

Multiprofessional approach for class III malocclusion rehabilitation with autogenous calvarial bone graft followed by Le Fort 1 osteotomy and implant-supported prostheses – case report

Abordagem multiprofissional para reabilitação de má oclusão classe III com enxerto ósseo autógeno de calota craniana seguido de osteotomia Le Fort 1 e próteses implantossuportadas – relato de caso

Abordaje multiprofesional de la rehabilitación de maloclusión clase III con injerto autólogo de calota craneal seguido de osteotomía Le Fort 1 y prótesis implantosoportadas – reporte de caso

Received: 05/19/2021 | Reviewed: 05/29/2021 | Accept: 05/31/2021 | Published: 06/14/2021

Paulo Sérgio Borella

ORCID: <https://orcid.org/0000-0002-8481-5340>
Universidade Federal de Uberlândia, Brazil
E-mail: borella0@gmail.com

Júlio César De Carvalho Alves

ORCID: <https://orcid.org/0000-0002-0344-397X>
Universidade Federal de Uberlândia, Brazil
E-mail: juliocarvalho.consultorio@gmail.com

Larissa Ayres Scagliarini Alvares

ORCID: <https://orcid.org/0000-0002-7260-5688>
Universidade Federal de Uberlândia, Brazil
E-mail: larissayres@ufu.br

Áquila Valente Souza

ORCID: <https://orcid.org/0000-0001-8649-0175>
Associação Brasileira de Odontologia, Brazil
E-mail: aquilavalente@gmail.com

Karoline Ferreira da Mota

ORCID: <https://orcid.org/0000-0003-0955-0837>
Associação Brasileira de Odontologia, Brazil
E-mail: karolinefe@hotmail.com

Sérgio Antônio Araújo Costa

ORCID: <https://orcid.org/0000-0003-1403-2313>
Associação Brasileira de Odontologia, Brazil
E-mail: sergioaacosta@hotmail.com

Karla Zancopé

ORCID: <https://orcid.org/0000-0002-2205-9842>
Universidade Federal de Uberlândia, Brazil
E-mail: karlazancope@gmail.com

Marcel Santana Prudente

ORCID: <https://orcid.org/0000-0002-3554-0176>
Universidade Federal de Uberlândia, Brazil
E-mail: marcel_prudente@hotmail.com

Flávio Domingues das Neves

ORCID: <https://orcid.org/0000-0002-8676-302X>
Universidade Federal de Uberlândia, Brazil
E-mail: flaviodominguesneves@gmail.com

Abstract

Extensive treatments can eventually be challenging. Even more so when the patient has limitations such as extensive tooth loss and skeletal changes, including overgrowth of the lower jaw. When indicated, these treatments tend to discourage patients due to the history of previous failures. Therefore, in addition to an interdisciplinary dental team composed of oral and maxillofacial surgeons, and prosthodontists, a nutrologist, a speech therapist, and a psychotherapist were involved in the treatment of this case. A 52-year-old female patient, Angle Class III malocclusion, with few teeth and extensive maxillary bone loss, attended the dental clinic of the Brazilian Association of Dentistry in Uberlândia. The treatment involved reverse planning, extraction of the dental remnants, calvarial bone grafting, placement of 6 titanium implants (Neodent) in the maxilla (upper jaw) and 5 in the mandible (lower jaw), orthognathic surgery, and installation of implant-supported fixed complete dentures in both jaws. Furthermore, psychotherapeutic and nutrologist's interventions were necessary during the dental treatment, concluding the treatment with speech therapy. Within the limitations of this case, the multidisciplinary approach proved to be efficient. It promoted the reestablishment of the stomatognathic system functions without compromising nutrition during the periods when it was impossible to wear prostheses for better healing of the tissues.

Keywords: Dental implants; Implant-supported dental prosthesis; Mouth rehabilitation; Bone grafting; Orthognathic surgery; Angle class III.

Resumo

Tratamentos extensos podem ser eventualmente desafiadores. Ainda mais quando o paciente possui limitações como extensa perda dentária e alterações esqueléticas como crescimento excessivo da mandíbula ou maxila. Tratamentos assim tendem a desanimar pacientes pelo histórico de insucesso que as vezes o acompanha. Então, além de uma equipe interdisciplinar odontológica composta por cirurgiões e protesistas, nutrólogo, fonoaudiólogo e psicólogo foram envolvidos no tratamento deste caso. Paciente com 52 anos, gênero feminino, Classe III de Angle, portadora de poucos dentes e extensa perda óssea maxilar compareceu a clínica da Associação Brasileira de Odontologia – Regional Uberlândia. O tratamento odontológico realizado envolveu planejamento reverso, extração dos remanescentes, enxerto de calota craniana, instalação de 6 implantes de titânio (Neodent) na maxila e 5 na mandíbula, cirurgia ortognática e instalação de próteses totais implantossuportadas superior e inferior. Além disso, durante o tratamento odontológico, acompanhamento psicoterapêutico e nutrólogo se fizeram necessário, finalizando com fonoaudiólogo. Dentro das limitações desse caso, a abordagem multidisciplinar se mostrou eficiente. Promoveu devolução das funções do aparelho estomatognático sem comprometer a nutrição durante os períodos em que não foi possível o uso de próteses para melhor cicatrização dos tecidos.

