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Original article

Maxillomandibular Advancement for OSA: Serious Complications and Failures

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ABSTRACT – Objective: *The focus of this report was to analyze patients who presented for second opinion due to complications and failure following maxillomandibular advancement (MMA) performed elsewhere.* **Materials and Methods:** *During a five-year period, 16 patients presented with complications and/or failure of MMA. The indication for treatment was obstructive sleep apnea (OSA). Analysis of treatment records including plane radiography and/or cone beam computed tomography (CBCT), progress photographs and clinical examination were performed.* **Results:** *Complete clinical and imaging records were available in all patients for analysis. Thirteen patients were surgical failures with advancement ranging from -4 to 5 mm. Five of the 13 patients had limited advancement at the initial surgery, and eight patients had hardware failure that required removal with resultant retrodisplacement of the mandible. Due to complications occurring in 11 patients, additional surgery ranging from two to six additional procedures after the initial operation was required. The complications included hardware failure (ten patients) that led to bone segment displacement (eight patients), non-union of the maxilla (two patients), non-union of the mandible (eight patients), chronic facial and/or joint pain (five patients), facial nerve injury (two patients), complete anesthesia of the lip/chin (five patients) and severe malocclusion (four patients).* **Conclusions:** *Although MMA is typically a predictable operation with excellent outcomes, failure of improvement and severe long-term sequelae from surgical complications are possible. Surgical precision with sufficient skeletal advancement for airway improvement and stable skeletal fixation is necessary to achieve a successful outcome.*

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1. Introduction

Since the report of improved obstructive sleep apnea (OSA) following mandibular advancement in 1979[2], skeletal advancement surgery has evolved from a last stage operation of the phased surgical protocol to the primary, single stage maxillomandibular advancement (MMA) in properly selected patients. Over the past 25 years, the authors have extensively studied the relationship between the airway and maxillofacial skeleton. More importantly, the principles of maximizing skeletal advancement in improving OSA, maintaining proper facial balance and occlusion while minimizing complications have been established[1,3-21]. As the operation became widely performed, an increasing number of patients have presented for second opinion and management due to surgical complications and failure. The aim of this report was to analyze the surgical results of these patients to understand the factors that contributed to poor outcomes.

2. Materials and Methods

During a five-year period, 16 patients presented with complications and/or failure of MMA in improving OSA. Analysis of treatment records including plane radiography and/or cone beam computed tomography (CBCT), progress photographs, and clinical examination were performed to understand factors contributing to poor results. The outcomes were assessed as either failure in improving OSA and/or surgical complications that required additional operations and resultant long-term sequelae.

3. Results

Complete clinical and imaging records were available in all 16 patients for analysis. The group consisted of four women and 12 men with a mean age of 37.9 years (range 15-50 years). Thirteen patients were surgical failures with the final advancement ranging from -4 to 5 mm. Five of the thirteen patients had limited advancement at the initial surgery, and eight patients had hardware failure that required removal with resultant retrodisplacement of the mandible. Due to complications occurring in 11 patients, further surgery ranging from two to six additional procedures after the initial operation was necessary. The complications included hardware failure (ten patients) that led to bone segments displacement (eight patients), non-union of the maxilla (two patients), non-union of the mandible (eight patients), chronic facial and/or joint pain (five patients), facial nerve injury (two patients), complete anesthesia of the lip/chin (five patients) and severe malocclusion (four patients).

4. Case Reports

4.1. Case n° 1

A 44-year-old man with severe OSA underwent MMA after failed uvulopalatopharyngoplasty (UPPP). The operation was uneventful, with a reported 10 mm skeletal advancement. Due to persistent OSA symptoms, the patient presented for evaluation and second opinion. Analysis of the imaging records demonstrated a 4 mm maxillomandibular advancement, resulting in insufficient airway improvement (Fig. 1).

4.2. Case n° 2

A 32-year-old man with moderate OSA underwent MMA. The operation was uneventful, with a reported 10 mm skeletal advancement. Due to persistent OSA symptoms, the patient presented for evaluation and second opinion. Analysis of the imaging records demonstrated a 3 mm maxillomandibular advancement, resulting in insufficient airway improvement (Fig. 2).

4.3. Case n° 3

A 31-year-old man with moderate OSA underwent MMA. The operation was uneventful, with a reported 10 mm skeletal advancement. Due to persistent OSA symptoms, the patient presented for evaluation and second opinion. Analysis of the imaging records demonstrated 3 mm maxillomandibular advancement (red arrows), resulting in insufficient airway improvement (Fig. 3).

4.4. Case n° 4

A 48-year-old woman with moderate OSA underwent MMA. Due to multiple hardware failures and infections, the patient underwent six additional operations (Fig. 4). Unfortunately, the patient developed long-term facial and temporomandibular joint (TMJ) pain with difficulty in mastication and speech. The patient's OSA also worsened due to retrodisplacement of the mandible (-4 mm from baseline).

Figure 1
A 44-year-old man with severe OSA underwent MMA with a reported 10 mm skeletal advancement. (a) Preoperative panoramic radiograph. (b) Postoperative panoramic radiograph. Note the limited advancement (white arrows).

