3D planning: Start to finish

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To achieve the best possible results, the study authors of a recently published paper on 3D applications for plastic surgery planning, suggest that aesthetic surgeons consider five core components for making the most of 3D technology: analysis, planning, virtual surgery, 3D printing and comparison of planned to actual results.

Senior author Derek M. Steinbacher, M.D., D.M.D., director of craniofacial surgery at Yale Plastic and Reconstructive Surgery, New Haven, Conn., says "Some of those five core components that I mention in the article have to do with bone, boney repositioning and reconstructive surgery, but they are also applicable to 3D simulation, implant placement, and soft tissue manipulation."

1. Analysis

This basically informs the diagnosis, and complete 3D understanding of the anatomy. The analysis offers the opportunity to look at the nose, face, breast or other area from every vantage point.

"You can look from a frontal view, lateral view, bird's-eye view, worm's-eye view; you can rotate things; you can zoom in; you can measure distances and volumes; you can look at skin quality," he says. "All of those things can be really well described and discussed."

Analyses are performed for planning and thinking about what needs correction and what needs to be accomplished. They are also for patients, as a communication tool, to show patients not only things they may recognize and have presented for, but also to point out relationships or cosmetic issues the patient may not see.

2. Planning

Once you understand the patient's preoperative situation and existing anatomy, you can plan what needs to be done and what can be achieved. The planning component involves asking such questions as:

- How are we going to reposition structures?
- Are we going to be removing tissue?
- Are we going to be adding tissue?
- To what extent are we going to be doing those things?
- Are we going to be changing the skin?
- Widening the nose?
- Narrowing the nose?
- What type of breast implant, and where is the ideal pocket location, for breast augmentation?

"In some of these modules, there are different types, shapes and sizes of breast implants, so we can actually place those digitally, or virtually, and get a sense for how the soft tissue is going to respond and what the breast size will look like with a specific implant. The patients then can compare different options and sizes to come to an informed decision about the desired result…," Dr. Steinbacher says. "For a nose, we're doing simulation to look at removing tissue or changing tip projection or changing the appearance of the nose. And we're actually, in real-time, doing some modification and manipulation to the 3D nasal image to inform the patient of options, and ensure that the patient and surgeon are on the same page, with the same goals."

3. Virtual surgery

This means performing the surgical steps in the virtual space. As such, this component has more to do with procedures which involve bone repositioning, according to Dr. Steinbacher. For instance, for aesthetic jaw surgery, the facial bones can be repositioned in virtual space; the relationships with subjacent anatomical structures noted; and the soft-tissue response to these movements considered and modified.

"When we're repositioning the bone for jaw and orthognathic surgery, we actually move or reposition the bone segments and then go through the operative maneuvers, digitally. Interferences and anatomical nuances can be appreciated, and operative moves optimized. Some virtual manipulation can occur for breast augmentation, as well. We can place the implant, and then you can move the implant footprint along the chest wall. The implant-to-breast tissue interface and response can be virtually simulated, helping decide the type of implant and where on the chest wall that implant should go," he says.

4. 3D printing

Three-dimensional printing typically relates to custom implants, or splints and guides used to reposition bone or skeletal structures, Dr. Steinbacher says.

"We can use these guides or splints to help us reposition facial bones, so there's some kind of reference point or plane that we can tack onto," Dr. Steinbacher says.

Prints can be performed that represent the patient's actual or desired anatomy as well, to be used as intraoperative reference. Examples, according to Dr. Steinbacher, include printing a 3D image of a nose or breasts, both the preoperative and planned, and bringing those to the operating room to serve as a reference during manipulations.

"We can also print the patient's actual native structure that we can use to fashion implant size and fit, intraoperatively. For instance, for mandibular augmentation, we use the patient's actual mandible print, and chose, size and carve the implants we want to use," he says. "We can 3-dimensionally print custom implants that fit like a glove as onlays on the patient's facial skeleton. It is also theoretically possible to make custom breast implants, though that's typically not done, as the multitude of stock implants available suit most needs."

In essence, he says, the 3D printing component may involve one or more of these three things:

1. Printing the patient's actual anatomy to use as an intraoperative aid.
2. Fabrication of custom implants that are permanently implanted as the aesthetic intervention.
3. Using 3D printed splints or guides to help reposition facial or other skeletal structures. These 3D prints can help achieve the surgical goals and aesthetic results.
4. 5. Comparison of planned to actual results

5. By taking a postoperative 3D dataset (either photo or CT scan), cosmetic surgeons can look at and compare the actual result to simulations. The images can be overlaid or assessed side by side, to determine how closely they met their goals. In addition to using this information to improve or refine techniques, surgeons can use the comparisons, for example, to demonstrate to patients how their nasal shape or breast size has changed.