



Defining role of patient specific guiding tools in orthopaedics

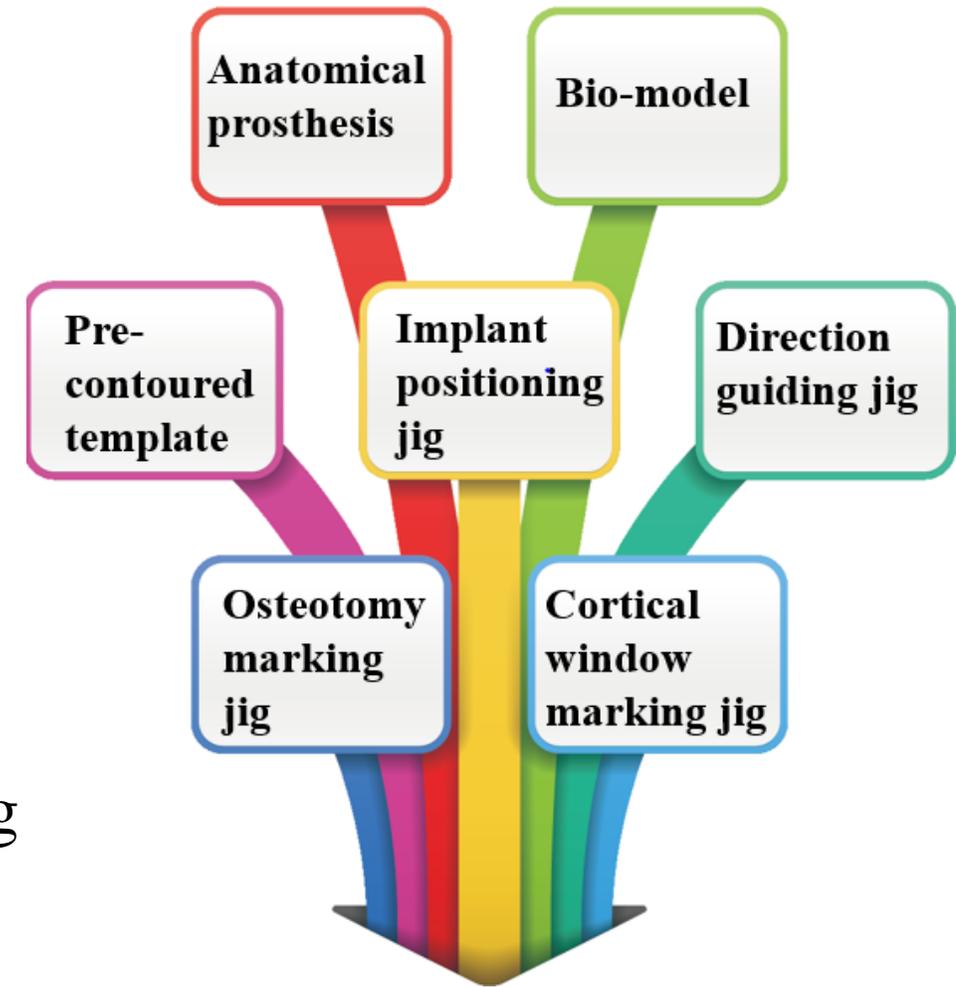
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Introduction

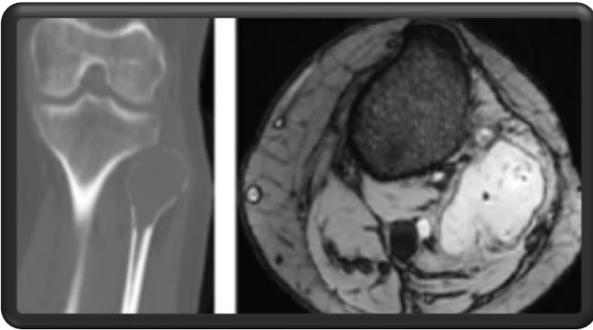
(experience of 209 cases)

- Patient-specific tool is one of the computer-assisted surgery techniques that aim to perform virtual surgery based on preoperative imaging (CT or MRI).
- These tools are based on three-dimensional (3D) printing in which layers of materials are gradually placed to create 3D objects.
- Patient-specific jigs and related technology is adopted by surgeons with intention to replace conventional techniques, while improving accuracy of implant sizing and positioning, saving time and improving the overall outcomes¹.