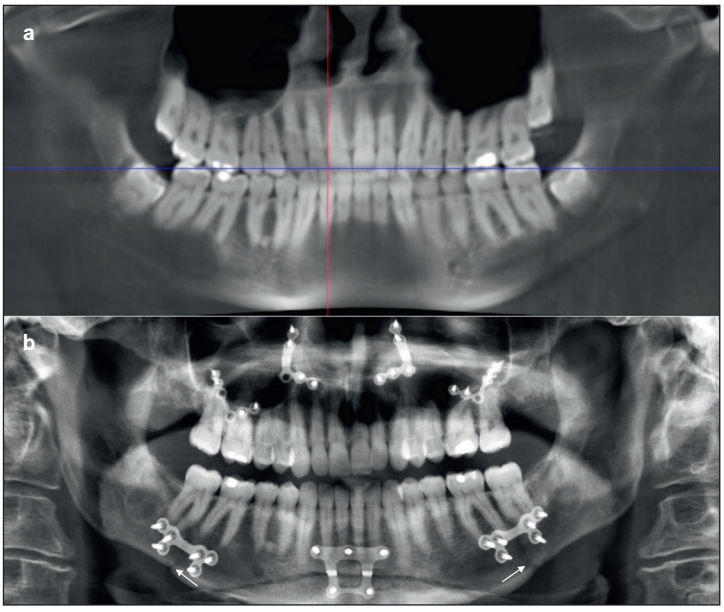

Figure 2
A 32-year-old man with moderate OSA underwent MMA and genioplasty with a reported 10 mm advancement. (a) Preoperative panoramic radiograph. (b) Postoperative panoramic radiograph. Note the limited advancement (white arrows).

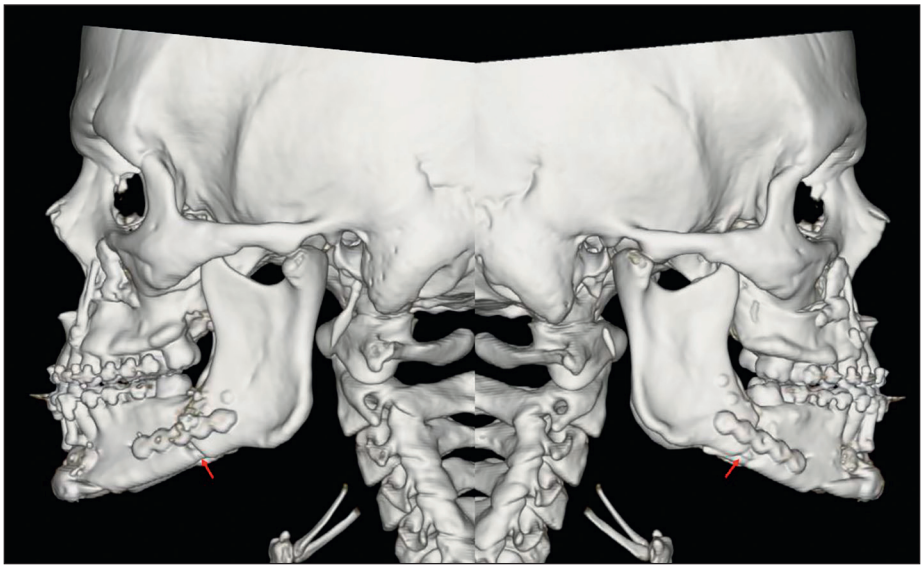

Figure 3
A 31-year-old man with moderate OSA underwent MMA and genioplasty with a reported 10 mm advancement. Note the limited 3 mm advancement (red arrows).