Palavras-chave: Implantes dentários; Prótese dentária fixada por implante; Reabilitação bucal; Enxerto ósseo; Cirurgia ortognática; Classe III de Angle.

Resumen

Los tratamientos extensos pueden eventualmente ser un desafío. Más aún cuando el paciente tiene limitaciones como la pérdida extensa de dientes y cambios esqueléticos como el crecimiento excesivo de la mandíbula o el maxilar. Estos tratamientos tienden a desanimar a los pacientes debido a la historia de fracaso que a veces los acompaña. Entonces, además de un equipo odontológico interdisciplinario compuesto por cirujanos y prostodoncistas, en el tratamiento de este caso participaron un médico especialista en nutrición, logopeda y psicólogo. Una paciente de 52 años, Clase III de Angle, con pocos dientes y pérdida extensa de hueso maxilar acudió a la clínica de la Asociación Dental Brasileña - Regional Uberlândia. El tratamiento odontológico realizado consistió en planificación inversa, extracción de los remanentes, injerto de calota creaneal, instalación de 6 implantes de titanio (Neodent) en maxilar y 5 en mandíbula, cirugía ortognática e instalación de prótesis totales implantossuportadas maxilar y mandibular. Además, durante el tratamiento odontológico fue necesario un seguimiento psicoterapêutico y médico especialista en nutrición, finalizando con un logopeda. Dentro de las limitaciones de este caso, el enfoque multidisciplinario resultó ser eficaz. Promovió el retorno de las funciones del aparato estomatognático sin comprometer la nutrición durante los períodos en los que no era posible utilizar prótesis para una mejor cicatrización de los tejidos.

Palabras clave: Implantes dentales; Prótesis dental de soporte implantado; Rehabilitación bucal; Injerto óseo; Cirugía ortognática; Clase III de Angle.

1. Introduction

Edentulism is a frequent problem in some places, depending on the culture and socioeconomic conditions. Populations affected by this condition present changes in masticatory performance, which negatively impact the quality of life, self-esteem, and nutritional status. Partial or complete edentulism may be associated with congenital and acquired bone and soft-tissue malformations, parafunctional habits, as well as intrinsic and extrinsic factors. (de Avila *et al.*, 2013; Frejman *et al.*, 2013; Gondivkar *et al.*, 2019; Khan *et al.*, 2018). Abnormal changes in the craniomaxillofacial development could generate

discrepancies in the positioning of facial bones, culminating in an unsatisfactory occlusion. Changes in the bone bases of the maxilla and mandible in relation to the skull base are major factors for the diagnosis of dentofacial deformities. The absence of a satisfactory occlusion is a worrying factor manifested through signs and symptoms such as tooth loss, limitations of jaw excursion movements, relevant changes in the soft and bony structures of the supportive periodontal tissues, along with changes in the temporomandibular joints and subsequent dysfunctions in its internal structure. Furthermore, the absence of teeth leads to an unsatisfactory overloaded occlusion which must be considered (Bitiniene *et al.*, 2018; Brandini *et al.*, 2016; Saber *et al.*, 2018). Angle Class III malocclusion is a skeletal deformity presented through a characteristic excessive increase in the volume and mandibular length characterizing anteroposterior deficiency of the maxilla. Class III patients have the bone bases of their jaws badly positioned in relation to the skull base uni or bimaxillary. Orthognathic surgery can be performed to correct these deformities. In the absence of teeth, implants are a good alternative to reestablish the bases for prosthetic rehabilitation (Branemark *et al.*, 1977), although in some situations, the patient has so many limitations that this type of treatment becomes challenging due to the comorbidities.

