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Predictors of Oral Function and Facial Aesthetics Post Maxillofacial Reconstruction with Free Fibula Flap

Ahmed Alotaibi, MBBS
Abdulsalam Aljabab, BDS
Ghazi Althubaiti, MD

Background: For maxillofacial reconstruction, free flaps have largely replaced pedicled flaps. In a Saudi Arabian sample, we (1) assessed patients' postoperative oral function and facial aesthetics (OFFA), specifically pertaining to diet, speech intelligibility, oral opening, maxilla-mandibular occlusion, and facial aesthetics (all rated 0–2) following fibular free flap surgery; and (2) identified preoperative predictors of a novel 10-point OFFA rating scale combining these 5 parameters.
Methods: We conducted a retrospective review of the medical records of all patients who underwent free fibula flap surgery for nontraumatic maxillofacial reconstruction from 2010 to 2017 and were followed postoperatively for at least 6 months or until death.
Results: In 20 patients (10 female; mean age, 33.8; range, 7–56), the results were excellent, 19 of 20 patients ultimately resuming a normal diet, one a soft diet; good oral opening in 18; and normal speech, normal occlusion, and an aesthetically good result, each in 17 patients. Half the patients had a perfect (10/10) OFFA score at final assessment, whereas 2 scored 9/10, one 8/10, and two 6/10. On univariate analysis, patient age > 45, tumor of higher malignancy potential, comorbid illness, and adjuvant radiotherapy predicted a worse OFFA score, whereas a multivariate model combining comorbid illness ($P = 0.002$) and preoperative radiotherapy ($P = 0.010$) predicted a lower OFFA score, accounting for 57% of the variance ($R^2 = 0.57$).
Conclusion: In Saudi Arabia, fibular free flaps yielded overall very good to excellent results in 19 of 20 patients undergoing nontraumatic maxillofacial reconstruction.
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BACKGROUND

When physicians first started performing surgical procedures to correct facial defects remains uncertain, but some records date back to the 15th century. Nonetheless, it was during World War I that the field of facial reconstruction took a giant step forward, with countless surgical procedures performed to treat soldiers with facial injuries and burns.[1] Now, facial reconstructions are used for numerous other indications beyond war injuries, including facial gunshot wounds, animal maulings and, most commonly, after resection of head and neck malignancies.[2]

From the Departments of Plastic and Oromaxillofacial Surgery, King Fahd Medical City, Riyadh, Saudi Arabia.

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For decades, the primary objectives of cancer resections were to enhance survival and reduce the likelihood of tumor recurrence, while minimizing complications.[3] Now, however, cancer treatment increasingly focuses on optimizing function and quality of life (QOL),[3] particularly among patients with malignancies and other lesions involving the head and neck that require resection, given the profound effects that unwanted facial changes can have upon self esteem, self acceptance, interpersonal relationships, functionality, and overall QOL.[4] No longer is it enough to merely cover otherwise-exposed internal tissues. Now, orofacial function—including the ability to speak, chew, and swallow—and the patient's appearance are prioritized.[2]

For over 60 years, pedicle flaps have been used to cover major facial defects during facial reconstruction.[5] Over the past 2–3 decades, however, they have largely been replaced by free flaps, for reasons that include the former's

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limited reach and volume; and the latter's ability to provide additional tissues like bone, cover much larger defects, and prevent tethering scars.[2,6,7] Free flaps rely upon microsurgical techniques that continue to advance,[8] so current flap survival rates are as high as 98–100%.[9–11] However, levels of success achieved for patient function are less consistent, with most patients left with residual difficulties, especially related to speaking and eating. For example, in 1999, Cordeiro et al.[11] published their results with osseous free flaps in 150 consecutive patients who underwent reconstruction of surgically removed mandibles; and while flap survival and bony union rates were 100% and 97%, respectively, rates for function and aesthetics were considerably lower. Overall, 90% returned to either a normal or soft diet, but 10% required either a liquid diet or enteral feeding. Speech was considered normal/near normal in 63%, but unintelligible in 9%; while aesthetic outcome was judged as excellent-to-good in 59%, fair in 27%, and poor in 14%. More recently, Dassonville et al.[12] performed 213 free-flap procedures, achieving just a 94% flap survival rate, and similar percentages for diet and speech. To date, no such studies have been conducted in Saudi Arabia.

