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Would augmentation genioplasty using patient-specific PEEK (Polyether Ether Ketone) implant meet patient's expectations?

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***Abstract*---**Introduction: Patient-specific implants become very valuable in restoring facial contours, including the chin area. Evaluation of patient satisfaction with the esthetic results should be a primary concern. Aim of study: To evaluate the success of augmentation genioplasty using patient-specific PEEK (Polyether Ether Ketone) implant in meeting patient's expectations. Methods: Seven patients were enrolled in this study. They were all having deficient chin that was managed by augmentation genioplasty using patient-specific PEEK implant. Preoperative clinical evaluation was performed for all patients. With the help of MIMICS and 3-MATIC soft wares, diagnosis, virtual planning and final implant design were done. Finally, STL file was sent for milling using PEEK material. Under GA, PSI was inserted through an intra-oral vestibular approach and fixed to the underlying bone using mini-screws. Patient expectations were evaluated by Face-Q questionnaire. Result: The study was conducted on 7 cases, 3(42.9%) of which were males and 4(57.1%) were females. The mean age of the cases was (22.00±1.29) years. All patients showed high degree of contentment with the procedure. Conclusions: Patient-specific PEEK implant can be used for chin augmentation with good esthetic results close to that of patients' expectations.

***Keywords*---**Genioplasty, PEEK, Patient-specific implant, Face-Q.

Introduction

The facial beauty depends on a balanced proportion of all facial features. Face appearance is a composite of all anatomic elements including teeth, bone, soft tissues and their relationship to one another. The chin plays a critical role in the aesthetic perception of the face. As a result of its relatively central location, the chin, along with the nose, affects the overall balance of the face. (Choe & Stucki-McCormick, 2000)

Genioplasty is the surgical reshaping of the chin either by osseous manipulation or implant augmentation. Despite the great advantages of osseous genioplasty, some complications were reported, as postoperative abnormal sensation of the lower lip, infection and improper healing of the overlying soft tissue, relapse and/or bone resorption, and injury to the root apices of the anterior teeth as well as unfavorable esthetics were all reported. Those are in addition to significant postoperative swelling and relative long postoperative recovery. (Bertossi et al., 2015; Schendel, 2010; Stanton, 2003)

On the other hand, augmentation genioplasty is characterized by being much more simple technique that needs less time and surgical experience for its performance. Moreover, there is no bony cuts and less soft tissue reflection required for implant insertion with subsequent decrease in postoperative pain and discomfort. (Karras & Wolford, 1998; Mittal et al., 2017)

However, augmentation technique is limited to type II chin, microgenia, as well as those with narrow chin that would get the advantage of the more natural appearance achieved by augmentation rather than osseous genioplasty. (Choe & Stucki-McCormick, 2000; Frodel, 2005; Stanton, 2003)

Different types of augmentation materials were used in genioplasty. The most commonly used grafts are the alloplastic ones. Different alloplastisc materials have been introduced. However, none of them could fulfill the criteria of an ideal implant. (Aynehchi et al., 2012; Binder et al., 1981)

Polyether ether ketone (PEEK) was originally developed as a semicrystalline polyaromatic linear polymer for use in spinal reconstruction. As an augmentation material, PEEK mimics bone in terms of strength (113 vs. 115 MPa) and elasticity (3.6e4.1 vs. 8e24 GPa); is easily modified in the operating room; may be re-sterilized and reused after a quiescent period in the case of failure from infection; and is durable. This is in addition to its imaging properties being radiolucent and non-magnetic which guarantee no artifacts in CT-scans and MRI. (Nieminen et al., 2008; Wenz et al., 1990)

Aim of the Work

To evaluate the possibility of using patient-specific PEEK implant in chin augmentation with good esthetic result that meet patients' expectations.

Subjets & Methods

Participants

Seven patients were selected from the out-patient clinic of Oral and Maxillofacial Surgery and Orthodontic Departments, Faculty of Dentistry, Cairo University seeking genioplasty for correction of retruded chin. All patients were adults with their age above 18 years.

Proper intra and extra-oral examination was performed to ensure that the patients does not need any skeletal operations in the mandible other than genioplaty as well as the absence of any pathological lesion related to the chin area.

Procedure

Diagnosis was made for all participants included in this study on clinical features and confirmed on basis of radiographic findings. A thorough history was collected from the patients including personal data, past and present medical and dental histories. Preoperative photographs of the face in natural head position were taken (frontal at rest, frontal at smile, profile at rest images), for each patient.

Preoperative CBCT was taken with patient's head is in natural head position and was acquired as "Digital Imaging Communication in Medicine" (DICOM) format.

