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Improvement in facial aesthetics of orthognathic patients after surgery-first approach

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Abstract

Facial appearance significantly affects psychosocial wellbeing, and an improvement in facial aesthetics is considered an essential outcome of orthognathic treatment. The surgery-first approach (SFA) has emerged as a promising alternative to the conventional orthodontics-first approach (OFA) due to its potential advantages in reducing treatment duration and cost, delivering early aesthetic improvement, and increasing patient satisfaction. However, its impact on final facial aesthetics and how it compares with the OFA has, to our knowledge, not yet been investigated. This retrospective study aimed to compare the improvement in facial aesthetics after orthognathic surgery in an SFA and an OFA group. Preoperative and postoperative 3-dimensional stereophotogrammetry facial images of 40 patients were evaluated by five professional assessors using the Global Aesthetic Improvement Scale (GAIS). Similar aesthetic improvement outcomes were found in both the SFA and OFA groups. The GAIS score significantly correlated with the following facial variables: upper lip projection, chin prominence, facial proportions, paranasal hollowing, lip competence, mandibular projection, and facial profile. No significant correlation was found between a change in aesthetic score and the surgical variables. There was a positive association between overall GAIS score and the gender and experience level of the individual assessors. This study suggests that aesthetic facial improvement achieved with the SFA is satisfactory and comparable to that of the OFA.

Keywords: Orthognathic; Surgery first; Aesthetic; Orthodontics; 3D facial assessment

Introduction

The facial aesthetic is an object of desire in modern societies. The balance and harmony of the face play an important role in social behaviour and perception worldwide.[1] In recent years, attention has been directed towards the impact of orthognathic surgery on facial appearance,[2] and increased awareness of facial aesthetics has led to an increase in the number of patients seeking treatment.[3]

Since the 1970s, the orthodontics-first approach (OFA), which includes three stages (pre-surgical orthodontics, orthognathic surgery, and post-surgical orthodontics), has been utilised as a standard protocol for the management of orthognathic cases.[4,5] In 1994, Lee discussed the concept of the surgery-first approach (SFA), suggesting that early correction of the skeletal deformity should facilitate easier and quicker orthodontic tooth movement due to normalisation of the soft tissue envelope.[6] Since then, interest in the SFA has increased due to the progressive accumulation of clinical evidence for its efficiency.[7] Compared with the conventional approach, the SFA offers shorter overall treatment time, the elimination of exaggerated facial disharmony and dental dysfunction caused by presurgical decompensation,

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and comparable postsurgical skeletal stability.[8–10] However, it is not applicable in all cases,[11] and requires careful orthodontic planning.[12]

There is evidence that orthognathic surgery improves dentofacial function, facial aesthetics, and quality of life parameters[13,14] but, to the best of our knowledge, no studies to date have compared the improvement in facial aesthetics produced by the SFA and OFA. Most studies have been limited to the assessment of facial aesthetics in patients treated using the OFA.[13,15]

The Global Aesthetic Improvement Scale (GAIS) is a validated universal scale that has been used in several studies to monitor the level of facial aesthetic improvement and treatment outcomes.[16–19] Using the GAIS as an objective tool, this study aimed to compare the improvement in facial aesthetics in two groups of patients, treated using the SFA and the OFA.

Method

Study design

A retrospective cohort study was conducted on all patients who had undergone orthognathic surgery and 3D facial imaging at our unit between 2016 and 2022. Cases involving both single jaw and bimaxillary surgery were included, and patients were divided into SFA and OFA groups. Treatment plans were based on the magnitude of the deformity as well as the patients' functional and aesthetic concerns. The quality of the predicted occlusion was of particular importance where the SFA was used. All patients were treated by the same surgeon and orthodontist following a standard protocol of data collection, analysis, and prediction planning. Those with a complete set of both preoperative and postoperative 3D images were considered for inclusion in the study. Patients were excluded if they had poor quality 3D images, cleft lip and palate, craniofacial syndromes, or a history of facial trauma or maxillofacial pathology.

3D imaging

The current study was based on the subjective analysis of a set of 3D images, which were captured before surgery and at 9–12 months postoperatively. The 3D facial scans were captured using the same stereophotogrammetric device: the Di3D capture system (Dimensional Imaging). All the facial images were taken under standard conditions by the same professional photographer. Patients were scanned at rest, in a natural head position, and with relaxed facial musculature.