Objectives

- To assess patients' postoperative oral function and facial aesthetics (OFFA), specifically pertaining to diet, speech intelligibility, extent of oral opening, degree of maxilla-mandibular occlusion, and facial aesthetics
- To identify predictors of overall oral function and aesthetics, by combining these 5 parameters.

METHODS

We retrospectively reviewed the medical records of all patients who underwent free fibula flap surgery for maxillofacial reconstruction from 2010 to 2017, between plastic and oromaxillofacial surgery departments, excluding patients lost to follow-up within the first 6 months postoperatively; patients with chronic comorbidities that might significantly impact their overall health and oral function (eg, stroke, temporomandibular joint disease); and patients whose reconstruction was performed for facial trauma.

Functional and aesthetic results were rated for all patients on 3-point scales, ranging from 0 to 2, where 2 = normal and 0 = severe impairment. The following 4 functional outcomes were rated: diet, speech intelligibility, extent of mouth opening (finger breadths), and maxilla-mandibular occlusion. We also rated the patient's final facial appearance (Table 1). In addition, an overall OFFA score was created, ranging from 0 to 10, by adding the (0–2) scores for each of the 5 above-listed outcomes. These outcomes indicate either (1) how the patients were at the time of their last follow-up visit, among those still alive and disease-free, or (2) how patients were at their last follow-up visit before either tumor recurrence or death.

RESULTS

Twenty patients (10 female/10 male), from 7 to 56 years old (mean, 33.8) were deemed eligible for analysis.

Table 1. OFFA Scale for Evaluating Postoperative Outcomes after Maxillofacial Reconstruction

Oral diet
2—Normal
1—Moderately impaired, restricted diet, soft diet
0—Severely impaired or impossible, requiring maintenance of an enteral feeding tube
Speech intelligibility
2—Normal, easily intelligible
1—Moderately altered, intelligible with effort
0—Severely altered or impossible, patient unintelligible for the listener
Mouth opening
2—Normal, greater than 2 finger breadths
1—Moderately limited, between 1 and 2 finger breadths
0—Severely limited, less than 1 finger breadth
Aesthetic outcome
2—Good
1—Acceptable: moderate deformations, depressions, or disalignment
0—Poor: severe disfigurement, major deformations, depressions, or disalignment that immediately attract one's attention
Occlusion (Angle's classification):
2—Neutroclusion
1—Distoclusion
0—Mesioclusion

Counting cigarette smoking as a comorbidity, 5 patients had some comorbidity, 2 with hypertension, 2 diabetes, and 1 cigarette-smoking. Histologically, there were 7 ameloblastomas, 4 squamous cell carcinomas (SCCs), 3 ossifying fibromas, 2 giant cell tumors, 2 fibrous dysplasia, and 2 sarcomas, meaning that 6 tumors (4 SCCs, 2 sarcomas) were higher grade malignancies.

Five of the 20 patients had received adjuvant radiation therapy. Seventeen underwent mandibulectomy, and 3 had hemi-maxillectomy. All patients were offered the same facility-standard dental rehabilitation postoperatively. No patient experienced flap failure, though 3 had minor surgical-site complications: 2 fistulae, 1 wound dehiscence. Overall results, incorporating the 5 outcomes rating OFFA, were excellent, with 19 patients (95%; 95% confidence limits: 85.4–100%) ultimately tolerating a normal diet; 18 (90%; 76.9–100%) able to open their mouth beyond 2 finger breadths; and 17 (85%; 69.4–100%) having normal, easily understood speech and normal maxillo-mandibular occlusion (Table 3). At final follow-up, no patient required enteral feeding, or had unintelligible speech, oral opening < 1 finger breadth, maxilla-mandibular mesioclusion, or residual severe facial deformity.

Fifteen patients scored 10 of 10 on their final OFFA score, whereas 2 scored 9 of 10, one 8 of 10, and two 6 of 10. Of the 5 with a suboptimal score, 2 had SCCs and 1 a sarcoma. Of those scoring 9 of 10, 1 had a fibroma, the other a sarcoma, the former experiencing maxillomandibular distoclusion, and the latter a suboptimal aesthetic result. The 1 patient scoring 8 of 10 had a mandibular ameloblastoma and experienced moderately altered speech and maxillary-mandibular distoclusion. Both patients with a final OFFA score of 6 of 10 had an SCC. One was consuming a normal diet, but had moderately altered speech, reduced mouth opening, maxilla-mandibular distoclusion, and moderate aesthetic deformations. The other was similar, but had to eat a soft diet, and had normal maxilla-mandibular occlusion.

