Condition-specific Quality of Life Assessment at Each Stage of Class III Surgical Orthodontic Treatment
—A Prospective Study—

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Abstract

Surgical orthodontic treatment has been reported to improve oral health-related quality of life (OHRQL). Such treatment comprises three stages: pre-surgical orthodontic treatment; orthognathic surgery; and post-surgical orthodontic treatment. Most studies have focused on change in OHRQL between before and after surgery. However, it is also necessary to evaluate OHRQL at the pre-surgical orthodontic treatment stage, as it may be negatively affected by dental decompensation compared with at pre-treatment. The purpose of this prospective study was to investigate the influence of surgical orthodontic treatment on QOL by assessing change in condition-specific QOL at each stage of treatment in skeletal class III cases. Twenty skeletal class III patients requiring surgical orthodontic treatment were enrolled in the study. Each patient completed the Orthognathic Quality of Life Questionnaire (OQLQ), which was developed for patients with dentofacial deformity. Its items are grouped into 4 domains: “social aspects of dentofacial deformity”; “facial esthetics”; “oral function”; and “awareness of dentofacial esthetics”. The questionnaire was completed at the pre-treatment, pre-surgical orthodontic treatment, and post-surgical orthodontic treatment stages. The results revealed a significant worsening in scores between at pre-treatment and pre-surgical orthodontic treatment in the domains of facial esthetics and oral function (p<0.01), and between at pre-surgical orthodontic and post-surgical orthodontic treatment in all domains except awareness of dentofacial esthetics (p<0.05, p<0.01). A significant correlation was observed between a negative change in overjet and worsening OQLQ scores at the pre-surgical orthodontic treatment stage. Significant correlations were also observed between improvement in upper and lower lip difference, soft tissue pogonion protrusion, and ANB angle and improvement in OQLQ scores at the post-surgical orthodontic treatment stage. These results indicate that morphologic change influences OHRQL in patients undergoing surgical orthodontic treatment not only after surgery, but also during pre-surgical orthodontic treatment.
Introduction

The concept of quality of life (QOL) was first introduced in 1946 as part of the definition of health in the World Health Organization Constitution. According to this definition, health is a state of complete physical, mental, and social well-being; not merely the absence of disease or infirmity. The concept of QOL consequently developed within this initial definition of health. When QOL can be improved by medical treatment, it is further defined as “health-related QOL” (HRQOL). In recent years, QOL has been used to evaluate patient perspective in the form of subjective awareness, with a particular focus on patient-reported outcomes (PRO). It has been noted that subjective problems such as pain and those related to social or mental function tend to be underestimated. It is important for the medical professional to be able to obtain an objective assessment of all health-related problems in treating patients, however, not just medical outcomes.

The goal of surgical orthodontic treatment is to improve dentofacial deformity, masticatory function, and psychological well-being. Advances in the technology available to achieve this have meant increased ability to accurately diagnose and therefore plan such treatment, with a concomitant improvement in outcomes. While morphological improvement and treatment safety have been well studied, however, the impact of surgical orthodontic treatment on oral health-related QOL (OHRQL) in patients with dentofacial deformity has only recently started to draw attention.

Quality of life is commonly treated as one aspect of PRO in patients with dentofacial deformity. The Short-Form 36-item (SF-36), Sickness Impact Profile, Nottingham Health Profile, and World Health Organization QOL are widely used to measure HRQOL in patients with a range of illnesses, as well as in healthy patients and control subjects. They are also used in combination with other measures of QOL. A number of instruments have also been developed specifically to measure OHRQL, including the Oral Health Impact Profile (OHIP), the General Oral Health Assessment Index, and Subjective Oral Health Status Indicator. There is also the Orthognathic Quality of Life Questionnaire (OQLQ), which was developed by Cunningham et al. to evaluate QOL in patients with dentofacial deformity undergoing surgical orthodontic treatment. Surgical orthodontic treatment has been reported to improve OHRQL in patients with dentofacial deformity. This treatment comprises 3 stages: pre-surgical orthodontic treatment; orthognathic surgery; and post-surgical orthodontic treatment. Many longitudinal studies have focused solely on change in QOL between before and after orthognathic surgery. However, patient QOL needs to be evaluated over the entire period of treatment, as change in QOL can be expected to take place at each stage: the patient will likely have expectations and anxiety regarding orthognathic surgery and the esthetic and functional deterioration that is likely to follow dental decompensation; they will also be concerned about how such surgery will improve facial appearance and function and the stress of undergoing orthodontic treatment.

