MOCK SURGERIES AND SPLINT FABRICATION

Facial skeleton surgery involves a sequence of non-surgical procedures that require complex three-dimensional movements. Bimaxillary osteotomies are a type of procedure that improve function and appearance by altering atocclusal level. Due to the change in occlusal level, planning for bimaxillary osteotomies must be done preoperatively using model surgery. A problem list and a treatment plan are generated after the clinical and cephalometric analysis has been completed and the results have been analysed. After that, the mounted models can be moved into the position that was planned for the purpose of correcting the skeletal disorder. Keeping in mind that the treatment of facial bone abnormalities is typically a collaborative effort between the surgeon and the orthodontist, this position needs to be agreed upon by both parties before it can be implemented. It is essential that all movements be rendered visible in a manner that takes into account three dimensions. In order to accomplish this, reference lines need to be scribed on the models before the movements are carried out.
Wax or glue is used to secure the models in their new positions after they have been moved. A mock operation is carried out to simulate the actual operation that will take place. In addition to this, it is an effective instrument for demonstrating the treatment plan to the patient. Finally, the surgical splints that are going to be used in the real operating room to reposition the osteotomized segments are fabricated with the help of the models that have been reoriented following the mock surgery.

Individual stereolithographic models can also be used to simulate surgical procedures and perform mock operations. This is recommended for deformities that are severe and predominantly asymmetric.

The pioneers in the field of dentistry, such as Hullihen in 1849, Angle in 1903, and Blair in 1907, primarily relied on the clinical and surgical appearance of their patients. Kostecka, in 1931, used unarticulated models to evaluate the occlusion of his patients before and after surgery. Later, sectional models were constructed using wax, and German silver alloy splints were created to fix the broken pieces, as demonstrated by Wassmund in 1935.Heggie questioned the precision of model surgery and proposed the utilisation of a calibrator, which was essentially a modified verniercalliper, in order to evaluate the position of the maxilla while it was being operated on. A calibrator is used to determine the distance between the nasion (an arbitrary point on the nose) and the tip of the incisor, which is located in the midline. In 1978, Lindof and Steinhauser, followed by Cottrell and Wolford in 1994, proposed a planning and operative procedure that differed from the standard of care that was previously followed. They hypothesised that if a thin-walled maxilla is repositioned first in the event of a significant mandibular advancement, then a maxillary shift may take place while the maxillomandibular fixation is being applied. This would result in a more ideal alignment of the jaws. Because of this, they started with the surgery on the mandible and used cephalometric tracings to determine where the patient would end up after the procedure. After that, a rigid fixation is used to stabilise the mandible, and then the maxilla is moved into the correct position to complete the occlusion.[2]

In order to achieve precision in determining the maxillary position in space and its relationship to the ideal functional centric occlusion following bimaxillary osteotomies, the

use of an anatomical articulator combined with a face bow transfer is necessary, as suggested by Hohl, Bamber, and Harris.[3].

The use of occlusal wafers is an important aspect of orthognathic surgery. These wafers serve as guides during the surgical procedure, allowing the surgeon to accurately reposition the jaws in the desired location. The occlusal wafer is fabricated based on the treatment strategy outlined in the model surgery, which takes into account all diagnostic data obtained from preoperative evaluations. The simulated postoperative model relationships are then used to fabricate the intermediate and final occlusal wafers. The use of occlusal wafers helps to ensure that the treatment plan is accurately translated into the surgical procedure, ultimately leading to a successful outcome.[4]

Figure 1: Occlusal Wafer

The following is a description of the Eastman anatomically-oriented model surgery technique, which, in essence, promotes the utilisation of a face bow recording in conjunction with a supine centric relation record and a semi-adjustable articulator.[5]

‘The facebow (also ‘face-bow’ or ‘face bow’) is a device used to record the relationship of the maxillary dental arch to the transverse horizontal condylar hinge axis of the temporomandibular joints, used for orthognathic patients requiring maxillary surgery. The facebow allows the maxillary dental model to be placed in an equivalent relationship on an articulator’. [6]