Table 2. Functional and Aesthetic Characteristics of the Patients

Characteristics	Description	n (n%)
Oral diet	Moderately impaired, restricted diet, soft diet	1 (5.0)
	Normal	19 (95.0)
Speech	Moderately altered, intelligible with effort	3 (15.0)
	Normal, easily intelligible	17 (85.0)
Mouth opening	Moderately limited, between 1 and 2 finger breadths	2 (10.0)
	Normal, greater than 2 finger breadths	18 (90.0)
Occlusion	Distoclusion	3 (15.0)
	Neutroclusion	17 (85.0)
Aesthetic	Acceptable: moderate deformations, depressions, or misalignment	3 (15.0)
	Good	17 (85.0)
Surgical site	No flap failure	20 (100)
	Fistula	2 (10.0)
	Wound dehiscence	1 (5.0)

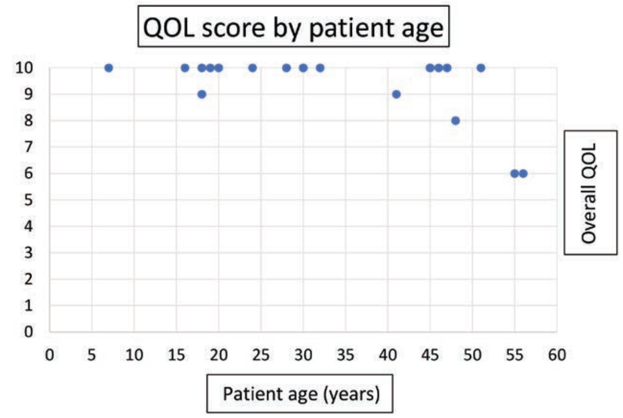

Fig. 2. OFFA scores by age. Note the clear increase in the number of suboptimum scores beyond age 40 years.

On the final OFFA score, males out-scored females (9.7 versus 9.1), and 8 of 10 males but just 7 of 10 females achieved a perfect "10" score; however, neither difference was statistically significant (t = 1.06, $P = 0.31$; $\chi2 = 0.27$, $P = 0.61$). There were nonstatistically, but clinically significantly higher scores among those with no versus some comorbid condition (9.9 versus 8.0; t = 2.08; $P = 0.11$); those with a lower- versus higher-malignancy potential lesion (9.8 versus 8.5; t = 1.57; $P = 0.17$); and those who received no versus some radiotherapy (9.8 versus 8.2; t = 1.73; $P = 0.16$; Fig. 1).

There was a statistically significant, moderately strong, inverse correlation between the final OFFA score and patient age (r = -0.54; $P = 0.014$), and statistically borderline higher scores in those ≤ 30 years old than those over 30 (9.9 versus 8.9; $P = 0.09$). Closer inspection identified a threshold of 45 years (Fig. 2), after which scores dropped appreciably (from 9.9 to 8.3), though this difference in means failed to achieve borderline statistical significance (t = 1.89; $P = 0.12$), likely due to only having 6 patients in the older group. Again, using 45-years-old as the threshold, 12 of 14 patients ≤ 45 (85.7%) had a perfect 10 final OFFA score, versus just 3 of 6 over 45 (50.0%; $\chi2 = 2.86$; $P = 0.091$).

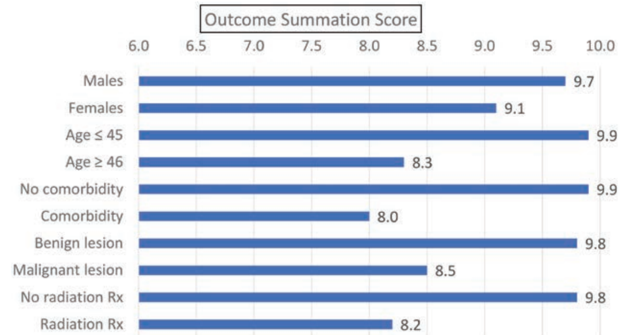

Fig. 1. Intergroup comparisons on the OFFA score. Nonstatistically, but clinically significantly higher scores are evident comparing those with vs. without a comorbid condition, those with a lower- vs. higher-malignancy potential lesion, and those who received no vs. some radiotherapy.