The purpose of this prospective study was to investigate the influence of surgical orthodontic treatment on QOL in patients with skeletal mandibular prognathism throughout the treatment period.
Materials and Methods

1. Study participants

The study protocol was approved by the Tokyo Dental College Ethics Committee (Approval No.590). The participants were recruited from among patients with skeletal mandibular prognathism requiring surgical orthodontic treatment at the Tokyo Dental College Chiba Hospital. To be eligible for inclusion in the study, the patient had to be scheduled to undergo pre- and post-surgical orthodontic treatment. Orthognathic surgery comprised either sagittal split ramus osteotomy (SSRO; 1-jaw surgery) or SSRO in combination with Le Fort 1 osteotomy (2-jaw surgery). All the patients included were in good general health and aged between 15 and 40 yr. The main exclusion criteria comprised a congenital abnormality such as craniofacial syndrome or cleft lip/palate or a history of mental and/or physical disorders. Patients were also excluded if they had significant active caries, periodontal disease, trauma, impacted teeth (except the third molars), or more than three missing adjacent teeth. The participants were informed of the examination procedures and assured confidentiality of information. It was explained that agreeing or refusing to take part in the study would have no bearing on the treatment provided. Only patients who signed a consent form were included in the study.

2. Procedures

A total of 22 patients were enrolled in this prospective study. All were requested to complete a condition-specific questionnaire. The data were collected at 3 time points: at pre-treatment (before setting of any appliances; baseline; T0); pre-surgical orthodontic treatment (at least 4 months after setting of multi-bracket appliance; T1); and post-surgical orthodontic treatment (at least 3 months after orthognathic surgery; T2). All patients received pre- and post-surgical orthodontic treatment using an edgewise appliance (.022-inch slot brackets) and underwent more than 6 months of pre- and post-surgical orthodontic treatment. A diagnosis was made for each patient and the necessity of extraction for pre-surgical orthodontic treatment determined. Orthodontic treatment was carried out by 8 orthodontists (6 of whom were board-certified specialists), each with over 6 years of clinical experience. All surgical procedures were performed by oral surgeons at the Department of Oral and Maxillofacial Surgery at Tokyo Dental College. All patients underwent surgical correction of the maxilla by Le Fort 1 osteotomy and/or mandibular correction by SSRO with semi-rigid fixation; all required more than 14 days of postoperative hospital treatment. Post-surgical stabilization with intermaxillary elastics was performed during a period of 1 month or more of healing.

All treatment was planned based on predictions made using lateral and frontal cephalograms and only initiated after obtaining informed consent.

Lateral cephalograms were obtained at pre-treatment (baseline; T0), at 1 month before orthognathic surgery (T1), and at 6 months after orthognathic surgery (T2). The items measured comprised overjet, antero-posterior difference in the upper and lower lip, soft tis-
sue pogonion protrusion, and ANB angle (Fig. 1)\textsuperscript{26,34}.

3. Questionnaire

Table 1 shows the OQLQ. It consists of 22 statements, and the respondent is required to grade their response to each one based on a 4-point scale depending on how much the issue covered by each statement bothers them: “1” indicates “bothers you a little” and “4” means “bothers you a lot”, with “2” and “3” representing somewhere in between, while N/A indicates “the statement does not apply to you or does not bother you at all”. Thus, a lower score indicates a higher QOL, and a lower score a poorer one. These 22 items are categorized into 4 domains: “social aspects of dentofacial deformity” (questions 15–22, yielding a total score of 0–32); “facial esthetics” (questions 1, 7, 10, 11, and 14, yielding a total of 0–20); “oral function” (questions 2–6, yielding a total score of 0–20); and “awareness of dentofacial esthetics” (questions 8, 9, 12, and 13, yielding a total score of 0–16). Summary scores for each domain were calculated by summing scores within domains. The OQLQ is a highly reliable index of QOL in patients with dentofacial deformity and has proven validity\textsuperscript{10}. It has, therefore, been widely used in studies of QOL in patients with dentofacial deformity\textsuperscript{2–4,9,18,24,28,38}.

| Table 1 Twenty-two statements in Orthognathic Quality of Life Questionnaire at each domain |
|---|
| (1) Social aspects of dentofacial deformity |
| 15. I try to cover my mouth when I meet people for the first time. |
| 16. I worry about meeting people for the first time. |
| 17. I worry that people will make hurtful comments about my appearance. |
| 18. I lack confidence when I am out socially. |
| 19. I do not like smiling when I meet people. |
| 20. I sometimes get depressed about my appearance. |
| 21. I sometimes think that people are staring at me. |
| 22. Comments about my appearance really upset me, even when I know people are only joking. |
| (2) Facial esthetics |
| 1. I am self-conscious about the appearance of my teeth. |
| 7. I don’t like seeing a side view of my face (profile). |
| 10. I dislike having my photograph taken. |
| 11. I dislike being seen on video. |
| 14. I am self-conscious about my facial appearance. |
| (3) Oral function |
| 2. I have problems biting. |
| 3. I have problems chewing. |
| 4. There are some foods I avoid eating because the way my teeth meet makes it difficult. |
| 5. I don’t like eating in public places. |
| 6. I get pains in my face or jaw. |
| (4) Awareness of dentofacial esthetics |
| 8. I spend a lot of time studying my face in the mirror. |
| 9. I spend a lot of time studying my teeth in the mirror. |
| 12. I often stare at other people’s teeth. |
| 13. I often stare at other people’s faces. |
4. Statistical analysis

