

## Supplementary File

**Supplementary Table S1.** Search strategies for PubMed database.

| Search Number | Keywords Association  |
|---------------|---|
| 1.            | <p>“3D printing” AND “maxillofacial surgery” AND “in-house”</p> <p>((("printing, three dimensional"[MeSH Terms] OR ("printing"[All Fields] AND "three dimensional"[All Fields]) OR "three-dimensional printing"[All Fields] OR ("3d"[All Fields] AND "printing"[All Fields]) OR "3d printing"[All Fields]) AND ("surgery, oral"[MeSH Terms] OR ("surgery"[All Fields] AND "oral"[All Fields]) OR "oral surgery"[All Fields] OR ("maxillofacial"[All Fields] AND "surgery"[All Fields]) OR "maxillofacial surgery"[All Fields]) AND "in-house"[All Fields]) AND ((fft[Filter]) AND (humans[Filter]) AND (2015/1/1:2022/2/28[pdat]) AND (english[Filter])))</p>   |
| 2.            | <p>“3D printing” AND “cranial surgery” AND “in-house”</p> <p>((("printing, three dimensional"[MeSH Terms] OR ("printing"[All Fields] AND "three dimensional"[All Fields]) OR "three-dimensional printing"[All Fields] OR ("3d"[All Fields] AND "printing"[All Fields]) OR "3d printing"[All Fields]) AND (("cranially"[All Fields] OR "skull"[MeSH Terms] OR "skull"[All Fields] OR "cranial"[All Fields]) AND ("surgery"[MeSH Subheading] OR "surgery"[All Fields] OR "surgical procedures, operative"[MeSH Terms] OR ("surgical"[All Fields] AND "procedures"[All Fields] AND "operative"[All Fields]) OR "operative surgical procedures"[All Fields] OR "general surgery"[MeSH Terms] OR ("general"[All Fields] AND "surgery"[All Fields]) OR "general surgery"[All Fields] OR "surgery s"[All Fields] OR "surgerys"[All Fields] OR "surgeries"[All Fields])) AND "in-house"[All Fields]) AND ((fft[Filter]) AND (humans[Filter]) AND (2015/1/1:2022/2/28[pdat]) AND (english[Filter])))</p>   |
| 3.            | <p>“3D printing” AND “maxillofacial surgery” AND “hospital printed”</p> <p>((("printing, three dimensional"[MeSH Terms] OR ("printing"[All Fields] AND "three dimensional"[All Fields]) OR "three-dimensional printing"[All Fields] OR ("3d"[All Fields] AND "printing"[All Fields]) OR "3d printing"[All Fields]) AND ("surgery, oral"[MeSH Terms] OR ("surgery"[All Fields] AND "oral"[All Fields]) OR "oral surgery"[All Fields] OR ("maxillofacial"[All Fields] AND "surgery"[All Fields]) OR "maxillofacial surgery"[All Fields]) AND (("hospital s"[All Fields] OR "hospitalisation"[All Fields] OR "hospitalization"[MeSH Terms] OR "hospitalization"[All Fields] OR "hospitalising"[All Fields] OR "hospitality"[All Fields] OR "hospitalisations"[All Fields] OR "hospitalised"[All Fields] OR "hospitalizations"[All Fields] OR "hospitalized"[All Fields] OR "hospitalize"[All Fields] OR "hospitalizing"[All Fields] OR "hospitals"[MeSH Terms] OR "hospitals"[All Fields] OR "hospital"[All Fields]) AND ("printed"[All Fields] OR "printing"[MeSH Terms] OR "printing"[All Fields] OR "print"[All Fields] OR "printings"[All Fields] OR "prints"[All Fields])))) AND ((fft[Filter]) AND (humans[Filter]) AND (2015/1/1:2022/2/28[pdat]) AND (english[Filter])))</p> |
| 4.            | <p>“3D printing” AND “cranial surgery” AND “hospital printed”</p> <p>((("printing, three dimensional"[MeSH Terms] OR ("printing"[All Fields] AND "three dimensional"[All Fields]) OR "three-dimensional printing"[All Fields] OR ("3d"[All Fields] AND "printing"[All Fields]) OR "3d printing"[All Fields]) AND (("cranially"[All Fields] OR "skull"[MeSH Terms] OR "skull"[All Fields] OR "cranial"[All Fields]) AND ("surgery"[MeSH Subheading] OR "surgery"[All Fields] OR "surgical procedures, operative"[MeSH Terms] OR ("surgical"[All Fields] AND "procedures"[All Fields] AND "operative"[All Fields]) OR "operative surgical procedures"[All Fields] OR "general surgery"[MeSH Terms] OR</p>   |

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|    | ("general"[All Fields] AND "surgery"[All Fields]) OR "general surgery"[All Fields] OR "surgery s"[All Fields] OR "surgerys"[All Fields] OR "surgeries"[All Fields])) AND ((("hospital s"[All Fields] OR "hospitalisation"[All Fields] OR "hospitalization"[MeSH Terms] OR "hospitalization"[All Fields] OR "hospitalising"[All Fields] OR "hospitality"[All Fields] OR "hospitalisations"[All Fields] OR "hospitalised"[All Fields] OR "hospitalizations"[All Fields] OR "hospitalized"[All Fields] OR "hospitalize"[All Fields] OR "hospitalizing"[All Fields] OR "hospitals"[MeSH Terms] OR "hospitals"[All Fields] OR "hospital"[All Fields]) AND ("printed"[All Fields] OR "printing"[MeSH Terms] OR "printing"[All Fields] OR "print"[All Fields] OR "printings"[All Fields] OR "prints"[All Fields])))) AND ((fft[Filter]) AND (humans[Filter]) AND (2015/1/1:2022/2/28[pdat]) AND (english[Filter]))  |
| 5. | “three-dimensional printing” AND “maxillofacial surgery” AND “in-house”<br>(("printing, three dimensional"[MeSH Terms] OR ("printing"[All Fields] AND "three dimensional"[All Fields]) OR "three-dimensional printing"[All Fields] OR ("three"[All Fields] AND "dimensional"[All Fields] AND "printing"[All Fields]) OR "three dimensional printing"[All Fields]) AND ("surgery, oral"[MeSH Terms] OR ("surgery"[All Fields] AND "oral"[All Fields]) OR "oral surgery"[All Fields] OR ("maxillofacial"[All Fields] AND "surgery"[All Fields]) OR "maxillofacial surgery"[All Fields]) AND "in-house"[All Fields]) AND ((fft[Filter]) AND (humans[Filter]) AND (2015/1/1:2022/2/28[pdat]) AND (english[Filter]))  |
| 6. | “three-dimensional printing” AND “cranial surgery” AND “in-house”<br>(("printing, three dimensional"[MeSH Terms] OR ("printing"[All Fields] AND "three dimensional"[All Fields]) OR "three-dimensional printing"[All Fields] OR ("three"[All Fields] AND "dimensional"[All Fields] AND "printing"[All Fields]) OR "three dimensional printing"[All Fields]) AND ((("cranially"[All Fields] OR "skull"[MeSH Terms] OR "skull"[All Fields] OR "cranial"[All Fields]) AND ("surgery"[MeSH Subheading] OR "surgery"[All Fields] OR "surgical procedures, operative"[MeSH Terms] OR ("surgical"[All Fields] AND "procedures"[All Fields] AND "operative"[All Fields]) OR "operative surgical procedures"[All Fields] OR "general surgery"[MeSH Terms] OR ("general"[All Fields] AND "surgery"[All Fields]) OR "general surgery"[All Fields] OR "surgery s"[All Fields] OR "surgerys"[All Fields] OR "surgeries"[All Fields])) AND "in-house"[All Fields]) AND ((fft[Filter]) AND (humans[Filter]) AND (2015/1/1:2022/2/28[pdat]) AND (english[Filter]))   |
| 7. | “three-dimensional printing” AND “maxillofacial surgery” AND “hospital printed”<br>(("printing, three dimensional"[MeSH Terms] OR ("printing"[All Fields] AND "three dimensional"[All Fields]) OR "three-dimensional printing"[All Fields] OR ("three"[All Fields] AND "dimensional"[All Fields] AND "printing"[All Fields]) OR "three dimensional printing"[All Fields]) AND ("surgery, oral"[MeSH Terms] OR ("surgery"[All Fields] AND "oral"[All Fields]) OR "oral surgery"[All Fields] OR ("maxillofacial"[All Fields] AND "surgery"[All Fields]) OR "maxillofacial surgery"[All Fields]) AND ((("hospital s"[All Fields] OR "hospitalisation"[All Fields] OR "hospitalization"[MeSH Terms] OR "hospitalization"[All Fields] OR "hospitalising"[All Fields] OR "hospitality"[All Fields] OR "hospitalisations"[All Fields] OR "hospitalised"[All Fields] OR "hospitalizations"[All Fields] OR "hospitalized"[All Fields] OR "hospitalize"[All Fields] OR "hospitalizing"[All Fields] OR "hospitals"[MeSH Terms] OR "hospitals"[All Fields] OR "hospital"[All Fields]) AND ("printed"[All Fields] OR "printing"[MeSH Terms] OR "printing"[All Fields] OR "print"[All Fields] OR "printings"[All Fields] OR "prints"[All Fields])))) AND ((fft[Filter]) AND (humans[Filter]) AND (2015/1/1:2022/2/28[pdat]) AND (english[Filter])) |
| 8. | “three-dimensional printing” AND “cranial surgery” AND “hospital printed”<br>(("printing, three dimensional"[MeSH Terms] OR ("printing"[All Fields] AND "three dimensional"[All Fields]) OR "three-dimensional printing"[All Fields] OR ("three"[All Fields] AND "dimensional"[All Fields] AND "printing"[All Fields]) OR "three dimensional printing"[All Fields]) AND ((("cranially"[All Fields] OR "skull"[MeSH Terms] OR "skull"[All   |