The placement of implants requires sufficient bone in the alveolar ridge to enable fixation and osseointegration, in addition to well-controlled systemic health conditions, allowing oral rehabilitation procedures. Patients who have lost teeth at a young age may suffer from bone resorption of varying morphologies in the different edentulous areas compared to areas where the tooth presence preserved the alveolar bone due to the masticatory stimulus (Cawood & Howell, 1988; Khan *et al.*, 2018; Kurahashi *et al.*, 2015). In areas lacking enough bone, grafts are a great alternative to gain bone structures, such as atrophic jaws reconstructions (Benech *et al.*, 2011; De Santis *et al.*, 2012; Pieri *et al.*, 2012; Ribeiro-Junior *et al.*, 2009; Soehardi *et al.*, 2015; Varol *et al.*, 2016). Autogenous grafts are often used for this purpose. The most relevant donor sites for the oral region are the mandible ramus, more precisely, external oblique line, as well as mental protuberance, iliac crest, and skullcap, all of them presenting high success rates and stability (Aloy-Prosper *et al.*, 2015). Implant installation and grafting can be performed in the same surgical procedure when the case favors minimal implant stability. However, some cases require a waiting period for the biological osseointegration to occur, ensuring greater safety on the procedure and higher success rates in implant osseointegration (Chiapasco *et al.*, 2007; Ferri *et al.*, 2008; Rasmusson *et al.*, 2012).

In the following case report, we present a clinical case of facial skeletal deformities in which the rehabilitation was possible performing a calvarial bone grafting in association with implant installation, followed by orthognathic surgery and implant-supported fixed complete dental protheses.

2. Methodology

Informed Consent Form

The oral treatment was performed at the integrated clinic of the Brazilian Association of Dentistry in Uberlândia, Minas Gerais, Brazil. It is a recognized dental education institution where all treatments require an Informed Consent Form signed by the patient who acknowledges that their case may be used for educational purposes. Approval from the ethics committee is not required for this case report.

Case report

A 52-year-old female patient, classified as ASA I according to the American Society of Anesthesiology, attended the integrated clinic of the Brazilian Association of Dentistry in Uberlândia complaining of masticatory impairment and unsatisfactory aesthetics. The patient reported unsatisfying experiences with previous alternative treatments, expressing discouragement regarding the possible future treatments due to previous failures. During clinical examination, the patient presented a class III skeletal deformity (mandibular prognathism), hypermentonism, and dental midline deviation as well as

mandibular asymmetry due to uneven vertical excess growth. There were also few teeth remaining due to previous treatments and a poor prognosis in conventional oral rehabilitation. The complementary imaging exams requested were computed tomography, panoramic radiograph (Figure 1 A-C) with disocclusion of the teeth to evaluate the possibility of utilization and permanence of the present teeth.

Figure 1: A-C. Initial extraoral images and panoramic radiograph.



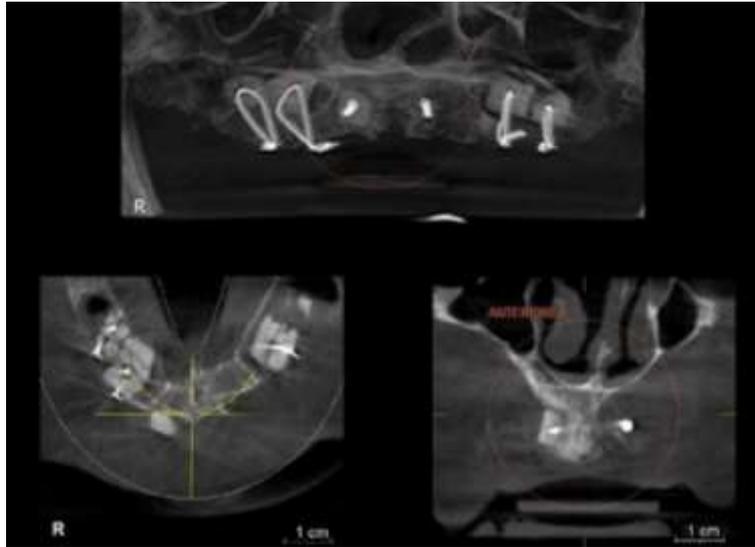
Source: Author's creation.

Therefore, the authors excluded the possibility of orthodontic treatment due to the cost-benefit aspect of this specific case and the poor prognosis of the remaining teeth. An alternative treatment was then proposed for oral rehabilitation using a bone graft along with correction of skeletal deformities by orthognathic surgery. In the first moment, upper and lower jaw teeth were extracted, followed by the installation of two provisional prostheses establishing an Angle's class I occlusion. After 3 months of bone healing without intervention, a new radiographic examination was performed to check bone levels and bone deficient sites to plan the grafting procedure.

