Retentive aids and a comparison between conventional and digital workflow in maxillofacial prosthodontics: A review.

Sumit Duryodhan
Consultant Prosthodontist and Implantologist, Chandrapur, Maharashtra, India.

Abstract
A maxillofacial prosthesis, an alternative to surgery for the rehabilitation of patients with facial disabilities, are meant to replace parts of the face or missing areas of bone and soft tissue and restore oral functions such as swallowing, speech and chewing, with the main goal being to improve the quality of life of the patients. One of the most important factors that determines the success of a maxillofacial prosthesis is retention. Retention has always been a problem in prosthodontics. Increased retention improves comfort as well as the confidence in the patient while wearing a facial prosthesis at work and in social settings. The journey from using metal bands to using adhesives to placing implants for retaining maxillofacial prosthesis has been fascinating and satisfying to many clinicians. The conventional procedures for maxillofacial prosthesis manufacturing involve several complex steps, are very traumatic for the patient and rely on the skills of the maxillofacial team. Computer-aided design and computer-aided manufacturing have opened a new approach to the fabrication of maxillofacial prostheses. The present article tries to describe different types of retentive aids, classification and to perform an update on the digital design of a maxillofacial prosthesis.

Keywords: Retentive aids, conventional and digital workflow in maxillofacial prosthesis, maxillofacial defects, craniofacial implants.

Address of correspondence: Sumit Duryodhan, Nagina bagh (near shubhmangal karyalaya), Chandrapur, PIN-442401.
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Introduction

Body abnormalities or defects that compromise appearance, function, or render an individual incapable of leading a relatively normal life have typically elicited responses aimed at restoring the individual to a normal state. Surgery is the first line of treatment for early cancers and cancers that do not respond to radiation or chemotherapy, resulting in cosmetic, functional, and psychological impairment, all of which have a significant impact on the patient's quality of life.[1] Rehabilitation of such patients is difficult and necessitates the involvement of a multidisciplinary team in order to provide comprehensive care and achieve the best post-treatment functional outcomes. The brain, eyes, ears, nose, mouth, and facial expression muscles are all housed in the head, making it one of the most important anatomical regions of the human body.[2] The branch of prosthodontics concerned with the restoration and replacement of stomatognathic and craniofacial structures with prostheses that may or may not be removed on a regular or elective basis is known as maxillofacial prosthetics.[3]

Treatment for acquired or congenital defects affecting various facial structures that would otherwise lead to severe depression is included in rehabilitation.[4] The size, location, and severity of the defect, the patient's age and satisfaction, and finally the cost of the prosthesis all influence the choice and success of the prosthesis. The treatment's ultimate goal is to create an illusion by developing a prosthesis for the missing part that will improve the patient's quality of life.[5] This article aims to describes classification, comparison between two techniques and five possible treatment modalities, their likely outcomes, and their

impact on patients' ability to cope in life. Mechanically retained prosthesis using the patient's anatomy of defect and undercuts, followed by the use of bio adhesives, governed prosthesis retention prior to the dawn of the osseointegrated implant era.[6,7] Many modern prosthetic replacements can be secured with adhesives such as interfacing pastes, liquids, sprays, or double-coated tapes even today.[8] The use of implant support to support a combination of intraoral and extraoral restorations has become a viable treatment option. Extraoral implant placement and orientation are critical for a successful prosthetic outcome. The rate of people surviving disfiguring injuries that used to kill them has risen dramatically over the years due to advanced surgical procedures. With advancements in surgical and radiation treatment procedures, maxillofacial prosthetic therapy for acquired defects has become more complex and sophisticated. For the most effective and efficient treatment of patients with maxillofacial problems, a collaborative effort is required.[9]

Classification of the Maxillofacial Defects

For clarity and a more comprehensive description of maxillofacial prosthesis reconstruction, the defects were classified as extraoral (missing nose, eye, orbit, ear or face parts), intraoral (missing parts of the maxilla, middle face and mandible) and complex (missing extraoral and intraoral anatomical parts), as shown in figure 1. For the intraoral maxillary and midface defects (figure 2), Brown and Shaw classification, based on the vertical extent defect measure (classes I–VI) and the horizontal extent defect measure (a–d), was used.[10] For mandibular defects, Cantor and Curtis classification, proven to be useful for guiding surgical and prosthetic rehabilitation, was considered (figure 3).[11-13]

The Primary Objectives of Maxillofacial Rehabilitation are[14]:

1. ***Restoration of aesthetics***- A prosthodontist restores the orofacial appearance of patients with maxillofacial defects, improving the patient's cosmetic acceptability. The form, size, position, texture, and colour of the lost tissue should all be replicated in an aesthetically pleasing facial prosthesis.
2. ***Restoration of function***- Health issues and psychological disorders result from functional disparities caused by the loss of orofacial structures. As a result, rehabilitation of maxillofacial defects aids in the restoration of mastication, deglutition, and speech functions.
3. ***Psychological benefit***- The inability to maintain a normal social life leads to serious psychological problems. As a result, rehabilitating a facial deformity aids in achieving facial symmetry, allowing those individuals to resume active participation in society.
4. ***Therapeutic effect***- After surgical procedures in carcinoma and trauma cases, maxillofacial prosthetic aids help by acting as carriers for medicinal applications.
5. ***Preservation of tissues***- A prosthodontist's main goal is to preserve what is already there indefinitely. In maxillofacial prosthetic rehabilitation cases, success is defined as preserving the tooth, bone, and surrounding orofacial structures.