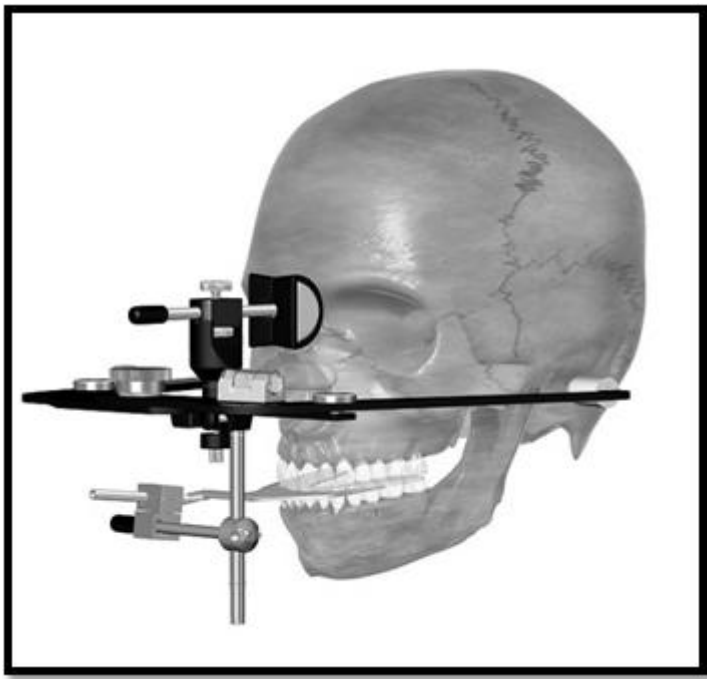

Figure 2: Face

I. BOW

'An Articulator is a mechanical device that represents the temporomandibular joints, to which the maxillary and mandibular dental models may be attached, with the intention of simulating some or all mandibular movements. The information is transferred from the patient to the articulator using a facebow transfer.

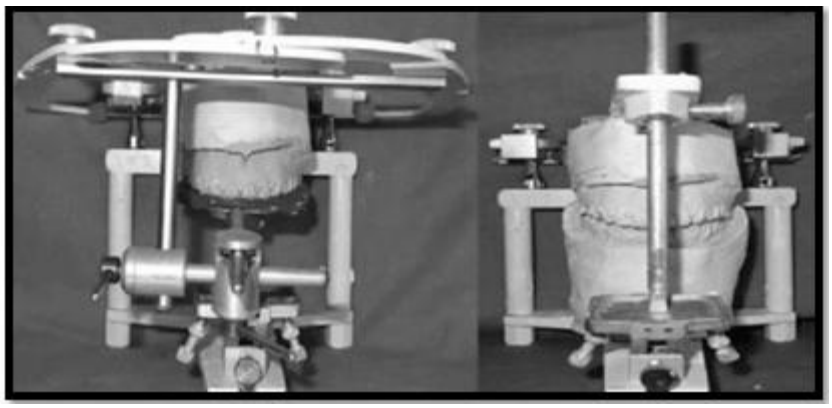

Figure 3: Face Bow Attached to an Articulator

Surgical wafer splint: 'Rigid interocclusalcustommade splints used in orthognathic surgery to guide intraoperative repositioning of the jaws, consisting of an acrylic resin prosthesis wired to the fixed orthodontic appliance/teeth in the maxilla (or mandible) and joined intraoperatively with stainless steel ligatures or elastics to keep the segments immovable while repositioning the jaws'.[7]

The level of complexity in model surgery can be categorized based on the difficulty level of the actual surgery. Bilateral sagittal split osteotomy (BSSO) of the mandible is considered the simplest form of model surgery, while the complexity level increases when a bimaxillary Le Fort I osteotomy and BSSO are combined.