The treatment proposed was a maxillary reconstruction using autogenous unilateral calvarial bone graft; placement of six implants in the maxilla and five in the mandible; orthognathic surgery combining Le Fort 1 osteotomy and symmetrical linear maxillary advancement; and an immediate fixed complete provisional prostheses by fixing the previous removable prostheses onto the implants using acrylic resin. For this case, an autogenous graft was chosen, blocks were removed from the parietal bone in a hospital with local anesthesia. The bone graft was removed by the neurosurgery team, more precisely, the outer cortex of the diploe at the right-side parietal eminence between the lambdoid suture and the sagittal suture, where the bone is thicker. The technique was performed as previously described (Sbordone *et al.*, 2009). Onlay and inlay bone grafts were performed in the maxillary alveolar ridge and sinus floor sites, anchoring and stabilizing the bone blocks with steel wire (Acyflex #1).

The patient was advised not to wear the prostheses for 5 months to improve the graft healing. A new pair of provisional prostheses was made and relined with soft material. Also, the prostheses were used for reverse planning as a surgical guide. New imaging exams (computed tomography) (Figure 2) were performed afterward, showing an increase the alveolar ridge bone level and a better condition of the maxillary arch to receive implants.

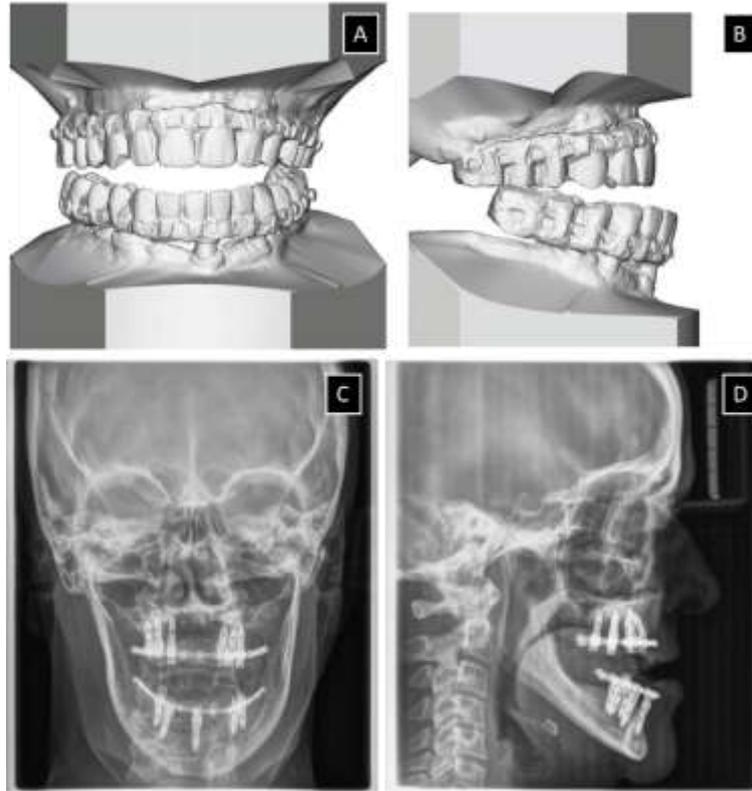
Figure 2: Computed tomography after maxillary graft.



Source: Author's creation.

External hexagon implants (Helix HE - Neodent) were selected for the case respecting bone level for each area. The implants remained unloaded for 6 months until their proper osseointegration. Reopening surgery was performed followed by the placement of mini conical abutments (Neodent) according to the gingival level and installation of provisional implant-supported fixed complete prostheses. Erich Bars were fixed bimaxillary (Figure 3 A-D), promoting an intermaxillary fixation during the trans-operative period.

Figure 3 A-D: Prostheses in an ideal position for adapting to the post-operative disposition of the tissues. **A** – Frontal view from intraoral scanning. **B** – Lateral view from intraoral scanning. **C** – Anteroposterior cranial radiograph. **D** – Lateral cranial radiograph.

