Is 3-dimensional printing the right fit for your reconstruction?

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Recently, centers have used 3-dimensional (3D) printing in the management of patients with chest wall masses or deformities requiring resection,¹ as it has previously been used in other fields to create prosthetics. Examples of such uses include limbs for patients with trauma, facial prostheses for patients with cancer, and skin for patients with burns.²⁻⁴ In many instances, these prostheses have been associated with better cosmetic and functional results.

In their case report in this issue of the *Journal*, Cano and colleagues⁵ detail a patient undergoing chest wall resection and reconstruction for a third time for fibrous dysplasia of the sternum and 3 ribs bilaterally. Although Cano and colleagues⁵ are to be congratulated for their excellent results in a very difficult clinical scenario, their report raises 3 key questions as other surgeons consider use of this technology in their own cases. First, when should surgeons consider using 3D printing versus standard methods? Figure 1 shows a computed tomographic image of a patient with a relatively small sarcoma and no previous surgery. Only 2 ribs required resection to remove this mass. This patient clearly did not require 3D printing technology. As such, when should 3D printing be used? Should it be used only in reoperative cases, only if the anticipated resection exceeds a certain diameter or number of ribs, or what? As surgeons consider using 3D printing in these cases, relative indications should be developed so that we avoid overuse of this technology.

Second, what are the specific advantages of prostheses created with 3D printing⁶? Surgeons desire better cosmesis, better function, and fewer complications. But how do we specifically measure these end points? Should we perform pulmonary function studies before and after resection? Do we look at postoperative functional parameters, such as time needed to return to work or level of mobility? Do we expect that postoperative satisfaction scores will be improved? Although Cano and colleagues⁵ claim that this 3D-printed prosthesis “enhances respiratory activity” relative to standard prostheses, this assertion is purely theoretic. Until we have specific and objective data to show improved functional results, care should be taken to declare the superiority of 3D-printed prostheses in the chest.

This young patient with a relatively small mass does not need 3D printing before surgery.

Central Message

Three-dimensional printing can be used to create a prosthesis after chest wall resection. Given its high cost, however, clear indications for its use should be established.

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Third, how much costlier is use of this technology? Indeed, the elephant in the room is that in our current climate cost-efficiency must be considered with each new proposed intervention in medicine.⁷ Although we are constantly presented with new surgical devices or adjuncts, we must decide how to incorporate these new products responsibly and efficiently. As we decide how to use 3D-printed prostheses in the chest, a detailed, line-item analysis of the cost of this technology will be paramount.

Ultimately, I expect that we will find that 3D-printed prostheses for chest wall reconstructions should be used for selected patients. Although there will be the temptation to overuse this “shiny new object,” we should initially limit it to complex clinical dilemmas or as part of a prospective trial. Regardless, 3D printing is yet another exciting

FIGURE 1. This young patient with a relatively small mass does not need 3-dimensional imaging and printing before surgery.

advance that will have an effect on the ever-changing field of thoracic surgery.

References

1. Simal I, Garcia-Casillas MA, Cerdá JA, Riquelme Ó, Lorca-García C, Pérez-Egido L, et al. Three-dimensional custom-made titanium ribs for reconstruction of a large chest wall defect. *Eur J Pediatr Surg Rep*. 2016;4:26-30.
2. Gretsck KF, Lather HD, Peddada KV, Deeken CR, Wall LB, Goldfarb CA. Development of novel 3D-printed robotic prosthetic for transradial amputees. *Prosthet Orthot Int*. 2016;40:400-3.
3. Schwam ZG, Chang MT, Barnes MA, Paskhover B. Applications of 3-dimensional printing in facial plastic surgery. *J Oral Maxillofac Surg*. 2016;74:427-8.
4. Wei Y, Li-Tsan CW, Liu J, Xie L, Yue S. 3D-printed transparent facemasks in the treatment of facial hypertrophic scars of young children with burns. *Burns*. 2017;43:e19-26.
5. Cano J, Escobar F, Alonso D, Rivero L. Reconstruction of the anterior chest wall with a 3-dimensionally printed biodynamic prosthesis. *J Thorac Cardiovasc Surg*. 2018;155:e59-60.
6. Wyatt MC. Custom 3D-printed acetabular implants in hip surgery—innovative breakthrough or expensive bespoke upgrade? *Hip Int*. 2015;25:375-9.
7. Arbel R, Greenberg D. Rethinking cost-effectiveness in the era of zero healthcare spending growth. *Int J Equity Health*. 2016;15:33.