Further complexity is added when a multisegment maxillary osteotomy with differential mobility of the segments, along with a mandibular symphyseal osteotomy and BSSO, are performed.[8]

II. STAGES OF MODEL / MOCK SURGERY

Making Impressions

Making Models

Facebow Transfer

Articulator

Reference Lines

Fabrication Of Splints

III. MAKING AN IMPRESSION

Orthognathic model surgery relies heavily on an impression process that is notoriously sensitive. Even though a flaw is not visible on the plaster model, it may have an impact on the occlusal relationship, especially after segmental operations.[10]Having intraoperative occlusal positioning wafers that don't quite fit is another potential problem.

The goal is to leave two distinct imprints. Diagnostic casts, anatomical markers, and surgical models all find utility in the production of occlusal wafers.

To ensure an accurate fit of the splints during surgery and proper dental occlusion post-surgery, it is advisable to ligature the final preoperative orthodontic archwire with stainless steel ligatures a few weeks before taking dental impressions. Dental impressions should be taken no later than one month before the scheduled surgery to minimize the risk of

tooth movement that could lead to poorly fitting splints during surgery and compromise the position of the dental occlusion after surgery.[8]

In order to reduce the possibility of modest, unwanted tooth movement during the process of getting impressions as well as the process of replacing the archwires, it is advised that the archwires be remained in place while the impressions are being taken.

In order to prevent the imprint material from running underneath the archwire, a strip of wax is first flattened between the fingers, then placed underneath the archwire and brackets, and then moulded into position. This is done so that the wax will stay in place. Despite this, the occlusal aspect of the brackets should still be visible after the wax has been applied, as it should not be hidden by the wax.[9]

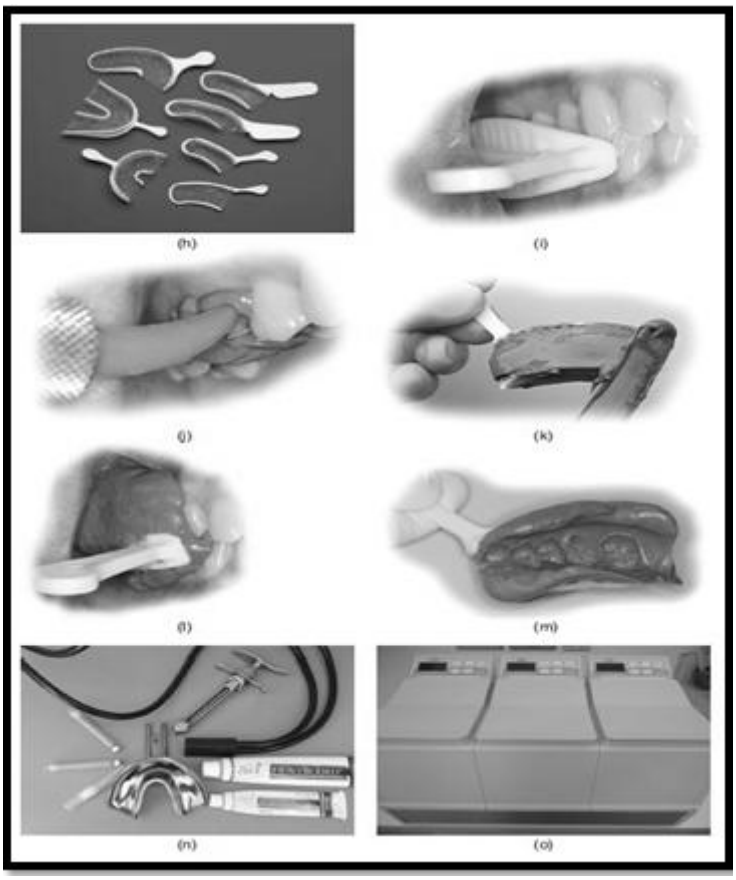

Figure 4: Impression Technique

When selecting the size of the imprint tray, it is absolutely necessary to ensure that all of the teeth in the corresponding dental arch can be accommodated within the confines of the tray. It is simple to accidentally leave the second and third molars outside the posterior portion of the impression tray when taking the impression. This indicates that the alginate impression material will distort in that area during the casting process, which may lead to an inaccurate dental occlusion and an improperly fitting splint. The second and third molars should not be accidentally left outside the posterior portion of the impression tray when taking an impression. Additionally, it is crucial to prevent the alginate material from shifting inside the impression tray.[9]If there are deep cracks in the occlusal surfaces of the posterior