Retention

Retention is that quality inherent in the dental prosthesis acting to resist the forces of dislodgement along the path of placement.[3] Any prosthesis serves its purpose only when it is retentive. There are 5 different ways by which anchorage can be achieved in maxillofacial prosthesis,[15] they include-

1. Anatomic retention.
2. Chemical retention.
3. Mechanical retention.
4. Surgical retention.
5. Implants.

1***) Anatomic Retention***:

As a mode of retention for maxillofacial prosthesis, anatomic undercut areas can always be created by planning before and after surgery. As with the undercut area in ocular defects, anatomical retention is achieved by already existing anatomical structures.[16] Anatomic retention can be either intraoral or extraoral.

a) Intraoral Retention

Hard and soft tissues are used to achieve intraoral retention. Teeth, mucosal, and bony tissues are all possible sources to achieve it. The palatal area, cheek, retromolar area, remaining teeth, alveolar ridge, septum, and anterior nasal aperture all have anatomic undercuts. Flat ridges and palates provide less retention than large alveolar ridges and high arched palates. Intraoral retentive aids are usually considered comfortable for the patient because they are easy to remove and allow the dentist to examine the surgical site for recurrence of the tumour.[17]

b) Extraoral Retention

The movement of the prosthesis has the potential to cause stress on the abutment teeth, which could result in tooth loss. As a result, an additional retention can be used in such cases. The hard and soft tissues of the maxillofacial and neck region can be used to achieve extraoral retention. Prosthesis insertion and removal are complicated by deep undercuts. Because of their mobility and lower resistance to displacement when a force is applied, soft tissues pose a problem. The maxillary sinus, nasal cavity, and orbital regions are commonly affected by soft tissue undercuts. Prosthetics used in these areas have the advantages of being cost effective, aesthetically pleasing, and simple to fabricate.[18]

2***) Chemical retention***

Double-sided tape, glue, sprayers, pastes, and liquid systems are more commonly classified according to their use; double-sided tape, glue, sprayers, pastes, and liquid systems are classified according to the silicone substrate.[19] Due to their difficulty in removal, latex-based pats and surgical cement cause odours and remain on the surface of the skin and prosthesis. As a result, they aren't particularly popular. Due to its ease of application, removal, and renewability, double-sided tape is the most popular type of adhesive. However, this type of tape has some drawbacks, including low flexibility and the need for frequent reassembly due to stickiness loss. The type of adhesive to be used with the maxillofacial elastomer and the cleaning solution should be selected carefully. Adhesives and solvents may an adverse effect on the physical and optical properties of the maxillofacial elastomers.[20] The properties of ideal adhesive materials are,[20]

- The material should be biocompatible, non-toxic, and should not cause irritation on the tissue
- The adhesive should keep the prosthesis in place for at least 12 hour a day
- The material should be odorless and moisture-resistant
- The prosthesis should not damage tissue during removal from the skin
- The dried adhesive must have a porous structure to allow for the passage of secretions
- The sticker should be presented in a portable package
- The adhesive should be easy to apply
- The material should dry quickly

The use of an adhesive has a few disadvantages. During insertion and removal, it can harm both the prosthesis surface and the skin. They don't offer enough resistance to gravity, sweating, and tissue movement. Adhesive systems can cause contact dermatitis if used for a long time. The use of adhesives may cause the colour of the prosthesis to change. Adhesives can cause the prosthesis' structure to be disrupted and the edges to be abraded. All adhesive systems are

insufficient for securing facial prostheses in place. In order to facilitate the application of adhesives thicker prosthetic margins are used which increases both microorganism involvement and aesthetic damage due to the non-resetting of the marginal passage.[21]

Types of adhesive materials

Acrylic resins, silicone adhesives, and pressure sensitive tapes are frequently used with facial prostheses. Acrylic resin adhesives are water soluble and become supple as the water evaporates. Except for polyurethane, these adhesives can be easily removed from all prosthetic materials. This system is demonstrated by Hydrobond (Epithane 3). Silicone adhesives are highly resistant to moisture and only absorb a small amount of it. Chemicals, oil, and sunlight have no effect on them. Silicone adhesives that are room temperature vulcanizing (RTV) are low molecular weight polymers that end in hydroxy. Secure medical adhesive is an example of this group (SMA). Another option is to use pressure sensitive tapes. 3M doublesided tape is an example of this type on the market. These systems, which use finger pressure to increase bonding strength, may be recommended for use with liquid adhesives.[21] Tissue protectors can be used to reduce adhesive side effects and improve bonding strength. Secure medical adhesives are more retentive than Epithane 3, tissue protectors on both materials have a positive effect on binding, the effect of adhesives is reduced in about 8 hours, and the combination of both materials increases connectivity (when SMA was applied on the skin, on the E3 silicone prosthesis), according to a detailed study on the two materials.[22] Because of its cost effectiveness, noninvasiveness, and lack of aggressive side effects, adhesive use in facial prostheses is well received by patients and their families. Patients should be instructed to take out their prosthesis once a day to allow the surrounding tissue to heal. It is strongly advised that the prosthesis be removed before sleeping to reduce the risk of skin contact disorders and to give the tissues a chance to rest.[23]