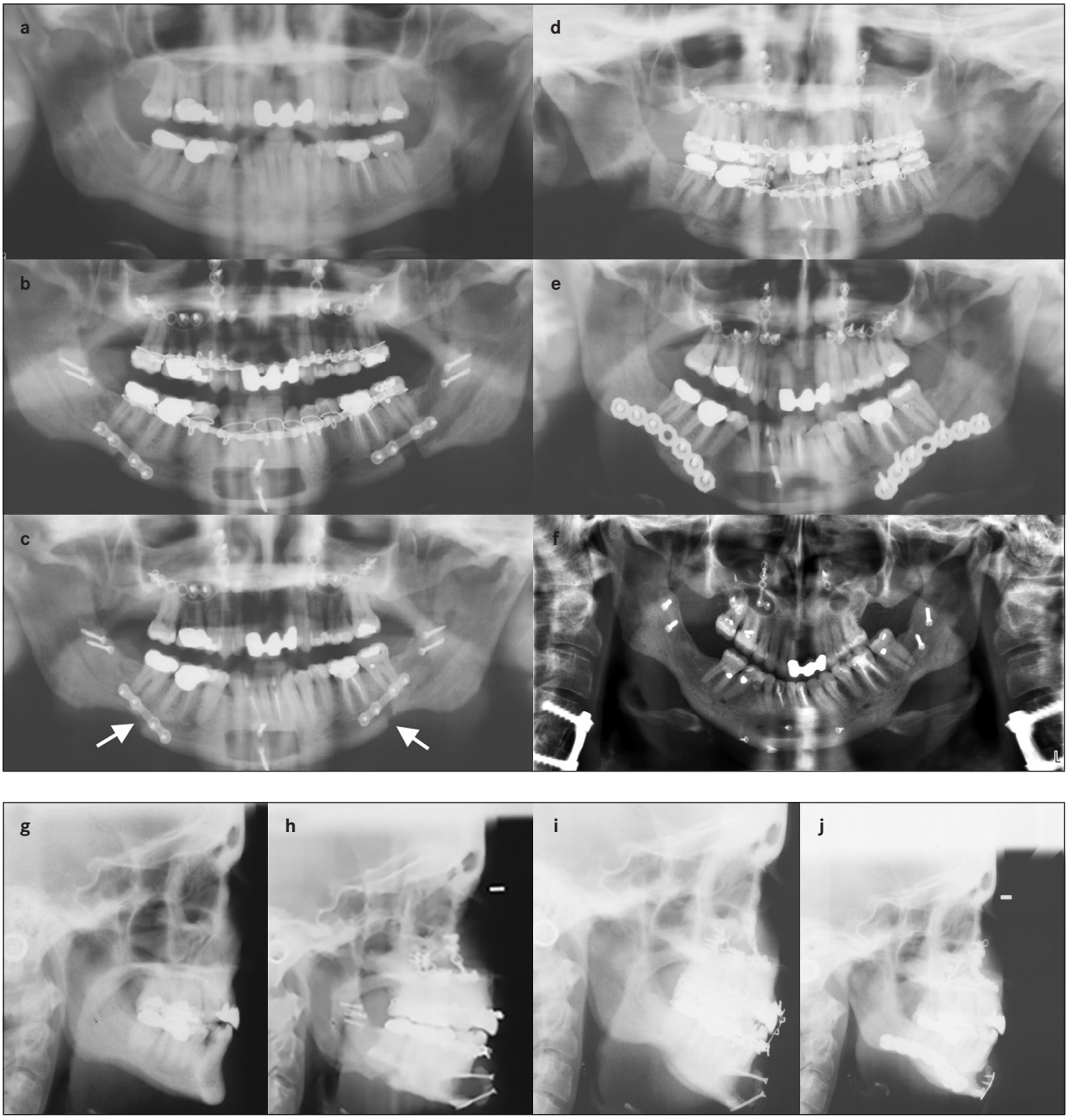

Figure 4

A 48-year-old woman with moderate OSA underwent MMA and genioglossus advancement. (a) Preoperative panoramic radiograph. (b) Postoperative panoramic radiograph. (c) Postoperative panoramic radiograph demonstrating bilateral hardware failure and mandibular displacement (white arrows). Note the endodontic treatment of the mandibular anterior teeth due to genioglossus advancement. (d) Panoramic radiograph demonstrating persistent infection necessitating mandibular hardware removal that resulted in bone segment displacement and retrodisplacement of the mandible. (e) Panoramic radiograph demonstrating rigid fixation of bilateral mandible with reconstruction plate. Note the revision surgery at the genioglossus advancement site due to persistent infection. (f) Panoramic radiograph demonstrating revision MMA due to continual non-union of the maxilla and the mandible. Note further revision surgery at the genioglossus advancement site. (g-j) Sequential lateral cephalometric radiograph demonstrating the mandible retrodisplaced 4 mm from baseline.

4.5. Case n° 5

A 36-year-old man initially requested MMA from the authors but was advised to continue positive airway ventilation treatment. The patient decided to proceed with MMA elsewhere. Due to hardware failure and infection, the patient underwent two additional operations after the initial MMA procedure. The patient presented for second opinion due to persistent mandibular pain and inability to masticate after three operations. The evaluation demonstrated pathologic fracture with continuity defect of the right mandible. The patient was subsequently lost to follow up (Fig. 5).

4.6. Case n° 6

A 45-year-old man with severe OSA underwent MMA. Due to multiple hardware failures and infections, the patient underwent hardware removal and subsequent mandibular reconstruction with iliac bone grafts via external approach.

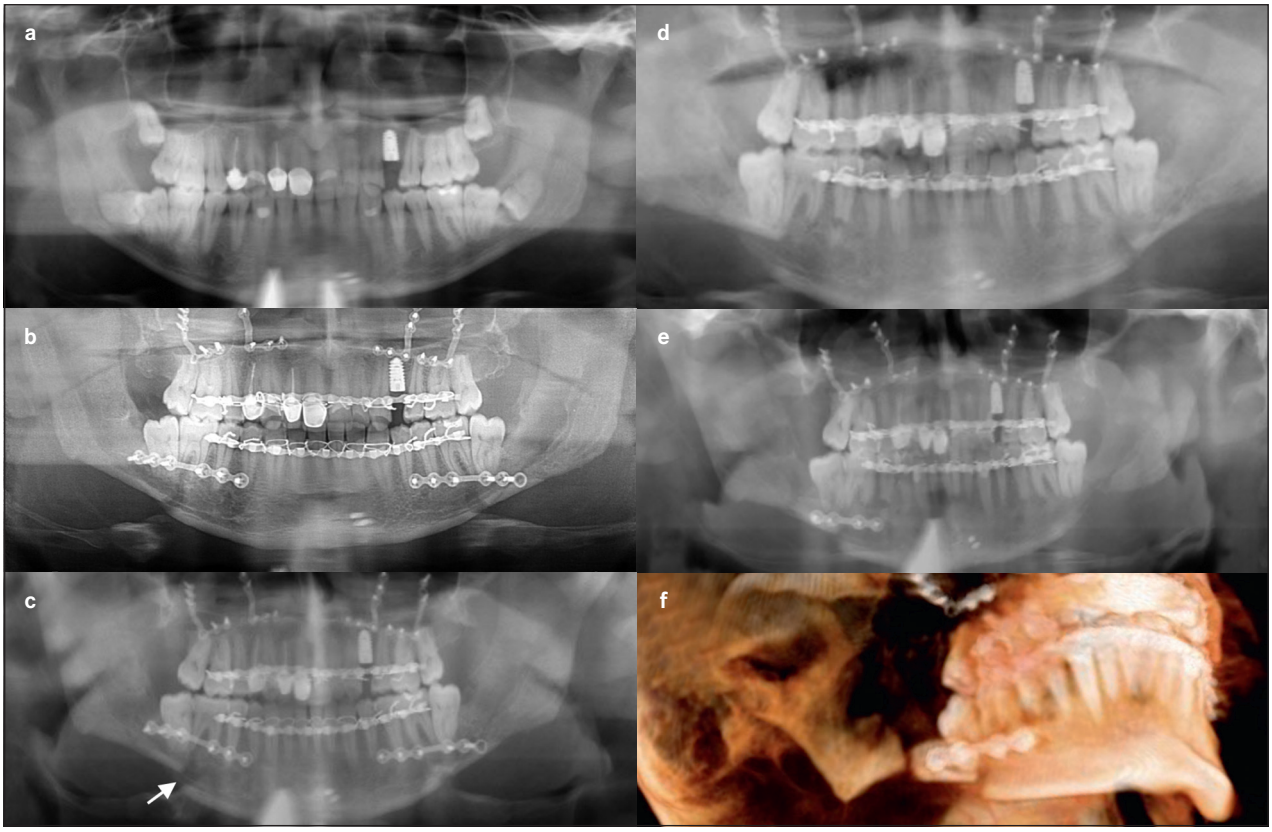

Figure 5

A 36-year-old man with severe OSA underwent MMA. (a) Preoperative panoramic radiograph. (b) Postoperative panoramic radiograph. (c) Postoperative panoramic radiograph demonstrating right mandibular hardware failure and mandibular displacement (white arrow). (d) Panoramic radiograph demonstrating persistent infection necessitating mandibular hardware removal with resultant bone segment displacement and retrodisplacement of the mandible. (e) Panoramic radiograph demonstrating rigid fixation to stabilize the right mandibular segments. Note the displaced bilateral mandibular proximal segments. (f) CBCT demonstrating a pathologic fracture proximal to the fixation plate, resulting in continuity defect of the mandible.

