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Changes of dental anxiety, aesthetic perception and oral health-related quality of life related to influencing factors of patients' demographics after anterior implant treatment: a prospective study

Xin Xie^{1,2†}, Zhengchuan Zhang^{1,2†}, Jing Zhou^{2,3,4*} and Feilong Deng^{1,2*} 

Abstract

Background Accumulating evidence has revealed the effects of anterior implant procedures on dental anxiety (DA), aesthetic perception and oral health-related quality of life (OHRQoL). However, few reported the changes and influencing factors of the above outcomes before and after anterior implant treatment. This study was to evaluate the changes of DA, aesthetic perception and OHRQoL related to influencing factors of patients' demographics after anterior implant treatment.

Methods Thirty-nine patients satisfying the inclusion criteria were prospectively recruited before surgery. The subjects completed the Modified Dental Anxiety Scale (MDAS), the Orofacial Esthetic Scale (OSE) and the Oral Health Impact Profile-14 (OHIP-14), before implant surgery and after definitive prosthesis placement. Mann–Whitney *U* test and Kruskal–Wallis test by Bonferroni correction were applied for the data analysis and the influencing factors evaluation ($p < 0.05$).

Results Overall, 39 patients (mean age of 44.9 ± 12.0) completed the three scales. After anterior implant treatment, MDAS was not significantly changed ($p > 0.05$). The overall OSE ($p < 0.001$) and OHIP-14 ($p < 0.05$) were significantly improved. Females showed more improvement of overall OHIP score than males after anterior implant treatment ($p < 0.05$).

Conclusions Anterior implant procedures did not change the level of patient's DA, while aesthetic perception and OHRQoL were enhanced. Only gender difference of overall OHIP change was found in our study. Thus, more related influencing factors with larger sample and long-term effective follow-up are needed.

Trial registration: ClinicalTrials.gov, NCT05424458. Registered 13 June 2022—Retrospectively registered, <https://clinicaltrials.gov/ct2/show/NCT05424458>.

Keywords Dental anxiety, Aesthetic perception, Oral health-related quality of life, Anterior implant treatment

[†]Xin Xie and Zhengchuan Zhang contributed equally.

*Correspondence:

Jing Zhou

zhouj373@mail.sysu.edu.cn

Feilong Deng

dengfl@mail.sysu.edu.cn

Full list of author information is available at the end of the article

Introduction

The critically demanding task for aesthetic restorations of anterior missing teeth poses a challenge to a successful implant treatment [1]. Accumulating evidence has revealed the positive effects of anterior implant procedures on dental anxiety (DA), aesthetic perception and oral health-related quality of life (OHRQoL) [2–5]. However, the changes of DA, aesthetic perception and OHRQoL under different demographics were few reported.

Moderate-to-high level of perioperative DA has been reported in many studies, which may have a negative influence on the physical and psychological experience of implant treatment satisfaction [3, 6]. Besides, the fear of dental surgery may get patients to refuse implant solutions and turn to accept conventional dentures, which will lead to the compromised aesthetic and functional rehabilitation of the anterior teeth [7]. These results may also lead to an endless loop of unsatisfied experience and continuing high DA level. However, whether the anterior implant treatment could change the DA level of patients is unclear.

Anterior implant treatment may yield preferable aesthetic outcomes [8]. Aesthetic perception, one kind of self-perception, is suitable to evaluate the result of patient-centred treatment [9]. Implant treatment will change the orofacial aesthetics characteristics, which may cause the changes of self-perception outcomes [5]. Besides, OHRQoL must be taken seriously enough to evaluate clinical interventions [10]. Changes of OHRQoL by the anterior implant treatment have been showed more radical than the posterior implant treatment [11, 12]. It was reported that a high aesthetics and function satisfaction after both definitive prosthesis placement and 10-year follow-up [2, 13]. Thus, the earliest and most significant improvement of OHRQoL might be the time of the definitive restoration placement.

