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| | WORKINSTRUCTION TEMPLATE | |
| | Code: TEMPLATE | Version: 1 |

WORK INSTRUCTION FACIAL IMPLANT

Content

| | | |
|-------|--|-------------------------------|
| 1 | Objective..... | 2 |
| 2 | Introduction to Facial implant – Clinical Background | 2 |
| 3 | Region of interest..... | 2 |
| 4 | Surgical approach..... | 3 |
| 5 | 3-Matic training | 3 |
| 5.1 | Prepare the surface..... | 3 |
| 5.2 | Type of implant..... | 5 |
| 5.2.1 | Based on the Sketch | 5 |
| 5.2.2 | Based on the mirror. | 10 |
| 5.2.3 | Based on the specific projection | 15 |
| 5.2.4 | Based on the specific projection | ¡Error! Marcador no definido. |

| | | |
|--|------------------------|-------------------|
| | WORKINSTRUCTION | |
| | TEMPLATE | |
| | Code: TEMPLATE | Version: 1 |

1 Objective

This work instruction aims to give a detailed overview of all steps to be performed in the preparation, planning, and design of a facial implant case by a company designer using 3-Matic Medical Materialise software to ensure high quality standardized, and production process.

2 Introduction to Facial implant – Clinical Background

A Solution intended for an aesthetic result and restoration of facial symmetry of malar areas. Also included in the group are Jaw implants, spacers, and custom solutions for the mid-facial and mandibular third where plates are not required.

3 Region of interest.

One of company's solutions is facial implants for the correction of symmetry or custom details to improve the patient's aesthetics. Facial implants help correct bone volume to preserve the patient's skeletal dimensions. The most common that are developed in our company is the correction of the jawline, cheekbone volume, and orbital floors.

For those cases, is important to have the DICOM images with the region of interest according to the section "3.1. FILE OF VIEW PER CASE FOR SEGMENTATION." of the "work instruction image protocol and segmentation" to continue with the planning process of the facial implant.

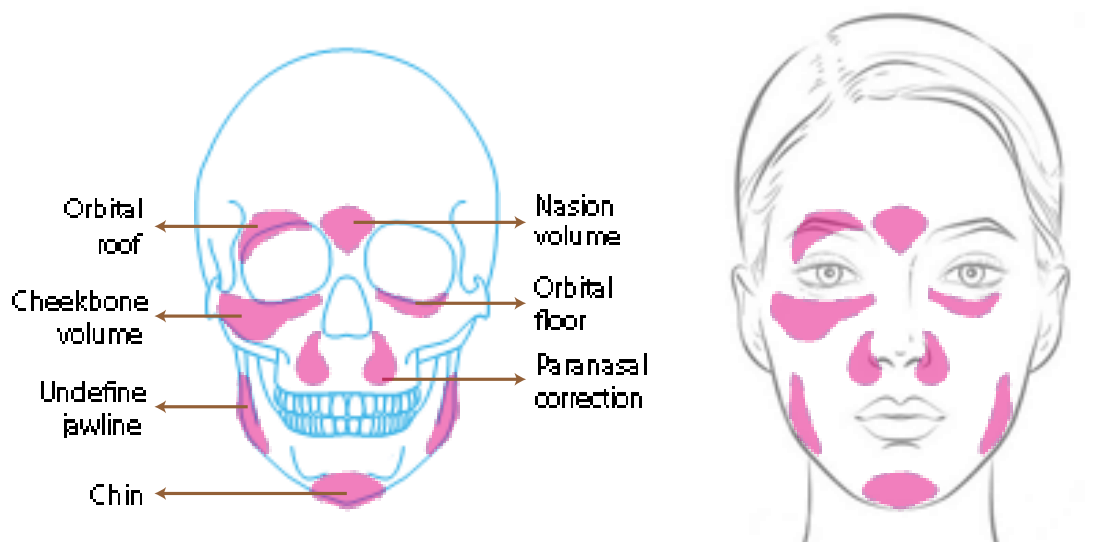


Figure 1 Types of facial implants made in Digital Surgery

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| | WORKINSTRUCTION | |
| | TEMPLATE | |
| | Code: TEMPLATE | Version: 1 |

4 Surgical approach.

This procedure involves fitting an implant around your natural bone to create a more pronounced, Cuts are typically made inside the mouth, so you must think about the thickness implant and how will be located, when the implant is big the best option is an implant by sections. Generally, the implants are fixed with screws.

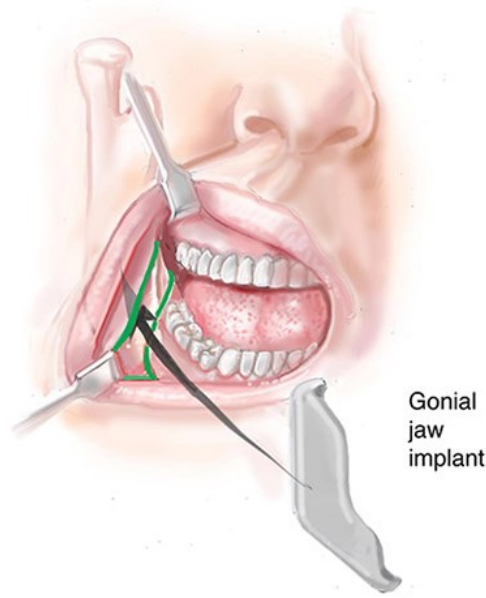


Figure 2 Surgical approach in jaw implant

5 3-Matic training

For this case, it was started with orthognathic planning, then it is performed and the Boolean Union of the entire segmented jaw, and this model you can name as mandible for an implant.

5.1 Prepare the surface.

All bone surfaces must be prepared to start performing the facial implant. For this, you can follow the steps below.

Step I: Use “*Wrap*” with a Gap closing =3.0 or 5.0 Once the movements are carried out, the facial implants are created.

Step II: Apply “*Reduce*” with a geometrical error = 0.5, Next apply “*Improve mesh*” with a minimum edge height = 20.0, select “*Smooth*” with a smooth factor = 0.7, and apply the smooth tool until you have a suitable surface shape.