The patients' CBCT was imported into surgical planning software. Segmentation process was then performed. Threshold level was adjusted and 3D rendering performed. Three anatomical planes; Midsagittal, coronal and Frankfort were created perpendicular to each other. Virtual osteotomy cut of the chin was performed on the 3D model. Splitting was done to allow virtual repositioning of the chin segment to the previously planned position. This was followed by subtraction of the newly positioned chin from the underlying original mental bone to get the required chin implant. Vents were created by adding to the implant design through and through cylinders followed by their subtraction to get those vents where the fixation screws can be inserted. The final PSI design was exported as a stereolithographic format (STL) to be sent and milled by a five-axis milling machine from pure non-contaminated PEEK blocks.

For the surgical procedures, all the patients were operated upon under general anesthesia (GA) using naso-endotracheal intubation through intra-oral approach. A vestibular incision was performed to expose the mental area. The implant was inserted to fit the underlying bone. After confirming the proper seating of the implant, drilling through the vents to the bone was performed under copious irrigation and fixation of the implant was done with miniscews. Finally, the overlying soft tissue was closed in layers using 3.0 resobable suture.

For the postoperative care, compression packs were applied and antibiotics were prescribed with strict oral hygiene measures were illustrated to all patients.

Fulfillment of patients's expectations was evaluated by using Face-Q chart "Expectations". Patients were allowed to complete the chart within 1 month postoperatively.

Statistical Methods: Categorical were presented as frequency and percentage values. Numerical data were presented as mean and standard deviation values and were tested for normality using Shapiro-Wilk test. Statistical analysis was performed with R statistical analysis software version 4.1.2 for Windows.

Results

The current prospective study was conducted on seven patients with retruded chin, 3(42.9%) of them were males and 4(57.1%) were females. The mean age of the cases was (22.00±1.29) years.

All the patients underwent chin advancement by augmentation genioplasty using patient-specific PEEK implant.

1. Clinical results

1.1 Intraoperative complications

There were no significant complications encountered intraoperatvely. All the applied implants were properly fit to the underlying mentum with no modification were required in any of the cases.

1.2 Postoperative follow-up

All patients showed uneventful healing with mild edema as well as paresthesia of the lower lip and chin. Both were resolved within 2-3 weeks. Three patients showed mild ecchymosis with total resolution within 2 weeks.

2. Radiographic results:

All the implants were well-fit to the underlying host bone and were properly fixed with the inserted screws.

3. Face-Q (expectation chart):

All the patients completed the Face-Q expectations chart within 1 month postoperatively. After transforming the sum of patients' scores using expectations conversion table, two of the patients scored 62 %, one patient scored 77 %, two patients scored 83 % and two patients scored 90 %.

Discussion

Seven patients were selected from the out-patient clinic of Oral and Maxillofacial Surgery and Orthodontic Departments, Faculty of Dentistry, Cairo University seeking genioplasty for correction of retruded chin. For all patients, preoperative photographs as well as CBCT were taken. The latter was acquired as "Digital

Imaging Communication in Medicine" (DICOM) format and was imported to MIMICS and 3-Matic soft wares by which virtual planning and implant design were performed. The final implant design was then imported as STL files for the construction of PSI from pure PEEK blocks.

Intra-operatively, the implant was inserted and fixed to the chin with miniscrews. Degree of fulfillment of Patient's expectation with the final outcome was evaluated using Face-Q questionnaire.

During the era of CAD/CAM technology, computer-assisted virtual planning in orthognathic surgeries, including genioplasty, with the creation of computer-guided stents and/or templates to transfer the initiated planning to the operating room became widely adopted. This is in addition to the introduction of patient-specific implants to augment any of the facial contour defects. (Gaber et al., 2017; Hsu et al., 2013; Li et al., 2020; Rückschloß et al., 2020; J. Xia et al., 2000)

As the main goal of genioplasty is the esthetic outcome, meeting patient's expectations with the end-result is highly essential to evaluate the actual success of the procedure. Moreover, it could be a helpful way to improve patient-care service (Cano et al., 2009; Klassen et al., 2010)

In this study, patients' expectations were evaluated using Face-Q questionnaire, patient expectations chart in specific. The chart includes several questions to be answered as 'definitely disagree', scores 1, 'somewhat disagree', scores 2, 'somewhat agree', scores 3, and 'definitely agree', scores 4. The sum of these scores were calculated for each patient and by using conversion table for the chart the raw summed scale scores were transformed into a score from 0 to 100, with higher scores indicates for higher degree of satisfaction. The scores in this study ranged from 62-90 % with average 76 % that indicates for good achievement regarding to patients' expectations.

Conclusions

Patient-specific implant using PEEK can be an applicable technique for augmentation genioplasty in cases with retruded chin that can fulfill to great extent patients' expectations. Face-Q questionnaire is a reliable tool to be used in evaluating degree of patient satisfaction and meeting his/her expectations.

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