Multidisciplinary Management of Congenitally Missing Teeth with Osseointegrated Dental Implants: A Long-Term Report

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Objective: *To describe a multidisciplinary approach to ensure optimal treatment and timing of treatment for these patients.*
Methods: *Ten patients with congenital missing teeth were treated with dental implants with a multidisciplinary approach, including orthodontics, prosthodontics, and/or orthognathic surgery, from 1997 to 2006 in the Department of Implant Dentistry, Peking University, Hospital of Stomatology. All patients were followed up over five years. Clinical and radiographic examinations were conducted for all the patients. A thorough diagnostic workup was used and the outline of the treatment planning was given from the prosthodontic point of view.*
Results: *A total of 31 implants were placed and restored for the 10 patients involved. Follow-up averaged 108.4 months (61–155 months) after implant prosthetic functioning. With the multidisciplinary approach, a satisfactory treatment for these patients was acquired, with follow-up for more than 5 years. The peri-implant marginal bone level was stable with bone resorption averaged 1.97 mm. Peri-implantitis was found in one patient with two implants and effectively treated with local anti-infection. Ceramic chips were observed in two cases and the crowns were re-fabricated.*
Conclusion: *Implant restoration with an interdisciplinary approach provides an alternative way with predictable clinical results for patients with congenitally missing teeth.*

Key words: *augmentation, congenital missing teeth, hypodontia, implant, rehabilitation*

Hypodontia, or congenitally missing teeth, is described as the congenital absence of one or more primary or permanent teeth[1]. It is the most common developmental anomaly and often presents a clinical management challenge. In many patients, the diversity of presentations of hypodontia precludes whether an orthodontic solution and/or prosthodontic interventions are required. The latter approach, irrespective of whether it is a fixed or a removable one, risks an ecological upset of the patient's oral health since both hard and soft tissues, including pulpal integrity, risk being compromised.

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The compelling data base that underscores the efficacy and effectiveness of implant treatment suggested a lateral move of the osseointegration technique to manage the challenge of hypodontia[2,3]. This short-term study reports on the preliminary results obtained in a convenience sample of patients whose congenitally missing teeth were replaced by means of a multidisciplinary treatment planning and treatment approach.

Materials and methods

Patient selection

From 1997 to 2006, 10 patients with 36 congenitally missing teeth were consecutively treated in the Department of Implant Dentistry, Peking University Hospital of Stomatology. All patients have been followed up over five years. Among them, five were males and five were females, with the mean age being 33.9 years