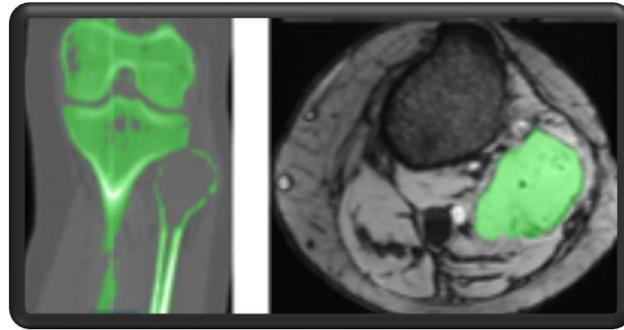


Patient specific tools

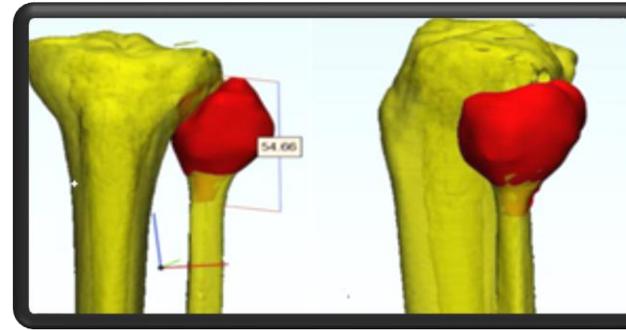
Methodology of developing a patient specific tool