dentition, it is recommended that some alginate be smeared along these surfaces with a finger shortly prior to taking the impression. This will help prevent the impression from being distorted. This will decrease the likelihood of air blows occurring within the alginate, which, if they did occur, would otherwise endanger the postoperative position. It is simple to undervalue the significance of the occlusal registration, which is a registration of the dental occlusion of the patient. Occlusal registration is also known as "jaw registration," "bite registration," and "bite record," among other names. Within the confines of the laboratory, the maxillofacial technologist is adhering to a tolerance of 0.3 millimetres. If the jaw connection is off, it will result in an imprecise movement of the maxillary bone.[9]

Patients who have a significant amount of incisor overjet will sometimes position their mandible in an anterior position when the bite registration is being taken. The patient will feel the resistance in the wax as they bite together, and as a result, they will position their mandible in a forward position. It is simple for the physician or maxillofacial technician to miss such motions because of how easy it is for them to do so.

IV. MAKING OF MODELS

Trimming the base of the cast requires placing a level plane over the occlusal surface of the mandibular teeth after the impressions have been formed in dental stone. The foot is shortened so that it lies flush with the tabletop. To that end, the maxillary cast is shaped similarly, with squared off corners and sides that are parallel to the mandibular foundation.
To avoid damaging models during the casting process, Plaster of Paris is no longer considered an ideal material. Instead, models can be made with scratch-resistant polyurethane resin (such as Hit Model from Euro Resina, Italy) and metal retention rings (such as Retention Washers from Skillbond Direct Ltd. UK) can be inserted into the resin while it hardens to secure the plaster in place.[10]

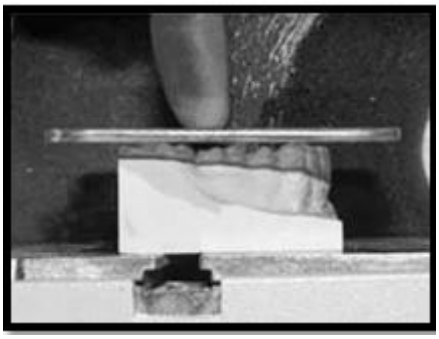

Figure 5: The sides of the squared-off maxillary cast are parallel to the mandibular base.

V. FACE BOW TRANSFER

To ensure accuracy in the articulator system, it is advised that each system has its own specific facebow and bite fork assembly, which cannot be swapped between different systems. To transfer the facebow recording to the SAM articulator, an Axioquick transfer bow (ATB 303) and an Axiomatic transfer fork assembly (ATB 395) with a universal clamping mechanism and a removable transfer fork are used. While a facebow recording is

not usually necessary for single mandibular surgery, it may be necessary for isolated maxillary or bimaxillary surgery.

VI. ARTICULATORS

Maxillary advancement with no change in maxillary height (i.e. no impaction per number down graft) can be performed with plain simple hinge articulators. Secondly, Advancing the mandible as a single jaw operation. There are benefits to using semiadjustable articulators for planning orthognathic surgery over more basic devices. For accurate maxillary position I space and its link to the best functional centric occlusion, as well as in the following circumstances, a semiadjustable anatomical articulator with a face bow transfer is required during maxillary osteotomies. Height-altering maxillary osteotomies (implant-retained down graft, impacted maxilla) Procedures in the Bimaxilla Maxillary osteotomies, especially those that are segmental or multi-part, are the third most common type of facial surgery. Mandibular casts are mounted after rnaxillary casts utilising the centric wax record, which is obtained at the same clinical session as the face bow registration.