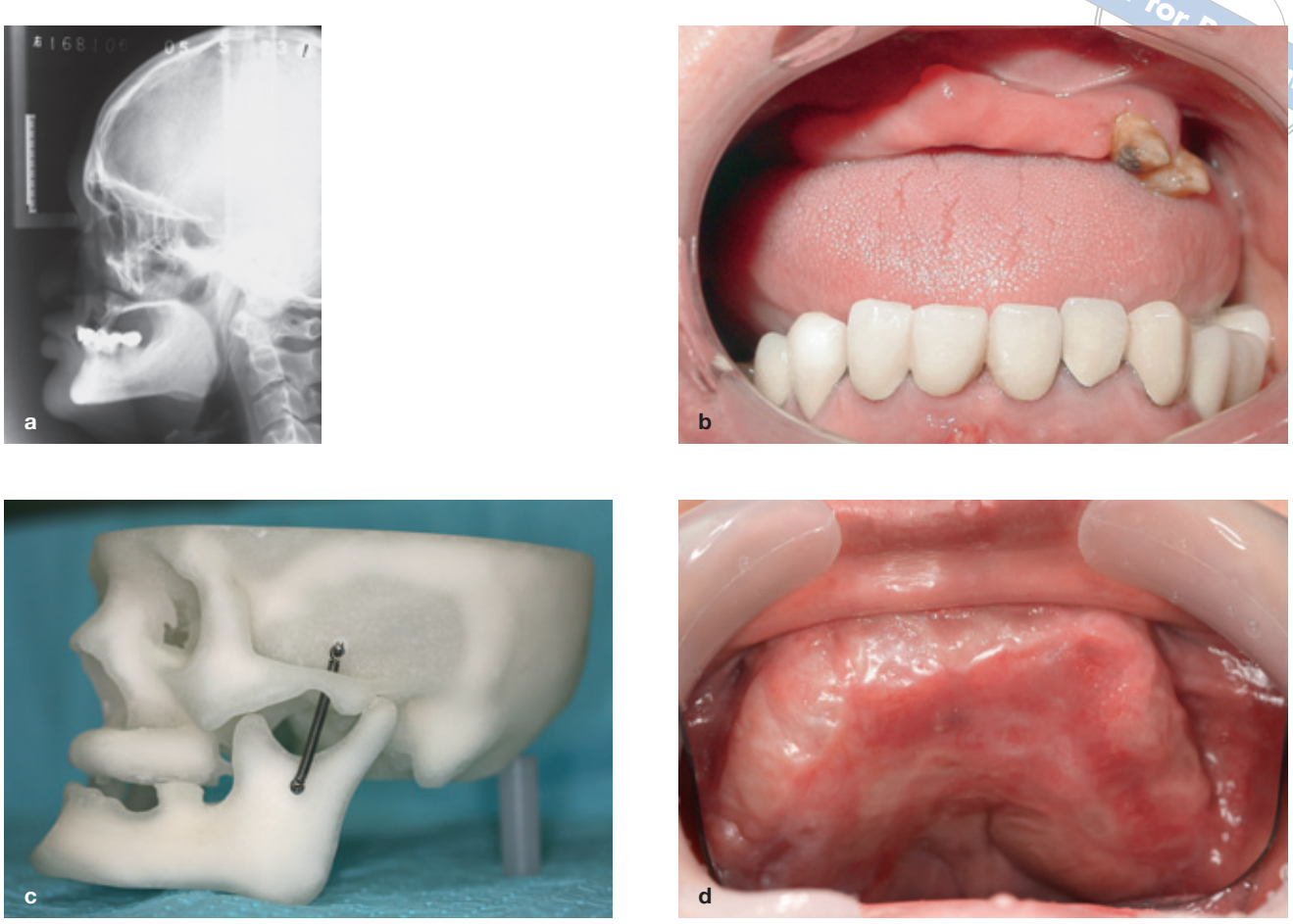


Fig 1 A 45-year-old male patient with hypodontia used a poor functional removable denture in the maxilla and a failing PFM fixed bridge in the mandible. The figures show the clinical situations before and after implant treatment: a) severe bone defect in maxilla with retrusion and pseudo-Angle's III intermaxillary relationship; b) two residual coronal teeth were left in the upper jaw; c) STL model showed the correction of the intermaxillary relationship using revascular fibular flap reconstruction of the maxilla; d) clinically it showed attached soft tissue was reconstructed using the free palatal epithelium; e) implants were inserted using flapless technique according to the surgical guide; f) implants healed uneventfully and peri-implant soft tissue was healthy; g) occlusion view of fixed bridges in the maxilla; h) peri-implant marginal bone in maxilla was stable after 61 month follow-up.

(25–45 years). A total of 31 implants were placed and restored in the 10 patients with the follow-up averaging 108.4 months (61–155 months). Informed consent was obtained from each patient.

The criteria for the study required patients with congenital missing teeth, aged over 18 years old, with healthy residual teeth. Patients were excluded if they had a medical history of uncontrolled systemic diseases.