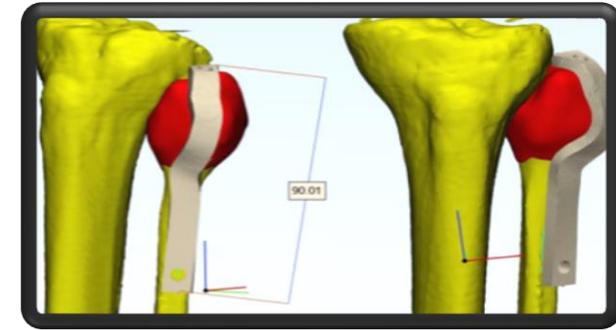
DICOM from CT & MRI imported



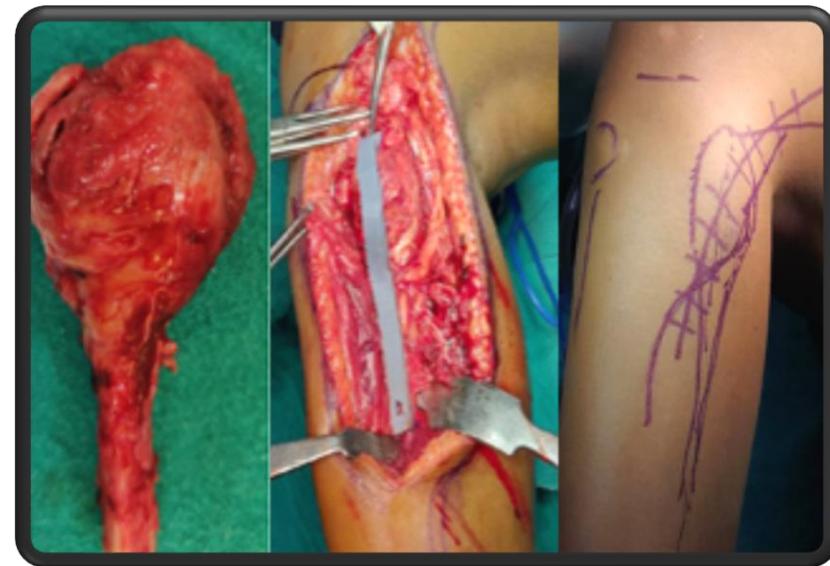
Segmentation of bone and tumor



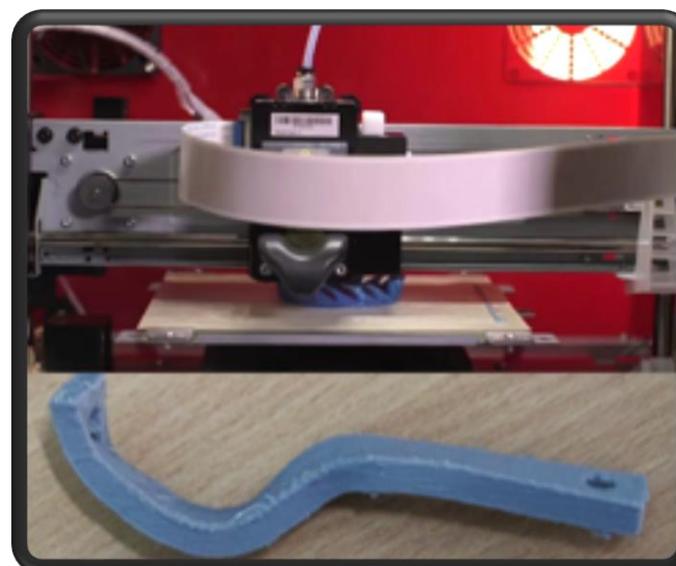
3D model with tumor in red



Resection jig matching the anatomical contour



Jig used intraoperatively



Model printed layer by layer

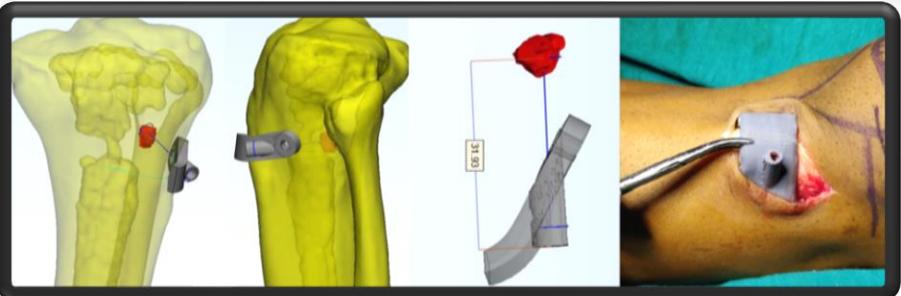


Jig file transferred to 3D printer

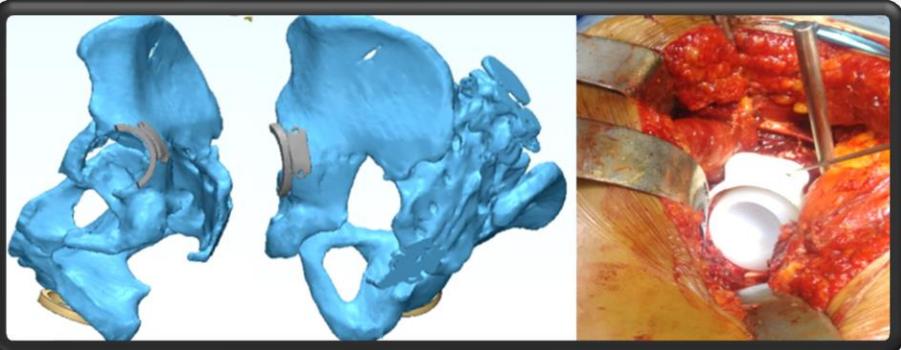
Patient specific tool	Diagnosis (n= number of case)	Patient specific instrument(PSI) developed
Anatomical prosthesis	<ul style="list-style-type: none"> Chondrosarcoma calcaneum (n=1) Subtrochanteric fracture in poliottic limb (n=1) 	<ul style="list-style-type: none"> 3D printed Calcaneal prosthesis Anatomical plate with jig guiding the proximal screws
Pre-contoured template	<ul style="list-style-type: none"> Fracture acetabulum (n = 110) 	<ul style="list-style-type: none"> Template to guide the contour of recon plate
Implant positioning jig	<ul style="list-style-type: none"> THR (n=18) 	<ul style="list-style-type: none"> Jig for accurate acetabular cup placement
Bio-model	<ul style="list-style-type: none"> Ameloblastoma Mandible (n=4) Infected TKR (n=1) 	<ul style="list-style-type: none"> Bio-model to contour graft and plate for reconstruction of defect Scaffold to create anatomical antibiotic spacer
Direction guiding jig	<ul style="list-style-type: none"> Spine fracture (n=51) Osteoid osteoma (n=1) SCFE (n=1) 	<ul style="list-style-type: none"> Pedicle screw guiding jig Jig guiding Radio frequency ablation probe Jig guiding cannulated screw direction
Osteotomy jig	<ul style="list-style-type: none"> Bone tumor requiring resection(n= 20) Developmental dysplasia hip (n =3) 	<ul style="list-style-type: none"> Jig guiding osteotomy level Jig guiding proximal femur osteotomy
Cortical window marking jig	<ul style="list-style-type: none"> Bone tumor requiring curettage (n=9) 	<ul style="list-style-type: none"> Jig marking the cortical window