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|     | Fields] OR "cranial"[All Fields]) AND ("surgery"[MeSH Subheading] OR "surgery"[All Fields] OR "surgical procedures, operative"[MeSH Terms] OR ("surgical"[All Fields] AND "procedures"[All Fields] AND "operative"[All Fields]) OR "operative surgical procedures"[All Fields] OR "general surgery"[MeSH Terms] OR ("general"[All Fields] AND "surgery"[All Fields]) OR "general surgery"[All Fields] OR "surgery s"[All Fields] OR "surgeries"[All Fields] OR "surgeries"[All Fields])) AND (("hospital s"[All Fields] OR "hospitalisation"[All Fields] OR "hospitalization"[MeSH Terms] OR "hospitalization"[All Fields] OR "hospitalising"[All Fields] OR "hospitality"[All Fields] OR "hospitalisations"[All Fields] OR "hospitalised"[All Fields] OR "hospitalizations"[All Fields] OR "hospitalized"[All Fields] OR "hospitalize"[All Fields] OR "hospitalizing"[All Fields] OR "hospitals"[MeSH Terms] OR "hospitals"[All Fields] OR "hospital"[All Fields]) AND ("printed"[All Fields] OR "printing"[MeSH Terms] OR "printing"[All Fields] OR "print"[All Fields] OR "printings"[All Fields] OR "prints"[All Fields])) AND ((fft[Filter]) AND (humans[Filter]) AND (2015/1/1:2022/2/28[pdat]) AND (english[Filter])) |
| 9.  | "additive manufacturing" AND "maxillofacial surgery" AND "in-house"<br>(("addit manuf"[Journal] OR ("additive"[All Fields] AND "manufacturing"[All Fields]) OR "additive manufacturing"[All Fields]) AND ("surgery, oral"[MeSH Terms] OR ("surgery"[All Fields] AND "oral"[All Fields]) OR "oral surgery"[All Fields] OR ("maxillofacial"[All Fields] AND "surgery"[All Fields]) OR "maxillofacial surgery"[All Fields]) AND "in-house"[All Fields]) AND ((fft[Filter]) AND (humans[Filter]) AND (2015/1/1:2022/2/28[pdat]) AND (english[Filter]))   |
| 10  | "additive manufacturing" AND "cranial surgery" AND "in-house"<br>(("addit manuf"[Journal] OR ("additive"[All Fields] AND "manufacturing"[All Fields]) OR "additive manufacturing"[All Fields]) AND (("cranially"[All Fields] OR "skull"[MeSH Terms] OR "skull"[All Fields] OR "cranial"[All Fields]) AND ("surgery"[MeSH Subheading] OR "surgery"[All Fields] OR "surgical procedures, operative"[MeSH Terms] OR ("surgical"[All Fields] AND "procedures"[All Fields] AND "operative"[All Fields]) OR "operative surgical procedures"[All Fields] OR "general surgery"[MeSH Terms] OR ("general"[All Fields] AND "surgery"[All Fields]) OR "general surgery"[All Fields] OR "surgery s"[All Fields] OR "surgeries"[All Fields] OR "surgeries"[All Fields])) AND "in-house"[All Fields]) AND ((fft[Filter]) AND (humans[Filter]) AND (2015/1/1:2022/2/28[pdat]) AND (english[Filter]))  |
| 11. | "additive manufacturing" AND "maxillofacial surgery" AND "hospital printed"<br>(("addit manuf"[Journal] OR ("additive"[All Fields] AND "manufacturing"[All Fields]) OR "additive manufacturing"[All Fields]) AND ("surgery, oral"[MeSH Terms] OR ("surgery"[All Fields] AND "oral"[All Fields]) OR "oral surgery"[All Fields] OR ("maxillofacial"[All Fields] AND "surgery"[All Fields]) OR "maxillofacial surgery"[All Fields]) AND (("hospital s"[All Fields] OR "hospitalisation"[All Fields] OR "hospitalization"[MeSH Terms] OR "hospitalization"[All Fields] OR "hospitalising"[All Fields] OR "hospitality"[All Fields] OR "hospitalisations"[All Fields] OR "hospitalised"[All Fields] OR "hospitalizations"[All Fields] OR "hospitalized"[All Fields] OR "hospitalize"[All Fields] OR "hospitalizing"[All Fields] OR "hospitals"[MeSH Terms] OR "hospitals"[All Fields] OR "hospital"[All Fields]) AND ("printed"[All Fields] OR "printing"[MeSH Terms] OR "printing"[All Fields] OR "print"[All Fields] OR "printings"[All Fields] OR "prints"[All Fields])) AND ((fft[Filter]) AND (humans[Filter]) AND (2015/1/1:2022/2/28[pdat]) AND (english[Filter]))   |
| 12. | "additive manufacturing" AND "cranial surgery" AND "hospital printed"<br>(("addit manuf"[Journal] OR ("additive"[All Fields] AND "manufacturing"[All Fields]) OR "additive manufacturing"[All Fields]) AND (("cranially"[All Fields] OR "skull"[MeSH Terms] OR "skull"[All Fields] OR "cranial"[All Fields]) AND ("surgery"[MeSH Subheading] OR "surgery"[All Fields] OR "surgical procedures, operative"[MeSH Terms] OR ("surgical"[All Fields] AND "procedures"[All Fields] AND "operative"[All Fields]) OR "operative surgical  |