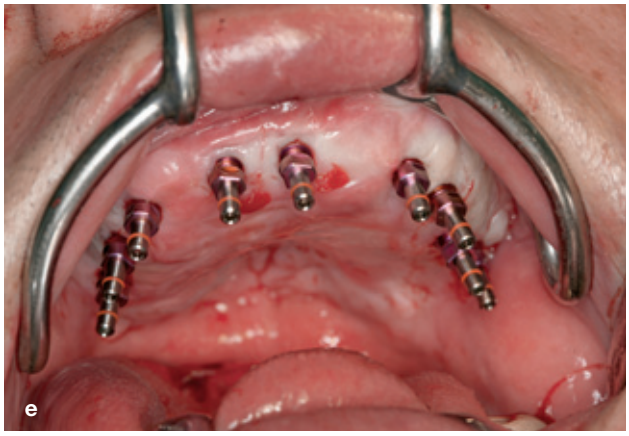
Clinical and radiographic examination

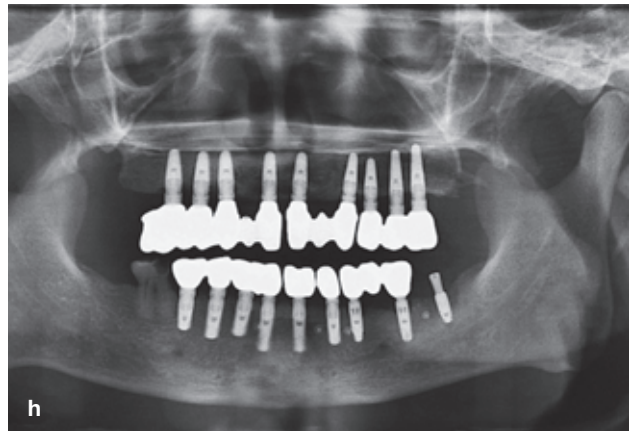
Patients who were scheduled for implant restorations underwent clinical examination and radiographic evaluation.

Orthopantomogram and lateral cephalometric radiographs (Planmeca Promax, Finland) were used to assess the residual alveolar bone height and width, the anatomy of the edentulous and adjacent areas, intermaxillary relationship, and lateral profile in each patient (Fig 1a). Computerised tomographic scans (CT, MultixMT DR, Siemens, Germany) were used optionally for further identification of the bone quality and quantity.

Treatment protocol and planning

In patients with congenitally missing teeth, the development of the corresponding alveolus is interrupted and often leads to an underdeveloped ridge, which is especially true for the maxilla. Clinical assessment of the mid-face will also give information if maxillary hypoplasia is evident in those fully or partially afflicted with hypodontia (Fig 1b). This can often be identified in a lateral cephalometric survey, which may give indication for orthodontics and/or orthognathic surgery.





Effective clinical management of implant rehabilitation for patients with congenitally missing teeth usually requires careful multidisciplinary planning with orthodontists, prosthodontists, and oral maxillofacial surgeons. All the patients enrolled in the study underwent the necessary multidisciplinary treatment planning and consents were achieved. The serial treatment protocol according to the different missing tooth situations were as follows:

- For single missing anterior tooth, orthodontic treatment was usually required to correct the malocclusion, align the dentition and create appropriate space where the implant would be placed and an aesthetic restoration would be required. Bone graft and soft tissue graft were usually later required as the necessary pre-implant surgery for those patients (Fig 2a–d).
- For single missing posterior tooth, it would be required with removal of deciduous tooth and with orthodontic therapy. Soft tissue or bone augmentation would be used according to the individual situation (Fig 3a–b).
- For multiple missing teeth, orthodontic and orthognathic assessments were required. Orthodontic therapy was needed to close the diastema, correct malocclusion, and align the dentition. Orthognathic surgery was needed to optimise the intermaxillary relationship and improve the lateral profile (Fig 4a–d).
- For edentulous arch, orthognathic assessment was needed for patients with multiple missing teeth. Interim removable denture may be needed to rehabilitate the vertical dimension and to evaluate the soft and hard tissue fullness and final aesthetic results[4] (Fig 1).

Surgical techniques for tissue graft and implant insertion

Because tooth eruption is correlated with alveolar and gingival development, hard and soft tissues are frequently deficient in patients with congenitally missing teeth, making augmentation an often-indicated treatment. In this study different bone augmentation techniques were used according to the bone defect situation. If the residual alveolar bone thickness was about 3 to 5 mm, then a guided bone regeneration technique (GBR) could be used to rebuild bone volume around implants. If the residual bone thickness was less than 3 mm, onlay graft was needed to reconstruct bone volume firstly followed by implant insertion three to four months later. Meanwhile, if the recipient's area is for more than four teeth, iliac graft or revascular fibular graft was required to harvest enough bone graft (Fig 1c). Otherwise mandibular external oblique ridge was the first choice[5].

In this study, the palatal free mucosa graft was used to reconstruct peri-implant attached soft tissue (Fig 1d). Timing of the soft tissue graft can be done 12 weeks post implant placement, or during a two-stage operation[6].

All implants were placed according to the manufacturer's guidelines (Fig 1e–f). Normally implants with 10 mm length or more, and 3.8 mm width or more, were used to achieve sufficient osseointegration and maintenance of a long-term result.

Second stage surgery was performed after a healing period of 6 months, and implant-supported prostheses were restored if the implants were fully osseointegrated clinically (Fig 1g–h).