Panel assessment

The panel consisted of five selected consultants (two of whom were male). The assessors had different levels of experience and were not involved in the treatment of the patients. A series of 10 3D facial images, which were not included in the study sample, was shown to the panel members for training and calibration purposes. The assessors were instructed to ignore skin tone and texture, as well as hairstyle, and position of the ears. They were asked to focus only on the improvement in facial aesthetics with respect to facial balance and harmony. The assessors were shown a PowerPoint (Microsoft) presentation, which included a 360° video of each patient's preoperative and postoperative 3D facial capture, as well as a standard set of still images comprising the frontal, profile, and 45° images of the right and left sides of the face (Fig. 1). These were then used to grade the perceived improvement in facial harmony using the GAIS.[16] The GAIS score consists of seven categories ranging from 3 for considerable improvement, to -3 for considerably worsened (Table 1). The grades were translated into numerical scores from 1 to 7, to allow statistical analysis of the results. To test intra-rater reliability, 10% of the patients' images were replicated and included randomly within the rest of the images.[20,21]

Statistical analysis was performed using Microsoft Excel and IBM SPSS Statistics for Windows version 26 (IBM Corp). A Kolmogorov–Smirnov test was conducted to assess normal distribution, followed by parametric or non-parametric statistical testing, as indicated. Descriptive statistics (mean, standard deviation (SD), and frequency) were computed for the data. Inter-rater reliability was evaluated using the interclass correlation coefficient (ICC).[22] The ICC values were measured with a two-mixed model, consistency type at a 95% confidence interval (CI). The correlation of the overall GAIS score with facial aesthetic parameters, surgical variables and panel's demographic variables was analysed using Spearman's correlation test. Differences were considered significant at $p < 0.05$. A correlation coefficient (r) was defined as high ($r > 0.70$), moderate ($r = 0.30$ - 0.70), or low ($r < 0.30$).[20]

Results

A total of 40 orthognathic patients (30 females and 10 males) were included in the study, 20 in each group. Twenty-two had undergone Le Fort I osteotomy, nine bilateral sagittal split osteotomy (BSSO), and nine bimaxillary osteotomy (BIMAX). The median (range) age at the time of surgery was 23 (14–50) years. Of the panel members, three of the five had more than 10 years of clinical experience.

No statistically significant difference was found in the overall GAIS score between the two groups using the independent *t* test ($p = 80.417$). The mean (SD) GAIS score of the SFA group was 6.08 (0.92), which was comparable to the mean (SD) score of 5.98 (0.88) for the OFA group. Good inter-rater reliability was noted, with a correlation coefficient of 0.85. The scores for the replicated cases demonstrated good intra-rater reliability, with an agreement rate of 75% - 100%.

"Significant improvement" and "considerable improvement" scores were noted in 77.5% of the cases in both groups, and a "small improvement" score was noted in 16%. In two cases, "no change" was noted, and one case

Fig. 1. Example of 3-dimensional imaging set (preoperative and postoperative) presented to the panel assessors.

Table 1
Global aesthetic improvement scale (GAIS).

Score	Evaluation	Description
3	Considerable improvement	Excellent aesthetic result
2	Significant improvement	Significant aesthetic improvement compared to the initial condition but not the best one for the patient
1	Small improvement	Clear aesthetic improvement compared to the initial condition
0	No change	The condition unchanged compared to the initial one
-1	Small deterioration	The condition has slightly worsened compared to the initial one
-2	Significant deterioration	Significant aesthetic deterioration compared to the initial condition
-3	Considerably worsened	Considerable deterioration compared to the initial condition