The patient presented for second opinion due to chronic pain of the mandible. No further surgery was advised, and the patient was referred to Neurology for chronic pain management (Fig. 6).

4.7. Case n° 7

A 30-year-old man with moderate OSA underwent MMA due to persistent symptoms following distraction osteogenesis maxillary expansion (DOME). The patient presented for second opinion with continual OSA symptoms. The evaluation demonstrated a 5 mm skeletal advancement, maxillary mobility, chronic infection involving the maxillary central incisors, and significant bone defect between the central incisor roots. The patient underwent endodontic therapy with guarded prognosis of the maxillary central incisors and is anticipated to undergo reconstruction for the maxillary non-union (Fig. 7).

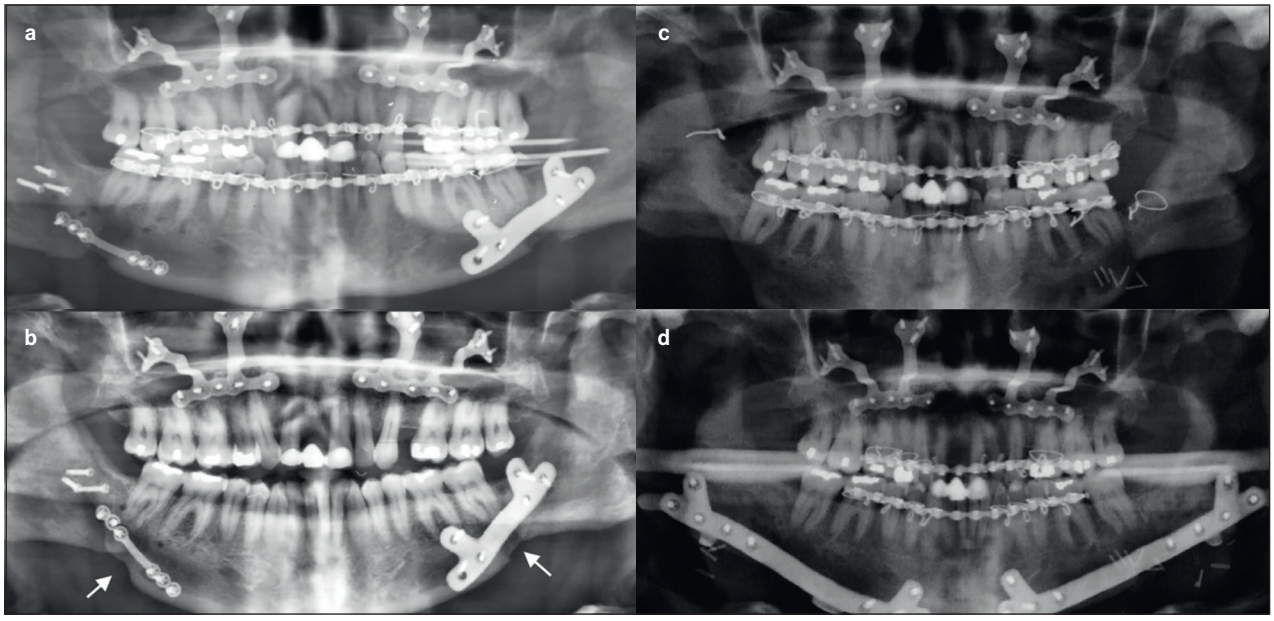

Figure 6

A 45-year-old man with severe OSA underwent MMA. (a) Postoperative panoramic radiograph. (b) Subsequent panoramic radiograph demonstrating bilateral mandibular hardware failure and mandibular displacement (white arrows). (c) Panoramic radiograph demonstrating hardware removal and further displacement of the mandibular segments. (d) Panoramic radiograph demonstrating bilateral mandibular reconstruction with iliac bone graft via external approach.