3) **Mechanical Retention Mechanical anchorage includes**-

1. Magnets.
2. Eye glasses and frames.
3. Extension from denture.
4. Precision attachments.
5. Elastic and non-elastic straps

- ***Magnets***

Magnets gained popularity in the field of maxillofacial prosthesis due to strong attractive forces and their small size. The most appropriate size of magnet can be chosen based on the size of the defect. For sectional dentures, hemi-maxillectomy, obturators, complete dentures, or extensively atrophied ridges, magnets are used as a retentive aid. They are said to offer the best retention and stability for maxillofacial prostheses. Magnets are used as a retentive aid to help attach the implant to the prosthesis. Magnetic attachments are used on teeth and implants to improve prosthetic stability, support, and retention. Many researchers have studied various magnetic systems and used magnets as a retentive aid in maxillofacial prosthesis cases in the past. A sectional prosthesis is usually considered as a treatment option for large maxillary defects. Two magnetic pairs are used to join two sections in this case. For the production of small dental magnets, two types of alloys are commonly used. Cobalt-samarium, iron-neodymium, and boron are the elements involved. They have strong attractive forces in small sizes but poor corrosion resistance.[24] Magnetic properties of samarium-cobalt magnets are said to be superior to those of other magnets. Due to their high attractive force, Fe-Pt dental magnetic attachments are clinically useful for maxillofacial prosthesis retention. A dental

casting machine can be used to cast the Fe-Pt magnetic attachment system (magnet and keeper). As a result, any size or shape of castable magnetic attachment for maxillofacial prostheses can be created.[25]

In the fabrication of sectional intraoral maxillofacial prostheses, magnets are used in both mandibular and maxillary implant-supported, full-arch bar, fixed-detachable prostheses. These magnetic attachments' retentive forces are limited in comparison to lateral masticatory forces. Additional retention should be considered in such cases. Because of the size and weight of the prosthesis, it is difficult to keep it in place in large maxillofacial defects caused by cancer resection. Adhesives, resilient attachments, implants, or magnets can all be used to keep the obturator in place in this situation.[17,25,26]

- ***Eye and glass frame***

Eyeglasses can be used to retain nasal, auricular and orbital prostheses. It also helps in masking the borders of the prosthesis. It also aids in masking the prosthesis's borders. In the case of an auricular prosthesis, the bow of the glasses frame must be rigid enough to keep the auricular prosthesis in place on the head. There must also be enough room in the crevice media between the helix and the curved portion of the bow to receive it.[27]

When other means are not available, eyeglasses can be used to keep nasal prostheses in place. The eyeglasses you choose should have a frame that is moderately thick. The prosthesis is more noticeable with a thin frame. It is advantageous if the eyeglasses frame is made of acrylic resin, as this will allow a chemical bond to be formed between the glasses and some of the currently available types of facial materials using auto polymerizing resin. To avoid visible retention marks, the eyeglass frame should be opaque rather than translucent in colour.[28] The permanent fixation of a nasal prosthesis to eyeglass frames should be avoided because, if the glasses must be removed, the prosthesis must be removed as well, which can be very embarrassing.

- ***Extension from Denture***

Most primitive type of retentive aids namely cast clasps, retentive clips and acrylic buttons are still being used as they are the most economical way amongst the others.

- ***Precision Attachments***

The most common precision attachment that connects the prostheses and implant, as well as between different parts of the prosthesis, is bar clips. In maxillofacial prosthesis cases, telescopic crowns and extracoronal ball attachments are used to increase and improve retentive force.

- **Elastic and non-elastic straps**

Extraoral prostheses are used with them. In the case of auricular prosthesis, head bands are used. To make it adjustable, non-elastic straps and buckles are used. it needs a head cap to gain anchorage form. For extensive maxillofacial prosthesis, orthodontic headgear assemblies such as a head cap and adjustable strap extension are very useful.[29]

4) Surgical retention

Surgical anchorage is using surgically created retention elements.[15]

5) Implants

The use of extraoral implants provides excellent support and retentive abilities to improve aesthetics as well as quality of life (QOL). Implants offer a high degree of stability and retention. Generally, four types of thread forms are suggested for implants-

- V-form
- Square
- Buttress

- Reverse buttress.