Maintenance and follow-up

Routine clinical follow-up was scheduled 1 week postoperatively and then every 2 to 3 months until implant exposure. The patients were routinely seen for clinical examination at 3 months after prosthesis delivery, and again 6 months thereafter. From the second year, the evaluation was performed annually. Examinations including periapical and panoramic radiographs were conducted 3 or 6 months postoperatively, and then annually after implant restoration. Peri-implant soft tissue healthy status, prostheses stability, functions, and ceramic chips were observed clinically. Peri-implant marginal bone resorption with translucent shadow was measured in the radiographs.

Results

Among the enrolled 10 cases, seven had single teeth missing, two had multiple teeth missing and one was nearly edentulous. The most common missing tooth observed in this study was the premolar, with 10 teeth in the maxilla and seven in the mandible. Missing maxillary lateral incisor(s) was the second most common condition with 10 teeth total, and missing maxillary canine(s) was in third place.

According to the treatment plan, preprosthetic orthodontic therapy was performed in five cases to close the diastema, align the dentition and correct malocclusion. Orthognathic surgery was performed in a case with multiple teeth missing, to adjust the intermaxillary relationship and lateral profile of the patient. Three single missing premolars were restored to imitate the previous premolar crown without orthodontic treatment.

In this study, two cases received sinus grafts, as well as onlay grafts in four cases, and an onlay graft together with a sinus graft in one case, GBR in two cases, and GBR together with a sinus graft in one other case. Palatal free mucosa graft was used in six cases to reconstruct the physiological peri-implant soft tissue structure.

In total 31 implants were placed, including three Frialit-2 implants, 16 IMZ implants and 12 Camlog implants. The implant diameter together with the number of implants used in the study was as follows, in descending order: 4 mm (15), 3.8 mm (11), 4.3 mm (4) and 3.3 mm (1). The implant length together with the number of implants used in this study was as follows, in descending order: 13 mm (27), 11 mm (2), 10 mm (1) and 15 mm (1). The mean follow-up was 108.4 months (61–155 months) after implant restoration.

Peri-implant marginal bone level was stable with the mean bone resorption level of 1.97 mm. In seven cases, each with a single tooth missing, ceramic crowns were fabricated and cemented to the implant abutments. In two cases with multiple missing teeth and in one edentulous case, implant-supported fixed prostheses were delivered, of which two prostheses were cemented and one was screwed. Peri-implant soft tissue infection was found in one case with two implants, local anti-infection therapy was applied immediately and the peri-implant bone was stable until last recall. Ceramic chips were observed in two cases and the crowns were refabricated.