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| | WORKINSTRUCTION | |
| | TEMPLATE | |
| | Code: TEMPLATE | Version: 1 |

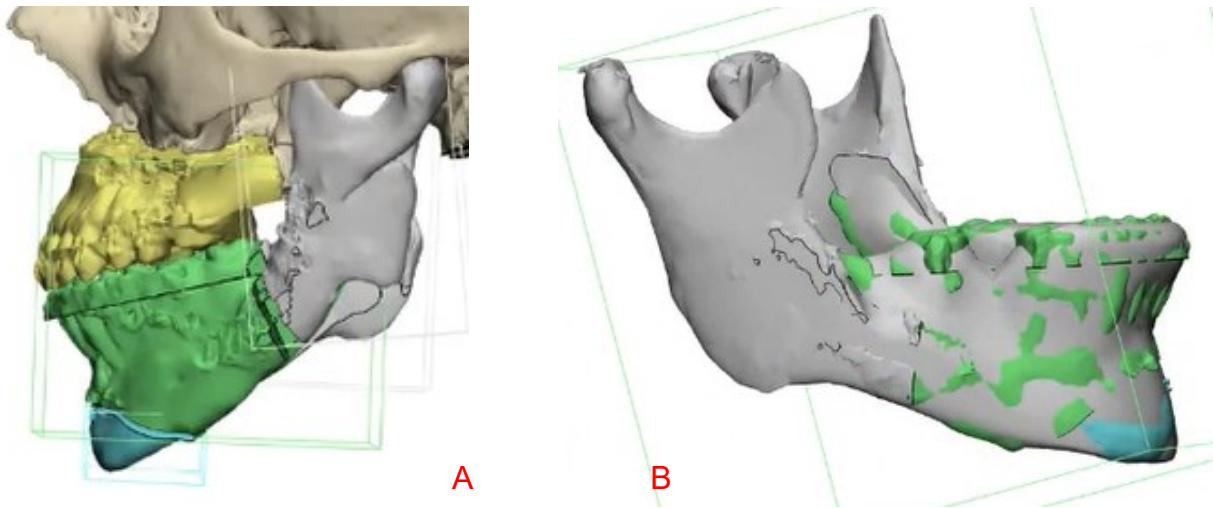


Figure 3 A) Merge the segments. B) Smooth surface shape.

Step III: Use “Push and Pull” to modify the surface and add or rest the volume.

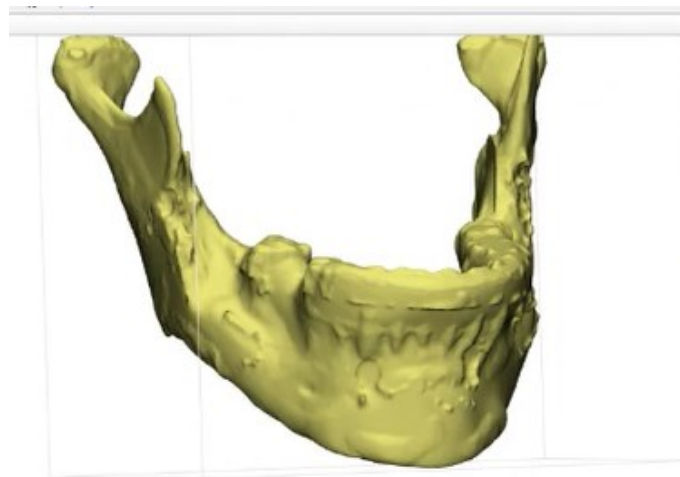


Figure 4 Modify surface

NOTE: When the CT images have some metallic structures due to previous surgical interventions, it is important to segment them to identify the bone integration that is around them, in addition, these plates are generally removed to locate the facial implant, therefore, you must work with the resulting bone surface after removing the metal plates.

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| | WORKINSTRUCTION | |
| | TEMPLATE | |
| | Code: TEMPLATE | Version: 1 |

5.2 Type of implant.

5.2.1 Based on the Sketch

This method is used when the after options to design are not suitable to start the design process. You can follow the next steps.

Step I: Create the “*sketch*” parallel to the midline, next use the “*translate*” tool to align the sketch with the surface, and use the “*interactive rotate*” tool to locate the sketch tangential to the surface.

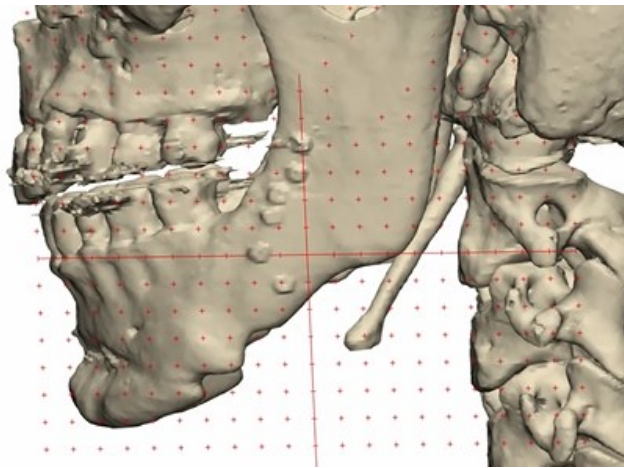


Figure 5 Create the sketch

Step II: Use the “*create spline*” tool to create the contour of the implant form, if you add more points, you can modify the form with the “*drag geometry*” tool before.

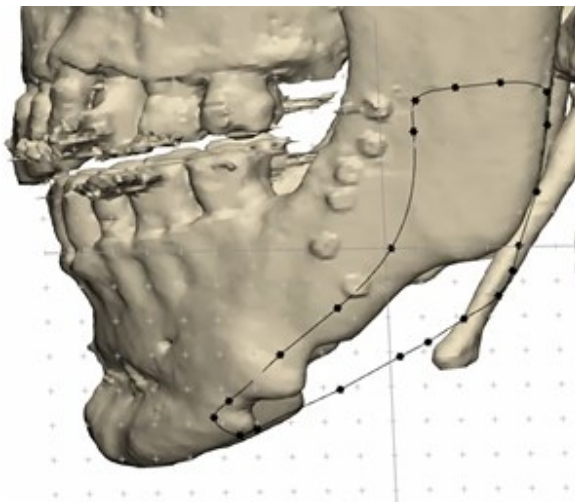


Figure 6 Create and modify the spline

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| | WORKINSTRUCTION | |
| | TEMPLATE | |
| | Code: TEMPLATE | Version: 1 |

Step III: “*Extrude*” the contour in both directions: interior=4mm (to ensure the mirror) and exterior= 5mm (the requirement projection)

NOTE: Sometimes the model requires improving the surface, so use the “improve mesh”, and “subdivide” tools to continue the design process.