Sample size estimation was based on our preliminary investigation. This study was powered to detect an 8.3-point OQLQ score difference between T0 (baseline) and T2 surgical orthognathic treatment \((n = 18\) would have an 80% power at a standard deviation of 13 and \(\alpha = 0.05\) for a two-sided test). Considering the potential number of dropouts, \(n = 20\) was thought to be necessary.

A Friedman analysis of variance was used to compare change in OQLQ scores and cephalometric measurements among T0, T1, and T2. The Wilcoxon signed-rank test was used to determine significant differences in QOL and change in cephalometric measurements between T0 and T1, T1 and T2, and T0 and T2. The Bonferroni adjustment was used for \(p\) values to control type I errors. Levels of significance were set at \(p < 0.05\) and \(p < 0.01\); a \(p\) value of \(< 0.001\) was taken to indicate a high level of significance. Correlations between change in OQLQ scores and cephalometric measurements were quantified by using the Spearman rank correlation. Moreover, we also investigated the correlation between change in OQLQ scores and some factors which appeared to influence OQLQ scores: sex, age (under or over 20 yr), extraction or non-extraction for pre-surgical orthodontic treatment (with the exception of the third molars), and 1- or 2-jaw surgery. The software package SPSS ver. 19.0 (IBM, Armonk, New York) was used for the statistical analysis.

Results

A total of 22 patients were enrolled in the sample at baseline (T0). Two withdrawals occurred: one transferred to another hospital due to a change of residence, and the other discontinued treatment. The final data set, therefore, comprised data obtained from a total of 20 patients. The patient characteristics and treatment plans and terms are shown in Table 2.

| Table 2 Patient characteristics at baseline (T0) |
|-----------------------------------------------|
| Sex                                           |
| Male 10 (50%)                                 |
| Female 10 (50%)                               |
| Age (y)                                        |
| Mean 23.2 ± 7.3                                |
| Range 15–39                                    |
| Treatment                                     |
| Treatment term                                |
| Pre-surgical orthodontic treatment (month)     |
| Mean ± SD 15.2 ± 5.2                           |
| Range 8–24                                     |
| Post-surgical orthodontic treatment (month)    |
| Mean ± SD 10.0 ± 2.3                           |
| Range 6–14                                     |
| Extraction teeth                              |
| 14, 24 7 (35%)                                |
| Other 2 (10%)                                  |
| Non-extraction                                |
| 11 (55%)                                      |
| Surgery                                       |
| SSRO (sagittal split ramus osteotomy) 9 (45%)  |
| Le Fort I + SSRO 11 (55%)                     |

1. Change in OQLQ score at each stage by domain

1) Social aspects of dentofacial deformity

No significant difference was observed in OQLQ scores for social aspects of dentofacial deformity, despite a tendency for these scores to increase between baseline (T0) and T1. Scores decreased significantly between T1 and T2, and between baseline (T0) and T2 (Fig. 2a).

2) Facial esthetics

The OQLQ scores for facial esthetics showed a significant increase between baseline (T0) and T1. Furthermore, a significant decrease in scores was also observed between T1 and T2, and between baseline (T0) and T2 (Fig. 2b).

3) Oral function

As with “facial esthetics”, the OQLQ scores for oral function showed a significant increase between baseline (T0) and T1, followed by a
significant decrease between T1 and T2, and between baseline (T0) and T2 (Fig. 2c).

4) Awareness of dentofacial esthetics

The scores showed almost no change for any of the questions in this domain. Unlike with other categories, however, the scores did show a slight increase between baseline (T0) and T2 (Fig. 2d).

2. Morphological change (cephalometric measurements) at each stage of treatment

The mean change in overjet was $-4.3 \pm 3.9$ mm between baseline (T0) and T1, $10.6 \pm 5.1$ mm between T1 and T2, and $6.3 \pm 4.5$ mm between baseline (T0) and T2 (Table 3). The mean difference between the upper and lower lip difference was $1.8 \pm 1.6$ mm between baseline (T0) and T1, $-6.4 \pm 2.8$ mm between T1 and T2, and $-4.6 \pm 2.1$ mm between baseline (T0) and T2. A significant difference was observed in these items at all stages. The mean soft tissue pogonion protrusion was $0.0 \pm 1.0$ mm between baseline (T0) and T1, indicating no significant difference, but $-11.4 \pm 4.2$ mm between T1 and T2 and $-11.4 \pm 4.1$ mm between baseline (T0) and T2, indicating significant differences. The mean ANB angle was $0.6 \pm 0.9^\circ$ between baseline (T0) and T1, revealing no significant change, but $5.3 \pm 2.3^\circ$ between T1 and T2 and $5.9 \pm 2.1^\circ$ between baseline (T0) and T2, indicating significant changes.