However, patient's perception may be influenced by their individuality. Patients may not show the same self-perception and psychosocial impacts because of different demographics, such as age, gender, educational status, tooth loss number, smoking habit, simultaneously bone augmentation, loading timing and prosthesis type [14, 15]. Previous studies have showed higher occurrence of tooth loss by periodontitis and subsequent implant failure in patients with smoking habit, which may cause a contradictory psychological need for the balance of the anterior implant treatment and the addiction to smoking [16, 17]. Anterior implants involve the comprehensive solutions of surgery and prosthetics, such as simultaneously bone augmentation, loading timing and prosthesis type [18, 19]. However, whether these influencing factors of patients' demographics could change DA, aesthetic

perception and OHRQoL after anterior implant treatment is unclear.

The purpose of this prospective study was to evaluate the changes of DA, aesthetic perception and OHRQoL related to influencing factors of patients' age, gender, educational status, tooth loss number, smoking habit, simultaneously bone augmentation, loading timing and prosthesis type after anterior implant treatment.

Materials and methods

Study design

The present study was designed as a prospective study and reported according to STROBE guideline. The study protocol was approved by the Medical Ethics Committee of Hospital of Stomatology, Sun Yat-sen University (KQEC-2021-46-01) and conducted in full accordance with the Helsinki declaration of 1975 and revised in 2013.

Patient selection

The subjects ($n=39$) included in this prospective study were recruited from those patients with anterior missing teeth at the Department of Oral Implantology, Guanghua School of Stomatology, Sun Yat-sen University.

Patients satisfying the following inclusion criteria were recruited: (1) age ≥ 18 years old; (2) partially anterior edentulous jaws; (3) patients will be given an anterior implant surgery and implant-supported fixed rehabilitation; (4) patients could express themselves and communicate normally; (5) willing to participate in and accept investigation. Exclusion criteria were (1) use of anti-anxiety and painkillers within 1 year; (2) mental and psychological diseases with poor emotional self-control; (3) a history of previous implant loss; (4) ongoing active infections by endodontic or periodontal problems of all the remaining teeth; (5) combined complex surgery, such as large-block autogenous bone grafting; (6) severe systemic diseases influencing implant survival (uncontrolled diabetes mellitus, previous chemotherapy, previous irradiation of the head and neck region, immunosuppression, etc.).

Data collection

Before implant surgery, all participants signed an informed consent form and were given sufficient time in the waiting room to answer the following three scales (Table 1). The modified dental anxiety scale (MDAS) included five questions with a 5-category scale, ranging from 'not' to 'extremely' [20]. The Orofacial Esthetic Scale (OES) was a scale that was designed by 8 items to evaluate the self-perception of aesthetic implant treatment (ranged from 0 to 10 scores, 0 is 'Very dissatisfied' and 10 is 'Very satisfied') [21]. The Oral Health Impact Profile (OHIP) was to measure OHRQoL, comprising 14

Table 1 The MDAS, OSE and OHIP questionnaires**MDAS questionnaires**

- Q1 How anxious would you feel if you prepared to see a dentist at home?
 Q2 How anxious would you feel if you were waiting for treatment in the waiting room?
 Q3 Have you felt anxious when the dentist drilled your teeth with a dental drill?
 Q4 Have you felt anxious when you were about to have your teeth treated?
 Q5 Have you felt anxious when you saw the anesthetic needle in your mouth?

OSE questionnaires

- Q1 Frontal appearance of face
 Q2 Appearance of facial profile
 Q3 Mouth appearance (smile, lips and visible teeth)
 Q4 Appearance of teeth rows
 Q5 Teeth shape
 Q6 Teeth colour
 Q7 Gum appearance
 Q8 Overall, how do you feel about the appearance of your face, mouth and teeth?

OHIP questionnaires

- Q1 Have you felt pronunciation problem because of your teeth?
 Q2 Have you felt less tasty of food because of your teeth?
 Q3 Have you felt painful areas in your mouth?
 Q4 Have you felt that your appearance has been affected by missing teeth?
 Q5 Have you been uncomfortable in public because of your teeth?
 Q6 Have you been nervous because of your teeth?
 Q7 Have you been unsatisfied with food because of your teeth?
 Q8 Have you had to stop eating because of your teeth?
 Q9 Have you been difficult to relax because of your teeth?
 Q10 Have you been embarrassed because of teeth?
 Q11 Have you been temperish because of teeth?
 Q12 Have you had difficulties doing your usual job because of teeth?
 Q13 Have you felt that life was less satisfying because of teeth?
 Q14 Have you felt that you could do nothing because of teeth?