VII. REFERENCE LINES

To measure anteroposterior movement during surgery, vertical reference lines can be inserted on the sides of the maxillary cast. To prevent or correct a transverse discrepancy, parallel lines can be drawn on the anterior and posterior of the maxillary cast to describe the amount of arch rotation. The articulator mounting ring also has horizontally positioned markings located 10 and 20 mm away, which can aid in surgical positioning.Maxillary preoperative anatomic position is recorded using a series of measurements made using dental landmarks. The distance between the upper and lower incisors is measured from the incisal pin on the articulator. A straightforward apparatus was fabricated from a square tube and screwed onto the incisal pin of the articulator. The sliding pin can be positioned to touch the teeth, and the resulting measurement can be used to determine how far the maxilla has moved. The distance between the teeth and the pin can also be measured with a verniercalliper. The cast will have these measurements written on it for easy reference.[10]

Figure 6: Reference Lines and Dental Landmarks marked on the Models

VIII. FABRICATION OF SPLINTS

1. **Isolated mandibular surgery:** Hand articulating dental models into the desired occlusion is typically possible if isolated mandibular surgery is being conducted. The articulator can be mounted using a simple hinge articulator, and the wafer splints can be fabricated using the articulator itself. After dental surgery, a wafer splint may not be required if the

anticipated dental occlusion is clear and well-interdigitating. The dental occlusion can be used to guide the new position of the osteotomized mandible, which can then be secured intraoperatively. Most doctors, however, advocate for one last splint before surgery.

2. **Isolated maxillary or bimaxillary surgery:** Model surgery is used to replicate the ideal maxillary relocation established through preoperative clinical and cephalometric planning, whether for solo maxillary surgery or bimaxillary surgery. The final placement of the mandible depends on the precision with which the maxilla is repositioned. In the case of a maxillary osteotomy, the dental models must be installed on a semi-adjustable articulator with precise occlusion registration and facebow transfer. The precision of the interocclusal surgical splints relies on the accuracy of the preceding phases, hence it is crucial to minimise errors at each of these stages.[11]

   To assess the proposed surgical procedures on simulated patients, measuring equipment is necessary. The position of the maxillary central incisor edges, canine cusp tips, and mesiobuccal cusp tips of the maxillary first molars can be measured using a model repositioning instrument or a model measuring block such as the Erickson Model Platform and Block manufactured by Great Lakes Orthodontics located in Tonawanda, New York.The maxillary model's current position and proposed new placement can both be determined with these three-dimensional measurements. Clinical and cephalometric planning will establish the maxillary dislocations along the three spatial axes and their relationships to each other.[11]

   A saw is used to cut the occlusal part of the maxillary cast away from the rest of the cast. The cast is adjusted by removing as much plaster as necessary to make room for the relocated maxilla. The space between the cast's base and occlusal part is filled with soft wax. The occlusal part of the model can be tweaked somewhat with the help of the wax. Once the desired maxillary location has been determined, the tooth cusps are measured in three dimensions until a match is found. Sticky wax or plaster is used to attach the model to the mounting ring, and the articulator is then placed on the model once the measuring equipment confirms the new position of the maxilla. The maxillofacial technician will now have a mounting of the maxilla with relation to the mandible in the preoperative position.[11]

   The new sagittal and transverse position of the maxilla relative to the preoperative position of the mandible is determined intraoperatively with the help of an acrylic splint, called the intermediate splint. The final splint, which depicts the new location of the mandible to the relocated maxilla, is fabricated using a second mounting with the dental models in the ideal postoperative occlusion.

IX. MAXILLARY MOVEMENT

The articulator system requires specific tools to measure and manipulate the maxillary bone during simulated surgery. One tool is the model repositioning instrument (MRI 300), which is exclusive to this system. An alternative tool is the Erickson Model Platform and Block, which can also be used to measure the position of the maxillary central incisor edges, canine cusp tips, and mesiobuccal cusp tips of the maxillary first molars. To ensure accuracy, the Erickson measuring block or an equivalent can be used in conjunction with the model

repositioning instrument. Holes are drilled into the maxillary model using a drill bit (MRI 311), in the region of the mesiobuccal cusp of the first molars on both sides and in the anterior region in line with the midline of the maxillary central incisors. Plastic sleeve inserts (MRI 210) are inserted into these holes using the insert instrument (MRI 212).