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**Supplementary Table S2.** Data collection process.

| Author and Year of Publication | Applications  | Accommodation of Infrastructure                                  | Human Resource  | Software            | Hardware-3D Printers and Materials                                   | Planning Time                                      | Production- 3D Printing Time                    | Operating Room Time                        | Cost   | Outcome  |
|--------------------------------|---|--|---|---------------------|--|--|---|--|--|--|
| Mendez et al., 2015 [17]       | Skull model   | In-house (In office)   | Surgeon   | Rapid3D – OS        | MakerBot Replicator-FDM  | NA   | 14 h  | Case 1/2: 4.5h/4h OR time                  | P: 2750\$ (Printer protection plan: 350\$/year). M: 25\$/model Training by Maker Bot: 225\$; Additional cost: physician's time and effort-NA | Cost-effective (Outsourced models costing 4000\$). Less time-consuming Efficient method of creating surgical models -  |
| Weinstock et al. 2015 [18]     | Models of AVM   | Hospital lab ran by Boston Children's hospital Simulator Program | Neuroradiologist and treating clinician                                 | NA                  | Connex 500 (Stratasys)- PolyJet                                      | 2–6 hours of imaging review and model segmentation | 6–12 h  | OR time: 30 min. faster with 3D model      | NA   | 30 minutes faster OR time with 3D models. Neurovascular lesions are printable in less than 24 hours ;(3) direct correlation between 3D models and surgical anatomy |
| Matsumoto et al. 2015 [37]     | Models (Anatomy, education, research, forensics, and quality control) | In-house (Radiology department)                                  | Technologist + radiologist / radiologist alone/ radiologist and surgeon | MIMICS, 3-matic- L  | Objet350 Connex; Stratasys-PolyJet; Dimension Elite Fortus 400mc-FFF | NA   | A few hours to multiple days (no numbers given) | NA   | M: few dollars to several thousand dollars (no numbers given)  | Safety, efficiency, and reduction in OR time. Increased surgeon confidence in a positive outcome.  |
| Mottini et al. 2016 [19]       | Models (For pre-bending), Fibula cutting guide                        | Not clearly stated but with in-house potential use evoked        | surgeon   | Amira- L Blender-OS | P:-NA M: Med 610 photopolymer  | NA   | Less than 48h                                   | Prebent plate reduces operative time       | NA   | Guide offers better stability precision  |
| Ahmed et al. 2016 [22]         | Temporal bone models  | Not clearly stated but with in-house potential use evoked        | NA  | Mimics-L            | P: undisclosed –FDM M: PLA, ABS                                      | NA   | NA  | Surgeon noticed decreased time and ease of | P: 1,200\$; M: < 5\$/ PLA model, <5\$/ABS model  | Models compared to tegmen anatomy based upon imaging and IO findings   |

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|                           |                                      |   |                   |   |  |  |   | graft placement-no time data to validate this notion.      |   |   |
| Goetze et al.2017 [39]    | Fibula cutting guide                 | Not clearly stated but with in-house potential use evoked | Surgical resident | Simplant O&O®-L<br>OsiriX-L<br>NetFabb Basic-L(free)<br>MeshLabOS<br>PlastyCAD®-L | Stratasys EDEN260V<br>PolyJet.<br>M: MED610 photopolymer | First plannings took 10 h while the last plannings took around 5 h | Planning was performed in 4 days (text suggests planning and printing)  | Osteotomy and assembly time did not exert 1 h in all cases | (1) in-house workflow (517–863€)<br>(2) Self-printed 3D model 150–220€/planning<br>(3) Material for a skull and fibula with 220€<br>*Without printer/software costs | Involvement of surgeons in planning might have a positive effect on flap survival and complication rate.  |
| Legocki et al. 2017 [20]  | Pediatric mandible models            | IT department of the medical center.                      | IT staff member   | OsiriX-L<br>MeshLab-OS  | MakerBot Replicator 3D printer-FDM                       | 20 to 60 min. for software processing and printer preparation      | Print time 6-12 h<br>Postprocessing: 1h<br>Protocol resulted in a next-day model, faster than commercial by at least 1day | NA   | P: 3D 2899\$<br>-OsiriX: \$699/year<br>-PLA \$50/kg<br>-IT hospital employee \$45/h   | The cost: 3-D printing technology and software pays for itself after 4 prints                             |
| Msallem et al. 2017 [72]  | Cranial implant analogue for molding | Not clearly stated but with in-house potential use evoked | NA                | MIMICS-L<br>3-matic-L<br>DDS-Pro-L  | MakerBot Replicator 3D Printer (5th Gen.)-FDM            | NA   | Printing:1-5 h (palm-size templates)  | NA   | DDS-Pro –300\$ (lifelong L)   | Reduction of blood loss, OR time<br>Reduced general anesthesia time=>costs decrease, reduced comorbidity. |
| Abdel Hay et al.2017 [57] | Mold for cranial plate               | Not clearly stated but with in-house potential use evoked | NA                | Horos, MeshMixer, Blender-OS/free   | Delta2040-FDM  | mold design-2h   | Print time: 2h56m - 9h 6m   | Patient1- 1h; Patient 2- 1h and 25m                        | Printer-5000\$; PLA/mold- 5\$; Cost/ implant-230\$  | Cranial implant fitted precisely into the defect  |
| Liu et al.2017 [73]       | Cerebral aneurysm simulator          | Not clearly stated but with in-house potential use evoked | NA                | Mimics, Magics-L  | P: D-Force 400; M: PLA, PVA, silicone                    | NA   | NA  | NA   | P:600\$; M: PLA 11.90\$/kg; PVA 21.70\$/kg<br>Simulator 22.88\$   | Facilitated the training. Better 3D understanding aneurysm. Allows creation of multiple medical scenarios |