The V-form is the most commonly used endosseous intraoral implant among these. Despite its ability to transmit high compressive and low shear forces to bone, square thread is unsuitable for small implant lengths. Buttress threads are thought to be better for supporting maxillofacial prostheses. Because the outward thread face is flat, the reverse buttress thread form can take care of the pullout force to a greater extent. As a result, reverse buttress thread forms can be used to support maxillofacial prosthetics. Extraoral implants can be modified in a limited number of ways. These are a lot shorter and have a dual structure with an endosseous part and a thread in the abutment. A perforated flange is typically used to increase the implant surface area and increase bone to implant contact (BIC) to aid initial immobilisation and prevent excessive intracranial pressure.[15]

Implant application area

The planning of craniofacial osseointegration is complex. Bone mass evaluations using computed tomography (CT) scans or other radiographic methods are essential. The results of CT scans can be analysed and used to plan an implant. Bone volume and density can be assessed using implant planning software.[30] Asar et al.[31] interpreted the classification of the bone regions in which the facial implants made by Jensen and his colleagues[32] could be placed as follows:

- ***A-bone regions***

Bone volume is 6 mm or more in these areas, allowing for the use of dental implants as well as zygomatic implants. These areas include the maxillary anterior aspect, zygomatic arch, and zygoma. The anterior maxillary, zygoma, and/or zygomatic arthritis are bone regions on the facial skeleton. The periorbital bone's lateral aspect was found to be mostly 6 or 7 mm in length.

- ***B-bone zones***

4 mm craniofacial implants can be used in bone volumes of 45 mm. The superior, lateral, and inferolateral orbital margins, as well as the mastoid margin of the zygoma and temporal bone, all contain these bone regions.

- ***C-bone zones***

The bone mass in the margin areas is 3 mm or less. The pyriform edge, infraorbital margin, nasal bone, and zygomatic arch are all parts of the temporal bone in the facial area. They necessitate the use of 3 mm or smaller craniofacial implants.[32]

Implants used in maxillofacial prostheses should adhere to a set of guidelines. The skin layers should be surgically thinned to prevent any damage, and this operation should be performed 10 mm away from the abutments. For hygienic purposes, the implants should be spaced 1 cm apart. The bars between the abutments should be designed to follow natural facial features and provide the necessary hygiene. The distance between the implant and the hairy scalp should be at least 7 mm. Skin grafting should be used if this is not possible.[32-34]

Facial implant application principles

- Auricular area

The aesthetics of auricular prosthesis are highly dependent on the placement of the implants in the temporal region. Because retention systems must stay within the limits of the auricular prosthesis, implants should be placed at the antihelix level. The auricular prosthesis may be retained by two implants placed in the temporal region. In such cases, the two implants should be 15 mm apart and each should be about 18 mm from the auricular duct's centre. For the right ear, an implant should be placed at 9 o'clock and 11 o'clock, and for the left ear, at 1 o'clock and 3 o'clock. These traditional suggestions should be regarded as a constant principle. The exact positions A wax sample and a surgical stent should be used to determine the placement of the implants.[31,35] Despite the complexity of preoperative planning for osseointegrated prosthetic implant placement in auricular site

defects, the technical simplicity and cosmetic results outperform traditional reconstructive procedures. These implants can be used in conjunction with osseointegrated hearing implants, though the planning and surgical steps are more difficult when tissue loss is evident.[36]

- Orbital and ocular area

When compared to auricular prostheses, the disadvantage of using adhesives in the orbital region is greater; as a result, implants are frequently required. The humidity generated under the prosthesis, depending on the secretions, reduces patient satisfaction, especially when adhesives are used. The implant prosthesis can be easily removed, which protects the orbital area from air and contact.[38]

1) Ocular prostheses

Although ocular implants today are diversified with the use of different materials, there are two basic groups of structures:

a) Integrated (porous) implants

Porous structures in these implants allow fibrous tissue to form. Integral implants, which are usually made up of spheres of various sizes and contain hydroxyapatite, are used to move the tissue bed. As a result, the prosthesis that will be placed on the implant will be able to move.

b) Non-integrated implants

There is no direct mechanical connection between these implants and the eye prosthesis. They're usually covered in a mesh-like material that allows the rectum muscles to bind together.[29]

2) Orbital prostheses

Because of the osseous anatomy of the orbital bone, orbital implants must be placed radially into the orbital boundary in order to provide sufficient bone thickness for retention. Implant placement in the lateral walls is usually recommended due to the increase in bone thickness and quality. Because of the increased anatomical complexity caused by the lacrimal fossa and a lack of adequate bone, the medial border is usually problematic. Unfortunately, this means that the desired axial loading of the implants is not possible in this region, resulting in a less favourable biomechanical condition than other craniofacial implant sites. As a result, a rigorous technique for staged bone grafting may be required for a successful implant-supported orbital prosthesis. To provide denture stability, three to four implants are usually placed in the lateral wall.[29] The implants' long axes should be pointing toward the orbit's centre. The ocular prosthesis should be 5 to 8 mm posterior to the supraorbital rim, 0 to 2 mm posterior to the infraorbital rim, and 8 to 12 mm anterior to the lateral orbital rim in the normal position. For additional retention and stability, it may be necessary to use the defect's medial walls. For prosthesis aesthetics, implants should be placed on the upper or side of the orbital wall so that it can be camouflaged with the prosthesis.[39]