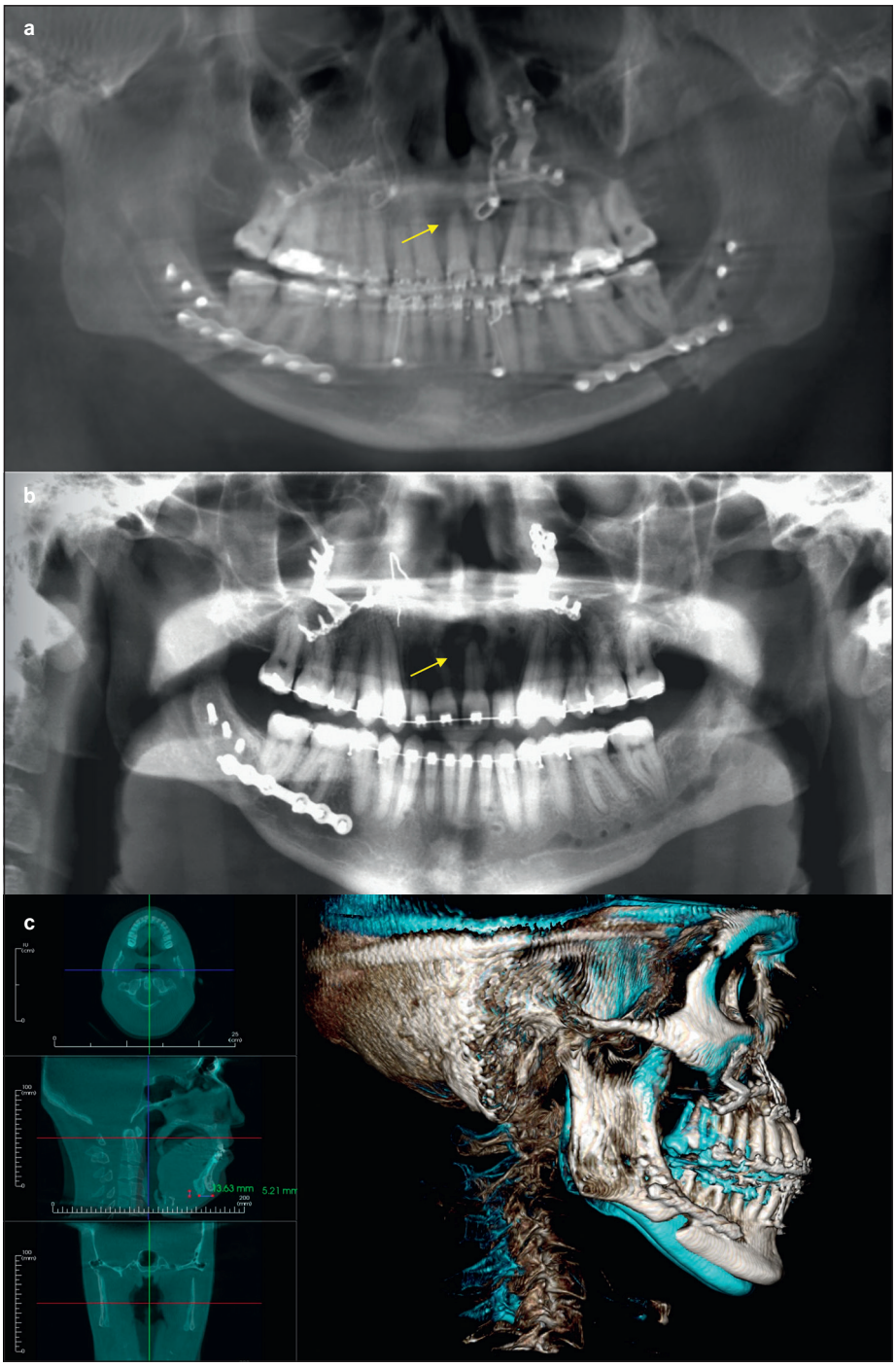

Figure 7

A 30-year-old man with moderate OSA underwent MMA due to persistent symptoms following DOME. (a) Postoperative panoramic radiograph. Note the large periapical radiolucency at tooth #9 (yellow arrow). (b) Postoperative panoramic radiograph demonstrating left mandibular hardware removal due to infection. Note the large periapical radiolucency at tooth #9 (yellow arrow). (c) CBCT demonstrating 50% of the advancement was from autorotation of the maxillomandibular complex that does not improve the airway. The effective skeletal advancement was 5 mm. The patient was noted to have a maxillary non-union and is anticipated to undergo reconstruction of the maxilla.

4.8. Case n° 8

A 45-year-old woman with moderate OSA underwent MMA and genioplasty. The patient developed facial and TMJ pain, absence of maxillary tooth show at full smile, and inability to close her lips. Subsequent surgery with maxillary hardware removal did not improve her symptoms, and the patient presented for second opinion. The evaluation demonstrated over-shortening of the maxilla due to excessive maxillary impaction, facial nerve injury, and mentalis muscle dysfunction. Revision maxillary surgery improved the maxillary tooth show, but facial pain and mentalis muscle dysfunction with lip incompetence persisted (Fig. 8).