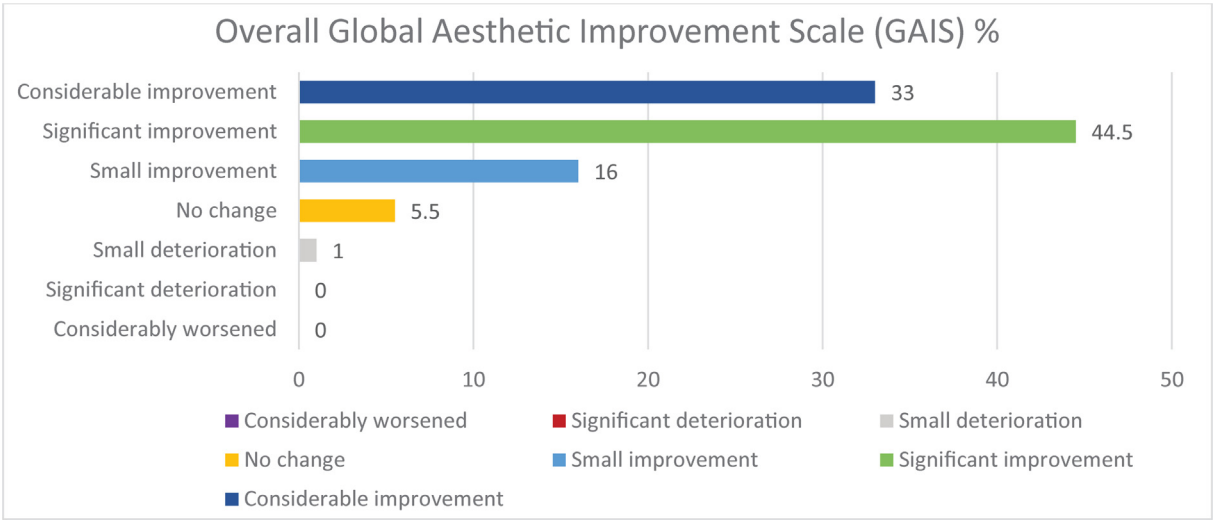

Fig. 2. Overall global aesthetic improvement scale (GAIS). Data are expressed as a percentage.

was judged to have a "small deterioration". No "significant deterioration" or "considerably worsened" scores were noted for any of the cases in the two groups (Fig. 2). The total improvement scores for the various facial parameters were 91.5 % (facial profile), 75.3% (mandibular projection), 68% (upper lip projection), 66% (chin prominence), 57% (paranasal hollowing), 42% (lip competence), 39% (facial proportions), 33% (nasal prominence), and 27.5% (facial symmetry) (Fig. 3).

As part of the study, the effect of the surgical variables on the overall GAIS score was evaluated, including the type of surgery (Le Fort I, BSSO, or BIMAX), and involvement of a genioplasty or malar augmentation. The Spearman correlation test was used to evaluate the correlations between the overall GAIS score and other variables, including facial aesthetic parameters, surgical variables and the panel's demographic variables. The results indicated that relations between the overall GAIS score and the surgical variables were not statistically significant ($p > 0.05$).

For the facial aesthetic parameters, significant high correlations were observed between the facial profile and GAIS scores (Table 2). Low correlation coefficients were observed for facial proportions ($p = 0.23$). A moderate correlation coefficient was found to be statistically significant between the overall GAIS and facial aesthetic variables, including upper lip projection, chin prominence, mandibular projection, paranasal hollowing, and lip competence (Table 2). There was a statistically significant difference between the years of experience of the panel and overall GAIS score ($p = 0.017$).

Discussion

There is no doubt that the SFA avoids the deterioration in facial aesthetics produced by the pre-surgical dental decompensation phase of the OFA.[8–10] However, there is no clear evidence that the final aesthetic outcomes of the SFA are better or worse than those of the OFA. This study aimed to evaluate the improvement in facial appearance as one of the outcome measures for the SFA. Three-dimensional facial images of SFA and OFA patients were graded by trained professional assessors, using the validated GAIS. The null hypothesis for the study was accepted, with no differences detected in the achieved GAIS scores for the two groups.

Healthcare authorities have looked at mechanisms to deal with the delays in delivering orthognathic services caused by the COVID-19 pandemic. The SFA could be a valid option as it significantly reduces the number of treatment visits and the duration of the treatment, in addition to achieving comparable occlusal outcomes with those of the conventional OFA.[23,24]