3) Nasal prostheses

The anterior surface of the maxilla, just inferior to the nasal cavity, provides sufficient bone thickness and an ideal position for 4 mm implants for a nasal defect. In this area, longer implants of 6 mm or more are possible. On the sides of the defect, a split-thickness skin graft is required to provide a firm, non-movable foundation for the nasal prosthesis. The mobility of the tissue bed under the prosthesis will be reduced, and the stress on the implants will be reduced. The anterior septal cartilage must be surgically reduced. This procedure will allow the prosthesis to engage the lateral walls of the defect, increasing the prosthesis' stability. A minimum of two implants, one in each lateral rounded nasal eminence, are required. The abutments are connected by a bar because the implants are not evenly distributed and are only in one part of the defect. For better retention of the prosthesis, the bar can be extended superiorly 10 to 15 mm from the abutments. The retentive elements are housed in an acrylic resin section of the prosthesis. Magnets or retentive clips can be

used. Before placing the implants, a waxed pattern of the prosthesis must be completed and tried to ensure that the position of the abutments and retentive elements do not compromise the prosthesis' contours.[9,41,42]

Digital Versus Conventional Workflow for Maxillofacial Prosthesis Design and Manufacturing

- ***Conventional workflow***

The steps in a typical maxillofacial prosthesis production workflow are as follows: (fig. 15). A precise impression of the area requiring prosthesis is achieved by choosing an appropriate impression material (hydrocolloid alginates or elastic silicone polymers are the most commonly used materials) based on the type of defect, size, and presence or absence of any undercuts in the respective area, with a custom tray frequently required. To remove the impression without damaging the surrounding tissue, some anatomic undercuts are blocked. The gypsum cast is obtained after the impression is poured, and a wax model of the anatomic part to be replaced is fabricated. The wax is carved to reproduce the defect's natural morphological details, followed by a try-in of the maxillofacial prosthesis wax-up and the corresponding adjustments for marginal fit and aesthetic appearance. The moulds are made from the final retouched wax-up by using the lost wax method, which involves pouring gypsum over the wax model and then removing the wax with hot water.[43] The appropriate material is used to create the final prosthesis. Before the try-in, an impression of the opposite arch and mounting in a semi-adjustable articulator are required for intraoral and complex defects involving a part or the entire dental arch. Complex defects, including intraoral and extraoral missing anatomical parts, require the use of materials with different characteristics, such as silicones or acrylic resins.[44]

- ***Digital workflow***

The general steps for digitally manufacturing maxillofacial prostheses are the same. Medical scans and surface scans can be used to collect defect data. Medical scanning includes computed tomography (CT), which produces files in the Digital Imaging and Communication in Medicine (DICOM) format and is specific to the maxillofacial region; cone beam computed tomography (CBCT) or magnetic resonance imaging (MRI)[45] which produces files in the DICOM format; and convertible 3D models of a patient's specific anatomy. For defect data collection, surface scanners (e.g., laser scanners, structured light scanners, facial scanners, and intraoral scanners) are a good option.[46] Photogrammetry is also used to create 3D surface models of patients' faces, which involves extracting three-dimensional measurements from two-dimensional images of anatomical parts using specialised software.[47] The external or internal maxillofacial prosthesis is designed using a variety of CAD programmes and software suites, both open-source (OS) and commercially available (CA) (Table 1). The final prosthesis is created using rapid prototyping, particularly additive manufacturing. Maxillofacial prostheses are manufactured indirectly by obtaining a model of the prosthesis or the mould, followed by the traditional workflow for anatomic part processing, or directly by 3D printing with appropriate material (e.g., silicone-based elastomers and acrylic resins, among others) according to the proposed digital workflow and the material used.

Conclusion

A maxillofacial defect leaves a scar not only on the patient's physical appearance but also on mental well-being. Fabricating a maxillofacial prosthesis that matches the original tissue is a difficult process, but the patient gains confidence as a result of the prosthesis. The comfort with which the patient can carry the prosthesis is determined by its retention. Various time retentive measures have evolved over time.

Implants have grown in popularity as a result of the osseointegration process, which makes them more dependable as a retentive aid. Osseointegrated implants are the first choice whenever possible because they provide the best retention for extraoral maxillofacial prosthesis. The bar-clip system was the most wise option for auricular prosthesis. Magnets or bar-clips can be used in the ocular and nasal regions. The following factors influence the decision: indication, practitioner ability, and cost. There are a variety of options for retaining extraoral maxillofacial prostheses, including non-osseointegrated mechanical and adhesive retention techniques. They are the cheapest and have no contraindications.