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| Callahan et al.2017 [63] | Orbital implant templates used as stencil and mold for actual implant | Hospital affiliated institutions                          | NA      | Vitrea, Mimics,3-Matic-L   | P: Makerbot Replicator 2, Stratasys Fortus 250mc-FDM<br>M: ABS plus | NA  | NA   | NA   | NA   | 10.6 months follow up- no complications and no further revision  |
| Velasco et al.2017 [21]  | Mandibular models printed for planning and plate prebending           | Not clearly stated but with in-house potential use evoked | NA      | InVesalius, Meshmixer, MatterControl-OS/free   | P: ROBO 3D R1-FDM<br>M: PLA   | 75 min. (segmentation, isolation, and fix)              | Print time: - 4-7 hours depending on detail and size (Case 1-5h 31m, Case 2-4h 38m Case 3- 5h 20m) | OR time: Case 1- 3h 50m, Case 2 - 5h 30m, Case 3- 5h 15m. Suggested time savings 1 or 2 hours (based on literature data) | P: \$ 1,000; M: PLA – 0.022\$ Cost/model: Case1-0.9\$, Case 2- 0.67\$, Case3 - 0.99\$(model weight in g)                   | Precise models: Plates fixed without IO modification. PO symmetry. Reduced OR time, costs, patient morbidity, anesthesia risk. Increased patient satisfaction.                             |
| Bosc et al.2017 [40]     | Mandibular/fibula cutting guides                                      | In-house  | Surgeon | Ayra (undisclosed/ (unavailable data on license) , OsiriX-L 3D Slicer, Meshmixer, Blender-OS | Stratasys Objet30 Pro-PolyJet; Zortrax M200-FDM                     | Time required to produce the virtual model- 12 to 48 h. | Fabrication process; 3-15 days (mean 5.1 days); Could be reduced to 48 h.                          | OR time: 6 to 10 h (mean 7 h 2 m)  | Additional cost: 17,800E (3D printers, software, consumables) => 989E /patient, 195E cutting guide; P: Zortrax M200-1800 E | All mandibular reconstructions were successful with a good match between the PO 3D planning and the results. Simulated bone segments and angles similar to PO volume renderings (P =0.61). |
| Hatamleh et al.2017 [41] | Mandibular hyperplasia cutting guides                                 | Not clear stated but with in-house purpose of use evoked  | NA      | CMF Pro Plan, 3-Matic -L   | P: undisclosed; M: Model 610 biocompatible resin                    | NA  | NA   | Patient 1: Surgery lasted for 70 min.; Patient 2: undisclosed  | NA   | 3D technologies are accurate and reliable in the designing of cutting guides for the correction of hemi mandibular hyperplasia in timely and cost-effect manner                            |
| Ganry et al.2017 [42]    | Fibula cutting guide  | In-house: planning; Outsourced: Printing.                 | Surgeon | Osirix-L, MeshLab, Netfabb, and Blender-OS   | P: undisclosed (SLS); M: polyamide 12 (poly-lauro lactam)           | NA  | Time frame for printing, delivery, and sterilization was less than 7 days.                         | Surgical procedure time was reduced by 1.5 h   | Overall cost was < 100 E/case (due to object printing) - vs. several thousand E in case of commercial service),            | Enhanced flap viability; Reduced risk of neoplastic cell contamination; Precision in line with precision obtained using specialized companies.   |

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| Ganry, Hersant, et al. 2017 [43]                      | Fibula cutting guide                     | In-house (hospital production suggested)       | Surgeon  | OsiriX, Netfabb -L Meshlab, Blender - OS                    | NA   | NA  | NA  | NA   | Even with 3D printing professional assistance, the costs would not exceed 25E/fibular and 8E/ Mandibular SG                         | To recommend this protocol as an alternative to professional service, further studies are needed to determine if accuracy is similar to the professional technologies.                          |
| Werz et al.2017 [75]                                  | Surgical Simulator (Upper and lower jaw) | Laboratory work but validated for in-house use | Maxillofacial surgeons                                 | 3D Slicer, Blender- OS                                      | P: MakerBot Replicator 5th Generation; M: ABS or PLA | NA  | 4 models printed simultaneously in 4.5h (mandible),5.5h( maxilla)                   | NA   | model cost between 1.40-1.60\$ (ABS) and 1.80-2.00\$ (PLA)  | 3D printing with inexpensive FDM 3D printers is a promising method to create training models  |
| Smithers et al. 2017 [46]                             | Cutting guides (Mandibular and fibula)   | In-house                                       | Surgical team technician – both on same physical site. | 3D Slicer, Instant Mesh, Mesh lab – OS 3DS Max, Z Brush - L | P: UP BOX Printer- FDM                               | Acquisition phase (6 h); Planning phase (16 h)  | Printing time: mandibular/fibul a guides, external fixator: 8 h; Post processing:2h | Median operative time was 7 h 46 min (range: 6 h 50 min–9 h 51 min)  | P: printer- 4000\$; M: PLA- 60\$/0.5kg Software: 3DS Max-6195\$/3 y   | VSP - accurate, reduce OR time and less stressful for surgeons (based on references, authors did not measure these outcomes)  |
| Numajiri, Morita, Nakamura, Tsujiko, et al. 2017 [47] | Maxillary and fibula cutting guides      | In-house                                       | Surgeon  | Blender-OS  | P: MakerBot Replicator 3D printer 5th generation     | 4.1 h for PO planning                           | 12 h for guide printing   | Average OR time was 17 h 21 min. (ischemic time: flap suturing/bone fixation, 70 min., anastomoses, 64 min.) | P: 4000\$ The in-house approach is 2\$/guide (but the cost is much higher when preparation, effort and surgeon's time are included. | Mean deviation after reconstruction was 0.44 mm (standard deviation, 0.97 mm). Deviations were 67.8% for 1 mm, 93.8% for 2 mm, and 98.6% for 3 mm. All reconstructions were judged as accurate. |
| Numajiri et al.2018 [44]                              | Maxillary and fibula cutting guide       | In-house (hospital production suggested)       | Surgeons   | InVesalius, Blender-OS                                      | P: undisclosed- FDM; M: PLA                          | Surgeons do it in their spare time (no numbers) | NA  | Time-saving (based on references, no clear numbers or statistics)  | In-house approach seems cheaper than commercial approaches, the real cost (including  | Accurate osteotomy length, width, and angle in cutting bones while using cutting guides. (Based on references, no clear numbers or statistics)  |



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|  |   |   |                          |   |   |  |  |   | surgeon's effort) is neglected.   |  |
| Dell'Aversana Orabona et al. 2018 [45] | Mandibular and fibula cutting guides                          | In-house  | Surgeons                 | InVesalius, 123D Design - OS                              | P: Ultimaker 2 - FDM<br>M: PLA  | Virtual planning was about 3 h   | Printing process and sterilization: 6h   | NA  | P: 3000 Euro.<br>M: 6 meters of PLA - 3.6 E   | An average mean distance of 1.631 mm (range 0.594 - 4.067) and a standard deviation of 5.496 mm (range 1.966 - 8.024) has been demonstrated 3D volumes overlay analysis. |
| Elegbede et al. 2018 [23]              | Models of virtually reduced fractures (for plate bending)     | In-house  | Surgeon                  | 3D Slicer – OS; NetFabb Standard-L                        | P: LulzBot TAZ 6;<br>M: ABS   | Image processing takes <30 minutes                                     | 2-12 h (complete mandible about 6 h)   | OR time can be reduced (based on author's experience) | P: 2500\$;<br>M: 43\$/kg;<br>S: NetFabb Standard: 1000\$/y  | NA<br>(There have been no randomized studies showing better patient outcomes when this technology is applied)  |
| Evins et al. 2018 [58]                 | FDM experimentally produced craniofacial prosthesis and molds | Laboratory work but validated for in-house use. (IO production - simulation of process on cadaveric models) | Surgeon (suggested)      | Mimics; 3-matic -L  | P: Stratasys Fortus 250mc-FDM;<br>M: ABS                              | Average time for design (CT import to print initiation was): 14.6 min. | Average print time for all cranioprostheses : 108.6min.; At medium resolution- less than 3 h | NA  | NA<br>Variable costs made impossible a comprehensive analysis.<br>Printed prostheses cost: < 1\$ (using PMMA and designed by clinical personnel). | Seamlessly approximated the defect, followed skull curvature, were flush with the skull and easily fixed using conventional titanium gear (just qualitatively assessed)  |
| Philipp Honigsmann et al. 2018 [66]    | FFF experimental production PSI                               | Research facility but tested and validated for in-house use.  | Surgeon (suggested)      | Mimics; 3-matic -L  | P: Apium P220-FFF<br>M: PEEK  | NA   | NA   |   | NA  | NA   |
| Valding et al. 2018 [24]               | Orbital floor model   | Research facility but tested for in-house use.  | Technician and physician | Medical use: Mimics-L; Not medically approved: InVesalius | P: Professional: 3D System ProJet 3510 - MJP;<br>Nonprofessional: al: | Professional: Mimics: plan time- 1 h 15 min to 1 h 30 min;             | Professional: Mimics: total time- 22 h 30 min (18 h print time);<br>Nonprofessional:         | NA  | P: 3D System ProJet 3510)- 50,000E;<br>FABtotum - 1300 E;   | NA   |