On MDAS questionnaire numbers correspond to the dimensions (1 = Not, 2 = Slightly, 3 = Fairly, 4 = Very, 5 = Extremely. Overall MDAS score: Q1–Q5 summary score)

On OSE questionnaire numbers correspond to the dimensions (ranged from 0 to 10, 0 is 'Very dissatisfied' and 10 is 'Very satisfied')

On OHIP questionnaire numbers correspond to the dimensions (1 = Not, 2 = Seldom, 3 = Sometimes, 4 = Often, 5 = Very often)

In translation to Chinese for patients use

statements with 5 scores (1 = Not, 2 = Seldom, 3 = Sometimes, 4 = Often, 5 = Very often; total scores: 14–70) [10]. Influencing factors of patients' demographics including age, gender, educational status, tooth loss number and smoking habit were obtained from the medical records.

Clinical procedures

Patients received routine examinations before surgery. The surgical procedures were performed by experienced experts. Immediate loading protocol was delivered if the insertion torque was over 35 N·cm; otherwise, removable restorations with submerged implants were applied. After a healing period of 3–6 months, a definitive screw-retained porcelain-fused-to-metal (PFM) or a CAD/CAM zirconia restoration were performed.

In the first month after definitive prosthesis placement, patients were recalled to complete the MDAS, OES and OHIP questionnaires for the second time. Changes of overall MDAS, OSE and OHIP scores were defined as the score after definitive prosthesis placement minus that before the treatment. Negative score changes indicated score decrease of the second questionnaire compared to the first one. Positive score changes indicated score increase.

Statistical analysis

The surgeon, prosthetist and nurse of all the enrolled patients were the same and consistent. Data were collected and evaluated from the scales by two independent researchers. Data were calculated by descriptive

statistics (mean, standard deviation) and were analysed using the SPSS 25.0 software package (SPSS Inc., USA). Mann–Whitney *U* test was used to determine the score change before and after anterior implant treatment. Mann–Whitney *U* test (gender, tooth loss number, smoking habit, simultaneously bone augmentation, loading timing and prosthesis type) and Kruskal–Wallis test by Bonferroni correction (age and educational status) were applied for the influencing factors evaluation based on the changes of overall MDAS, OSE and OHIP scores. The level of significance was set at $p < 0.05$.

Results

Patient’s demographics

A total of 39 patients were enrolled and evaluated. The mean time intervals between two-time questionnaire were 9.8 ± 2.6 months. The mean age of the patients during the surgery was 44.9 ± 12.0 years ranged from 24 to 70 years. Over half of all the participants (56.4%) were

middle-aged ($40 < \text{age} \leq 60$). Males accounted for 56.4%, slightly higher than females (43.6%). From the aspect of educational status, 87.2% of patients had a college degree or above. The number of tooth loss was 2.0 ± 1.5 with 56.4% portion for single tooth loss. Only 17.9% of patients had smoking habit. Implant placement with simultaneously bone augmentation accounted for 56.4%. Most of the enrolled patients received delayed loading with zirconia definitive restorations (Table 2). The extraoral, intraoral, radiographic photographs and the scores with different genders before and after implant treatment are exhibited as Fig. 1.

Dental anxiety

Dental anxiety levels were assessed by MDAS (Table 3). Before anterior implant treatment, the overall MDAS score was 11.9 ± 4.2 (slightly to fairly anxious). After definitive prosthesis placement, the overall MDAS score was 11.3 ± 4.8 (slightly to fairly anxious). Differences of