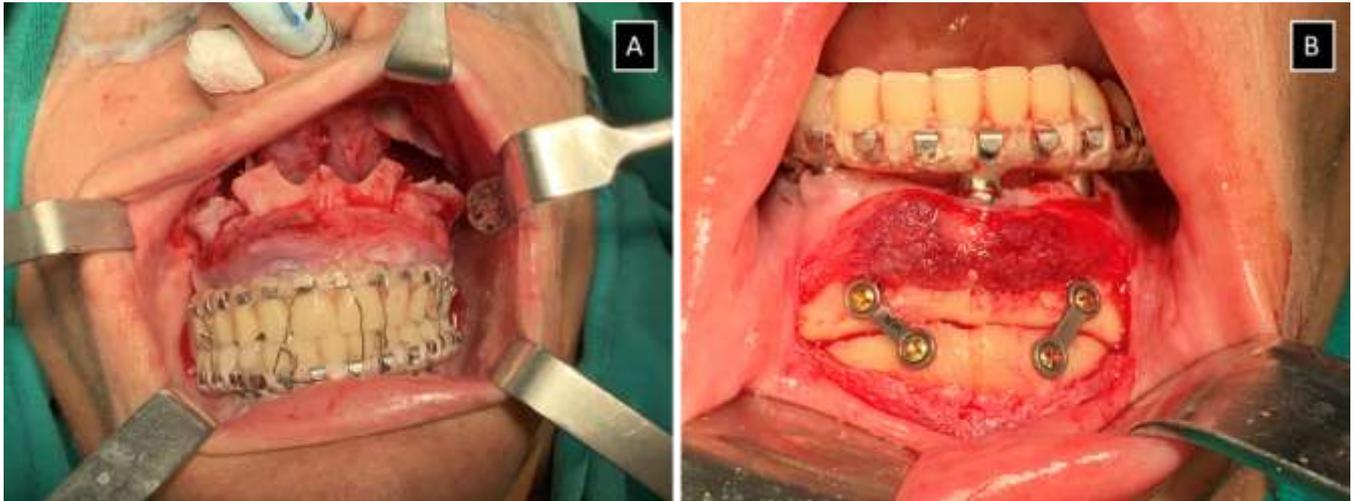


Source: Author's creation.

These bars are also important to enable the best virtual planning for orthognathic surgery by the radiopacity of the metal, delimiting the plane of the arches on imaging exams. The provisional prostheses were intended to be installed in a position that would be ideal for adapting to the post-operative disposition of the tissues, regardless of the occlusion at this moment. At the installation, the ratio of prostheses in the arch characterized a class III with anterior open bite. Due to the feeding restrictions, the patient was referred to nutritional monitoring. New measurements using virtual orthognathic planning software were made.

The patient underwent general anesthesia. Local anesthesia with a vasoconstrictor was injected in the operating site. The glabellar external reference pin was inserted. Le Fort I maxillary osteotomy was performed causing a total rupture of the maxillary pillar areas by a controlled down fracture and Howe's forceps pressure lever. The prostheses installed at the moment of the surgery guided the previously planned maxillary position. The arches were stabilized employing intermaxillary fixation throughout the prostheses (Figure 4A and 4B).

Figure 4A and 4B: **A** - Intermaxillary fixation throughout the prostheses. **B** – Chin reduction and anchoring.



Source: Author's creation.

The sinus gap was filled with exogenous grafts (Bioss Gaishlesh) and was anchored and stabilized with a set of titanium plates and screws (Signo Vincas) (Figure 4A and 4B). A reduction in the proportion of the chin was anchored by rigid internal fixation and was carried out using mini plates and titanium screws of the 2.0 system (Signo Vincas), thus promoting the correct positioning of the maxilla in relation to the skull base with correction of the mandibular asymmetry creating a better maxillomandibular relationship with an adequate vertical and horizontal proportion of the face. A trans-surgical radiograph was performed to check the maxillomandibular relationship and position. The patient remained with the intermaxillary fixation only during the surgery until the fixation of the bone stumps and stabilization of the maxillomandibular connection, being removed immediately after the end of the surgical procedure. The prostheses were removed 3 days after surgery so that there was no loading or displacement of the anchorages. The patient did not wear the prostheses for 3 months to ensure proper healing of the tissues and avoid overload of the graft. Drug therapy consisted of antibiotics and analgesics according to the prescription recommendations. Immediate post-operative diet was exclusively liquid, and pasty as indicated by a nutritionist. Oral mucosa hygiene consisted of 0.12% chlorhexidine mouthwash rinse for 7 days.

After the 3-month period, the patient was able to receive the permanent implant-supported fixed complete prostheses. After checking the contacts and refining the occlusion, the patient was referred to speech therapy to facilitate the adaptation to new prostheses (Figure 5 A-D).

Figure 5 A-D: **A** – Panoramic radiograph after orthognathic surgery without prostheses. **B** – Extraoral lateral view after implant-supported fixed complete prostheses installation. **C** – Extraoral frontal view after implant-supported fixed complete prostheses installation. **D** – Intraoral view from implant-supported fixed complete prostheses installed.



Source: Author's creation.

3. Discussion

A multidisciplinary and interdisciplinary approach was necessary in this case. The dental team performed the surgical and prosthetic procedures. A nutrologist was consulted for food supplementation and a speech therapist conclude the treatment adapting the patient to the new prostheses and correct functioning of the stomatognathic system. Psychological monitoring was fundamental to access the patient's well-being due to functional and aesthetic changes.