The papers published in the last 20 years on maxillofacial prosthesis production using CAD and CAM technology demonstrated the viability of changing a traditional workflow from being highly skill-dependent, time-consuming, labor-intensive, expensive, and uncomfortable for patients to a simplified and predictable digitalized protocol. In most cases, the indirect approach with a 3D printed mould for silicone injection, using conventional procedures and followed by manual colour individualization, is required to achieve aesthetic outcomes similar to those obtained with the analogical path for the final extraoral prosthesis. The advantage of maxillofacial prostheses is that they require little to no surgery and restore aesthetics and function in a natural-looking manner. In maxillofacial prosthesis, retention is crucial. Professional evaluation should be encouraged on a regular basis to determine prosthesis adaptability to soft tissues, stability, retention, function, and aesthetics.

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FIGURES

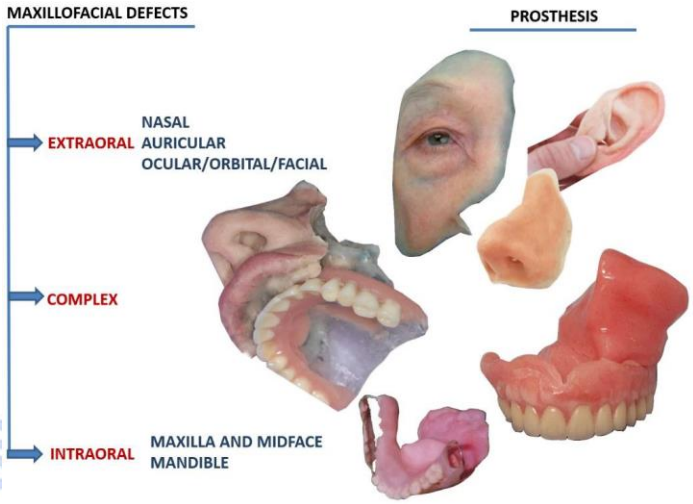

Fig. 1 Classification of the maxillofacial defects in intraoral, extraoral and complex cases (including extraoral complex and intraoral prostheses).

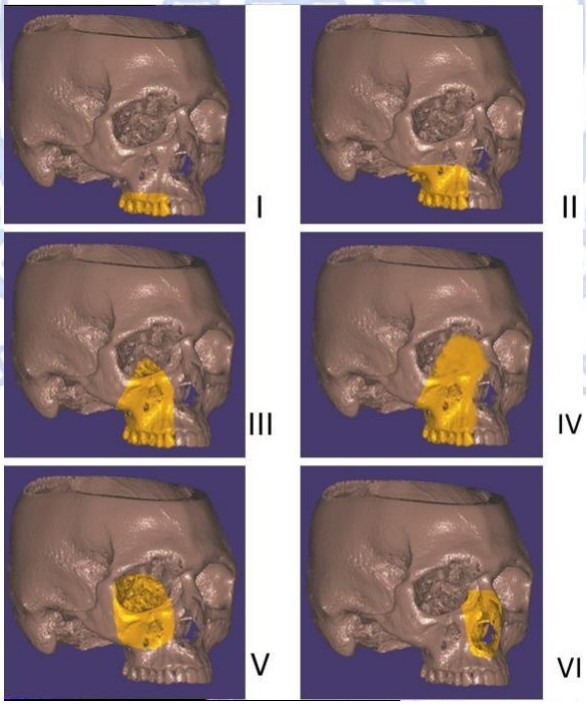

Fig. 2 The intraoral maxilla and midface defects, classified according to Brown and Shaw, classification in six classes: vertical classification, with a maxillectomy not causing an oronasal fistula (I); not involving the orbit (II); involving the orbital adnexae with orbital retention (III); with orbital enucleation or exenteration (IV); with an orbitomaxillary defect (V); and with a nasomaxillary defect (VI). For horizontal classification, only a palatal defect not involving the dental alveolus (a); less than or equal to a half unilateral (b); less than or equal to a half bilateral or transverse anterior (c); a greater than half maxillectomy (d).

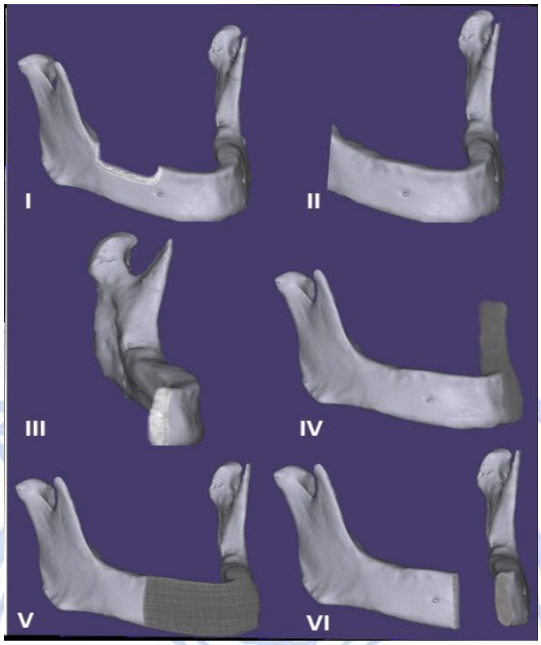

Fig. 3 The intraoral mandibular defects, according to Cantor and Curtis classification in six classes, radical alveolectomy with preservation of mandibular continuity (I); lateral resection of the mandible distal to the cusp area (II); lateral resection of the mandible to the midline (III); bone graft and surgical reconstruction (IV); anterior bone graft and surgical reconstruction (V); and anterior mandibular resection without surgical reconstruction (VI).