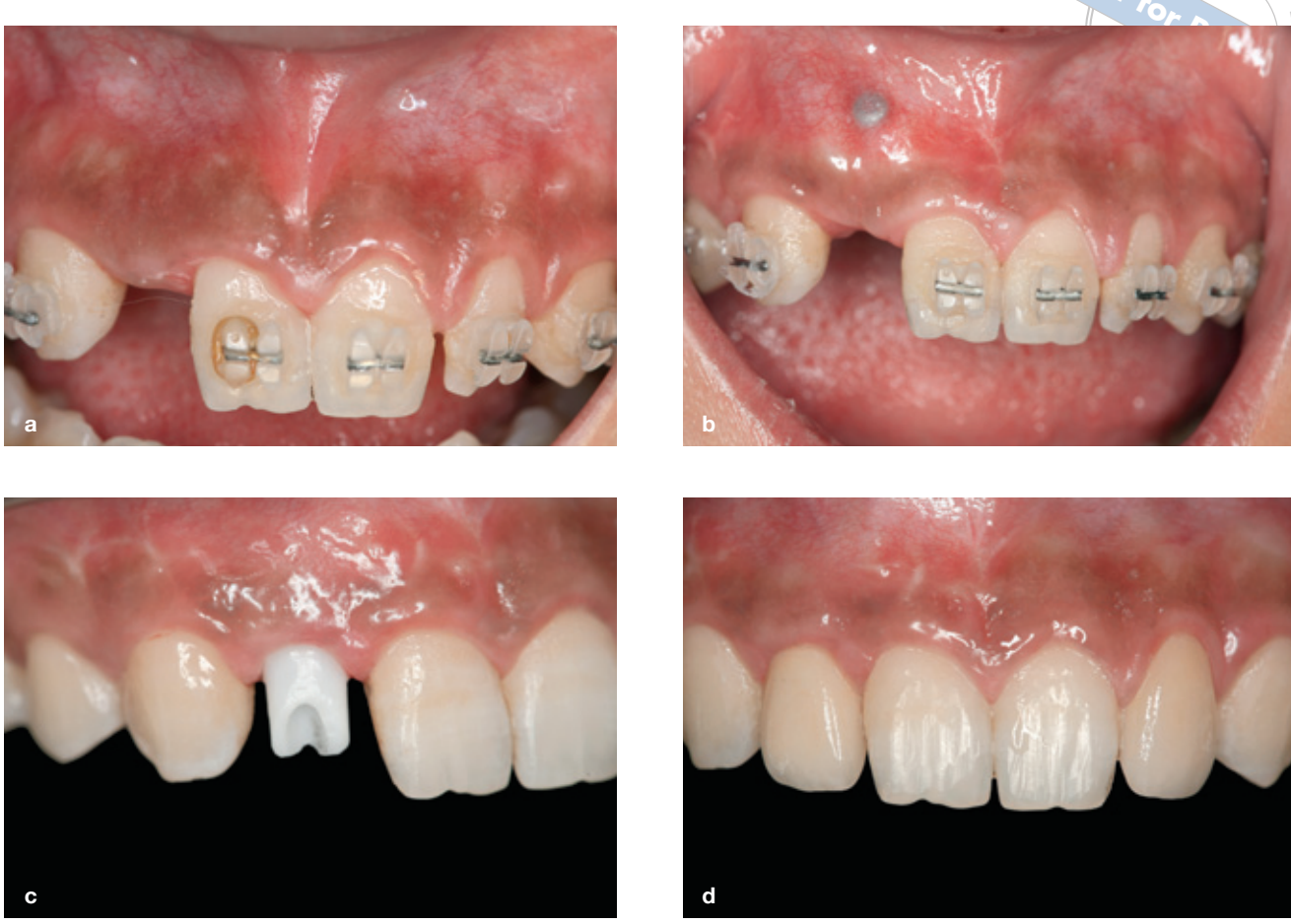


Fig 2 The figures showed a 29-year-old female patient with bilateral congenital missing lateral incisors asked for implant treatment and underwent the multidisciplinary therapy: a) 12 was congenitally missing and 22 was a conical crown; b) onlay bone graft was employed to rebuild the bone volume; c) ceramic abutment was inserted after reshaping the gingiva; d) clinically it showed the final aesthetic results, and 22 was restored using all-ceramic veneer.

Discussion

A number of studies indicate an improvement in the physiologic and psychosocial function of adult patients with an implant-supported denture, when compared with their condition before implants were placed[2,7]. As already noted, prosthodontic treatment is extremely important in patients with congenital missing teeth, for physiologic and psychosocial reasons[4]. As a result, implant-supported prostheses seem to offer a desirable treatment option for these patients. Another reason to consider dental implants for congenital missing teeth is the beneficial impact they can have on the preservation of alveolar bone[4]. As mentioned previously, the alveolar ridges of individuals with hypodontia are underdeveloped because of the lack of tooth development. These alveolar ridges must support the prosthesis over the course of a lifetime. Thus, treatment measures that will maintain an alveolar bone and enhance the prognosis for future prosthodontic treatment are extremely important.

A few studies in related literature reported the results of placement of osseointegrated implants in a growing jaw[8,9]. However, growth in developing patients is an extremely critical assessment to make before their treatment. Growth of the maxilla and mandible parallels of the entire skeleton, and skeleton maturity-related indicators, such as radius epiphyseal plate closure and adductor sesamoid bone, signals completion of skeletal growth[10]. The jaws will undergo three phases of growth throughout development: width, length, and height. Width of the jaws will be completed before puberty at age 12. Growth in the length of both jaws continues through puberty until two to three years after the first menstruation, and four years after attaining sexual