3. Correlation between change in OQLQ scores and cephalometric measurements

Change in OQLQ scores, in particular, showed a moderately negative correlation
Table 3  Comparison of cephalometric measurements between baseline (T0) through T2

| Cephalometric measurements | Baseline (T0) | T1 | T2 | Baseline (T0)-T1 | T1-T2 | Baseline (T0)-T2 |
|----------------------------|---------------|----|----|------------------|--------|------------------|
| Mean | SD | Mean | SD | Mean | SD | p | Mean | SD | p | Mean | SD | p |
| Overjet (mm) | −3.7 | 4.4 | −8.0 | 5.0 | 2.6 | 0.7 | −4.3 | 3.9 | 0.000 *** | 10.6 | 5.1 | 0.000 *** |
| Upper and lower lip difference | 2.8 | 2.8 | 4.6 | 3.3 | −1.8 | 2.0 | 1.8 | 1.6 | 0.000 *** | −6.4 | 2.8 | 0.000 *** |
| Soft tissue pogonion protrusion (mm) | 7.1 | 4.2 | 7.1 | 4.2 | −4.3 | 4.4 | 0.0 | 1.0 | 0.913 | −11.4 | 4.2 | 0.000 *** |
| ANB angle (°) | −4.7 | 2.9 | −4.1 | 2.9 | 1.2 | 2.7 | 0.6 | 0.9 | 0.266 | 5.3 | 2.3 | 0.000 *** |

T1: Pre-surgical orthodontic treatment stage, T2: Post-surgical orthodontic treatment stage. Friedman analysis was used to assess variation in scores within domains; Wilcoxon signed rank test was used to assess differences between treatment stages. *** p<0.001: Statistically significant difference. Bonferroni adjustment was used for p values.

Table 4  Correlations between change in OQLQ scores and cephalometric measurements at each stage

| Cephalometric measurements | Social aspects of dentofacial deformity | Facial esthetics | Oral function | Awareness of dentofacial esthetics |
|----------------------------|----------------------------------------|-----------------|---------------|----------------------------------|
|                            | R  | p | R  | p | R  | p | R  | p |
| Baseline (T0)-T1           | –0.25 | NS | –0.56 | ** | –0.08 | NS | –0.31 | NS |
| Overjet                   | –0.02 | NS | –0.26 | NS | –0.27 | NS | –0.18 | NS |
| Upper and lower lip difference | 0.09 | NS | –0.02 | NS | –0.07 | NS | –0.03 | NS |
| Soft tissue pogonion protrusion | –0.15 | NS | 0.06 | NS | 0.27 | NS | –0.01 | NS |
| ANB angle                  | 0.41 | NS | 0.36 | NS | 0.35 | NS | 0.68 | ** |
| Upper and lower lip difference | 0.29 | NS | 0.48 | * | 0.17 | NS | 0.38 | NS |
| Soft tissue pogonion protrusion | –0.21 | NS | –0.30 | NS | –0.21 | NS | –0.47 | * |
| T1-T2                     | –0.26 | NS | –0.21 | NS | –0.31 | NS | –0.43 | NS |
| Overjet                   | 0.18 | NS | 0.24 | NS | –0.21 | NS | –0.16 | NS |
| Upper and lower lip difference | 0.15 | NS | 0.08 | NS | 0.26 | NS | –0.07 | NS |
| Soft tissue pogonion protrusion | –0.54 | NS | 0.43 | NS | 0.59 | ** | –0.07 | NS |
| ANB angle                  | 0.16 | NS | –0.25 | NS | –0.51 | * | 0.05 | NS |

Correlations between change in OQLQ scores and cephalometric measurements at each stage were quantified by using Spearman rank correlation. T0: Baseline, T1: Pre-surgical orthodontic treatment stage, T2: Post-surgical orthodontic treatment stage. NS: Not significantly different, * p<0.05, ** p<0.01: Statistically significant difference.

with overjet ($r = −0.56$) between baseline (T0) and T1 in the domain of facial esthetics (Table 4). Between T1 and T2, the OQLQ scores for awareness of dentofacial esthetics showed a positive or moderately negative correlation with change in upper and lower
lip difference \( (r = 0.68) \) and ANB angle \( (r = -0.47) \), while those for facial esthetics showed a moderately positive correlation with change in soft tissue pogonion protrusion \( (r = 0.48) \). Furthermore, the OQLQ scores for oral function showed a positive or moderately negative correlation with soft tissue pogonion protrusion \( (r = 0.59) \) and ANB angle \( (r = -0.51) \) between baseline (T0) and T2. In terms of sex-related differences, the OQLQ scores for social aspects of dentofacial deformity showed a moderately positive correlation with upper and lower lip difference \( (r = 0.65) \) and soft tissue pogonion protrusion \( (r = 0.67) \) between T1 and T2 in males (Table 5). In patients aged <20 yr, the OQLQ scores for social aspects of dentofacial deformity showed a strong positive correlation with soft tissue pogonion protrusion \( (r = 0.78) \) between T1 and T2 (Table 6). Extraction or non-extraction, and 1- or 2-jaw surgery showed no influence on change in OQLQ scores (Tables 7, 8).