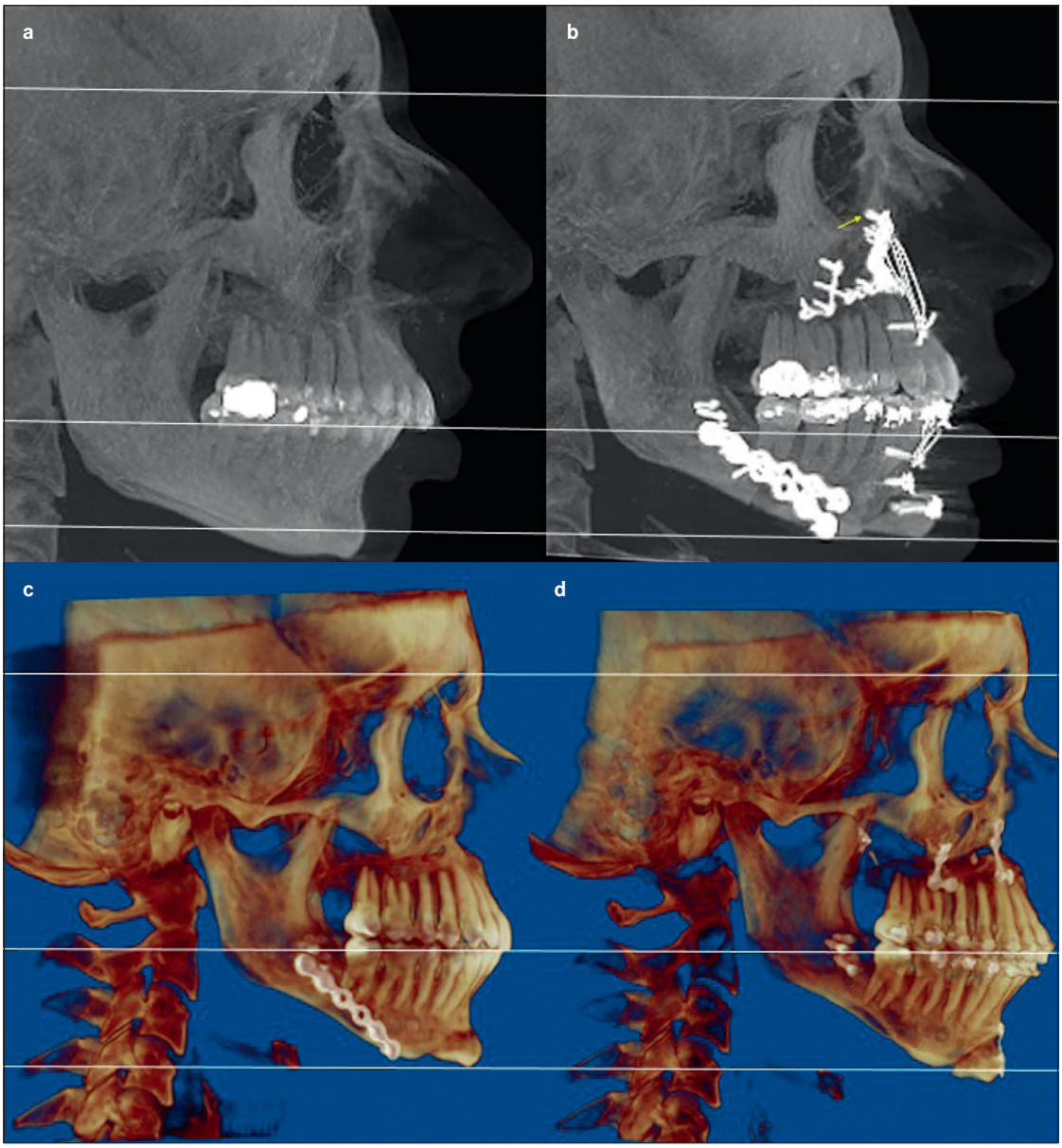

Figure 8

A 45-year-old woman with moderate OSA underwent MMA and genioplasty. The patient presented for second opinion due to facial and TMJ pain, absence of maxillary tooth show at full smile and inability to close her lips. (a) Preoperative lateral view. (b) Postoperative lateral view demonstrating excessive maxillary shortening. Note the maxillary plate/screws at the orbital rim. (c) The patient presented with second opinion with continual problems despite maxillary hardware removal. (d) Postoperative lateral view demonstrating revision maxillary surgery with bone grafting for maxillary lengthening. Revision genioplasty was also performed. The tooth shows improved but facial pain and mentalis muscle dysfunction with lip incompetence persisted.

4.9. Case n° 9

A 39-year-old man with moderate OSA underwent MMA due to failure of DOME, lingual tonsillectomy, nasal septoplasty, and turbinate reduction. The patient developed malocclusion postoperatively and presented for second opinion. The evaluation demonstrated bilateral mandibular non-union with infection on the left side.

The patient required two additional operations for mandibular debridement, fixation, and long-term intravenous antibiotics. Unfortunately, due to minimal bone contact due to the initial surgical design, the prognosis is guarded. Potential future reconstructive surgery with bilateral iliac crest bone grafting via external approach may be required when the infection resolution is assured (Fig. 9).

4.10. Case n° 10

A 30-year-old man with moderate OSA underwent MMA and genioplasty following failure of DOME, nasal septoplasty, and turbinate reduction. Due to bilateral mandibular infection, hardware removal and oral fistula closure was performed. The patient presented for second opinion with worsening malocclusion and return of OSA symptoms.

Evaluation demonstrated mandibular non-union that required debridement of necrotic bone and mandibular stabilization. Due to persistent OSA symptoms, the patient returned to positive airway therapy (Fig. 10).

5. Discussion

Despite the predictability and success of MMA in improving OSA, this report demonstrated that severe complications and failure are possible. Moreover, long-term sequelae due to complications can occur.

It is essential to maximize the advancement while taking consideration of the facial esthetics to enhance the success of MMA in improving OSA. Due to the impact of skeletal advancement on facial changes, the surgical plan must be a collaborative decision by the surgeon and the patient. Surgical precision is essential to minimize complications and ensure surgical stability. The osteotomy design and the fixation methods must be carefully planned as many of the complications reported were due to improper osteotomy technique and fixation failure. Proper adaptation of the plates and maximizing the bone contact between the mandibular segments are essential in orthognathic surgery. When large skeletal movement is performed to improve OSA, their importance cannot be overemphasized (Fig. 11). It was evident that despite the use of large plates for the mandibular fixation, failures occur. One must understand that regardless of the size of the plates/screws, a basic rigid fixation technique with precision plate adaptation must be performed since improper plate adaptation could cause displacement of the bone segments, leading to mandibular mobility, infection, and non-union, as demonstrated in this report.