Make sure the maxillary model is positioned correctly in relation to the mandibular model before re-attaching it to the articulator. After that, the articulating plate and mandibular model are removed, and the model repositioning tool is attached to the articulator's lower arm. Three pins are present on the repositioning device: one on the right, one on the left, and one in the centre. The maxillary model's pins can then be inserted after the locking nuts have been unfastened. The plaster spacer that was positioned between the model and the articulating plate is removed after everything is in position and secure and the locking bolts are tightened.[12]

To ensure accuracy during repositioning of the maxillary model, it is crucial to record the readings for each arm of the model repositioning device, which are calibrated in millimetres. The MRI allows for a full range of movements, such as superior repositioning (impaction), inferior repositioning (set-down), advancement, set-back, and rotation around the three axes of rotation, including differential impaction for correcting a maxillary cant. Once the movement has been determined by the surgeon and orthodontist, the maxillary model can be repositioned accordingly. When the desired location is achieved, the model is secured in place with plaster, and magnets are used to hold the segments in position.

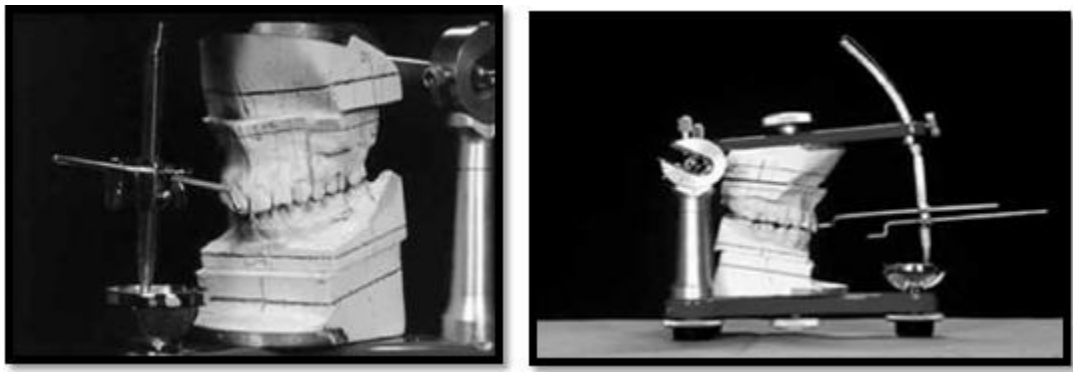

Figure 7: Maxillary Advancement in Model Surgery Procedure

X. MANDIBULAR MOVEMENT

After positioning the maxillary and mandibular models such that they are in the postoperative position, wax is used to hold them together, and then the articulator is returned to its original position. This postoperative position ought to be decided upon by the orthodontist in conjunction with the surgeon. After that, the maxillofacial technologist will use plaster to fix the mandibular model into place.[12]

The mandibular symphyseal split is a surgical procedure that may be performed by an oral surgeon to correct a crossbite and narrow the jaw. The procedure can result in a total constriction of 8mm, with each segment being able to move a maximum of 4mm. It is important to position the fulcrum point between the mandibular central incisors to prevent the

creation of a triangular space between them. Torquing of either segment should be avoided. While technically not a difficult procedure, it should be performed by a qualified maxillofacial technologist.

XI. VIRTUAL MODEL SURGERY

Traditional model surgery techniques have some drawbacks. For one, dental models placed on an articulator do not show the jaw's structure, so the surgeon must visualize potential skeletal alterations resulting from dental model movements. Additionally, facebow transfer can be imprecise. It is crucial to properly position dental models on the articulator to replicate the patient's teeth' positions accurately. Furthermore, significant variations were detected between the inclinations of the occlusal plane on mounted models and those on lateral cephalometric radiographs of patients.