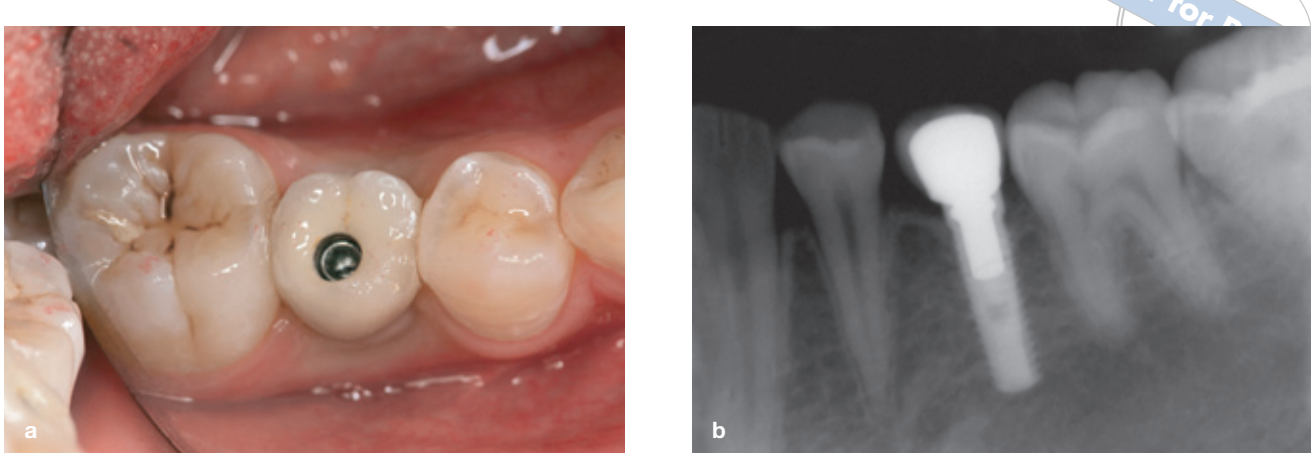


Fig 3 A 26-year-old female lost the second deciduous molar and asked for implant restoration. a) Tooth 35 was congenitally missing and restored with screw retained ceramic crown. b) A radiograph showed peri-implant bone was stable after 39 months of functioning.

maturity for females and males respectively. Growth in height of both jaws with eruption of teeth will continue throughout life but does plateau to the adult rate at 17 or 18 for girls and early twenties for boys[10].

Dental implants should not be placed for patients under 18 years to achieve predictable prognosis. Otherwise implant submergence, implant exposure and implant movement due to jaw growth would be likely to present aesthetic and functional complications[8,9]. Jaw growth was also limited if implants are connected by a rigid prosthesis that crosses the midline. In this study all the patients enrolled were above 18 years, according to the course of jaw maturation in the Chinese population. However, there is variation in growth among individuals to consider and overgeneralisation of clinical situations should be avoided.

For congenitally affected patients, soft tissue and bone grafting is usually needed to augment the soft tissue and bone deficiency before or at the same time of implant placement. Frequently, soft tissue augmentation was needed in many of these teeth areas to reconstruct the peri-implant soft tissue with good quality as well as enough quantity, which is one of the main requisites for long-term maintenance of osseointegrated implants. It is well understood that the soft tissue surrounding implants provides the function to resist mechanic trauma, and forms a peri-implant mucosal seal in the same way that tissue surrounding natural teeth do. Many techniques of soft tissue augmentation have been described, but the palatal free mucosa flap seems to be the most predictable and get a large quantity[6]. In patients with hypodontia, the development of the corresponding alveolus is interrupted and often leads to an underdeveloped ridge, which presents difficulty for implant placement. Meanwhile, the quality and quantity of bone is the first indicator of feasibility for installation and long-term stability of implants. Bone volume should be of reasonable configuration in these patients to accommodate installation of implants 10 mm in length or more and 3.3 mm in width or more. Different bone augmentation techniques have been described, and can be used to reconstruct the bone defects, during or before implant placement[5,11].

According to the limited data in the study, it indicated that prosthodontic management with dental implants requires a broad knowledge base to handle the special problems associated with the treatment. For this reason, a multidisciplinary team approach is recommended for the optimal management of different clinical situations. Orthodontic treatment is usually required before the space can be restored satisfactory in the majority of patients with hypodontia. Although it is important to provide early treatment for this particular patient group, it must be remembered that any prostheses made for young patients must be closely monitored for needed adjustments or for a replacement prostheses made necessary by growth and development. A removable denture is the most frequent treatment modality for growing patients, waiting for the future implant prostheses. Meanwhile, a variety of bone and soft tissue augmentation techniques are needed before implant placement. In conclusion, dental implants can positively affect patients' well-being and quality of life, but proper treatment protocol and a joint effort with different disciplinary specialists are required before implants are placed in patients with congenital teeth missing.