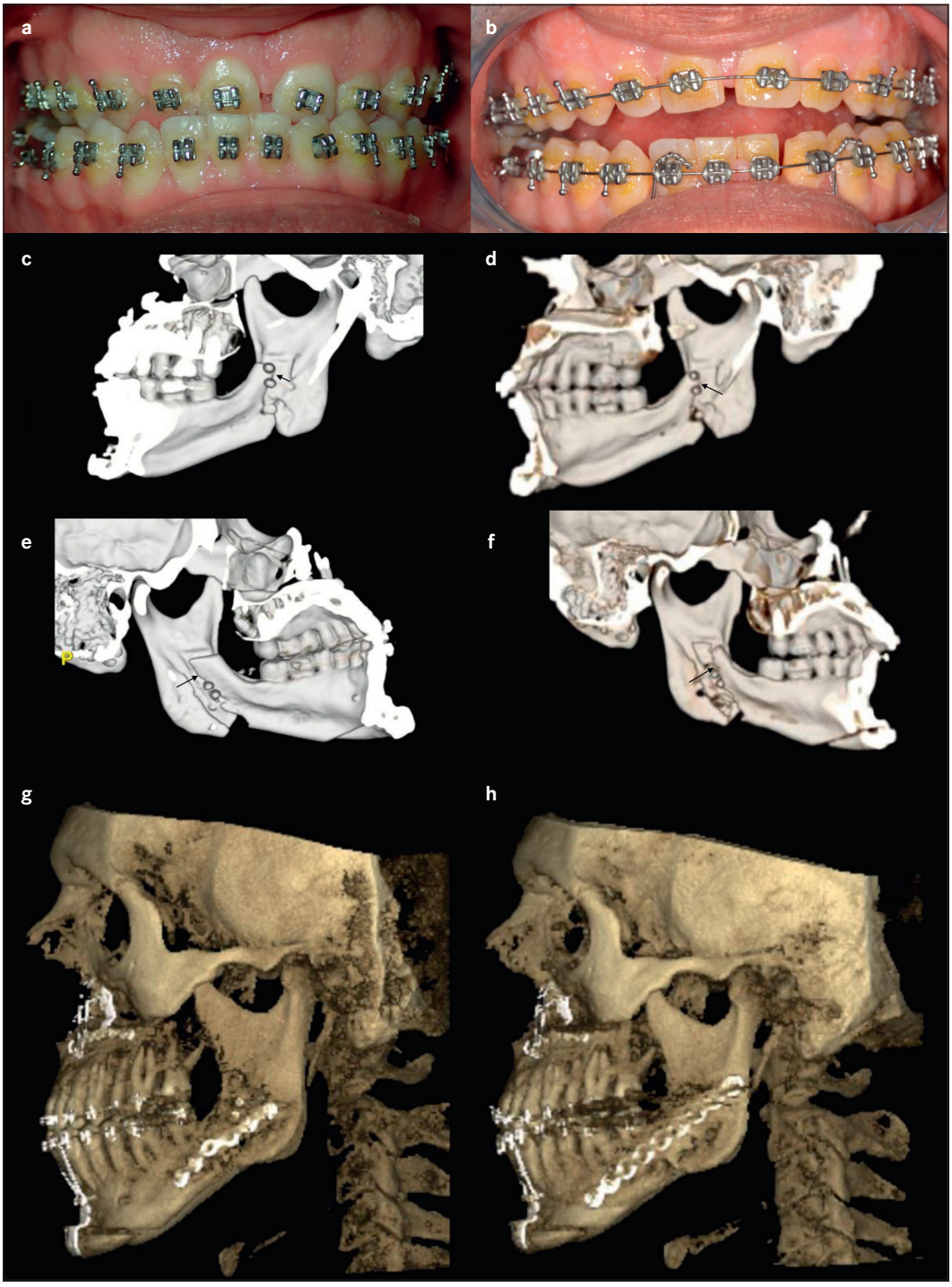

Figure 9

A 39-year-old man with moderate OSA underwent MMA due to failure of DOME, lingual tonsillectomy, nasal septoplasty and turbinate reduction. The patient developed malocclusion postoperatively and presented for second opinion. (a) Preoperative occlusion. (b) Postoperative occlusion upon presentation for second opinion. (c) Immediate postoperative CBCT demonstrating poor osteotomy design with inadequate bone overlap (black arrow). (d) CBCT upon presentation for second opinion. Note the displacement of the mandibular segments and bone resorption (black arrow). (e) Immediate postoperative CBCT demonstrating poor osteotomy design with inadequate bone overlap (black arrow). (f) CBCT upon presentation for second opinion. Note the displacement of the mandibular segments and bone resorption (black arrow). (g) CBCT upon presentation for second opinion for mandibular instability. (h) CBCT following debridement and fixation of mandibular segments.