Step IV: Use the “*Chamfer*” tool with the parameters Distant1= 3mm and distance2= 2mm

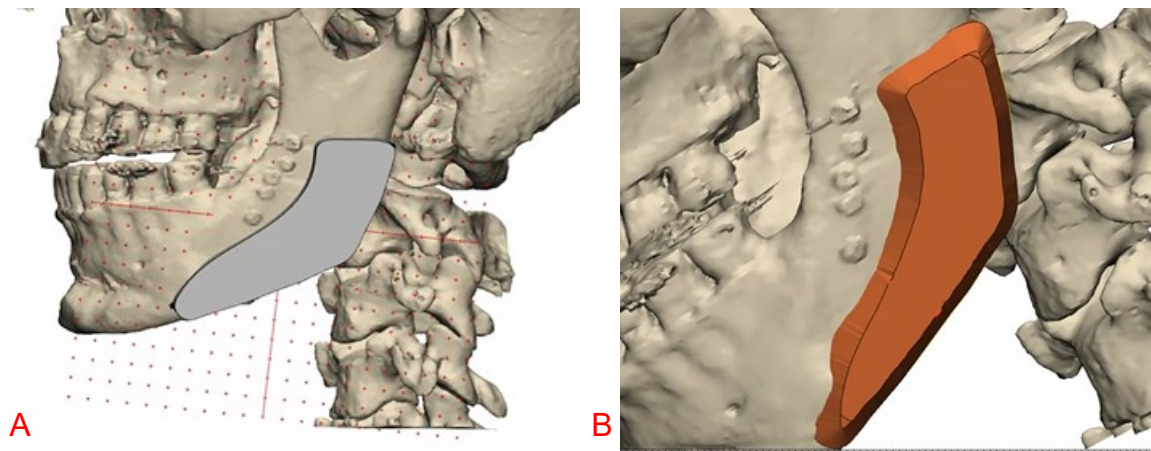


Figure 7 A) Create the surface B) Apply chamfer

Step V: Use the “*Fix Wizard*” until the items come into view green to avoid problems.

Step VI: select all surfaces of interest, then, right-click → merge

Step VII: Use “*Improve mesh*” with a minimum edge height = 20.0, select “*Smooth*” with a smooth factor = 0.8, and apply the “*Smooth*” tool until you have a suitable surface shape.

Step VIII: Select “*local smoothing*” to smooth the surface and remove edges and corners.

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| | TEMPLATE | |
| | Code: TEMPLATE | Version: 1 |

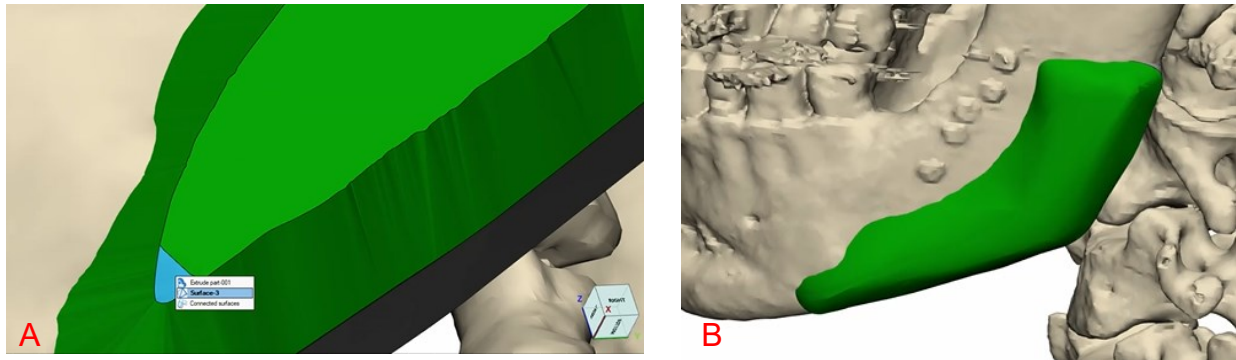


Figure 8 A) Merge surface B) Smooth surface

Step IX: Use the “Push and pull” tool to modify the surface and add or rest the volume.

Step X: Use again step VII and VIII by all implants until you have a suitable surface shape.

Step XI: Use the “Trim” tool to cut the surface and create a suitable poly-surface.

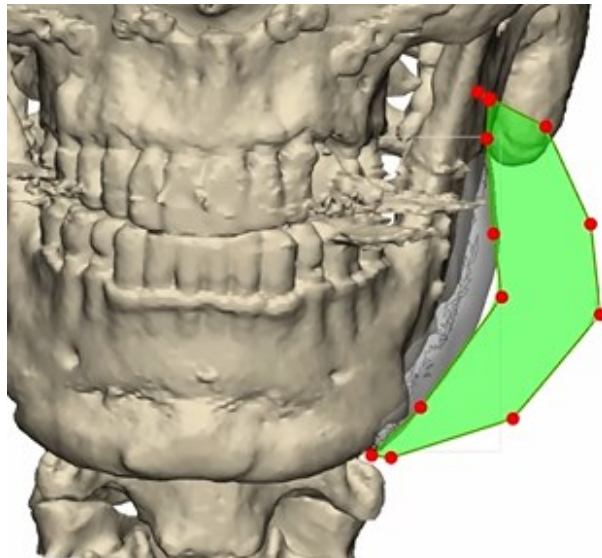


Figure 9 Trim the poly-surface

Step XII: select all surfaces of interest, then, right-click → merge, then, apply the “subdivide” tool.

Repeat steps VII, VIII, and IX until you have a suitable surface shape.

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| | TEMPLATE | |
| | Code: TEMPLATE | Version: 1 |