Table 2 Changes of overall MDAS, OSE and OHIP score related to influencing factors of patients’ demographics

| Variable | No. patients (%) | Change of overall MDAS score | | Change of overall OSE score | | Change of overall OHIP score | |
|----------------------------------|-------------------------|------------------------------|-----------------|-----------------------------|-----------------|------------------------------|-----------------|
| | | Mean \pm SD | <i>p</i> -value | Mean \pm SD | <i>p</i> -value | Mean \pm SD | <i>p</i> -value |
| Age | 44.9 \pm 12.0 [24–70] | | | | | | |
| Age \leq 40 | 13 (33.3%) | − 0.8 \pm 3.2 | 0.359 | 27.2 \pm 32.4 | 0.129 | − 4.1 \pm 8.7 | 0.189 |
| 40 < age \leq 60 | 22 (56.4%) | − 1.1 \pm 5.7 | | 36.4 \pm 29.2 | | − 6.6 \pm 14.9 | |
| Age > 60 | 4 (10.3%) | 2.0 \pm 2.7 | | 63.0 \pm 19.6 | | − 12.3 \pm 7.4 | |
| Gender | | | | | | | |
| Male | 22 (56.4%) | − 0.7 \pm 4.1 | 0.432 | 29.0 \pm 30.7 | 0.076 | − 2.5 \pm 8.5 | 0.047* |
| Female | 17 (43.6%) | − 0.6 \pm 5.6 | | 45.2 \pm 28.8 | | − 11.3 \pm 15.1 | |
| Educational status | | | | | | | |
| None/primary/middle school | 5 (12.8%) | − 1.4 \pm 3.0 | 0.780 | 39.2 \pm 34.2 | 0.126 | − 7.0 \pm 8.1 | 0.761 |
| College/undergraduate | 27 (69.2%) | − 0.6 \pm 5.6 | | 41.3 \pm 31.5 | | − 6.8 \pm 14.5 | |
| MS/PhD | 7 (18.0%) | − 0.4 \pm 1.5 | | 13.7 \pm 11.1 | | − 4.1 \pm 5.6 | |
| Tooth loss number | | | | | | | |
| Single | 22 (56.4%) | − 0.9 \pm 5.2 | 0.898 | 36.2 \pm 31.3 | 0.910 | − 9.9 \pm 14.1 | 0.063 |
| Multiple | 17 (43.6%) | − 0.4 \pm 4.2 | | 35.8 \pm 30.6 | | − 1.8 \pm 8.3 | |
| Smoking habit | | | | | | | |
| Yes | 7 (17.9%) | − 0.9 \pm 3.5 | 0.386 | 44.6 \pm 27.5 | 0.410 | − 5.7 \pm 7.3 | 0.840 |
| No | 32 (82.1%) | − 0.6 \pm 5.0 | | 34.2 \pm 31.3 | | − 6.5 \pm 13.4 | |
| Simultaneously bone augmentation | | | | | | | |
| Yes | 22 (56.4%) | − 0.3 \pm 4.0 | 0.764 | 29.3 \pm 30.0 | 0.076 | − 3.0 \pm 9.5 | 0.069 |
| No | 17 (43.6%) | − 1.1 \pm 5.6 | | 44.8 \pm 29.9 | | − 10.6 \pm 14.7 | |
| Loading timing | | | | | | | |
| Immediate | 4 (10.3%) | − 0.5 \pm 8.2 | 0.981 | 35.5 \pm 25.0 | 0.945 | − 9.5 \pm 12.9 | 0.404 |
| Delayed | 35 (89.7%) | − 0.7 \pm 4.4 | | 36.1 \pm 31.4 | | − 6.0 \pm 12.6 | |
| Prosthesis type | | | | | | | |
| Zirconia | 36 (92.3%) | − 0.8 \pm 4.8 | 0.832 | 36.4 \pm 30.6 | 0.792 | − 6.2 \pm 13.0 | 0.178 |
| PFM | 3 (7.7%) | 0.7 \pm 5.0 | | 32.3 \pm 36.6 | | − 8.0 \pm 1.7 | |

* $p < 0.05$ compared to other variable items by Mann–Whitney *U* test (gender, tooth loss number, smoking habit, simultaneously bone augmentation, loading timing and prosthesis type) and Kruskal–Wallis test by Bonferroni correction (age and educational status)



Fig. 1 Representative photographs and scores with different genders. **a** The extraoral, intraoral, radiographic photographs and the scores of a male patient before and after implant treatment. **b** The extraoral, intraoral, radiographic photographs and the scores of a female patient before and after implant treatment