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|                               |  |   |                     | MeshMixer,<br>Netfabb - OS                                   | FABtotum<br>Core-FDM                     | Nonprofessional (InVesalius, Meshmixer, Netfabb): 1 h 50 min to 3 h 20 min | 31 h 30 min (24h 30min print time: booting, machine setting, printing, cleaning t)  |   | M: PLA—35E / 750 g Resin—570E/2 kg<br>S: Mimics: 5000-12,000E/y;<br>Nonprofessional -0 -5000 E/y                     |  |
| Naros et al.2018 [25]         | Mandible models for pre-bent reconstruction plates   | In-house                                  | NA                  | IPlan CMF 3.0-L  | P: ProJet® CJP 360 - BJ                  | DICOM to .STL file-5 min   | 270 min (190 min powder bed and inkjet head 3D printing; 90 min dried and fixed with resin)   | IO time saving of 30–45 min.  | NA (Investment outweighs the reduced surgery costs (surgical team, anesthesia care team, materials))                 | Method prevents rotational error of the mandibular angle; improves restoration of intercondylar angle                          |
| McAllister et al. 2018 [49]   | Cutting and positioning guide (Orthognathic Surgery) | In-house                                  | Surgeon             | 3D slicer, Meshmixer-OS                                      | P: printer undisclosed-FDM               | NA   | Production takes frequently < 3 days (including 36 h for model and guide printing, sterilization) NOTE: Also mentioned production typically takes < 24-h total print time | Custom guides reduce operative duration, anesthetic time - not backed up by numbers | P: printer undisclosed-1000£<br>M: 10£/case<br>Outsourced models and guides for a bimaxillary osteotomy: 1500– 2000£ | Increased surgical predictability; Reduced OR time, anesthetic time and theatre costs- not backed-up by numbers and statistics |
| Morales-Gómez et al.2019 [59] | Mold for PMMA cranioplasty                           | In-house (Confirmed by full text reading) | Surgeon (suggested) | InVesaliu, Blender, MeshLab, MeshMixer-OS                    | P: Formlabs Form 2-SLA; Ultimaker 2+-FDM | Design process: 4-5 h  | 3D mold printing: 10 h  | OR ranged 90-150 min. (mean 126 min.)   | P: Form 2 - 3499\$;<br>Ultimaker 2+ - 2499\$;<br>Implant ranged 135.23\$ to 444.44\$ (mean307.79\$)                  | Excellent patient, family, and surgeon satisfaction at a fraction of the cost of commercial implants                           |
| Spaas and Lenssen 2019 [9]    | Model of mandibular reconstruction with fibula       | In-house                                  | Surgeon             | 3D slicer-OS; Netfabb Basic-L/Free, iPlan 3.0.5 (Brainlab)-L | P: Leapfrog Creatr-FDM                   | 18.5 (15-25) min. segmentation; 33.5 (18-53) min to plan the               | 266.5 (261-272) min. of 3D printing; Planning, printing, and  | NA  | Labour cost: 15.24E/h (junior surgeon); Additional cost/ patient   | Protocol is:<br>- cost-effective;<br>- easy to use;<br>- accurate - (sustained by numbers and statistics)                      |

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|                           |                                      |  |                                   |   |   | fibular osteotomy   | laboratory time total: 6 h   |  | 276 E (257.50-297.25E)  |  |
| Freiser et al. 2019 [67]  | Temporal bone model (simulator)      | In-house (Radiology-based printing lab)  | Radiologist and print technicians | 3D slicer, Meshmixer, Blender-OS                  | P: Formlabs Form 2  | CT image upload to print: 3.1 h   | Print time: 7.0 h/model; Postprocessing time: 1.5 h  | NA   | P: Form 2- 4000\$; M: resin cartridge 200\$; UV box- 800\$ \$103.08/model   | Model is an excellent utility for training purposes (median 9.3; range 8.4–9.9) and for reference during surgery (median 9.5, range 7.5–9.7);                            |
| Guest et al. 2019 [26]    | Anatomical models                    | Radiology department 3D planning lab and joint engineering center (houses the printer) | Radiologist and surgeon           | InVesalius - OS; Freeform, Design X, SOLIDWORKS-L | P: Stratasys uPrint SE Plus-FDM                                   | Structure segmentation:1-4h   | Print time: “several h”; Production: 4d (1d for DICOM processing and 3d of printing and assembly).       | Just hypothesis: model availability could reduce OR time.      | Average model cost: 350\$ (250\$ for polymer printing substrate and 100\$ technical setup)  | Models improved surgeon confidence. Just hypothesis: model availability could reduce OR time and risk of PO complications.   |
| Marschall et al. 2019 [6] | Mandible model for plate pre-bending | In-house   | Radiologist and surgeons          | Mimics, 3-matic-L                                 | P: New- Pro NP1(NewPro 3D prototype)-DLP; Alternative: Form2- SLA | Virtual fracture reduction: 20 min (depends on user’s software and anatomy familiarity) | Print time: New-Pro NP1: 1 h; Alternative: Form2- 5-7 h Isopropyl alcohol wash and curing: 15 min. each. | OR time 1.5 h vs. 2.25 h for traditional ORIF                  | P: New- Pro NP1- price undisclosed; Alternative: Form2: 3500\$ M: resin (VeriModel OS)- 175\$/kgReRsin tank-100\$(10x use); Curing station: \$500; Cost/model: 50\$ | Fit clinically identical to the virtually reduced model; No IO plate manipulation needed. Further studies needed to elucidate cost/case, OR time reduction, and accuracy |
| King et al. 2019 [27]     | Mandible model for plate pre-bending | In-house   | Surgeon                           | 3D Slicer, Meshmixer-OS                           | NA  | NA  | NA   | “Potential for reduced theatre time “-not backed up by numbers | “Expenditure of less than 100£” when “UK commercial printers charge in the region of 300-400£/ mandibular model.  | Accurate fracture fixation. Reduced OR time makes investment worth despite additional training and initial expenditure   |