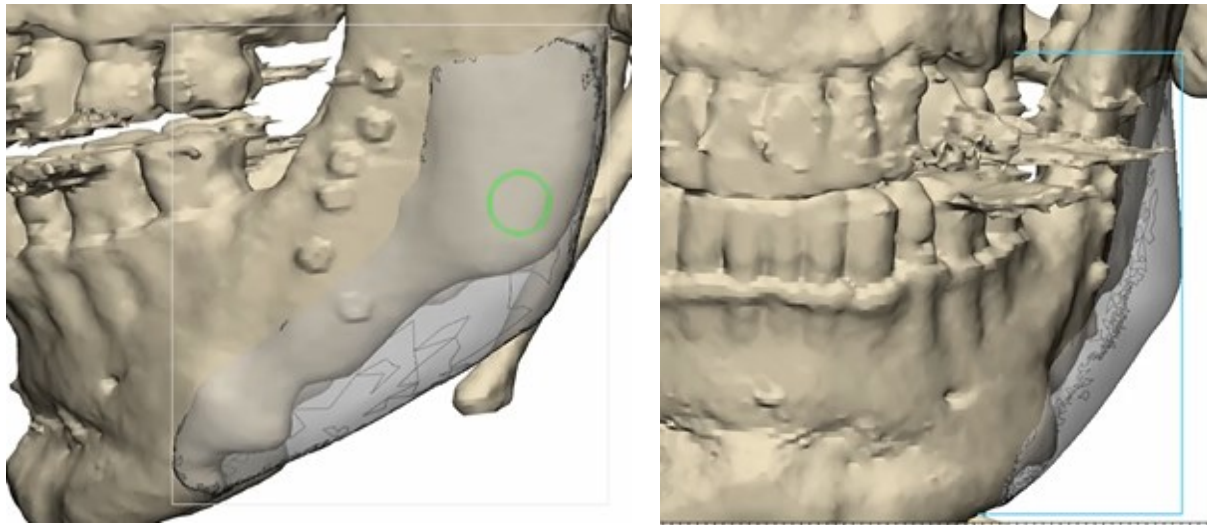


Figure 10 Implant views

Step XIII: Duplicate the midline and translate to measure the projection

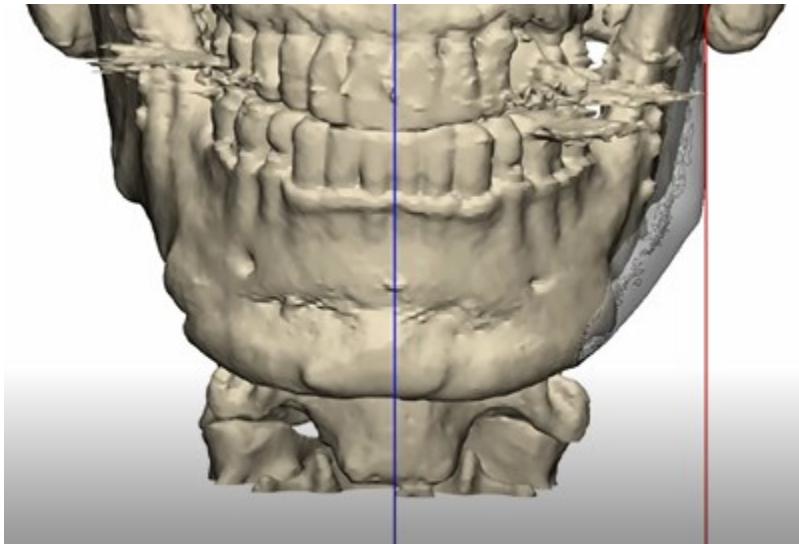


Figure 11 measure the projection

Step XIV: Use the “Mirror” tool to reflect the facial implant concerning the midplane

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| | WORKINSTRUCTION | |
| | TEMPLATE | |
| | Code: TEMPLATE | Version: 1 |

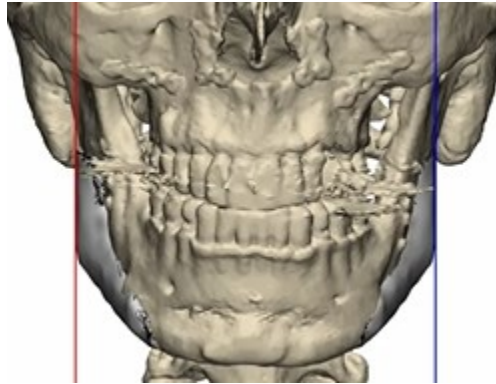


Figure 12 Mirror the implant

Step XV: Use the “Push and pull” tool to modify the surface and add or rest the volume.

Step XVI: Select “local smoothing” to smooth the surface and remove edges and corners.

Step XVII: Use the “Fix Wizard” until the items come into view green to avoid problems.

Step XVIII: Use “Boolean Subtraction” between the defect wrap 0,1 and the facial implants, next remove the unnecessary parts. Then select the “subdivide” tool and apply it with the standard parameters.

Step XIX: select the “Remove undercut” tool, click the normal surface to ubicated the direction of the undercut. Next, select the outer surface, right-click → merge.

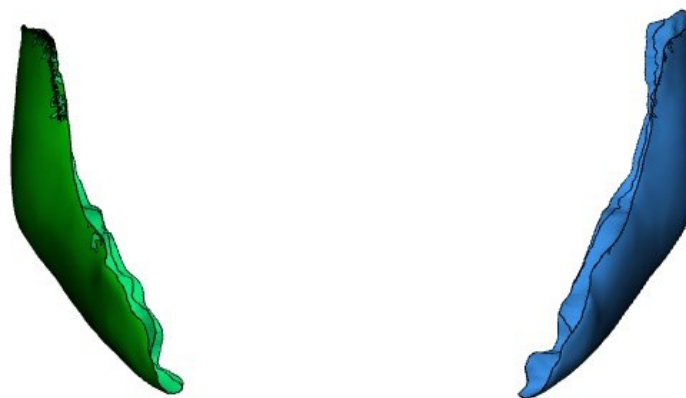


Figure 13 Boolean subtraction between the bone tissue and facial implant

Step XX: Apply “fillet” or “Smooth edge” with =0.2mm to the contour of facial implants.

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| | WORKINSTRUCTION | |
| | TEMPLATE | |
| | Code: TEMPLATE | Version: 1 |

Step XXI: Duplicate the implant and use the “Quick label” to mark implants with the TDS code and right and left ubication.

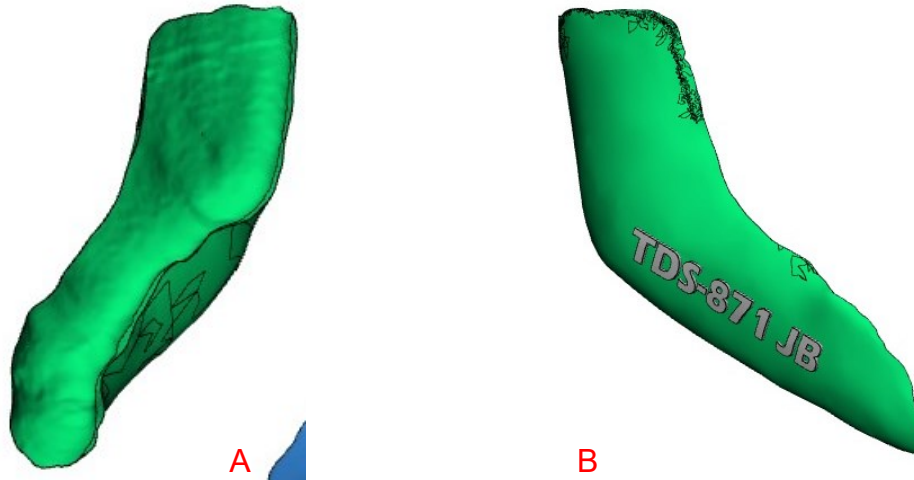


Figure 14 A) Apply undercut tool. B) apply Quick label tool

Step XXII: Use the “Fix Wizard” until the items come into view green to avoid problems in the manufacturing process.

Step XXIII: Save the file as TDS-code, and then, click on “file” → export → STL.

5.2.2 Based on the mirror.

Step I: Create a reference plane and place it on the midline of the jaw, then use the “mirror” tool to obtain a reference shape of the facial implant.