When each of the 4 factors—age > 45, higher malignancy potential, comorbidity, and adjuvant radiation therapy—was recoded as "1," with the opposite value recoded as zero, and these 4 values summed, a risk-stratification score, ranging from 0 to 4, was created, with 10 of 20 subjects scoring zero (having none of the 4 risk factors), 3 scoring "1," four scoring "2," one scoring "3," and 2 having all 4 risk factors. This risk-stratification score was strongly, inversely correlated with the final OFFA score (r = -0.75; $P < 0.001$), explaining 56% of the variance in the latter ($r^2 = 0.56$). Both patients with all 4 risk factors had the poorest OFFA score, of just 6 of 10, the average of which was significantly lower than that of the remaining 18 patients (6.0 versus 9.8; $P < 0.001$).

On stepwise linear regression analysis—entering patient age, patient sex, comorbidity, malignancy potential, and preoperative radiation therapy sequentially into a model by forward entry—only 2 variables remained in the final model predicting the final summed OFFA score: both the presence of a comorbid illness ($P = 0.002$) and preoperative radiation therapy ($P = 0.010$) predicted a lower summation score, together predicting 57% of the variance ($R^2 = 0.57$). Further post hoc analysis revealed that patients with a comorbid illness and patients who received preoperative radiation therapy were significantly older than their counterparts (51.0 versus 28.1 years, t = 4.02, $P = 0.001$; and 45.8 versus 29.8, t = 2.32, $P = 0.032$, respectively), potentially explaining the inverse relationship between the final OFFA score and age.

DISCUSSION

In our 20 patients, half male, half female, ranging from 7 to 56 years old, we observed no instance of free flap failure, and only 3 minor wound complications. Patients also generally attained excellent oral function and facial appearance, with 19 of 20 patients ultimately resuming a normal diet, the remaining a soft diet; good oral opening in 18 patients; and normal speech, normal occlusion, and an aesthetically good result, each in 17 patients. At final follow-up, no patient required enteral feeding, had unintelligible speech, was unable to achieve at least 1 finger-breadth of mouth opening, had severe malocclusion, or had a residual severe facial deformity. As such, our percentages compare favorably against those reported by others.[11–13]

However, closer inspection of our data identified patient subgroups who appeared to do less well. Those with lower self-reported OFFA at final follow-up included older patients (especially > 45-years-old); patients with some comorbid illness or smokers; patients whose surgically resected lesion was either an SCC or sarcoma versus a more benign lesion; and those who received adjuvant radiotherapy preoperatively.

The numbers we observed in our poorer outcome subgroups correspond more closely to those of a recently published study by Camuzard et al.[13] involving 77 patients, all having oral SCC. Besides all having a malignant lesion, their patients were older (mean age, 66 years); and though no data were provided on comorbidity or preoperative irradiation, 29% (versus our 5%) were smokers. At their 6-month postoperative evaluation, only 79%, 88%, and 83% of patients were consuming either a normal or near-normal oral diet, had intelligible speech, and had at least 1 finger breadth of oral opening, respectively; 6.5% remained dependent on enteral nutrition. The poorer results observed in the series of 150 patients treated by Cordeiro et al.[11] also might be attributed to higher risk patients, given that 68 patients had an SCC, 37 sarcoma, and 28 some other carcinoma; the patients also were older (mean age, 50 versus 34 in our series).

On the other hand, among 35 patients, age 10–24, with giant ameloblastomas, Li et al.[14] identified considerable patient dissatisfaction long-term, especially related to chewing and saliva control, suggesting that other factors, like tumor size, play a role in final outcomes. We note, however, that the results of Li et al.[14] were based upon subjective self-reported data and used entirely different measurement scales, rendering comparisons against our and others' results tenuous.

The differences we noted between the above-noted subgroups of patients, analyzed by univariate analysis, failed to achieve the a-priori threshold for statistical significance of $P \leq 0.05$, or even the delineation line for borderline significance at $P \leq 0.10$. However, this is almost certainly type II error due to insufficient statistical power, given the clinically significant magnitude of the differences. For example, patients ≤ 45-years-old, having no comorbidities, a clearly benign lesion, and not given preoperative radiation therapy averaged final summation scores for oral function and facial aesthetics of 9.9, 9.9, 9.8, and 9.8 of 10, respectively. Meanwhile, their counterparts' corresponding scores were 8.3, 8.0, 8.5, and 8.2. Put another way, no more than a single patient in any of the better outcome groups listed above had less than the highest score (2 out of 2) for any of the 5 oral function and facial appearance indices measured, while the average patient in the poorer outcomes group averaged 1½ to 2 such deficiencies.