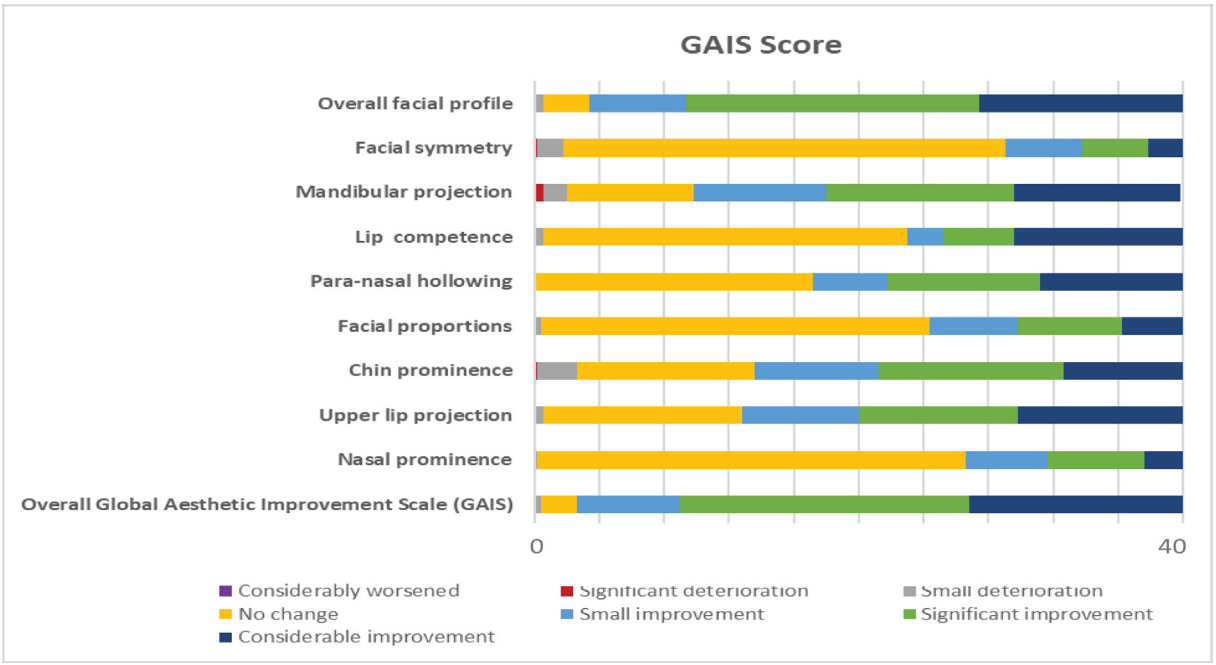

Fig. 3. Overall global aesthetic improvement scale (GAIS) for facial parameters. Data are expressed as a percentage.

Table 2
Correlation between facial parameters and overall GAIS score).

Facial parameters	Correlation coefficient (r)	p value
Facial profile	0.76**	<0.001
Nasal prominence	0.11	0.109
Upper lip projection	0.46**	<0.001
Chin prominence	0.37**	<0.001
Mandibular projection	0.49**	<0.001
Facial proportions	0.16*	0.023
Paranasal hollowing	0.40**	0.000
Lip competence	0.31**	0.000
Facial symmetry	0.12	0.091

*correlation significant at the 0.05 level (2-tailed); ** correlation significant at the 0.01 level (2-tailed)

Previous research investigating the aesthetic outcome of orthognathic surgery in patients with facial deformities has focused primarily on facial attractiveness.[3,2,25,26] Although much has been learned from these studies, limited information is available about the aesthetic improvement achieved. The present study reports the global aesthetic improvement of each case by comparing the initial facial soft tissue characteristics with the outcome. Previous studies have utilised a variety of 2-dimensional (2D) imaging techniques,[27,28] but with the advent of 3D imaging, a full representation of the morphology of the orofacial region is readily available, allowing a more realistic assessment of the aesthetic improvement.

Our previous studies have shown that the SFA significantly reduces treatment duration, with fewer clinical appointments, whilst also achieving comparable occlusal outcomes.[23] In addition, SFA patients have reported better quality-of-life measures in comparison with OFA patients, due to the elimination of the presurgical decompensation phase.[29] The current study has shown that there is no significant difference between the facial aesthetic outcomes of our SFA and OFA patients. Okamoto et al reported that soft tissue changes in SFA patients differed significantly from OFA patients, particularly in the amount of mandibular soft tissue projection.[30] However, their study was limited to cephalometric analysis and measurement of the soft tissue volume from cone-beam computed tomography (CBCT) scans, which may not have fully reflected the overall aesthetic improvement.

We acknowledge that the two study groups were not perfectly matched with respect to the magnitude of dentofacial deformity. It could be argued that the preoperative 3D facial images of the SFA patients showed less deformity, because the presurgical dental decompensation, which usually worsens facial aesthetics, was not present. However, the fact that the two groups showed comparable levels of improvement counteracts this argument, and the significant improvement in facial aesthetics achieved in the SFA group supports the wider application of this approach.

It would be difficult to conduct a prospective randomised trial to compare the aesthetic improvements between the SFA and OFA. Patients who are suitable for a SFA should be offered this management protocol, and we would consider it unethical to direct them to another treatment modality. In addition, a prospective RCT of this kind would be of questionable value, given the existing evidence that supports the advantages of the SFA.

Conclusions

The professional assessors perceived a similar level of improvement in overall facial aesthetics after orthognathic

surgery in both SFA and OFA patients. The findings of the current study suggest that comparable facial aesthetic outcomes are achieved in patients treated by either approach. This information is important to the multidisciplinary dentofacial deformities team when planning the treatment of orthognathic patients.

Conflict of interest

We have no known financial conflicts of interest.

Ethics statement/confirmation of patient permission

This study was approved by the local Clinical Governance Committee. The patients signed release forms that permitted use of their data and photographs for scientific research.

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