The use of implants to rehabilitate this patient was a good alternative as they act as bases for implant-supported fixed complete dental prostheses, reestablishing the stomatognathic system functions, which directly influences the masticatory

performance as well as the patient's general health and self-esteem as seen in other studies (Bitiniene *et al.*, 2018; Branemark *et al.*, 1977; Gondivkar *et al.*, 2019; Khan *et al.*, 2018).

During the orthognathic surgical planning, the dental arches were not in a favorable relationship. The patient fractured the provisional prostheses and was instructed not to wear them due to the lack of occlusion and discomfort caused by fractured areas. The patient was instructed to seek care from a nutrologist to adapt the diet to her current limitations, knowing that chewing influences nutrition and general health (Bitiniene *et al.*, 2018; Gondivkar *et al.*, 2019).

Cases like the one presented are not common, but it is important to understand and discuss the solution of choice to rehabilitate patients affected by both malocclusion and the loss of many teeth. All cases must be considered individually and have the appropriate planning for each situation, the best treatment option, as discussed by the team in charge of this case, was described in this report.

The case took 3 years from start to finish, which could be considered a significant amount of time compared to similar cases, in which there is the possibility of minimal anchoring of the implants associated with graft and orthognathic surgery in a single session. In this case, the authors opted to perform the grafting and implant procedures before the orthognathic surgery for the sake of better vascularization and osseointegration of the graft and implants, as well as reducing the risk of failure. Then, proceeding final step, to the orthognathic surgery was performed with grafts and implants stable and osseointegrated, all of which increases the success rate of implant osseointegration as already demonstrated in other studies (Branemark *et al.*, 1977; Chiapasco *et al.*, 2007; de Avila *et al.*, 2014; De Santis *et al.*, 2012; Ferri *et al.*, 2008; Gil *et al.*, 2008; Jacobson & Starr, 2008; Keller *et al.*, 1999; Ohba *et al.*, 2015; Soehardi *et al.*, 2015). It was also decided to reduce the chin, improving the patient's facial proportion and, consequently, facial aesthetics.

Even in patients where there is no need for correction of discrepancy in the relationship between arches, Le Fort I can be performed to increase bone levels, allowing dental implantation procedures in extremely atrophic upper jaws, which was not the situation in this case, where it was necessary to perform the onlay and inlay reconstruction of the maxilla using calvarial bone grafts and an anterior repositioning of the maxilla through orthognathic surgery. Due to the severity of maxillary atrophy, a considerable amount of bone was required for maxillary reconstruction and an increase of bone structures for implant installation. That type of autogenous bone graft is often not chosen because of temporary fragility in the skull after bone grafting.

During virtual planning, it was noticed that the position of the mandible in relation to the skull base was satisfactory. Therefore, the mandibular repositioning was excluded from the surgical planning, limiting the lower jaw intervention only to the chin reduction.

Extra care was taken during the periods of healing and osseointegration. When it comes to orthognathic surgery of the maxilla there is a total separation of the upper oral vestibule. Thus, decreased vascularization can happen in the detached tissue. It was decided to perform the implant installation previously aiming at greater vascularization and consequent oxygenation of the tissues, favoring safer healing and osseointegration of the bone blocks. After a period of one year, the success rate of the implants was 100% in this patient, which shows superior results to previous studies in which Le Fort I osteotomy was performed along with implant placement promoting ischemia of the area and contributing to the lower rate of implant success (Chiapasco *et al.*, 2007; Ferri *et al.*, 2008). However, literature shows reports of immediate loading implant placement with more satisfactory success rates which may be related to graft management, time of graft exposure to the external environment, fixation method, primary implant stability, patient habits such as smoking, professional management and the ability to follow instructions during the post-operative period (Rasmusson *et al.*, 2012; Soehardi *et al.*, 2015).

The success of the techniques used in this case does not limit further studies in more patients. Our case report has the limitation of having only one patient. More systematic clinical trial studies are needed to verify its real effectiveness in a

statistically relevant number of patients. The planning described can be personalized according to the patient's needs. The patient is grateful for the proposed treatment and reports improvements in the masticatory functions which had a great impact on her social life and perceived self-esteem. The patient was instructed to seek care from a psychologist to better deal with the past difficulties during treatment and the visual change generated by the procedures. Orthognathic surgery promotes facial modification and nasal anteriorization due to maxillary advancement.

4. Final Considerations

Within the limitations of this case report, the association of calvarial bone graft, implant placement, Le Fort I osteotomy in addition to exogenous bone graft, and implant-supported fixed complete dental prostheses were favorable choices for this case. The multiprofessional approach offered security and comfort, according to the patient report.