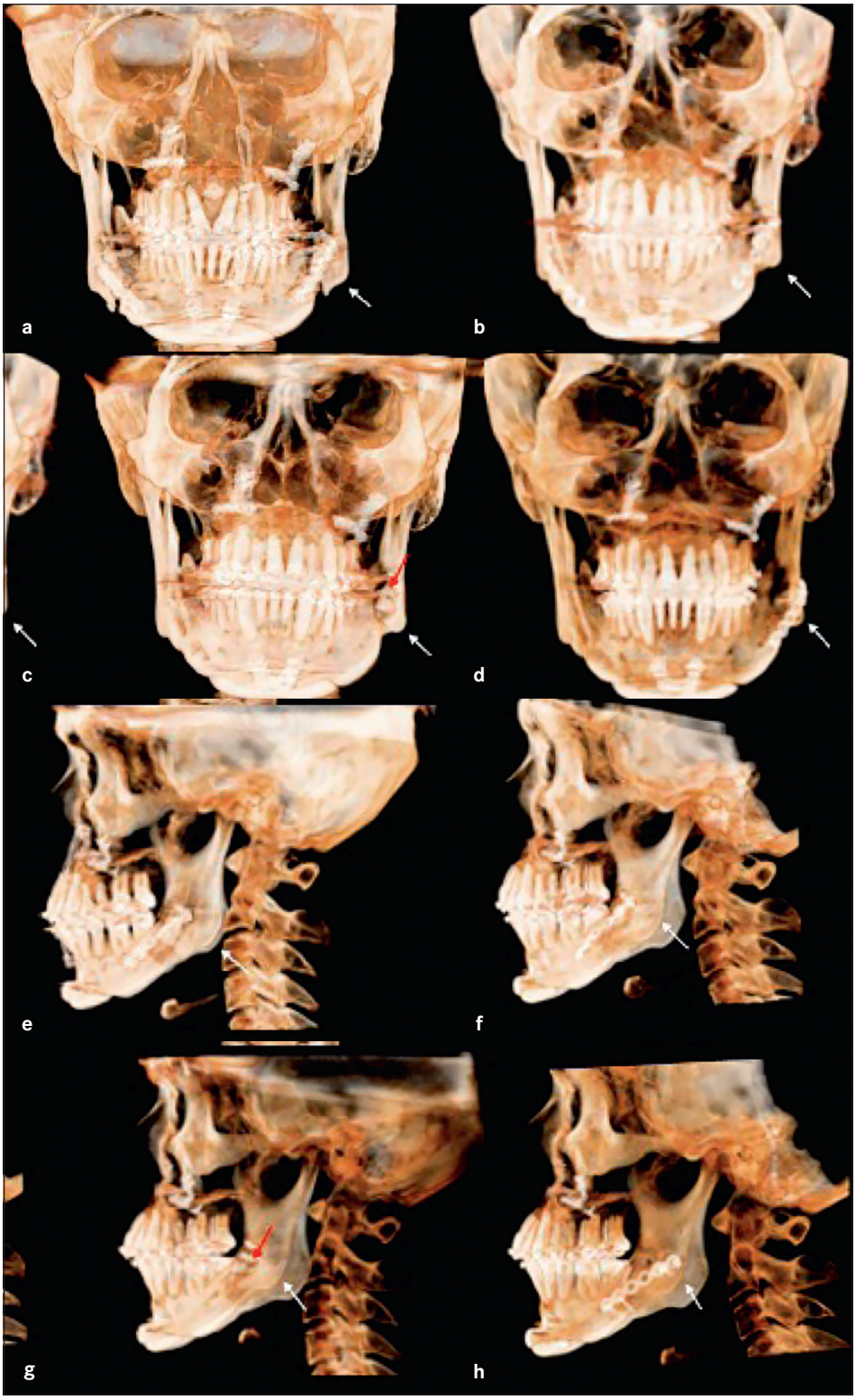

Figure 10

A 30-year-old man with moderate OSA underwent MMA and genioplasty due to failure of DOME, nasal septoplasty and turbinate reduction. The patient underwent a second operation for bilateral mandibular debridement, hardware removal and oral fistula closure. Due to malocclusion and worsening of OSA symptoms, the patients presented for second opinion. The patient was diagnosed with non-union of the mandible and underwent debridement of infected bone sequestrum and mandibular fixation. Sequential CBCT frontal (a-d) and lateral (e-h) images demonstrating infected bone sequestrum (red arrows) and mandibular displacement overtime (white arrows).

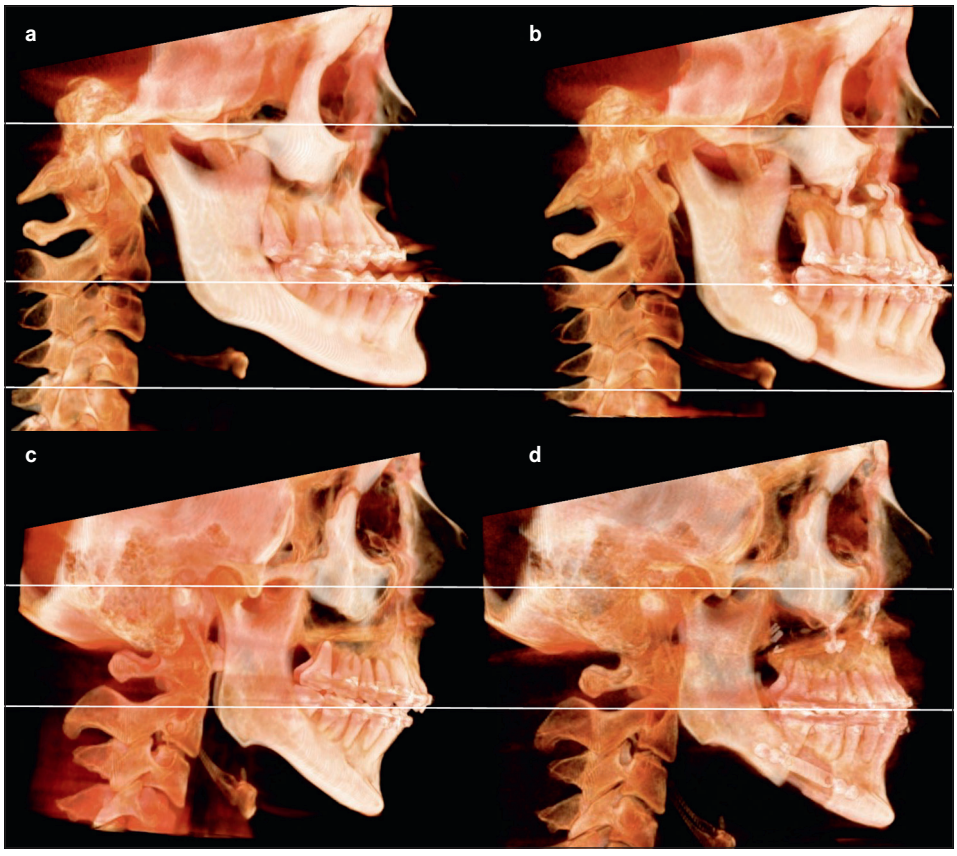

Figure 11

Two patients with distinctively different skeletal pattern that underwent MMA. The surgical design in advancement, rotation with occlusal plane and vertical dimension changes are vastly different but the principles of adequate bone overlap in osteotomy design to maximize fixation stability were maintained. (a) Preoperative image demonstrating maxillary deficiency and mandibular prominence in a patient with OSA. (b) Postoperative image demonstrating significant maxillary advancement and lengthening with mandibular advancement for airway improvement despite preoperative mandibular prominence. The postoperative facial esthetics was deemed satisfactory as per the patient because of the improved facial balance. (c) Preoperative image demonstrating maxillary and mandibular deficiency. (d) Postoperative image demonstrating maxillomandibular advancement with counter clockwise rotation of the skeletal complex and occlusal plane alteration.

6. Conclusion

Although MMA is typically a predictable operation with excellent outcomes, failure of improvement and severe long-term sequalae can occur. Understanding the surgical goal with sufficient skeletal advancement for airway improvement and precise surgical.

Links of interest

The authors declare that they have no interest in the data published in this article.

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