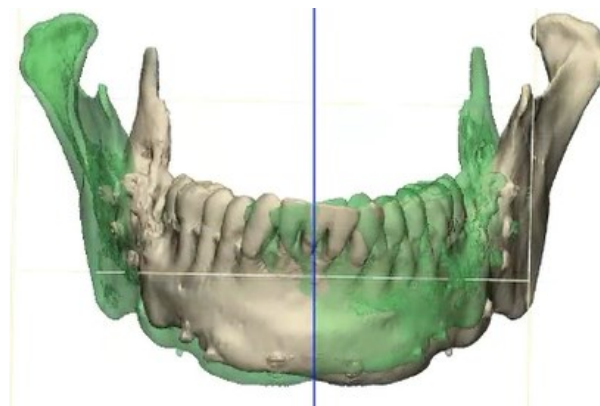


Figure 15 Jaw mirror

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| | WORKINSTRUCTION | |
| | TEMPLATE | |
| | Code: TEMPLATE | Version: 1 |

Step II: Cut the unnecessary parts, select the original jaw, and use “*Wrap*” with a resulting offset = 5mm, then, use “*Improve mesh*” with a minimum edge height = 20.0, select “*Smooth*” with a smooth factor = 0.7, and apply the “*Smooth*” tool until you have a suitable surface shape.

Step III: Use the “*Push and pull*” tool to modify the surface and add or rest the volume.

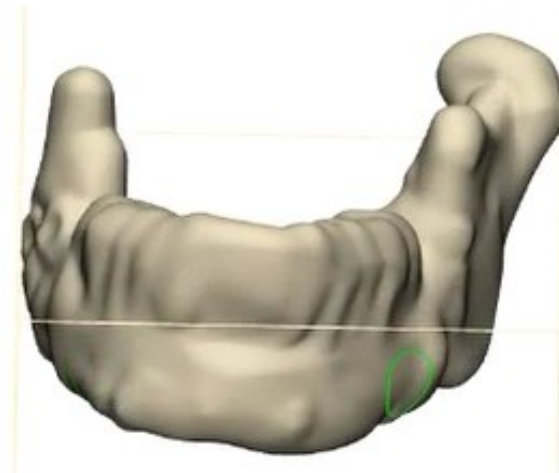


Figure 16 Resulting offset

Step IV: Select the “*Trim*” tool and create the shape of the facial implant, then select in the parameters the option “*remove outer*” and click apply.

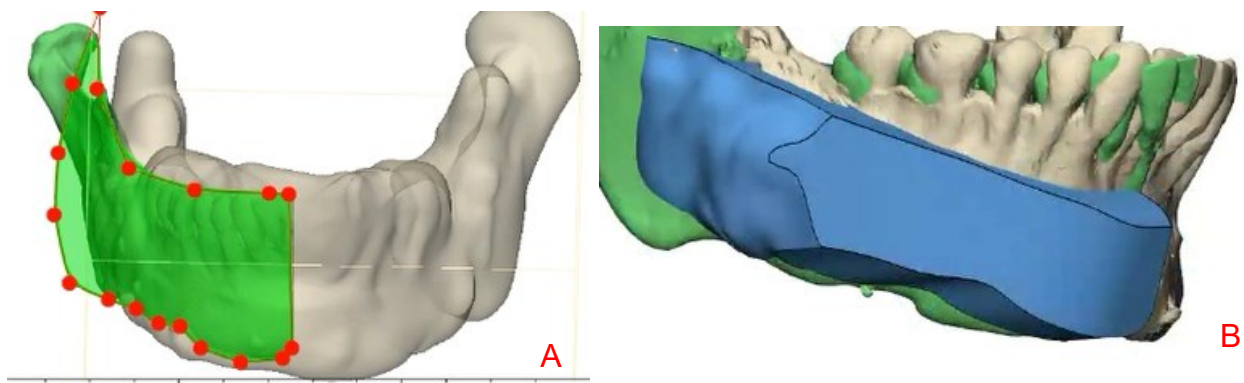


Figure 17 A) Trim the surface B) Implant surface

Step V: Right-click → merges the outer surface of the facial implant and uses “*Improve mesh*” with a minimum edge height = 20.0, select “*Smooth*” with a smooth factor = 0.7.

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| | WORKINSTRUCTION | |
| | TEMPLATE | |
| | Code: TEMPLATE | Version: 1 |

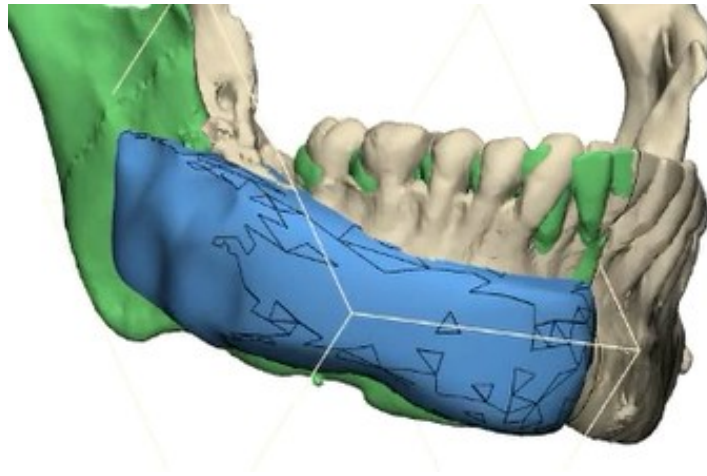


Figure 18 Smooth surface

Step VI: Select "*local smoothing*" to smooth the surface and remove edges and corners.

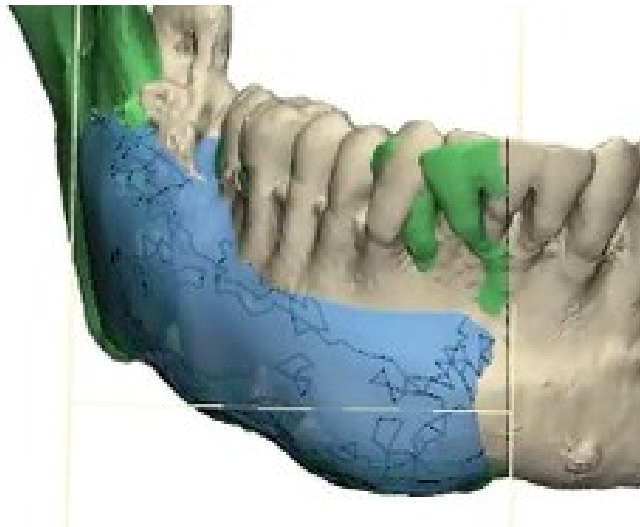


Figure 19 Poly-surface of the facial implant

Step VII: Use "*Trim*" to remove the unnecessary parts, repeat Step V, finally use "*Local Smoothing*" to smooth the surface.