Jig for pedicle screw placement



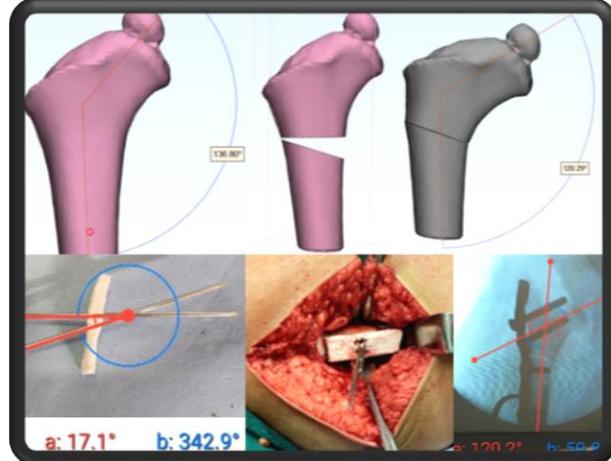
Jig guiding RFA probe in osteoid osteoma



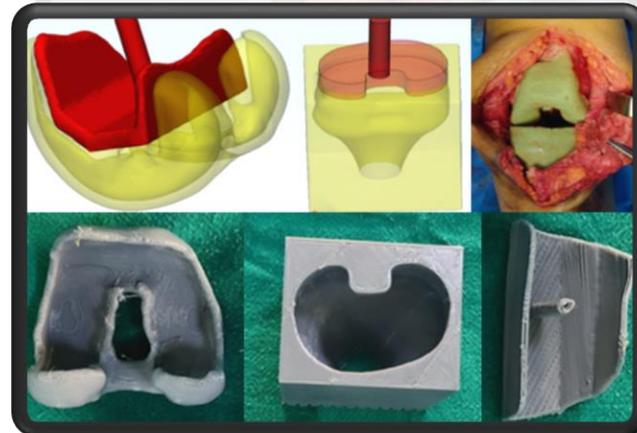
Jig for acetabular cup placement in THR



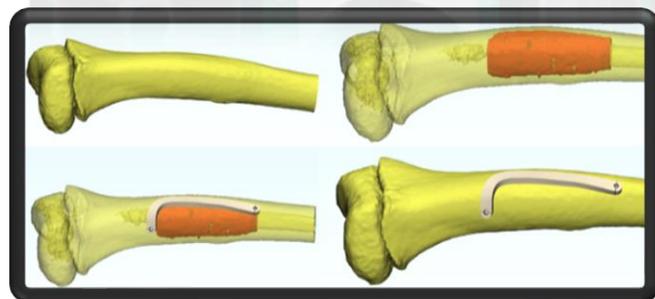
3D printed calcaneal prosthesis



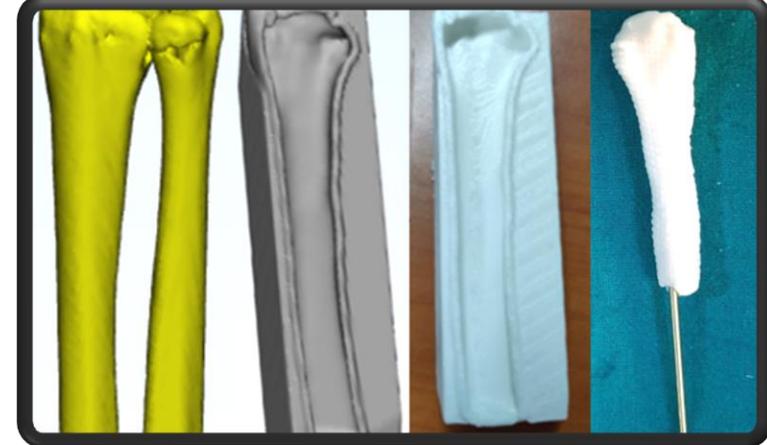
Osteotomy jig for DDH



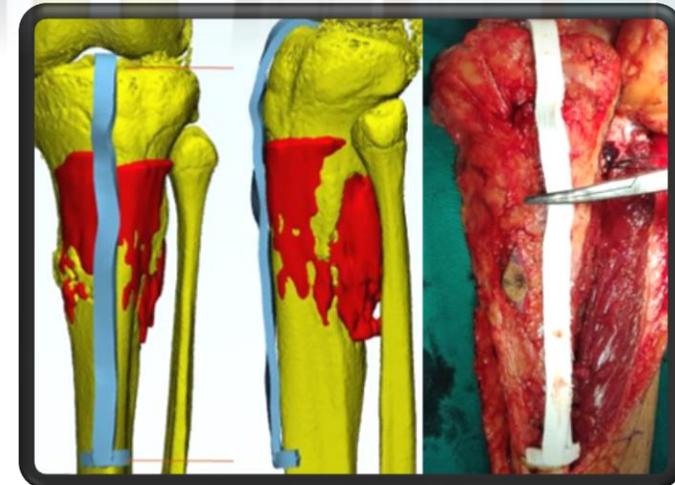
Customized spacer for infected TKR



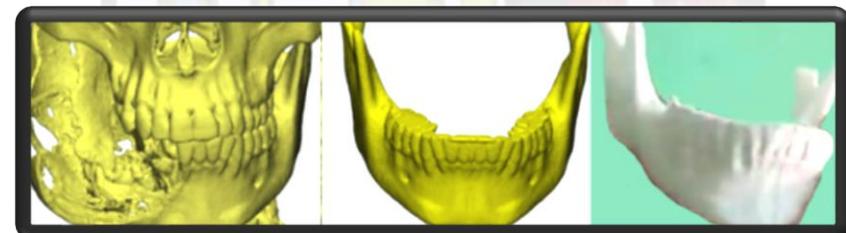
Jig for curettage window in ABC



Customized spacer for reconstruction



Resection jig for ewing's sarcoma



Bio-model for ameloblastoma mandible

Discussion

- Patient specific tools substantially improves the accuracy of surgery, enabling a surgeon to reproduce a given preoperative plan reliably and consistently².
- Well known for its customization, it presents new potential for treating complex orthopaedics surgery³.

Future lacunae

- 3D bio-printing of viable cells is being researched which will compose the missing bone and soft tissue which will define the new prospects for reconstruction in operative procedures⁴.
- 4D printing a technology under research to develop artificial bone for children which can grow as per patient requirement⁵.

2. Khan FA, Lipman JD, Pearle AD, Boland PJ, Healey JH. Surgical Technique: Computer-generated Custom Jigs Improve Accuracy of Wide Resection of Bone Tumors: Clin Orthop. 2013 Jun;471(6):2007–16.

3. Javaid M, Haleem A. Additive manufacturing applications in orthopaedics: a review: J Clin Orthop Trauma. 2018 Jul 1;9(3):202-6.

4. Chiesa I, De Maria C, Lapomarda A, Fortunato GM, Montemurro F, Di Gesù R, Tuan RS, Vozzi G, Gottardi R. Endothelial cells support osteogenesis in an in vitro vascularized bone model developed by 3D bioprinting. Biofabrication. 2020 Feb 19;12(2):025013.

5. Javaid M, Haleem A. 4D printing applications in medical field: a brief review. Clinical Epidemiology and Global Health. 2019 Sep 1;7(3):317-21.