Table 3 Distribution of scores by dimension and for the total MDAS (mean ± SD)

| | Before implant treatment | After implant treatment | p-value |
|--------------------|--------------------------|-------------------------|---------|
| Q1 | 2.8 ± 1.3 | 2.4 ± 1.3 | 0.243 |
| Q2 | 1.5 ± 0.9 | 1.5 ± 0.9 | 0.917 |
| Q3 | 2.7 ± 1.1 | 2.8 ± 1.1 | 0.847 |
| Q4 | 2.1 ± 1.1 | 1.9 ± 1.1 | 0.319 |
| Q5 | 2.8 ± 1.1 | 2.7 ± 1.2 | 0.598 |
| Overall MDAS score | 11.9 ± 4.2 | 11.3 ± 4.8 | 0.388 |

*p < 0.05 compared to the scores before implant treatment by Mann–Whitney U test

overall DA levels between the two time points were not significant ($p=0.388$). There were almost no obvious score changes of Q1–Q5 during the treatment. A relatively low level of anxiety was observed when the patients were waiting for treatment in the waiting room (not to slightly anxious) compared the other four situations from the 5-category scale.

Aesthetic perception

The Orofacial Esthetic Scale (OES) was designed to evaluate the aesthetic perception changes (Table 4). All the subitem’s scores of OSE and the overall OSE score after

Table 4 Distribution of scores by dimension and for the total OSE (mean ± SD)

| | Before implant treatment | After implant treatment | p-value |
|-------------------|--------------------------|-------------------------|----------|
| Q1 | 4.9 ± 3.6 | 9.2 ± 1.1 | < 0.001* |
| Q2 | 5.1 ± 3.5 | 9.2 ± 1.1 | < 0.001* |
| Q3 | 4.1 ± 3.6 | 8.7 ± 2.0 | < 0.001* |
| Q4 | 4.1 ± 3.5 | 9.0 ± 1.3 | < 0.001* |
| Q5 | 4.1 ± 3.7 | 8.9 ± 1.4 | < 0.001* |
| Q6 | 4.4 ± 3.6 | 8.9 ± 1.4 | < 0.001* |
| Q7 | 4.3 ± 3.6 | 8.8 ± 1.5 | < 0.001* |
| Q8 | 4.9 ± 3.3 | 9.1 ± 1.2 | < 0.001* |
| Overall OSE score | 35.9 ± 27.0 | 71.9 ± 9.6 | < 0.001* |

*p < 0.05 compared to the scores before implant treatment by Mann–Whitney U test

implant treatment displayed significant increase than those before implant treatment ($p < 0.001$). Based on the change of the overall OSE score, doubled aesthetic perception level was achieved after the anterior implant treatment by the patient-reported OSE outcomes.

Oral health-related quality of life

The Oral Health Impact Profile (OHIP) survey score was to measure oral health-related quality of life (Table 5). In

Table 5 Distribution of scores by dimension and for the total OHIP (mean ± SD)

| | Before implant treatment | After implant treatment | p-value |
|--------------------|--------------------------|-------------------------|---------|
| Q1 | 2.7 ± 1.2 | 2.0 ± 1.1 | 0.009* |
| Q2 | 2.1 ± 1.2 | 1.6 ± 1.0 | 0.141 |
| Q3 | 2.2 ± 1.0 | 1.8 ± 1.0 | 0.183 |
| Q4 | 3.6 ± 1.2 | 3.3 ± 1.4 | 0.490 |
| Q5 | 3.3 ± 1.2 | 2.8 ± 1.4 | 0.127 |
| Q6 | 2.9 ± 1.2 | 2.6 ± 1.2 | 0.176 |
| Q7 | 2.6 ± 1.2 | 2.1 ± 1.0 | 0.101 |
| Q8 | 2.4 ± 1.1 | 1.9 ± 0.9 | 0.048* |
| Q9 | 2.2 ± 1.1 | 1.9 ± 1.0 | 0.385 |
| Q10 | 3.0 ± 1.0 | 2.3 ± 1.1 | 0.003* |
| Q11 | 1.8 ± 1.0 | 1.4 ± 0.6 | 0.034* |
| Q12 | 1.8 ± 1.0 | 1.3 ± 0.6 | 0.016* |
| Q13 | 2.5 ± 1.2 | 1.8 ± 0.9 | 0.006* |
| Q14 | 1.6 ± 0.8 | 1.3 ± 0.6 | 0.036* |
| Overall OHIP score | 34.6 ± 11.4 | 28.2 ± 9.7 | 0.020* |