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| | WORKINSTRUCTION | |
| | TEMPLATE | |
| | Code: TEMPLATE | Version: 1 |

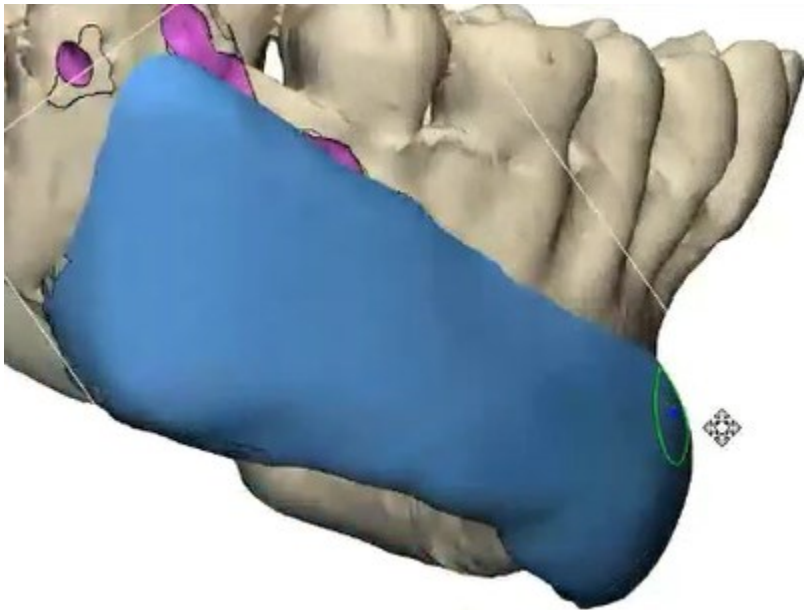


Figure 20 Smooth surface

Step VIII: Measure the distances between the facial implant and the healthy reflection concerning the midline.

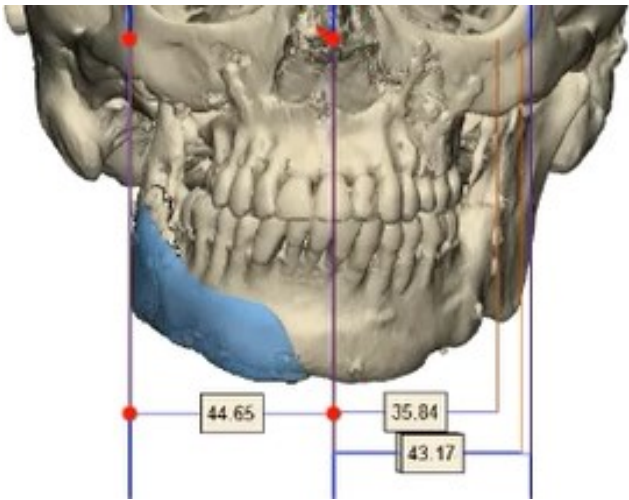


Figure 21 Remove unnecessary parts

Step IX: Use the “Trim” tool to cut the surface and create a suitable poly-surface. Then, apply the “Smooth” tool until you have a suitable surface shape.

Step X: Use the “Push and pull” tool to modify the surface and add or rest the volume.

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| | WORKINSTRUCTION | |
| | TEMPLATE | |
| | Code: TEMPLATE | Version: 1 |

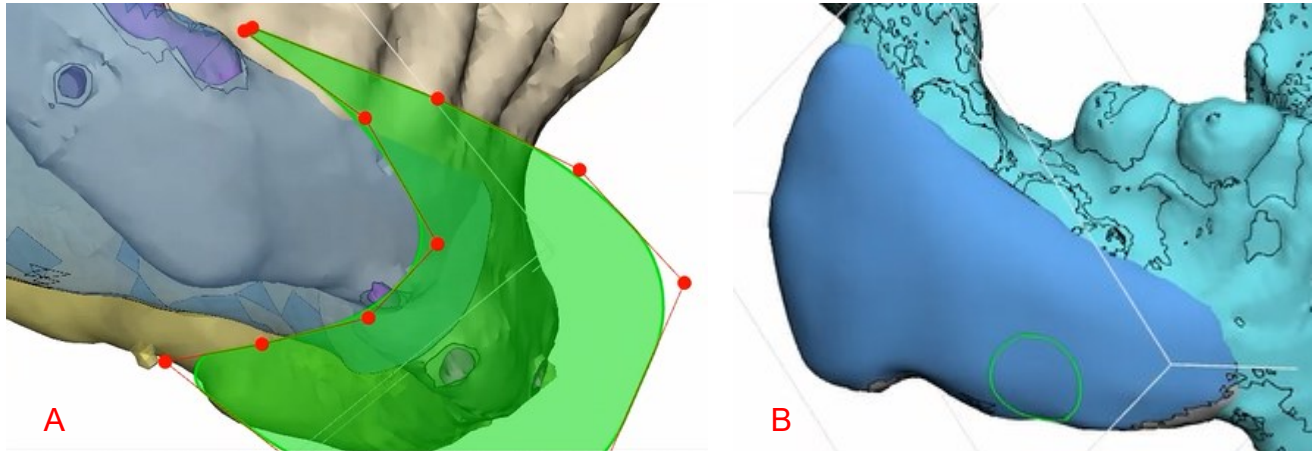


Figure 22 A) cut the surface. B) Smooth the surface

Step XI: Use the *"Fix Wizard"* until the items come into view green to avoid problems.

Step XII: Use *"Boolean Subtraction"* between the defect wrap 0,1 and the facial implants, next remove the unnecessary parts. Then select the *"subdivide"* tool and apply it with the standard parameters.

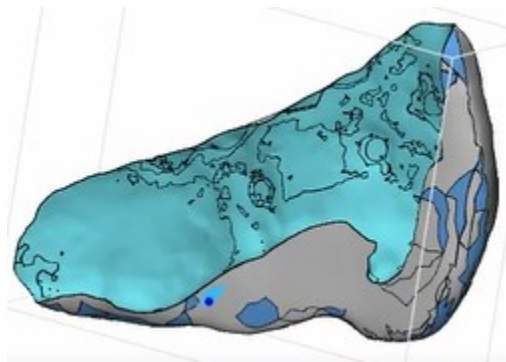


Figure 23 Boolean subtraction between the wrap 0.1 and the facial implant

Step XIII: select the *"Remove undercut"* tool, click the normal surface to ubicated the direction of the undercut. Next, select the outer surface, right-click → merge.

Step XIV: Apply the *"subdivide"* tool. Then use the *"Improve mesh"* with a minimum edge height = 20.0, select *"Smooth"* with a smooth factor = 0.7 until you have a suitable surface shape.