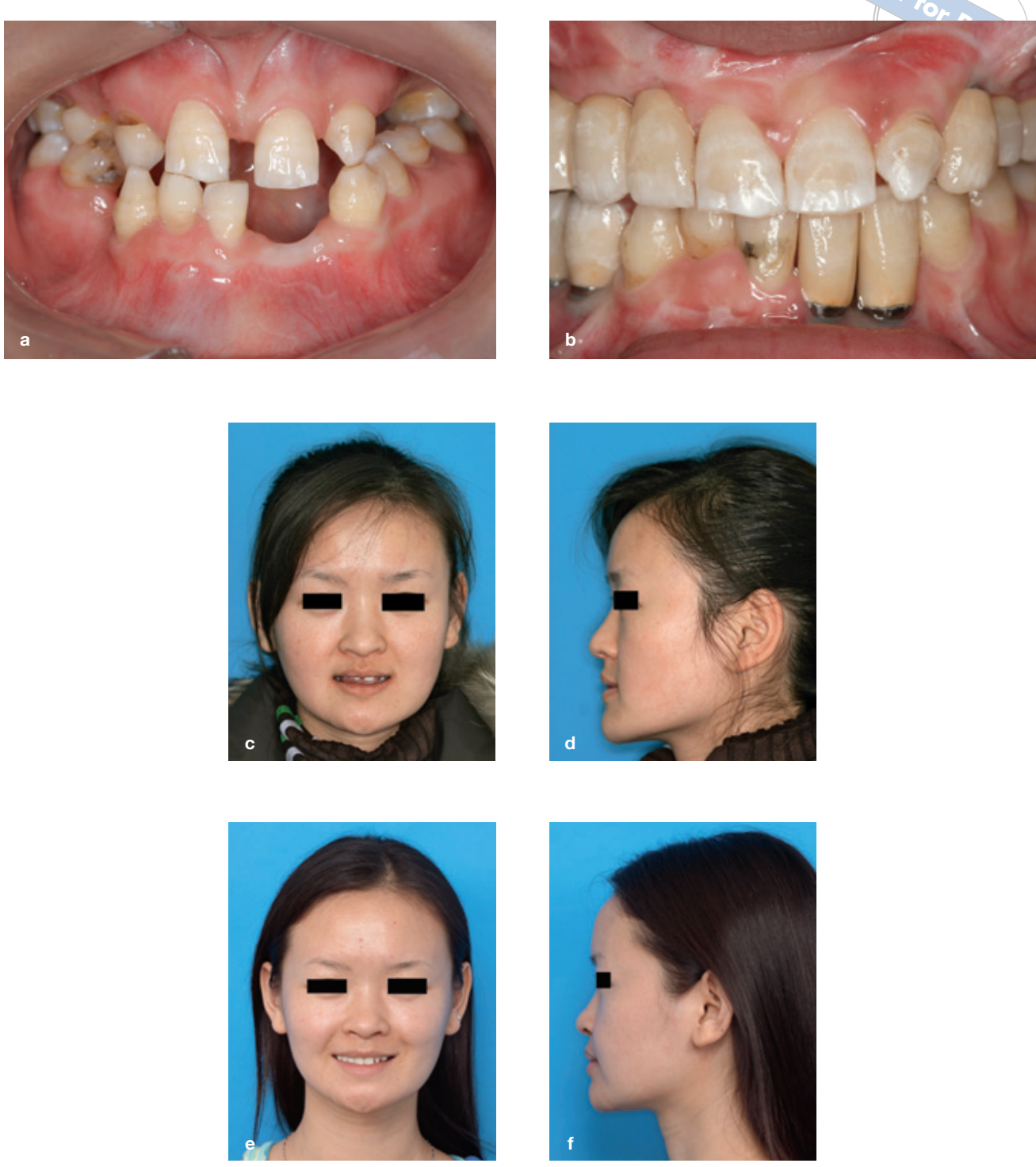


Fig 4 A 25-year-old female with multiple congenial missing teeth has been treated with a poorly functioning removable denture and asked for implant restorations. The following photographs showed the pre- and post-clinical situations: a) multiple teeth congenitally missing together with residual deciduous teeth were found in the maxilla and mandible; b) Lefort I osteotomy was performed to correct the malocclusion and lateral profile, implants were inserted and restored after bone and soft tissue augmentation; c) positive and lateral profile before orthognathic surgery showed protrusion of the mandible and maxillary hypoplasia; d) after multidisciplinary therapy, the positive and lateral profile and occlusion were improved.

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