* $p < 0.05$ compared to the scores before implant treatment by Mann–Whitney U test

total, the overall OHIP scores of the two time points were seldom to sometimes level in the both two time points. Statistically significant improvements were found after definitive prosthesis placement in the following dimensions: pronunciation problem ($p = 0.009$), eating disorders ($p = 0.048$), social obstacles ($p = 0.003$), emotional control ($p = 0.034$), usual job ($p = 0.016$), life satisfaction ($p = 0.006$) and confidence to do things ($p = 0.036$), as well as in the overall OHIP score ($p = 0.020$).

Influencing factors of patients' demographics

Table 2 shows the influencing factors of patients' demographics including age, gender, educational status, tooth loss number, smoking habit, simultaneously bone augmentation, loading timing and prosthesis type. Age and educational status were set as three categories. There were no significant differences of MDAS, OSE and OHIP score changes among age, educational status, tooth loss number, smoking habit, simultaneously bone augmentation, loading timing and prosthesis type. Females showed more improvement of overall OHIP score change than males ($p = 0.047$), while no significant differences were observed between males and females in MDAS ($p = 0.432$) and OSE score ($p = 0.076$), respectively.

Discussion

This prospective study focused on the changes of DA, aesthetic perception and OHRQoL related to influencing factors of patients' age, gender, educational status,

tooth loss number, smoking habit, simultaneous bone augmentation, loading timing and prosthesis type after anterior implant treatment. After anterior implant treatment, MDAS were not significantly changed ($p > 0.05$), while the overall OSE ($p < 0.001$) and OHIP-14 ($p < 0.05$) were significantly improved. Females showed more improvement of overall OHIP score than males ($p < 0.05$). Meanwhile, age, educational status, tooth loss number, smoking habit, simultaneously bone augmentation, loading timing and prosthesis type did not exhibit significant changes in MDAS, OSE and OHIP.

Slightly to fairly anxious DA levels in oral implant patients were reported both before anterior implant treatment and after definitive prosthesis placement in our study. This study reported DA prevalence of 69.2% and 66.7% for the patients before the treatment and after the treatment, respectively, in accordance with previous studies with high prevalence in oral surgery patients [3, 6]. High prevalence of DA may be not beneficial to comprehensive implant treatment, especially in the aesthetic or anterior zone. It was reported that the fear of surgery was the most common reason to avoid implants [7]. With the advent of the information age and big data era, multimedia information about the details of implant surgery was easily obtained and impressed for the patients, which led to high preoperative DA level without intervention of dental professionals [22]. After definitive prosthesis placement, DA changes were not found in the present study. High DA level was associated with enhanced pain perception; thus, DA level did not decrease after the surgery procedures with more or less surgery related pain [3]. Therefore, it is necessary to release anxiety in patients, especially during the first dental implant surgery. Preoperative psychological intervention and perioperative classical era music may help patients to decrease dental anxiety and pain perception [23, 24].

Greatly improved after-treatment rating of aesthetic perception based on the OES was achieved in the patient with implant-supported fixed anterior restorations in the present study. High overall satisfaction of face appearance, mouth appearance and teeth appearance was easily obtained with anterior implant treatment in comparison with conventional dentures [5]. Enhanced confidence from the improved oral function further promoted the positive aesthetic perception during the follow-up. Therefore, doubled scores of the aesthetic perception after definitive prosthesis placement confirmed the positive effect of anterior implant treatment on the patient-reported overall outcomes. A definitive screw-retained porcelain-fused-to-metal (PFM) or a CAD/CAM zirconia restoration were performed with lingual screw access hole as invisible as possible, which satisfied patients' aesthetic needs [25].