The precision of the mandibular autorotation simulation is the third factor to consider. There is evidence to suggest that even the very first rotational movement of the condyles that occurs during mouth opening involves some degree of condylar translation as well. That is to say, the movement does not consist of a straightforward rotation about the axis of the condylar hinge[13]. In spite of the fact that this is probably only going to be a small problem in the planning of the orthognathic surgery, it does add an element of inaccuracy to the model surgery that is performed on the semi-adjustable articulator.

Modern computer-assisted surgical simulation may provide a solution to some of the challenges posed by conventional methods of model surgery. However, it is important for clinicians to remain cautious and mindful of the warning given by Albert Einstein that technology can create a "generation of idiots." The value of computers is dependent on the quality of information provided and the clinician's understanding and use of that information, including any potential drawbacks. Ultimately, computers are only as helpful as the information they are given. Computer-aided surgical simulation procedures have utilized a CT model of the skull, along with a prefabricated bite-jig that the patient bites onto. These methods have been applied to actual patients, and involve the creation of a digital model of the patient's dentition and occlusion through a precise scan of their dental models. This digital model is then transferred and matched to the CT skull model of the patient for surgical simulation.Acomputerised composite model of the dentoskeletal structures is produced as a result of this process. This composite skull model can be used to mimic the operation that is going to be performed, as well as to compare and contrast the various treatments. In order to simulate a variety of various surgical procedures, the digital skull can have sections cut out of it and be moved about an unlimited number of times. After that, the computerised surgical plan can be conveyed to the patient through the use of computer-aided design and manufacturing of the surgical splints. The physical splints can be sterilised and utilisedintraoperatively after being generated by a rapid prototyping machine using digital splints that have been supplied to the machine from a computer.[13]

Constant leaps forward in technological capability are characteristics of the modern world. It is anticipated that computerised procedures will become more widely accepted as they continue to develop, get better, and become more user-friendly, and that they will eventually form the backbone of model surgery.

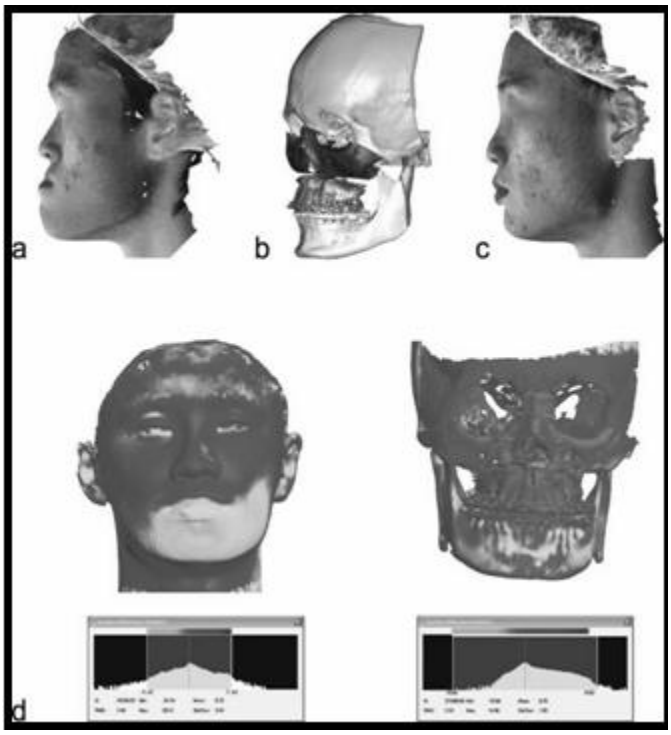

Figure 8: A) Preoperative patient image.B) 3D virtual model with simulated osteotomies.C)Postoperativeimage.D) Color maps illustrating facial and skeletal changes post-surgery. The preoperative image serves as the reference surface.