Fig. 4 Magnets used for retention of prosthesis

Fig. 5 Eye and ear prosthesis supported by glass fram

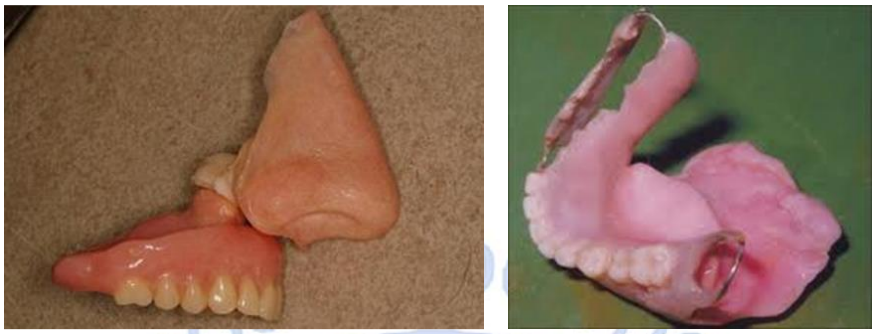

Fig. 6 Extension from a denture and a cast clasp

Fig. 7 Precision attachment used for retention of the prosthesis

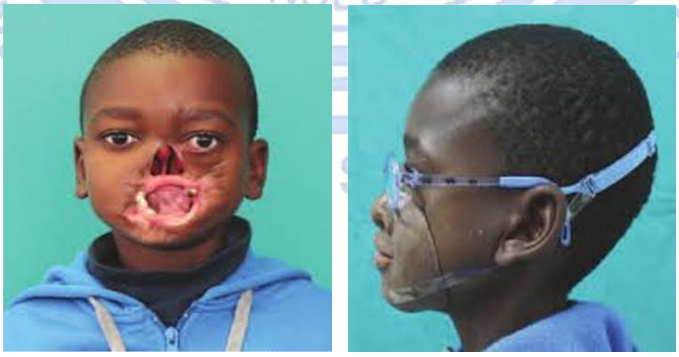

Fig. 8 Elastic straps used for retention of the prosthesis

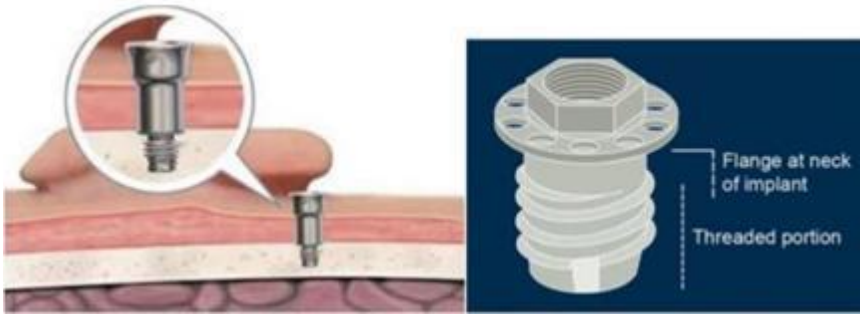

Fig. 9 Craniofacial implant

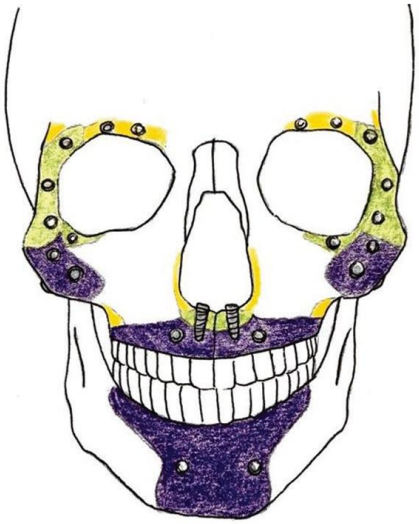

Fig. 10 Implant placement of the facial prosthesis frontal view

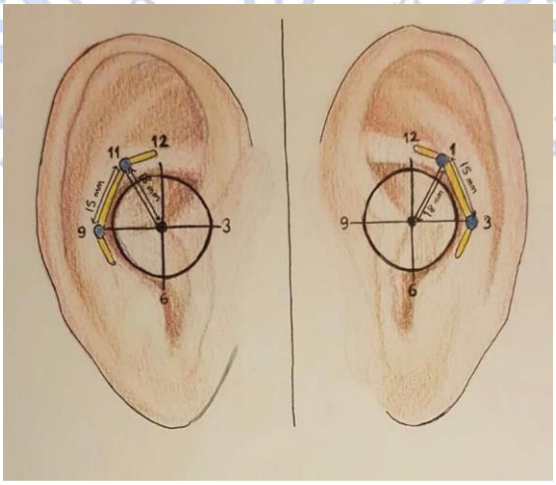

Fig. 11 Implant placements and bar application in auricular prosthesis

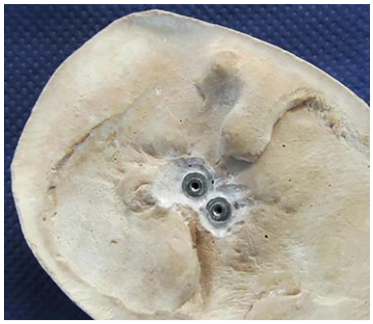

Fig. 12 shows external hexagon system extraoral implant analogues transferred into the cast model for the laboratory phase of an auricular prosthesis.