Step XV: Apply *"fillet"* or *"Smooth edge"* with =0.2mm to the contour of facial implants.

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| | WORKINSTRUCTION TEMPLATE | |
| | Code: TEMPLATE | Version: 1 |

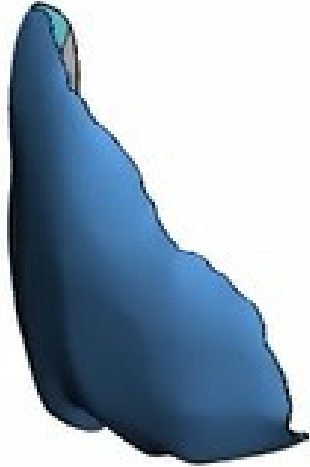


Figure 24 Final facial implant

Step XVI: Duplicate the implant and use the “*Quick label*” to mark implants with the TDS code and right and left ubication.

Step XVII: Use the “*Fix Wizard*” until the items come into view green to avoid problems in the manufacturing process.

Step XVIII: Save the file as TDS-code, and then, click on file → export → STL.

5.2.3 Based on the specific projection

Step I: Orientate the bone surface, duplicate the bone surface, and use the “*Trim*” tool to cut the defect. Next, right-click → separate → move to surface set →creates new.

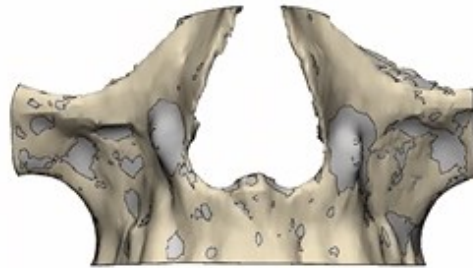
Step II: Apply “*Wrap*” with (Gap closing = 3.0 or 6.0) to the defect*

NOTE: Check if the two models are displayed when overlapping the surfaces is acceptable to continue the process. if you only see the model with the gap closing, it cannot be used to subtract.

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| | WORKINSTRUCTION | |
| | TEMPLATE | |
| | Code: TEMPLATE | Version: 1 |



A



B

Figure 25 A) Orientate bone B) Separate defect

Step III: Apply “*Wrap*” with (resulting offset = 0.1) and (gap closing = 3.0 or 6.0) to the defect and name as (defect wrap 0.1).

Step IV: Use the “*Mirror*” tool to reflect the skull concerning the midplane

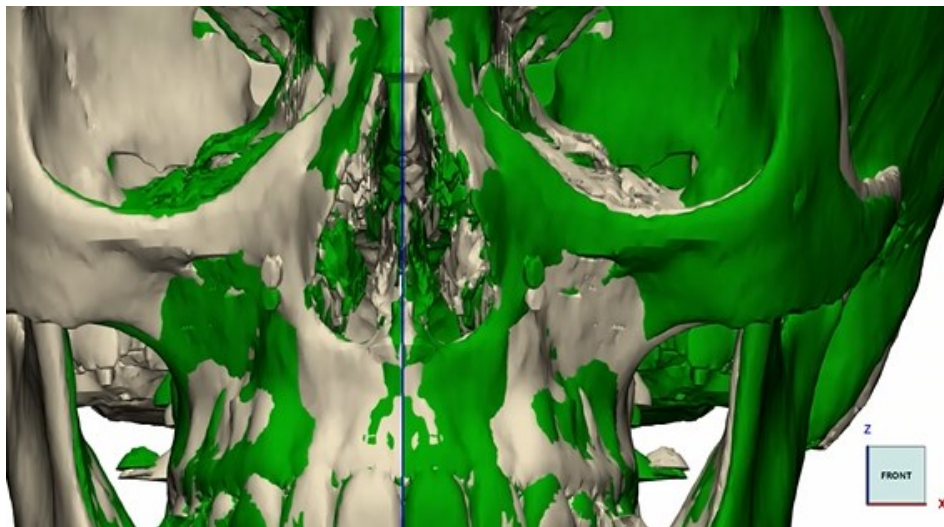


Figure 26 A) Mirror review

Step V: Select the “*Wave brush mark*” tool to select the surface of the cutting guide. Then use the “*Split surface by curve*” tool to cut the surface of the defect with the curve.

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| | WORKINSTRUCTION | |
| | TEMPLATE | |
| | Code: TEMPLATE | Version: 1 |

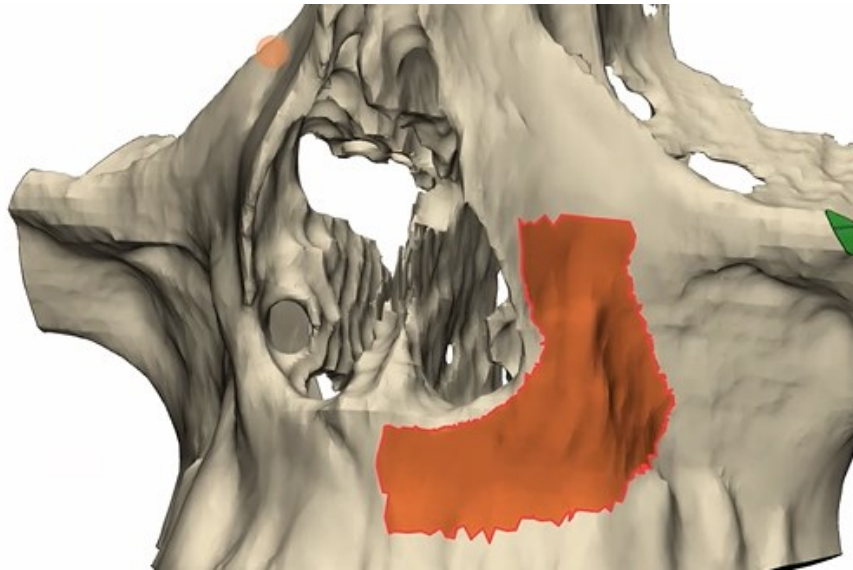


Figure 27 Mark the implant surface

Step VI: Use “*move surface*” with inside= 4mm and outside= 4mm, then apply the “*smooth*” tool until you have a suitable surface shape.

Step VII: Use the “*Fix Wizard*” until the items come into view green to avoid the problem. Next, apply the “*Chamfer edge*” with distance 1= 2mm and distance 2= 3mm on the contour of the implant surface.