**Discussion**

The results of the present study revealed that OHRQL changes over time depending on the stage of surgical orthodontic treatment. A significant worsening of OHRQL was observed in the domains of facial esthetics and oral function following pre-surgical orthodontic treatment \( (p<0.05) \). A similar trend was also observed in the remaining two domains. Meanwhile, in terms of morphological change, overjet showed a significant change in a negative direction as a result of dental decompensation during pre-surgical orthodontic treatment. Cappellozza et al. measured axes in the maxillary and mandibular anterior teeth in skeletal Class III patients who had undergone surgical orthodontic treatment and reported a mean lingual inclination of 2.5° in the maxillary teeth and a large labial inclination of 15.2° in the mandibular teeth. Some studies have revealed how standard pre-surgical orthodontic treatment in such patients can result in a consider-
Table 6  Correlations between change in OQLQ scores and cephalometric measurements at each stage in two different age groups

| Cephalometric measurements | Social aspects of dentofacial deformity | Facial esthetics | Oral function | Awareness of dentofacial esthetics |
|----------------------------|----------------------------------------|-----------------|---------------|-----------------------------------|
|                            | R  | p   | R  | p   | R  | p   | R  | p   | R  | p   | R  | p   |
| Baseline (T0)-T1           |    |     |    |     |    |     |    |     |    |     |    |     |
| Extraction                 | <20 yr old | ≥20 yr old | <20 yr old | ≥20 yr old | <20 yr old | ≥20 yr old | <20 yr old | ≥20 yr old | <20 yr old | ≥20 yr old | <20 yr old | ≥20 yr old |
| Overjet                    | -0.21 | NS | -0.27 | NS | -0.54 | ** | -0.55 | ** | 0.00 | NS | -0.10 | NS | -0.41 | NS | -0.43 | NS |
| Upper and lower lip difference | -0.08 | NS | -0.18 | NS | -0.39 | NS | -0.32 | NS | -0.09 | NS | -0.09 | NS | -0.15 | NS | -0.38 | NS |
| Soft tissue pogonion protrusion | 0.19 | NS | 0.07 | NS | -0.216 | NS | -0.02 | NS | -0.30 | NS | 0.00 | NS | -0.27 | NS | -0.27 | NS |
| ANB angle                  | -0.14 | NS | -0.11 | NS | 0.15 | NS | 0.15 | NS | 0.12 | NS | 0.22 | NS | -0.17 | NS | -0.05 | NS |
| T1-T2                      |    |     |    |     |    |     |    |     |    |     |    |     |
| Extraction                 | -0.58 | NS | -0.10 | NS | -0.28 | NS | -0.16 | NS | -0.36 | NS | -0.17 | NS | -0.49 | NS | -0.47 | NS |
| Upper and lower lip difference | 0.47 | NS | 0.50 | NS | 0.26 | NS | 0.33 | NS | 0.35 | NS | 0.19 | NS | 0.61 | ** | 0.62 | ** |
| Soft tissue pogonion protrusion | 0.78 | * | 0.35 | NS | 0.56 | * | 0.49 | * | 0.41 | NS | 0.24 | NS | 0.03 | NS | 0.46 | NS |
| ANB angle                  | -0.28 | NS | -0.29 | NS | -0.41 | NS | -0.23 | NS | -0.51 | NS | -0.46 | NS | -0.57 | * | -0.56 | * |
| Baseline (T0)-T2           |    |     |    |     |    |     |    |     |    |     |    |     |
| Overjet                    | 0.22 | NS | 0.28 | NS | 0.08 | NS | 0.16 | NS | -0.28 | NS | -0.45 | NS | -0.12 | NS | -0.13 | NS |
| Upper and lower lip difference | 0.20 | NS | 0.34 | NS | 0.12 | NS | 0.24 | NS | 0.32 | NS | 0.34 | NS | -0.36 | NS | -0.07 | NS |
| Soft tissue pogonion protrusion | -0.13 | NS | -0.08 | NS | 0.20 | NS | 0.44 | NS | 0.57 | * | 0.58 | * | -0.60 | NS | -0.06 | NS |
| ANB angle                  | 0.12 | NS | 0.21 | NS | -0.38 | NS | -0.52 | NS | -0.71 | NS | -0.61 | * | 0.52 | NS | 0.23 | NS |

<20 yr old (n=8), ≥20 yr old (n=12). Correlations between change in OQLQ score and cephalometric measurements at each stage were quantified by using Spearman rank correlation.