To test this further, we created a risk-stratification score, from 0 to 4, indicating the number of poorer-outcome categories (age ≥ 46, comorbidity, malignant lesion, preoperative radiotherapy) each patient had, and there was a strong, highly significant inverse correlation between this risk-stratification score and patients' summed final outcome score, the former explaining an impressive 57% of the variance in the latter. In addition, both patients with all 4 risk factors had the poorest final summed function and aesthetics scores (6 of 10), with deficiencies in 4 of the 5 indices.

There also was a moderately strong inverse correlation between patient age and the summed final OFFA score, the former explaining 29% of the latter. Graphically, cutoffs at age 40 and 45 were identified. Below age 41, only 1 patient had less than a perfect OFFA score, that patient being an 18-year-old girl with slight maxillo-mandibular malocclusion (distoclusion). Above the 2 age cutoffs noted above, only 5 of 9 and 3 of 6 had perfect scores, respectively.

On stepwise linear regression, of the 4 risk factors listed above, both patient age and the lesion's malignant potential dropped out of the model, leaving the presence of a comorbid medical condition and preoperative radiotherapy as statistically significant predictors, even in such a small subject sample. Of the 5 patients with a comorbid condition, 1 diabetic and 1 hypertensive patient scored 6 of 10, and the 1 smoker scored 8 of 10; the remaining diabetic and hypertensive patient had perfect scores. This justifies our a-priori decision to consider cigarette smoking a comorbid condition. That older patients generally experienced worse OFFA long-term might be explained by those with the 2 identified predictors being significantly older than those without, by roughly 23 and 16 years, respectively.

Our study has limitations, especially the small subject sample, which likely led to repeated instances of type II error (failure to statistically confirm a real intergroup difference). It also reduces the generalizability of our results, relative to other much larger studies.[11,12] Nonetheless, that the differences we identified were so clinically significant, and that our risk stratification score was strongly correlated, and age moderately correlated with our summed OFFA score, suggests that the risk factors we identified in this small analysis certainly warrant further investigation.

We acknowledge that our summed score rating oral function and facial aesthetics—which, to facilitate communication, we have abbreviated to "OFFA score"—is a novel rating scale that has not yet been scientifically validated. However, we were unable to identify any published similar score combining measures of OFFA that had already been validated. We chose purposefully not to measure our patients' QOL—for which various instruments have been published, like the Functional Assessment of Chronic Illness Therapy for Head and Neck Cancer (http://www.facit.org/facitorg/questionnaires) and a European counterpart, the European Organization for Research and Treatment of Cancer_H&N (http://www.eortc.org/tools/)—because, beyond issues related to speech and eating, these instruments also ask patients to rate symptoms like fatigue and nausea, which could easily be impacted by comorbid illness, cancer recurrence, and/or ongoing treatments, rather than reflecting surgical results, especially long term. Moreover, all the Functional Assessment of Chronic Illness Therapy and European Organization for Research and Treatment of Cancer scales, both general and targeting specific cancers, include a broad range of emotional, social, and employment-related issues that, again, could easily be impacted by factors besides surgical results.

Another potential limitation of our study is that we did not include death as an outcome, nor other potentially important variables such as resected lesion size, the length of surgical procedure, the cumulative dose of preoperative radiation, and others. We omitted death as an outcome because our interest was purely assessing final OFFA related to the procedure. Nonetheless, especially given that patients with more aggressive lesions tended to do worse at their final assessment (albeit, before disease recurrence was detected), it is possible that the same factors that predestined them to ultimately experience disease recurrence also impacted their surgical result. Arguing somewhat against this is that the malignant potential of the lesion ultimately was rejected from a model we found to be highly predictive of OFFA.

Finally, our findings cannot be extrapolated to traumatic or other causes of facial defects, because we restricted our recruitment to patients with tumors. In general, traumatic facial deformities requiring reconstruction do less well, irrespective of the surgical approach.[15,16]

Despite these limitations, we feel our results strongly warrant further investigation. We also point out that, to our knowledge, ours is the first study to assess the viability and functionality of free fibula flaps to cover facial deformities post humor resection in Saudi Arabia.

CONCLUSIONS

Free fibula flaps have been proven to be very reliable repairing mandibular defects, associated with a very low incidence of free flap failure and generally acceptable complication rates. A careful preoperative assessment, particularly to discern any comorbid conditions or a history of radiotherapy, might help to identify patients at higher risk for poorer final OFFA.

Ahmed S Alotaibi, MBBS
King Fahad Medical City
Riyadh, Saudi Arabia
E-mail: Draotb@gmail.com

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