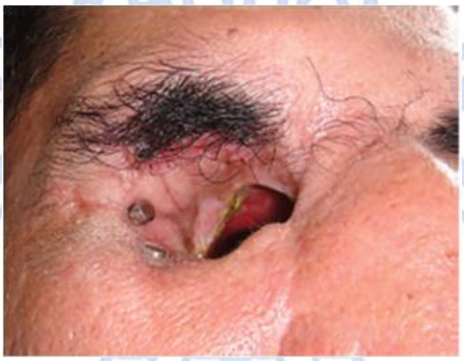

Fig. 13 Superior, Lateral and inferior orbital rims are favourable sites for implant placement.

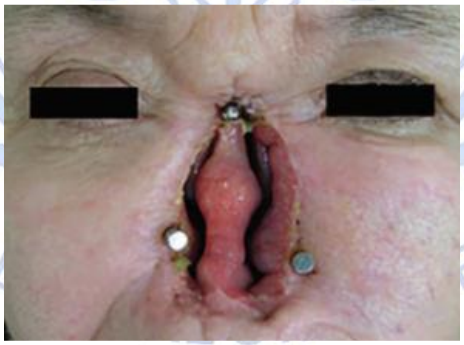

Fig. 14 Anterior part of maxilla or lateral rounded eminence serve as preferred sites for implant placement

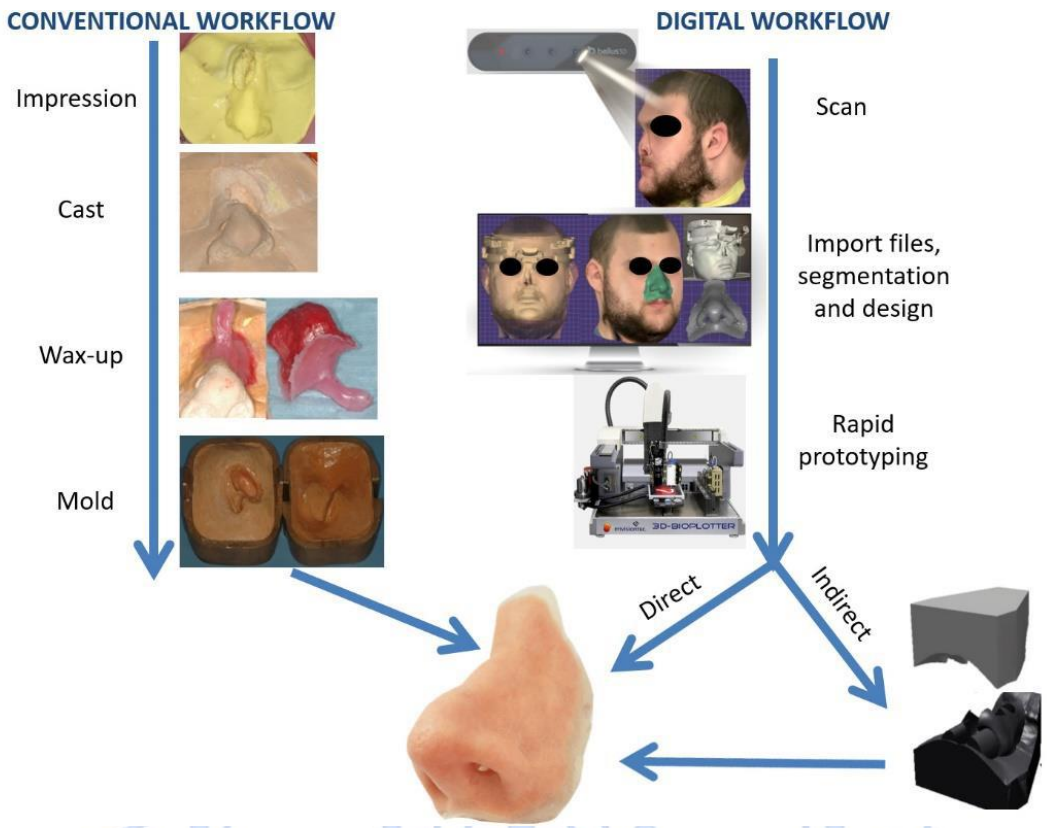

Fig. 15 Comparison of conventional and digital workflows for nasal extraoral prosthesis manufacturing.