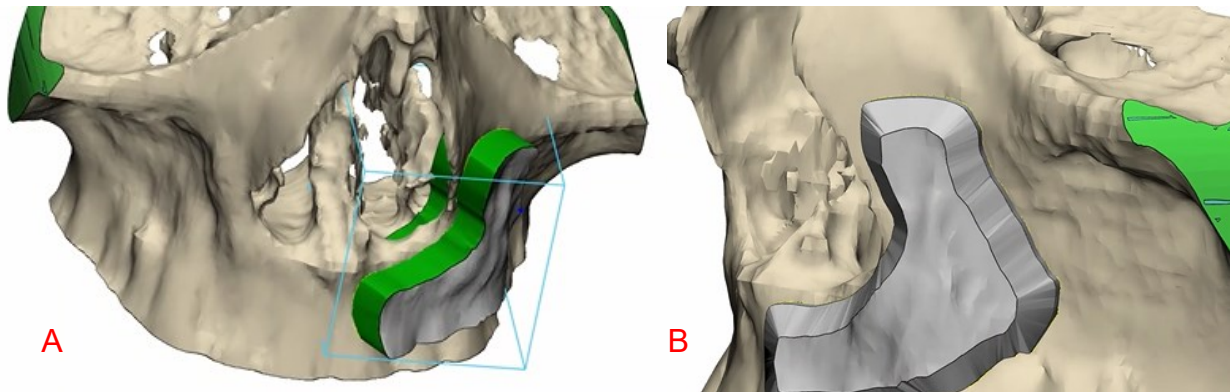


Figure 28 Create the implant poly-surface

Step VIII: Use “*Improve mesh*” with a minimum edge height = 20.0, select “*Smooth*” with a smooth factor = 0.7, and apply the “*Smooth*” tool until you have a suitable surface shape.

Step IX: Select “*local smoothing*” to smooth the surface and remove edges and corners.

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| | WORKINSTRUCTION | |
| | TEMPLATE | |
| | Code: TEMPLATE | Version: 1 |

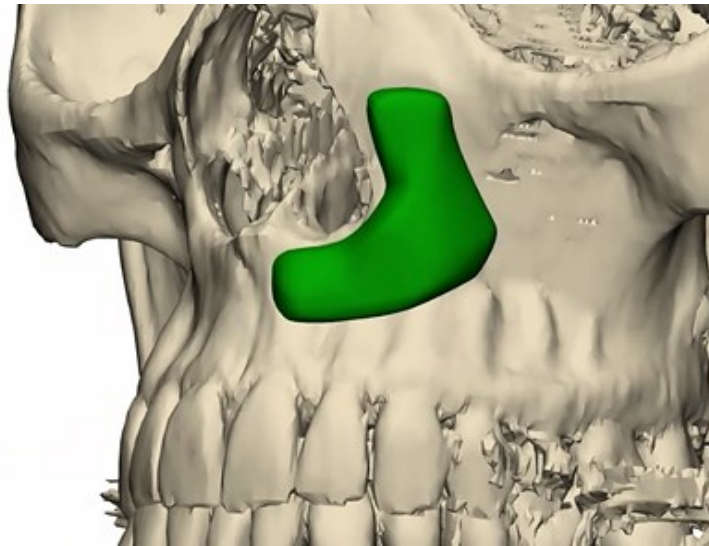


Figure 29 Smooth the implant poy-surface

Step X: Use the “*Push and pull*” tool to modify the surface and add or rest the volume.

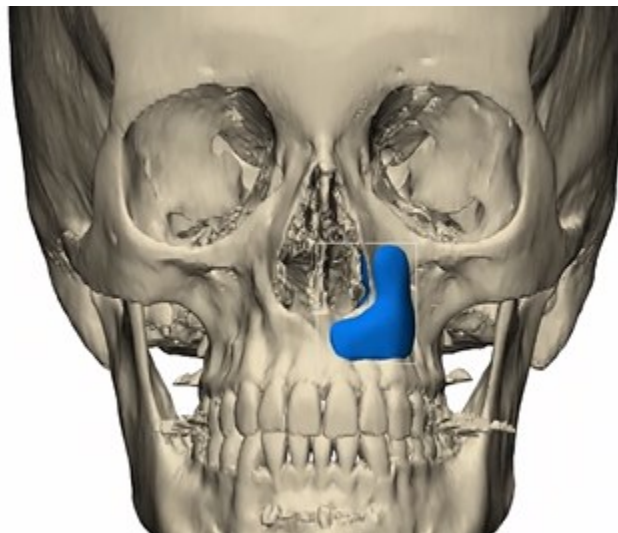


Figure 30 Modify the facial implant

Step XI: Use the “*Mirror*” tool to reflect the facial implant concerning the midplane.

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| | TEMPLATE | |
| | Code: TEMPLATE | Version: 1 |

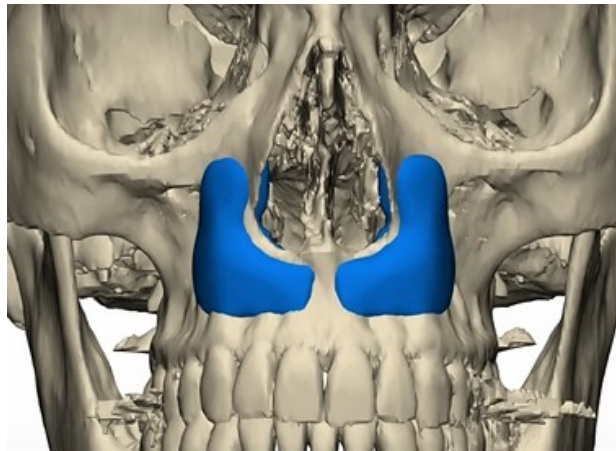


Figure 31 Mirror the facial implant

Step XII: Use the *"Fix Wizard"* until the items come into view green to avoid problems.

Step XIII: Use *"Boolean Subtraction"* between the defect wrap 0,1 and the facial implants, next remove the unnecessary parts. Then select the "subdivide" tool and apply it with the standard parameters.

Step XIV: Apply "fillet" with $\approx 0.2\text{mm}$ to the contour of facial implants.

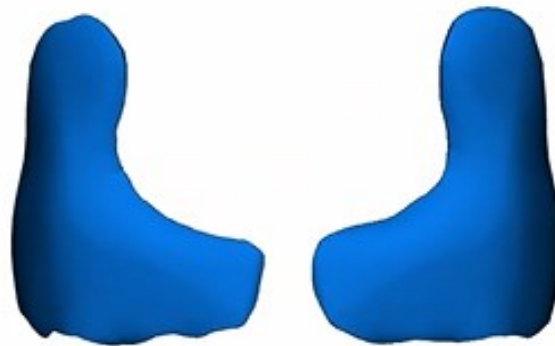


Figure 32 Facial implants

Step XV: Duplicate the implant and use the "Quick label" to mark implants with the TDS code and right and left ubication.

Step XVI: Use the *"Fix Wizard"* until the items come into view green to avoid problems in the manufacturing process.

Step XVII: Save the file as TDS-code, and then, click on *"file"* → export → STL.