References

- Aloy-Prosper, A., Penarrocha-Oltra, D., Penarrocha-Diago, M., & Penarrocha-Diago, M. (2015). The outcome of intraoral onlay block bone grafts on alveolar ridge augmentations: a systematic review. *Med Oral Patol Oral Cir Bucal*, 20(2), e251-258. <https://doi.org/10.4317/medoral.20194>
- Benech, A., Mazzanti, C., Arcuri, F., Giarda, M., & Brucoli, M. (2011). Simultaneous Le Fort I osteotomy and computer-guided implant placement. *J Craniofac Surg*, 22(3), 1042-1046. <https://doi.org/10.1097/SCS.0b013e318210765d>
- Bitiniene, D., Zamaliauskiene, R., Kubilius, R., Leketas, M., Gailius, T., & Smirnovaite, K. (2018). Quality of life in patients with temporomandibular disorders. A systematic review. *Stomatologija*, 20(1), 3-9. <https://www.ncbi.nlm.nih.gov/pubmed/29806652>
- Brandini, D. A., Amaral, M. F., Poi, W. R., Casatti, C. A., Bronckers, A. L., Everts, V., & Beneti, I. M. (2016). The effect of traumatic dental occlusion on the degradation of periodontal bone in rats. *Indian J Dent Res*, 27(6), 574-580. <https://doi.org/10.4103/0970-9290.199600>
- Branemark, P. I., Hansson, B. O., Adell, R., Breine, U., Lindstrom, J., Hallen, O., & Ohman, A. (1977). Osseointegrated implants in the treatment of the edentulous jaw. Experience from a 10-year period. *Scand J Plast Reconstr Surg Suppl*, 16, 1-132. <https://www.ncbi.nlm.nih.gov/pubmed/356184>
- Cawood, J. I., & Howell, R. A. (1988). A classification of the edentulous jaws. *Int J Oral Maxillofac Surg*, 17(4), 232-236. [https://doi.org/10.1016/s0901-5027\(88\)80047-x](https://doi.org/10.1016/s0901-5027(88)80047-x)
- Chiapasco, M., Brusati, R., & Ronchi, P. (2007). Le Fort I osteotomy with interpositional bone grafts and delayed oral implants for the rehabilitation of extremely atrophied maxillae: a 1-9-year clinical follow-up study on humans. *Clin Oral Implants Res*, 18(1), 74-85. <https://doi.org/10.1111/j.1600-0501.2006.01287.x>
- de Avila, E. D., de Barros, L. A., Del'Acqua, M. A., Nogueira, S. S., & de Assis Mollo, F., Jr. (2014). Eight-year follow-up of a fixed-detachable maxillary prosthesis utilizing an attachment system: clinical protocol for individuals with skeletal class III malocclusions. *J Oral Implantol*, 40(3), 307-312. <https://doi.org/10.1563/AAID-JOI-D-11-00195>
- de Avila, E. D., de Molon, R. S., Loffredo, L. C., Massucato, E. M., & Hochuli-Vieira, E. (2013). Health-related quality of life and depression in patients with dentofacial deformity. *Oral Maxillofac Surg*, 17(3), 187-191. <https://doi.org/10.1007/s10006-012-0338-5>
- De Santis, D., Trevisiol, L., D'Agostino, A., Cucchi, A., De Gemmis, A., & Nocini, P. F. (2012). Guided bone regeneration with autogenous block grafts applied to Le Fort I osteotomy for treatment of severely resorbed maxillae: a 4- to 6-year prospective study. *Clin Oral Implants Res*, 23(1), 60-69. <https://doi.org/10.1111/j.1600-0501.2011.02181.x>
- Ferri, J., Dujonquoy, J. P., Carneiro, J. M., & Raoul, G. (2008). Maxillary reconstruction to enable implant insertion: a retrospective study of 181 patients. *Head Face Med*, 4, 31. <https://doi.org/10.1186/1746-160X-4-31>
- Frejman, M. W., Vargas, I. A., Rosing, C. K., & Closs, L. Q. (2013). Dentofacial deformities are associated with lower degrees of self-esteem and higher impact on oral health-related quality of life: results from an observational study involving adults. *J Oral Maxillofac Surg*, 71(4), 763-767. <https://doi.org/10.1016/j.joms.2012.08.011>
- Gil, J. N., Claus, J. D., Campos, F. E., & Lima, S. M., Jr. (2008). Management of the severely resorbed maxilla using Le Fort I osteotomy. *Int J Oral Maxillofac Surg*, 37(12), 1153-1155. <https://doi.org/10.1016/j.ijom.2008.10.003>
- Gondivkar, S. M., Gadbail, A. R., Gondivkar, R. S., Sarode, S. C., Sarode, G. S., Patil, S., & Awan, K. H. (2019). Nutrition and oral health. *Dis Mon*, 65(6), 147-154. <https://doi.org/10.1016/j.disamonth.2018.09.009>
- Jacobson, N., & Starr, C. (2008). Implant-supported rehabilitation of severe malocclusion due to unilateral condylar hypoplasia: case report. *J Oral Implantol*, 34(2), 90-96. [https://doi.org/10.1563/1548-1336\(2008\)34\[90:IROSMID\]2.0.CO;2](https://doi.org/10.1563/1548-1336(2008)34[90:IROSMID]2.0.CO;2)
- Keller, E. E., Tolman, D. E., & Eckert, S. (1999). Surgical-prosthetic reconstruction of advanced maxillary bone compromise with autogenous onlay block bone grafts and osseointegrated endosseous implants: a 12-year study of 32 consecutive patients. *Int J Oral Maxillofac Implants*, 14(2), 197-209. <https://www.ncbi.nlm.nih.gov/pubmed/10212536>

