Machining

# How Precision Machinists Use Dental Milling Machines for the Perfect Bite

Kip Hanson | May 12, 2020

**Dental milling may look completely different from what most of us think of as regular machining, but there are some notable similarities. Here's a look at how dental tools might be just the ticket in your machine shop.**

It's a sad fact of life that humans suffer from occasional toothaches, some of which require a crown, an implant or a bridge.

But while you sit in the dentist's chair, looking up at the ceiling with your mouth opened wide, do you ever give any thought to the manufacturing process behind dental prostheses? What materials are they made of, and what types of CNC equipment and cutting tools are needed to machine them? And what differentiates dental machining from the work you do each day in your shop?

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> Kevin Dyer
> Applications engineering manager, OSG USA

For the most part, it's a very specialized process, with kiosk-like machining centers and "chairside" CAD/CAM systems that are anything but industrial in nature. That said, keep reading, because while you'll likely never operate one of these desktop dental mills or be tasked with machining a nest of molar replacements, there is some relevant overlap in the cutting tools and materials used to produce these specialized components.

## Why Your Next Set of Chompers Might Be 3D-Printed

A little more than a year ago, additive manufacturing equipment provider ***Formlabs announced the availability of Digital Dentures***, the first truly 3D-printed dental prostheses.

They're not alone. There's 3D Systems' NextDent 5100 "digital dentistry" solution, Carbon with its DENTCA dentures, online service bureau Xometry's network of 3D-printed dental prostheses providers, and Stratasys with its digital dentistry workflow.

The point here is simple: From crowns and bridges to dentures and retainers, dental prostheses are complicated affairs. As such, machining replacement parts for the intricate hunks of dentin and enamel within each of our mouths is challenging work—a low-volume, high-value operation far better suited for additive manufacturing than it is for subtractive.

What's more, this no-fixture, no-cutting tools, no-waste process is augmented by intraoral scanning technology. This enables even a relatively unskilled technician to snap a few photos of a patient's mouth and send the resultant 3D model to an in-house printer or online service bureau, then send said patient home with a new smile in hours.

Even the most die-hard machining fan has to admit, this is one place where 3D printing is a no-brainer.

### Why Cutting Tools are Key for Dental Milling

Dental milling is completely different from what most of us think of as machining, says Kevin Dyer, an applications engineering manager at OSG USA Inc.

In closed-loop machining systems, the operator—usually a dentist or dental technician—loads a blank, uploads a scan of the patient's tooth, and pushes cycle start. No feed and speed changes, no touching off of tools, no programming or optimization of toolpaths.

Dyer notes that the people operating the equipment used are not machinists, but many of the materials they use are the same.

"The dental industry uses cobalt chrome and titanium, ceramics such as zirconia and alumina, and high-strength polymers like PEEK and PMMA," Dyer says. "And the cutting tools needed to machine these materials are no different than those needed in the aerospace, medical or mold and die industries."

Jaime Dimayuga, also an applications engineer at OSG, is quick to point out that many of these end mills and drills have a proprietary shank or presetting ring that might make them unsuitable for use in a typical shop's 5-axis machining center or multitasking lathe. Still, many are indistinguishable from the cutting tools found in tool cribs everywhere, with coatings and geometries designed to tackle the materials just described.

"Our EXOCARB WXL line of ball end mills, for instance, does a great job on hardened and pre-hardened steels, while our EXOCARB Diamond comes with either a DLC (diamond-like carbon) or diamond-impregnated CVD coating," he says. "Both are designed for zirconia and glass-based ceramics but work equally well in any hard, abrasive material."

Granted, these cutting tools are used to cut tiny features in replacement teeth, so are therefore equally tiny. One of the largest in OSG's dental lineup—an EXOCARB WXS -CRE corner radius end mill—tops out at 12 millimeters, with most of the other tools falling in the 2 mm and smaller range. If you're machining tractor parts, you should probably stop reading and go back to work. For anyone who needs to cut small details in practically any abrasive, hardened, or otherwise difficult material, however, dental tools might be just the ticket.

## What to Consider When Thinking About Dentist Milling Cutting Tools

There is an important exception to the previous statement. Dental milling is a highly specialized field, and many of the cutting tools found on dedicated dental supply websites simply won't work on the larger, general-purpose CNC equipment common to most machine shops. For these machine tools, you're better off searching for suppliers of micro end mills and drills, OSG among them. Assuming you use tools with the correct coating and geometry, they will serve equally well in the materials just discussed but have shanks that fit standard toolholders.

Guhring Inc. is another source. Brandon Hull, director of product management and business development at the company, explains that, with the exception of proprietary and presetting rings, dental tools aren't all that different from other general-purpose cutting tools.

"You're talking about standard, albeit very small, ball-nose end mills and drills, able to get into the nooks and crannies of dental implants as well as EDM electrodes, electronic circuit board machining, mold making, and other micro applications," he says.

Like OSG, Guhring carries a complete line of miniature end mills, including its UNI PRO and GF300 line. Diamond coatings are available, as are the extended reach and long neck tools needed for 5-axis machining and contouring of relatively deep pockets. And here again, machining of hardened steels, superalloys or abrasive materials like zirconia (or graphite) is not a problem.

Bernd Fiedler, Kennametal Inc.'s senior global product manager for solid end milling, offers similar recommendations. He notes that the company does not carry the specialty cutters used in dental milling machines but does offer an extensive lineup of miniature square, ball and extended reach end mills needed for micromachining, mold making and similar applications.

"Many of these are designed for alloy and hardened steels, but we also cover stainless, nonferrous, including plastics, cobalt chrome and superalloys," he says. "It's a broad portfolio, with material-specific coatings and geometries needed to maximize productivity."

As with all milling applications, Fiedler recommends a high-quality toolholder to minimize runout, but adds that this is even more critical with micro-sized cutters, where even a tenth or two (0.0001″ to 0.0002″) might be too much. He also suggests that spindle rpm can be a constraint, especially with tool diameters 1 mm and smaller. For these situations, an air-powered or electric speeder head might be needed to achieve the correct surface speed.

"It's important to note as well that not all dental machining is done in an office environment," he says. "There are many labs and specialty manufacturers out there that are using more traditional CNC equipment, with the spindle speeds and highly accurate motion control needed for this and other types of medical work. For these shops, high-quality cutting tools produced by a company that covers the full spectrum of metal removal operations is likely the best solution, rather than the dental tooling designed for dedicated but light-duty equipment."

*How do you handle cutting small details in difficult material? What unique solutions have you found?*



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