T0: Baseline, T1: Pre-surgical orthodontic treatment stage, T2: Post-surgical orthodontic treatment stage.

NS: Not significantly different, * p<0.05, ** p<0.01: Statistically significant difference.

Table 7  Correlations between change in OQLQ scores and cephalometric measurements at each stage in extraction or non-extraction group

| Cephalometric measurements | Social aspects of dentofacial deformity | Facial esthetics | Oral function | Awareness of dentofacial esthetics |
|----------------------------|----------------------------------------|-----------------|---------------|-----------------------------------|
|                            | R  | p   | R  | p   | R  | p   | R  | p   | R  | p   | R  | p   |
| Baseline (T0)-T1           |    |     |    |     |    |     |    |     |    |     |    |     |
| Extraction                 | Extraction | Non-extraction | Extraction | Non-extraction | Extraction | Non-extraction | Extraction | Non-extraction | Extraction | Non-extraction |
| Overjet                    | -0.17 | NS | -0.49 | NS | -0.52 | ** | -0.55 | * | -0.12 | NS | -0.39 | NS | -0.32 | NS | -0.51 | NS |
| Upper and lower lip difference | -0.49 | NS | -0.18 | NS | -0.31 | NS | -0.34 | NS | -0.14 | NS | -0.37 | NS | -0.21 | NS | -0.18 | NS |
| Soft tissue pogonion protrusion | 0.18 | NS | 0.26 | NS | -0.04 | NS | -0.08 | NS | -0.07 | NS | -0.15 | NS | -0.18 | NS | -0.07 | NS |
| ANB angle                  | -0.08 | NS | -0.23 | NS | 0.21 | NS | 0.17 | NS | 0.55 | NS | 0.10 | NS | -0.04 | NS | -0.06 | NS |
| T1-T2                      |    |     |    |     |    |     |    |     |    |     |    |     |
| Overjet                    | -0.12 | NS | -0.52 | NS | -0.14 | NS | -0.54 | NS | -0.30 | NS | -0.21 | NS | -0.29 | NS | -0.39 | NS |
| Upper and lower lip difference | 0.27 | NS | 0.36 | NS | 0.57 | NS | 0.48 | NS | 0.22 | NS | 0.55 | NS | 0.70 | * | 0.64 | * |
| Soft tissue pogonion protrusion | 0.42 | NS | 0.48 | NS | 0.52 | * | 0.60 | * | 0.18 | NS | 0.44 | NS | 0.27 | NS | 0.41 | NS |
| ANB angle                  | -0.04 | NS | -0.29 | NS | -0.26 | NS | -0.48 | NS | -0.06 | NS | -0.18 | NS | -0.58 | * | -0.54 | * |
| Baseline (T0)-T2           |    |     |    |     |    |     |    |     |    |     |    |     |
| Overjet                    | 0.01 | NS | 0.14 | NS | 0.21 | NS | 0.14 | NS | -0.04 | NS | -0.50 | NS | -0.27 | NS | -0.46 | NS |
| Upper and lower lip difference | 0.19 | NS | 0.18 | NS | 0.31 | NS | 0.28 | NS | 0.41 | NS | 0.26 | NS | -0.01 | NS | -0.10 | NS |
| Soft tissue pogonion protrusion | -0.29 | NS | -0.32 | NS | 0.14 | NS | 0.55 | NS | 0.48 | * | 0.61 | ** | -0.37 | NS | -0.07 | NS |
| ANB angle                  | 0.14 | NS | 0.53 | NS | -0.28 | NS | -0.35 | NS | -0.74 | NS | -0.52 | * | 0.24 | NS | 0.05 | NS |

Extraction cases (n=9) had more than 1 tooth extracted excluding third molars in pre-surgical orthodontic treatment, and non-extraction cases (n=11) had no teeth extracted. Correlations between change in OQLQ scores and cephalometric measurements at each stage were quantified by using Spearman rank correlation.

T0: Baseline, T1: Pre-surgical orthodontic treatment stage, T2: Postsurgical orthodontic treatment stage.

NS: Not significantly different, * p<0.05, ** p<0.01: Statistically significant difference.
able degree of displacement in both the maxillary and mandibular anterior teeth. Negative overjet greatly impacts not only esthetics, but also functional aspects of mastication. Another earlier study revealed that worsening of overjet negatively impacts esthetics-related OHRQL. The results of the present study also revealed a significant correlation with negative overjet and OQLQ scores in the domain of facial esthetics during the pre-surgical orthodontic treatment stage.

