*

or more. This number of losses at follow-up was probably because the services involved in this research are a reference for the Brazilian public health system's treatment of dentofacial deformities for the entire state of Parana. More than 60% of the patients did not live in the capital city. Thus, for a longitudinal study composed exclusively of patients with skeletal class II malocclusion who are assisted by public services, the sample of 43 patients is considered satisfactory and is larger than the samples found in other studies evaluating TMD and/or QoL [5–7, 9, 18]. Because we used convenience sampling, no sample size calculation was performed because we evaluated all of the patients who attended both services in a predetermined time period. Although patients' age (18–66 years) had a wide range in our sample, we do not believe that it has affected our results because the median age was 31 years, with few patients being at the extremes of the inclusion age and just two being older than 60 years. Besides, skeletal class II patients of all ages may suffer from TMD and low quality of life, which must be investigated and treated.

Another limitation was in the tools used to evaluate QoL and the diagnostic criteria for TMD. We did not use the Orthognathic Quality of Life Questionnaire (OQLQ) [34], which is a specific questionnaire about QoL for patients who have been submitted to orthognathic surgery, which could bring more results to complement the OHIP-14's findings. Thus, we suggest future studies using this questionnaire. In addition, the DC/TMD [35] was validated in Portuguese only in 2020, yet we used the RDC/TMD. Additionally, we dichotomized and grouped some parameters of Axis I because of the number of subjects in this research. Thus, we could not study subdiagnoses of TMD, which may have caused a loss of specific information.

Finally, even though it is well established that orthognathic surgery improves OHRQoL, our study brings new findings. We found that, at a mean postoperative time of 9 months, class II patients did not present improvements in functional domains related to OHRQoL. We also found that although their articular pain, chronic pain, and NSPSEP improved after surgery, the psychosocial axis still impaired their postoperative OHRQoL. Therefore, it is necessary to give more attention to chronic pain, depression, and somatic symptoms. While orthognathic surgery provides many benefits, the treatment for these patients should be multifactorial, which requires providers to be aware of the patients' full context, addressing not only the physical aspects but also the psychological changes brought about dentofacial deformity throughout their lives.

Conclusion

In the present study, it was possible to observe that orthognathic surgery improved OHRQoL in patients with

skeletal class II malocclusion. Moreover, this intervention seemed to have beneficial effects on articular pain, chronic pain, and NSPSEP. Finally, the presence of chronic pain, depression, and nonspecific physical symptoms negatively impacted perceived OHRQoL at the postoperative period. Thus, oral and maxillofacial surgeons should consider all of these factors when planning and executing orthosurgical treatment in patients with this type of skeletal malocclusion.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s00784-020-03709-3.

Compliance with ethical standards

Conflict of interest Author Isabela Polesi Bergamaschi declares that she has no conflict of interest. Author Rafael Correia Cavalcante declares that he has no conflict of interest. Author Marina Fanderuff declares that she has no conflict of interest. Author Maria Fernanda Pivetta Petinati declares that she has no conflict of interest. Author Delson João da Costa declares that he has no conflict of interest. Author Rafaela Scariot declares that she has no conflict of interest.

Ethics approval This study was performed in line with the principles of Declaration of Helsinki. Approval was granted by the Ethics in Research Committee of Positivo University (No. CAEE 69240817.7.0000.0093) and Federal University of Paraná (No. CAEE 69725317.5.0000.0102).

Consent to participate Informed consent was obtained from all individual participants included in the study.

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