XII. OCCLUSAL WAFERS / OCCLUSAL SPLINTS

The transfer of specified three-dimensional movements to the patient is made possible by analytic model surgery, which makes use of particular measurements, reference points, and a surgical splint that is created to the patient's specifications. After recreating the arch movement on the arch model, you will only need to construct one splint (the final splint), regardless of whether you are having maxillary or mandibular surgery done.[14]

In order to complete the double jaw procedure, you will need to create an intermediate splint (wafer) to relate the osteotomized maxilla to the stable mandible and a final splint to relate the osteotomized mandible to the fixated maxilla. Both of these splints will be attached to the osteotomized mandible.

The mandibular cast is disassembled from the articulated mounting base and repositioned to the presurgical position. This position is known as the intermediate position, and it indicates that the maxillary surgery has been completed but the mandibular surgery has not yet taken place. The process that was explained before is utilised in the production of an acrylic wafer. When constructing wafers, it is best practise to utilise acrylic in a variety of colours because this makes for simple identification in the theatre. The technique that is used for this purpose ensures that the wafers used in the ultimate position are always clear, while the wafers used in the intermediate positions are always ivory. This minimises confusion regarding the selection of wafers during surgical procedures. When the casting process is finished, the castings are replaced in their final positions in the operating theatre for future reference.[14]

When considering the basic requirements of a splint, several factors come into play. Firstly, the splint should remain unchanged in its dimensionality, ensuring that it retains its intended shape and size over time. Additionally, it should be non-irritable, minimizing any discomfort or irritation to the patient. The construction of the splint should be simple, allowing for efficient and timely fabrication. Moreover, it should provide good stabilization, ensuring that it effectively supports the intended areas of the oral cavity. It is also important that the splint is not cumbersome to carry, offering convenience and ease of use for the patient. Occlusal accuracy is another crucial aspect, as the splint should provide an accurate fit and alignment with the patient's dentition. Lastly, the use of color coding can be beneficial in enhancing the visual identification and differentiation of different types or functions of splints. Considering these requirements contributes to the development of effective and patient-friendly splints.

Occlusal wafers are often fabricated using self-curing acrylic, silicone, or acrylic that has been light cured. The primary drawbacks of self-curing are the leaching of monomer and, in the case of silicone, the flexibility, both of which make it more challenging to accurately position and stabilise the material. Acrylic that has been light-cured is dimensionally stable and has exceptional occlusal precision, giving it a competitive advantage. Additionally, to this orthodontic power chain, the ability to stabiliseintraoperatively may be incorporated. An application of separating media has been made to both the upper and lower castings (Cold mould seal). After reaching the dough stage, the acrylic is rolled out into a cylindrical shape and made malleable to fit the bottom teeth. After this step, the upper cast is rotated into occlusion, the extra acrylic is removed with scissors, and the acrylic wafer is allowed to dry for the appropriate amount of time. This intermediate wafer has been color-coded to indicate the altered position of the maxilla, which will assist the surgeon in foray identification while the procedure is being performed.[15]After the mandible has been repositioned in the appropriate position, a mandibular final splint, also known as a wafer, will be produced.Because they help to combine the segments of ostomized maxillary or mandibular components and stabilise these segments into the proposed ultimate positions anticipated by oral surgeons, these occlusal wafers are of the utmost importance.

Figure 9: Occlusal Splints During Pre-Surgical Treatment.

XIII. SPLINT WAFER MODIFICATIONS FOR PARTIALLY DENTATE OR EDENTULOUS PATIENTS

Modifications to the surgical wafer splints are necessary when dealing with partially dentate patients who are missing their posterior dentition or when dealing with the extremely rare circumstance of an edentulous patient requiring orthognathic surgery (for example, for the treatment of sleep apnea).

There is a possibility of using a modified Gunning-type splint, which was initially reported for use in maxillofacial injuries. In this scenario, the occlusalvertical dimension (OVD) needs to be established. Thomas Brian Gunning, an English-born American dentist, gave his name to the Gunning splint, which is an eponym for a device that is fabricated from casts of edentulous maxillary and mandibular arches to assist in the reduction and fixation of a jaw fracture. The Gunning splint was named after Gunning (1813–89).[16]

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