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| Abbate et al. 2019 [64]         | Orbital floor mold for pressure bending of orbital mesh                         | In-house   | Surgeon (suggested)   | iPlan Cranial 3.0-L Meshmixer, 123D Design-OS | P: Ultimaker 2-FDM; M: PLA   | Time spent on planning lead to consistent gain during surgery. - not backed-up by numbers         | Assumed to take 24 hours but not backed up by numbers  | NA   | 3 meters of filament/3 E  | Good superimposition of preoperative planning over the PO result in all the cases - backed-up by numbers and statistics                                  |
| Yang et al. 2019 [4]            | Cutting guides, osteosynthesis plate  | In-house (cutting guides-design and printed; plate-design) | Surgeon: cutting guides, plate prototype; Engineer: optimized prototype | ProPlan CMF 3.0, 3-matic 13.0 -L              | Outsourced P: SLM125 –SLM; In-house P: P undisclosed M: grade 2 Ti, ULTEM 1010, MED610 resin     | Virtual surgery and plate design: 18.83 +/- 13.19 h   | Plate optimization, printing, post-processing, delivery: 162.9 +/-55.15h (4-9 d)   | NA   | NA  | Superimposing PO model onto the virtual plan -> mean absolute distance deviation 0.89 +/- 1.02 mm => optimal accuracy                                    |
| Hatz CR, et al. 2019 [28]       | Mandibular models (printed both inhouse and outsourced for accuracy evaluation) | In-house (+ external facility)                             | Surgeon (suggested)   | 3-matic-L                                     | P: In-house: MakerBot Replicator+-FDM; External facility: EOSINT P 385-SLS; M: PLA, Polyamide 12 | In-house fabrication takes few h (digital preparation and print) - not backed-up by numbers       | In-house fabrication takes few h (digital preparation and print) - not backed-up by numbers  | NA   | P: MakerBot Replicator +-2499\$; EOSINT P 385 –300.000\$ M: PLS-48\$/0.9kg Inhouse vs. commercial model: 4.46\$ vs. 664\$ Excluded: personnel, software L | In-house models are accurate and comparable to professional models - backed-up by numbers and statistics => therefore equally suitable for clinical work |
| Abo Sharkh and Makhoul 2019 [3] | Mandible, fibula, scapula models and cutting guides                             | In-house   | Surgeon   | 3DSlicer, Meshmixer-OS                        | P: Qidi PLA-FDM; Form 2-SLA  | Total VSP: 158 min (2h 38m)-segmentation (14 min.), VSP (99min.), virtual cutting guides (46 min) | Printing time: Cutting guides 2h 4min. (SLA); Models:5h 30min. In house protocol takes ,24h vs. 2-4 weeks in case of third-party VSP | NA   | P: Form 2-5000\$ CAD; Qidi PLA- 900\$ CAD; Surgical model- 5.21\$ CAD; Cutting guides\$ 12.80 CAD) - based material and amortized equipment               | Cost efficiency  |
| Zavattero et al. 2020 [48]      | Mandibular and fibula cutting guides  | In-house   | Surgeon   | 3D Slicer, Blender, Meshmixer-OS SolidWorks-L | P: Ultimaker-FDM   | Average designing time for the guides: 4.6 h  | Print time: one guide 4 h (depending on volume)  | 3D models and cutting guides help reduce the OR time | P: Ultimaker-5000\$;  | Accurate method; Reliable 3D printing in a hospital 3D lab;  |

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|                            |   |   |                                   |  |  |  |  |   | M:<br>material/guide<br>-10\$;<br>Cost of<br>designing-<br>0\$(medical<br>doctors)   | Anatomical models and<br>guides feasible for daily<br>clinical use at reasonable<br>costs.   |
| Chamo et al. 2020<br>[74]  | Cranioplasty<br>templates for<br>in-house<br>fabrication of<br>cranial plates | Not clear stated<br>but with in-house<br>purpose of use<br>evoked | Surgeon                           | MIMICS, 3-matic-L  | P: MakerBot<br>Replicator+; M:<br>PLA                                    | NA   | NA   | NA  | NA   | Molded PMMA<br>implants based on 3D<br>printed templates is<br>highly precise- < 1 mm<br>deviation evaluated in<br>two different defects   |
| Hassan et al. 2020<br>[29] | Mandibular<br>model and<br>surgical<br>template(guide<br>)                    | In-house  | Surgeon                           | 3D Slicer R,<br>Meshmixer-OS                             | P: Flashforge R<br>Creator Pro-<br>FDM<br>M: PLA                         | Segmentation<br>time of the CT<br>scan to VP:<br>Case 1 (2 h 35<br>min), Case 2 (1<br>h 15 min) and<br>Case 3 (45 min) | Print time:<br>Case 1 (4 h 29<br>min), Case 2 (3 h<br>27 min) Case 3 (3<br>h 55min);<br>Segmentation -<br>>VP ->3D<br>printing-<br>Average/case: 5<br>h 29 min | Technique is<br>reported to<br>reduce OR time<br>and increase<br>accuracy-not<br>backed up by<br>numbers  | P: Flashforge<br>Creator Pro-<br>915\$;<br>M: PLA-<br>20.29\$/kg;<br>Labor: 4.57\$ h<br>Average/case:<br>203.42, if<br>excluding<br>printer cost<br>average<br>cost/case:<br>10.35\$   | Reduced OR time and<br>increased accuracy-not<br>backed up by numbers  |
| Sigron et al. 2020<br>[30] | Models<br>(Orbit for pre-<br>contoured Ti<br>mesh)                            | In-house  | Surgeon<br>(Surgical<br>resident) | Mimics Innovation<br>Suite v. 20-21-L                    | P: MakerBot<br>Replicator+<br>FDM Stratasys<br>Objet30 Prime-<br>PolyJet | Total time<br>(segmenting<br>and preparing<br>data for 3D -<br>printing): < 1 h  | NA<br>(No printing<br>time was clearly<br>mentioned)   | OR time-><br>Intervention<br>Group: 57.3 +/-<br>23.4 vs<br>Conventional<br>Group 99.8 +/-<br>28.9;<br>Using pre-bent<br>implants can<br>reduce OR time<br>by 42.5 min | Material<br>cost/mode:<br>PLA-2\$,<br>Med610-25\$;<br>Surgical<br>theater<br>cost/min is<br>47.5-103\$ and<br>method<br>reduces OR<br>time by 42.5<br>min=><br>economy of<br>4377.50\$ | Pre-bent Ti<br>meshes are more<br>accurate than freehand<br>bent Ti meshes.<br>Significant reduction of<br>surgery time, thus cost<br>efficient.<br>(All backed up by<br>numbers and statistics) |
| Narita et al. 2020<br>[31] | Models<br>(Orthognathic<br>Surgery)   | In-house  | Surgeon<br>(suggested)            | Volume Extractor<br>3.0,<br>POLYGONALmeist<br>er Ver.4-L | P: Value3D<br>MagiX MF-<br>2000-FDM                                      | Panning and<br>printing time<br>not separated  | Mean<br>fabrication time:<br>12 h 14m  | OR time: With<br>3D models-226<br>± 18 min vs. No   | Average<br>weight of<br>model is 165g-<br>>5\$/model;  | Reduced OR time;<br>Reduced bleeding (252.2<br>± 97.7 g- With 3D   |