Cunningham et al. also found no significant difference in OQLQ after pre-surgical orthodontic treatment in comparison with at pre-treatment. They did, however, note a tendency toward worsening of OQLQ in all domains. In a longitudinal study comparing OHRQL over time in patients undergoing surgery-first or conventional surgical orthodontic treatment, Huang et al. found that OHRQL showed an improvement at just 1 month post-surgically in the surgery-first group, but that this required more time in the conventional treatment group.

In contrast, in a cross-sectional study, Palomares et al. reported a greater improvement in QOL over time in terms of both OHIP-14 and OQLQ scores in a pre-surgical orthodontic treatment group compared with a pre-treatment group. The present results do not agree with those of this earlier study. However, the pre-treatment and pre-surgical orthodontic treatment groups in their study included both skeletal Class II and III patients, and the mix of these two types of patient in addition to the cross-sectional design of the study resulted in a bias in the deformity types and numbers of patients between groups, which may have influenced the results.

Based on the results of a longitudinal study, Baherimoghaddam et al. found that change in OHRQL over time in Class II and III patients depended on the type of deformity involved. It was also noted that while an improvement was observed in OHRQL in Class III patients at the pre-surgical orthodontic treatment stage, the present study revealed a significant correlation with negative overjet.

Table 8  Correlations between change in OQLQ scores and cephalometric measurements at each stage in two different surgery groups

| Cephalometric measurements | Social aspects of dentofacial deformity | Facial esthetics | Oral function | Awareness of dentofacial esthetics |
|----------------------------|----------------------------------------|------------------|---------------|----------------------------------|
|                            | R p                                    | R p              | R p           | R p                              |
| Baseline (T0)-T1           | 1-jaw surgery                          | 2-jaw surgery    | 1-jaw surgery | 2-jaw surgery                    |
| Overjet                    | -0.18 NS                               | -0.27 NS        | -0.84 **      | -0.44 *                          |
| Upper and lower lip difference | -0.32 NS                             | -0.01 NS        | -0.18 NS      | -0.36 NS                         |
| Soft tissue pogonion protrusion | 0.13 NS                              | 0.09 NS         | -0.06 NS      | -0.12 NS                         |
| ANB angle                  | -0.08 NS                               | -0.41 NS        | 0.53 NS       | 0.04 NS                          |
| T1-T2                      | Overjet                                | -0.02 NS        | -0.39 NS      | -0.24 NS                         |
| Upper and lower lip difference | 0.08 NS                              | 0.41 NS         | 0.05 NS       | 0.40 NS                          |
| Soft tissue pogonion protrusion | 0.38 NS                              | 0.26 NS         | 0.58 *        | 0.54 *                           |
| ANB angle                  | -0.14 NS                               | -0.29 NS        | -0.18 NS      | -0.29 NS                         |
| Baseline (T0)-T2           | Overjet                                | 0.14 NS         | 0.05 NS       | 0.49 NS                          |
| Upper and lower lip difference | 0.13 NS                              | 0.07 NS         | 0.55 NS       | 0.24 NS                          |
| Soft tissue pogonion protrusion | -0.23 NS                              | -0.48 NS        | 0.53 NS       | 0.15 NS                          |
| ANB angle                  | 0.12 NS                                | 0.36 NS         | -0.25 NS      | -0.05 NS                         |

1-jaw surgery cases (n = 9) underwent SSRO, and 2-jaw surgery cases (n = 11) underwent SSRO in combination with Le Fort I osteotomy. Correlations between change in OQLQ scores and cephalometric measurements at each stage were quantified by using Spearman rank correlation.

T0: Baseline, T1: Pre-surgical orthodontic treatment stage, T2: Post-surgical orthodontic treatment stage.

NS: Not significantly different, * p < 0.05, ** p < 0.01: Statistically significant difference.
tic treatment stage, this was seen to worsen in those who were Class II. The authors further noted that Class III patients perceived deformity as more of a handicap than Class II patients as deformity is less common among Caucasians, with such patients therefore receiving much more encouragement to overcome the psychological issues of going through treatment. They suggest that this is why OHRQL was observed to improve at the pre-surgical stage in Class III patients, despite significant worsening of esthetics due to orthodontic treatment-related dental decompensation. On the other hand, the present study focused solely on a Japanese population, in which the occurrence of Class III cases is higher. We believe that this social characteristic is responsible for the differing OHRQL outcome observed here.