- Khan, S. U., Ghani, F., & Nazir, Z. (2018). The effect of some missing teeth on a subjects' oral health related quality of life. *Pak J Med Sci*, 34(6), 1457-1462. <https://doi.org/10.12669/pjms.346.15706>
- Kurahashi, M., Kondo, H., Iinuma, M., Tamura, Y., Chen, H., & Kubo, K. Y. (2015). Tooth loss early in life accelerates age-related bone deterioration in mice. *Tohoku J Exp Med*, 235(1), 29-37. <https://doi.org/10.1620/tjem.235.29>
- Ohba, S., Nakatani, Y., Kawasaki, T., Tajima, N., Tobita, T., Yoshida, N., Sawase, T., & Asahina, I. (2015). Oral Rehabilitation With Orthognathic Surgery After Dental Implant Placement for Class III Malocclusion With Skeletal Asymmetry and Posterior Bite Collapse. *Implant Dent*, 24(4), 487-490. <https://doi.org/10.1097/ID.0000000000000279>
- Pieri, F., Lizio, G., Bianchi, A., Corinaldesi, G., & Marchetti, C. (2012). Immediate loading of dental implants placed in severely resorbed edentulous maxillae reconstructed with Le Fort I osteotomy and interpositional bone grafting. *J Periodontol*, 83(8), 963-972. <https://doi.org/10.1902/jop.2012.110460>
- Rasmusson, L., Thor, A., & Sennerby, L. (2012). Stability evaluation of implants integrated in grafted and nongrafted maxillary bone: a clinical study from implant placement to abutment connection. *Clin Implant Dent Relat Res*, 14(1), 61-66. <https://doi.org/10.1111/j.1708-8208.2010.00239.x>
- Ribeiro-Junior, P. D., Padovan, L. E., Goncales, E. S., & Nary-Filho, H. (2009). Bone grafting and insertion of dental implants followed by Le Fort advancement for correction of severely atrophic maxilla in young patients. *Int J Oral Maxillofac Surg*, 38(10), 1101-1106. <https://doi.org/10.1016/j.ijom.2009.06.004>
- Saber, A. M., Altoukhi, D. H., Horaib, M. F., El-Housseiny, A. A., Alamoudi, N. M., & Sabbagh, H. J. (2018, Apr 5). *Consequences of early extraction of compromised first permanent molar: a systematic review*. Retrieved 1 from <https://www.ncbi.nlm.nih.gov/pubmed/29622000>
- Sbordone, L., Toti, P., Menchini-Fabris, G. B., Sbordone, C., Piombino, P., & Guidetti, F. (2009). Volume changes of autogenous bone grafts after alveolar ridge augmentation of atrophic maxillae and mandibles. *Int J Oral Maxillofac Surg*, 38(10), 1059-1065. <https://doi.org/10.1016/j.ijom.2009.06.024>
- Soehardi, A., Meijer, G. J., Hoppenreijts, T. J., Brouns, J. J., de Koning, M., & Stoelinga, P. J. (2015). Stability, complications, implant survival, and patient satisfaction after Le Fort I osteotomy and interposed bone grafts: follow-up of 5-18 years. *Int J Oral Maxillofac Surg*, 44(1), 97-103. <https://doi.org/10.1016/j.ijom.2014.06.002>
- Varol, A., Atali, O., Sipahi, A., & Basa, S. (2016). Implant Rehabilitation for Extremely Atrophic Maxillae (Cawood Type VI) with Le Fort I Downgrafting and Autogenous Iliac Block Grafts: A 4-year Follow-up Study. *Int J Oral Maxillofac Implants*, 31(6), 1415-1422. <https://doi.org/10.11607/jomi.4740>