In the current study, OHIP-14 results revealed a statistically significant improvement of OHRQoL in many aspects. The second questionnaires were made in the first month after definitive prosthesis placement with better perception of the treatment, without the interference of the most unfavourable OHIP scores of healing period [4, 26–28]. This study did not group the different implant timings, because the effects of different surgical solutions shared similar clinical procedures from the perspectives of patients in the time point after the definitive restoration [29, 30]. The time intervals of the present study were not fixed, which were different for varied healing periods of patients. The aim of this design was to emphasize the importance of the implant restorations in the short-term observation. Based on the previous study, a very high and stable long-term overall satisfaction was achieved regarding physical and psychological experience for 10 years after implant placement [2, 31].

To our surprise, we found that only gender differences of overall OHIP change were found after definitive prosthesis placement in our study. However, age, educational status, tooth loss number, smoking habit, simultaneously bone augmentation, loading timing and prosthesis type did not exhibit significant changes in MDAS, OSE and OHIP, which were also reported in other studies [3, 15]. Women were reported to be more attentive to oral health issues with the stronger desire to choose aesthetic treatment than men [32, 33]. Therefore, women may benefit from anterior implant treatment with favourable aesthetics and then report a better OHIP score.

The present study has limitations that should be taken into consideration when interpreting the findings. The sample size of the present study was calculated based on the level of DA, aesthetic perception and OHRQoL of implant patients from the previous studies, without consideration of related influencing factors [3, 5]. Thus, population distributions of age, gender, educational status, tooth loss number, smoking habit, simultaneously bone augmentation, loading timing and prosthesis type were not average in their subitems. Difference between groups may be influenced by minorities, such as age over 60 (10.3%), none/primary/middle school educational status (12.8%), immediate loading (10.3%) and PFM restoration (7.7%). Hence, a randomized controlled study design with a specific patients' demographic will be necessary to discover the response bias and substantiate the present study.

Conclusion

Within the limitations of the study, anterior implant procedures did not change the level of patient's DA, while aesthetic perception and OHRQoL were improved. Only gender differences of overall OHIP change were found

in our study. Besides, more related influencing factors with larger sample and long-term effective follow-up are needed.

Abbreviations

| | |
|---------|-------------------------------------|
| DA | Dental anxiety |
| OHRQoL | Oral health-related quality of life |
| MDAS | Modified Dental Anxiety Scale |
| OSE | Orofacial Esthetic Scale |
| OHIP-14 | Oral Health Impact Profile-14 |
| PFM | Porcelain-fused-to-metal |

Acknowledgements

The authors wish to thank all of the research staff members at the Department of Oral Implantology, Guanghua School of Stomatology, Sun Yat-sen University.

Author contributions

XX and ZZ conceived the ideas and designed the study; XX collected the data; ZZ performed data analysis and interpretation; ZZ drafted the paper; JZ collected the supplementary data and performed data analysis in the revised manuscript. JZ and FD revised it. All authors have read and approved the final manuscript.

Funding

None.

Availability of data and materials

All data generated or analysed during this study are included in this published article.

Declarations

Ethics approval and consent to participate

The study protocol was approved by the Medical Ethics Committee of Hospital of Stomatology, Sun Yat-sen University (KQEC-2021-46-01) and conducted in full accordance with the Helsinki declaration of 1975 and revised in 2013. Registered in ClinicalTrials.gov (NCT05424458).

Consent for publication

Consent was obtained from the patients involved in this study.

Competing interests

The authors declare that they have no competing interests.

Author details

¹Department of Oral Implantology, Hospital of Stomatology, Guanghua School of Stomatology, Sun Yat-Sen University, No. 56 of LingYuanXiLu, Guangzhou 510055, Guangdong, China. ²Guangdong Provincial Key Laboratory of Stomatology, Guangzhou, China. ³Department of Prosthodontics, Hospital of Stomatology, Guanghua School of Stomatology, Sun Yat-Sen University, No. 56 of LingYuanXiLu, Guangzhou 510055, Guangdong, China. ⁴Department of Stomatology, The First Affiliated Hospital/The First Clinical Medicine School of Guangdong Pharmaceutical University, Guangzhou, China.

Received: 2 November 2022 Accepted: 18 July 2023

Published online: 02 August 2023

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