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|                                |  |   |   | (undisclosed/<br>unavailable data on<br>license)                       |   |   | (planning and<br>printing)  | 3D models-260<br>± 36 min  | Not included:<br>labor, printer,<br>software costs.   | models vs 331.2 ± 85.9<br>No 3D models   |
| Lassausaie et al.<br>2020 [32] | Zygomatico-<br>maxillary<br>model<br>(For surgery<br>planning and<br>plate bending)                                    | In-house<br>("office-based 3D<br>printing")   | Surgeon<br>(suggested)  | 3D Slicer,<br>Meshmixer-OS   | Zortrax M200-<br>FDM                            | NA  | NA  | Pre-bended<br>plates facilitate<br>the<br>osteosynthesis<br>step reducing<br>OR time- not<br>backed up by<br>numbers | NA  | PO orbital volume was<br>significantly reduced<br>as planned (slight<br>difference persisted<br>between both sides -<br>Right orbital volume<br>PO: 24.21 cm <sup>3</sup> , Left<br>orbital volume: 22.12<br>cm <sup>3</sup> |
| Menzel et al.,<br>2020 [65]    | Orbital floor<br>mold ("form-<br>box") and<br>anatomical<br>models   | In-house  | Surgeon<br>(suggested)  | Mimics inPrint ; 3-<br>matic-L   | P: Form 2,-<br>SLA;<br>M: Dental SG<br>V1 resin | Planning: from<br>importing data<br>to the ready-to-<br>print file: 2<br>h;(out of which<br>45 min. to<br>design the<br>"form-box") | Printing time: 4<br>objects<br>(fractured orbit,<br>mirrored orbit,<br>upper and lower<br>part of the<br>"form-box"):<br>11.5 h | NA   | 100 E/case for<br>processing<br>software<br>license rights<br>and printing<br>material;<br>Polydioxanone<br>foil- 250 E   | Patient specific<br>polydioxanone foil<br>showed a very good<br>passive fit under optical<br>and haptic control by 2<br>oral and maxillofacial<br>surgeons   |
| Williams et al.<br>2020 [68]   | "in-house"<br>printed dental<br>prosthesis to be<br>used with<br>outsourced<br>gear for<br>mandible<br>reconstruction. | In-house:<br>prosthesis<br>Outsourced: rest<br>of the gear for<br>mandible<br>reconstruction. | Biomedical<br>engineer for<br>the VSP;<br>followed by<br>surgeon for<br>the<br>prosthesis | Blue Sky Plan (free<br>license, pay per STL<br>export);<br>Meshmixer-L | Form2,<br>Phrozen<br>Shuffle-SLA                | After digital<br>fibula<br>construct was<br>provided, in<br>24h the<br>prosthesis was<br>designed and<br>printed                    | Prin time:<br>Prostheses will<br>require 1 to 2 h   | NA   | P: 500-10.000\$;<br>Blue Sky Plan-<br>25\$/ STL<br>export;<br>M: 8.34\$ of<br>resin/prothesi<br>s; Initial cost of<br>printer and<br>supplies can be<br><3000\$ | All implants were in<br>restorable positions,<br>although 3 were not<br>included in the<br>prosthesis for 3 patients.<br>Implant integration rate<br>of 93% at 3-6 months.   |
| Tel et al. 2020 [60]           | 3d printed<br>mold for<br>cranioplasty<br>plate  | In-house-<br>(university<br>center-Virtual<br>Surgical Planning<br>and 3D Printing<br>Lab)    | Surgeon<br>(Surgical<br>team)   | Mimics ;3-Matic-L  | Form 2-SLA                                      | Mold<br>production,<br>from DICOM<br>to final<br>printing: 48 h   | Mold<br>production: 48 h;<br>Production time<br>(CT to surgery)<br>dropped from 20<br>or 30 d to only 2<br>D                    | Mean OR time<br>was 137.2 min.   | Software cost:<br>21,000\$/y<br>(segmentation,<br>design,<br>analysis<br>modules)<br>M: Grey Pro<br>resin- \$192/ 1L  | 3D analyses validate<br>accuracy of<br>reconstructions - based<br>on numbers and<br>statistics   |

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| Gomez-Feria et al. 2021 [38] | Head models   | In-house | NA      | MRICron, MRICroS, Meshmixer-OS         | P: BQ Witbox 2-FDM; M: PLA, flexible polyurethane                   | NA   | 3D printing process took 48 h   | NA  | Material cost: 30\$  | Survey from 8 surgeons strongly supports the use of this model for surgical planning, IO surgical guidance, patient communication, surgical training.   |
| Beckers et al. 2021[50]      | Implant positioning guide for ear epenthesis                | In-house | NA      | ProPlan CMF, Geomagic Sculpt-L         | P: MakerBot Replicator-FDM  | NA   | NA  | NA  | NA   | NA  |
| Ostas et al.2021[51]         | Cutting guide; Bone fragments positioning guide             | In-house | Surgeon | MIMICS, 3-matic Research-L             | P: Zortrax M300 Dua-FDM; Form 2-SLA; M: PLA Surgical Guide Resin V1 | Model and cutting guides design: 3.5 h; bone fragments positioning guide design: 1.2 H | Prin time: SLA - 3.8 h (2.5 h printing, 1.3 h for postprocessing). FDM-mandibular model for pre-bending was printed in 10.9 h (1 h for post-processing) | NA  | P: FDM- 4309 EUR; SLA- 5580 M: PLA-42 E/800g, Soluble filament-140 E/800g; Form 2 resin 280E/L | Experimental surgery model was compared with the virtual planned reconstruction-> accuracy of the hospital-based workflow is similar to previously published studies - based on numbers                             |
| Tel et al. 2021 [61]         | Modular mold system to perform craniofacial reconstruction  | In-house | Surgeon | Mimics Innovation Suite version 23.0-L | P: Form 2-SLA   | NA   | NA  | OR time was given (table 1 in paper) for every surgery without any indication of OR time reduction. | NA   | The IO prosthesis production was successful, it did not prolong OR time; No implant-related infections; No temporal hollowing cases; No abnormal depression or bulging along orbital rim. - not baked-up by numbers |
| Mascarenhas et al. 2021[52]  | Positioning guide (Orthognathic splint for singlejaw cases) | In-house | Surgeon | Dolphin Imaging software-L             | P: Form 2-SLA   | Average time for splint design: 4.5 min.   | Total time (initial scan to fabrication)/ case: 5-9 h (time for RP depends on complexity/ number of prints)   | NA  | Cost per orthognathic Splint: 0.73\$ CAD (The cost of the resin used to print each splint)     | Increased intraoperative efficiency, and reliable and accurate outcomes - just as a citation, not backed-up numbers or statistics   |