The approach used in pre-surgical orthodontic treatment differs between Class II and III patients. In Class II patients, the maxillary and mandibular anterior teeth are made to incline lingually in pre-surgical orthodontic treatment. In contrast, in Class III patients, the maxillary anterior teeth are made to incline lingually and mandibular anterior teeth labially due to dental decompensation. This results in an increasingly negative overjet. This may explain why change in patients’ perception due to pre-surgical orthodontic treatment is believed to differ depending on the type of jaw deformity involved. Therefore, in the present study, we focused solely on Class III patients. Ideally, it would be best to consider the effects of a range of factors on QOL in addition to the above, such as the treatment method adopted and timing thereof, medical technology applied, race, culture, sex, age, education, and family income. In reality, however, it is difficult to take all these factors into account. Further study is needed to address each of these issues.

In the present study, a significant improvement was observed in OHRQL in three of the domains (social aspects of dentofacial deformity, facial esthetics, and oral function) investigated at the post-surgical orthodontic treatment stage compared with at the pre-surgical orthodontic treatment stage. Lee et al. reported observing an improvement in facial esthetics only at 6 weeks post-surgically, while Silva et al. reported an improvement in both facial esthetics and the social aspects of dentofacial deformity at the same stage. Both of these reports describe a significant improvement in OQLQ in all domains except awareness of dentofacial esthetics at the 6-month postoperative evaluation. The present results are in agreement with these earlier findings. Murphy et al. also observed an improvement in all OQLQ items at 6 months post-surgically. Taken together, these reports demonstrate a tendency for postoperative QOL to gradually improve. Esthetic and social QOL both show an improvement at immediately after orthognathic surgery (after approximately 1–3 months), while this can take approximately 6 months for functional QOL. Furthermore, in studies investigating multi-bracket appliance debonding, Cunningham et al. and Azuma et al. reported a greater improvement in OQLQ scores in post-treatment than in pre-surgical groups in all domains except awareness of dentofacial esthetics. The authors suggest that this exception may be due to an increase in consciousness of such issues, whether subjective or objective. The present results showed a similar pattern in this respect, with OQLQ in the domain of awareness of dentofacial esthetics showing a tendency to worsen throughout the course of treatment. In other words, as treatment progresses, the patient experiences an increase in awareness of tooth alignment and facial appearance, both in themselves and in others.

In the present study, a highly significant improvement was observed in three domains (social aspects of dentofacial deformity, facial esthetics, and oral function) between at pre-treatment and at post-surgical orthodontic treatment. A number of earlier studies have also compared change in QOL between these two time points. Kiyak et al. investigated the long-term course in psychological well-being after orthognathic surgery by using a modified questionnaire. The results revealed that
self-esteem and body image temporarily worsened at 9 months post-surgically compared with at pre-surgical treatment\textsuperscript{22}. They suggest that this may have been due to the effects of still ongoing post-surgical orthodontic treatment and residual problems of pain and numbness. In another study, Kiyak \textit{et al.} also reported that psychological well-being improved after 24 months, suggesting that patient perspective improves over the long-term after orthognathic surgery\textsuperscript{20}. This suggests the need for further studies to address such issues after debonding and over the longer term\textsuperscript{23}.

Various factors are believed to influence OQLQ scores. In the present study, the OQLQ scores for social aspects of dentofacial deformity showed a moderately positive correlation with upper and lower lip difference and soft tissue pogonion protrusion in males. In patients of either sex aged <20 yr, the OQLQ scores for social aspects of dentofacial deformity showed a significant positive correlation with soft tissue pogonion protrusion. Therefore, it is possible that the younger the patient is, the higher the correlation between OQLQ scores for social aspects and improvement of chin position.

This study had several limitations. Our own Japanese version of the OQLQ was used in this study, and other translations have also been used\textsuperscript{4,38}. The validity of such translations remains to be established, however. Also, the statistical analysis focused on establishing simple correlations between morphological change and OQLQ scores. However, other variables such as sex and age may also affect OQLQ scores. Therefore, further multivariate analysis is needed to evaluate the relationship between OQLQ and these factors. This was not possible in the present study, however, due to the limited size of the sample. Furthermore, no control group was established here as there were very few patients with dentofacial deformity satisfying the inclusion criteria who did not elect to undergo surgical orthodontic treatment; and when surgical orthognathic treatment was refused, the reason for that decision may have skewed the results. As already mentioned, the sample size in this study was small. However, we believe that the number was sufficient to validate the present findings, although further studies with larger numbers of participants are warranted.

In conclusion, a significant improvement was observed in the condition-specific QOL in patients undergoing surgical orthodontic treatment for skeletal class III after orthognathic surgery. A transient worsening of QOL, however, was observed during pre-surgical orthodontic treatment, and this was associated with change in overjet in a negative direction as a result of dental decompensation. Other major events such as orthognathic surgery may serve to mask transient change in QOL during the course of surgical orthodontic treatment. Nonetheless, it is crucial that the dental professional be aware of temporary worsening of patient QOL during the surgical orthodontic treatment stage. Moreover, they will need to inform the patient about what to expect and provide support to help them overcome the temporary negative effects of treatment.

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