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| Schön et al. 2021 [69]    | Cranioplasty template models   | In-house   | NA                  | Mimics, 3-matic-L        | Stratasys Objet 30 Prime-PolyJet              | NA                                | Printing time for larger implants is around 5 h (based on previous study)  | Median (range) OR time was 121 (89-206) min. | Overall cost of implant Manufacturing : 250\$/ implant (excluding working 1-2 hours, costs for hardware, software, licensing | Superimposing the reconstructed CT data or by mirroring of the non-affected side with the CT data after cranioplasty demonstrated excellent congruency with the patients' tabula externa.   |
| Akiki et al. 2021[33]     | Model (Orbital model for IO molding of resorbable implants)  | In-house   | NA                  | 3D Slicer, Blender-L     | P: Stratasys J750-PolyJet                     | NA                                | NA   | NA   | NA   | PO patient had intact vision and discharged without complications; Resolution of diplopia within two weeks; No evidence of enophthalmos; no evidence of vertical asymmetry or hypoglobus.   |
| Maglitto et al. 2021 [53] | (1) Fibula and mandibulae cutting guide; (2) orbital mesh conformer; (3) zygomatic shield; (4) covid-19 mask and face shield | In-house   | Surgeon (suggested) | Invesalius, Meshmixer-OS | P: Ultimaker 2 and Extended+-FDM; M: TPU, PLA | (1)-design was about 3 h          | (1)- printing process and sterilization 6 h; (4)- to print the mask body- 6 h, filter slot- 1 h and face shield-3 h. | NA   | (1)- 6 m of PLA filament-3.6 E/case (4) - final device (covid-19 mask) < 5 E   | (1) 3D volume overlap-> standard deviation 5.496 mm (1.966 - 8.024 mm) (2) good overlap between the PO planning and the postop. result-backed-up by numbers and statistics (3) postop. CTs revealed excellent positioning of the device and a correct fracture reduction; (4) mask was considered to be highly reliable (based on survey) |
| Dvoracek et al. 2021 [34] | Models (orbit)   | In-house (Children's Hospital of Pittsburgh Department of Radiology 3D | NA                  | Mimics, 3-Matic-L        | P: Form 2-SLA; M: Dental SG resin             | Average model preparation: 10.4 h | Average model preparation: 10.4 h  | Average case duration 2.0 h                  | Material cost/ patient: \$21   | Excellent implant conformation on postop. CT; 3 postop. complications (not implant-related). PO difference in bilateral orbital volumes   |



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|                         |   | Printing Laboratory)  |                      |                           |   |  |   |   |  | was significantly greater than postop. difference (p < 0.01)  |
| Cole et al. 2021 [70]   | 3D printed calvarium-anchored ventricular catheter occlusion device | In-house (Suggested title: "Local 3-Dimensional Printing of..." | Surgeon and engineer | SolidWorks-L              | P: Form 2-SLA<br>M: Durable V2 resin                                    | NA   | NA  | NA  | NA   | Device eliminates the need for a surgical assistant to occlude and retain the intracranial catheter.  |
| Sharma et al. 2021 [71] | Cranial implants  | In-house  | NA                   | MIMICS, 3-matic- L        | P: Apium M220-FFF<br>M: PEEK  | NA   | NA  | NA  | NA   | Implants: -had high dimensional accuracy; revealed clinically acceptable fit; had strength for clinical use; variability between peak load was noticed- backed-up by numbers and statistics |
| Šimić et al. 2021 [54]  | Cutting guides (fibula and mandibular)                              | In-house  | Surgeon              | 3D Slicer, Blender- OS    | P: Stratasys Objet30-PolyJet<br>M: Med620                               | Cutting-guide modelling: 15 min or less (others report 50 min or higher) | NA  | NA  | NA   | Without cutting guides, work would be less precise and time consuming-mentioned in discussions, not backed-up by numbers and statistics   |
| Sigron et al. 2021 [35] | Models (orbit)  | In-house  | NA                   | Mimics Innovation Suite-L | P: MakerBot Replicator+-FDM;<br>Objet30 Prime-PolyJet<br>M: PLA, Med610 | NA (Included in the entire production time)                              | Virtual planning, 3D-printing, and PO mesh modelling: < 2 h | Surgery reduced by 35.9 min. (intervention group) - backed up by numbers and statistics | NA (Evaluation of the cost savings has not been feasible due to different standards) | Prebent meshes reduce OR time, do not delay surgery, have slightly more effective ophthalmic outcomes- backed up by numbers and statistics  |
| Postl et al. 2021 [55]  | Surgical guides (For biopsies of the lower jaw)                     | In-house  | NA                   | Mimics Innovation Suite-L | P: ZPrinter 650 –Inkjet (variant of CJP);<br>Form 2-SLA                 | NA (Planning and printing time taken together)                           | Surgical guide fabrication: 128 ± 17 min.                   | NA (Not clinical)   | NA   | Surgical guides allow significantly higher accuracy of biopsies- backed up by numbers and statistics  |

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| Bergeron et al. 2021 [36] | Models (cranial vault, mandible, orbit)                     | In-house (in-house printing, planning both in-house and outsourced) | Surgeon (surgeons / surgeon + technician when outsourced) | MeshMixer-OS                     | P: Ultimaker, Materio3D-FDM  | NA  | Overall in-house printing phase/model ranged from 2 h 36 min. - 26 h 54 min. (mean = 7h 55 min)                              | NA  | Printer-3500\$; Filament cost/model: \$0.20 and \$2.65USD (mean = \$0.95)                   | Models were accurate; prebent plates were used without modification once placed; There were no operative takebacks due to implant shape. - no numbers and statistics                  |
| Ritschl et al. 2021 [56]  | Cutting guides/ repositioning aids (For fibula ad mandible) | In-house  | Surgeon   | Mimics-L, Blender-OS             | P: Form 2-SLA<br>M: resin (Dental SG)  | Planning time: 5-6 h                            | Printing: 180 min. (120–255)/case; Total time (plan, print, postprocessing, drill sleeves preparation, sterilization): 2-3 d | The median overall OR time: 650 min. (480–840), ischemic time 165 min. (90–240) | Median costs / case were 14.30 E (4.50–25.30).  | Open-source software facilitates cost-effective, precise in-house virtual planning of mandibular reconstructions- backed up by numbers and statistics- see full text for further data |
| Pöppe et al. 2022 [62]    | Mold (For cranial plate)                                    | In-house  | Surgeon   | Brainlab iPlan, Mimics inPrint-L | P: Form 3B or Form 2-SLA<br>M: resins (Dental SG Resin, Surgical Guide Resin). | Preparation time for a cranial implant: 30 min. | Printing: template ring (3-5 h); template mold (5-8 h)<br>Postprocessing: 15 min.  | OR time: mean overall skin-to-skin time: 92 min.                                | Expenses/ implant: 300 E<br>Commercial option: 5.000-10.000 E => 95% cost reduction/implant | Reduced OR time, costs (calculated and compared with data from literature); Patients/legal representatives satisfied with skull shape and cosmetic appearance"                        |

OS-open source, NA-not available, h-hours, OR-operating room, cc-cubic centimeters, \$-American dollars, AVM-arterio-venous malformations, L-licensed, FFF-fused filament fabrication, IT-information technology, FDM-fused deposition modeling, min.-minutes, PLA-polylactic acid plastic filament, PVA-Polyvinyl Alcohol, M-material, P-printer, ABS-Acrylonitrile butadiene styrene, g-grams, IO-intraoperative, PO-postoperative, 3D- three-dimensional, SLS- selective laser sintering, E- euro, SG-surgical guide, y-years, CT-computer tomography, PMMA- polymethyl methacrylate, PSI-patient specific implant, PEEK – Polyetheretherketone, MJP- MultiJet Printing, S-software, BJ-Binder Jetting, DICOM-Digital Imaging and Communications in Medicine, STL- Standard Tessellation Language, SLA-stereolithography , d-days, DLP- Digital Light Processing, vs.-versus, ORIF-open reduction and internal fixation, £-sterling pound, SLM-selective laser melting, VSP-virtual surgical planning, CAD-Canadian dollars, CAD-CAM- computer assisted design - computer assisted manufacturing, VP-Virtual planning, RP- rapid prototyping, TPU- thermoplastic polyurethane, CJP- Color Jet Printing (CJP).