Guided Implantology Made Easy

by August de Oliveira, DDS

Abstract

A CE-based article written to introduce the steps involved in performing a guided implant surgery case. The entire process from diagnosis to surgery will be covered. Clinical examples will be provided as well as a step-by-step narrative describing an edentulous case. The article will also offer one users opinion on guided implant surgery in the general dental practice.

Guided implant surgery involves taking a CBCT scan with a patient sometimes wearing a radiographic guide. Information from the CBCT scan is used with an implant software program to plan out a surgical case. Information from the software is used by a laboratory to manufacture a surgical guide. Through the use of a specific guided surgical kit, an operator uses the surgical guide to perform an osteotomy and insert dental implants.

The goal of this CE article is to educate new users as to the steps and armamentarium involved in the entire process of guided surgery. Through years of experience, I have placed many implants safely and precisely with this method.

Educational Objectives

1. To inform new users on the steps involved in guided implant surgery
2. To describe the means in which data is transferred from the scan to the patient
3. To educate new users on the minimum distances used in implant surgery
4. To describe the surgical steps used in guided implant surgery
5. To inform new users the advantages and disadvantages of guided implant surgery

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Safety, predictability and efficiency – these three words, in my opinion, are the basis of what makes dentistry enjoyable. It seems that the longer I practice the less tolerance I have for the stress that usually comes with our job as general dentists. In any procedure I do I try to find ways to apply those three glorious words. When performing a root canal, I always use new rotary files and only once. Why? I know that it's safer because there is less chance of file separation. I know that I can predictably instrument the canals in a stepwise fashion. Finally, I know that using sharp rotary files reduces the time I spend working in a canal. I learned how to place implants in my GPR residency, long before CBCTs and guided surgery. After picking implants back up three years ago, I looked at ways in which I could make implant placement safer, more predictable and more efficient. Naturally I gravitated toward guided surgery. I probably perform at least 95 percent of my implant cases via guided surgery. With the advent of CAD/CAM chairside millable guides, this percentage will approach 100 percent (Fig. 1).

If you look through a number of threads on Dentaltown's implantology section, you will find many different opinions on the matter. "Guided surgery for single units is cost prohibitive," "Guided surgery does not work," "I can place implants just fine without them," "You can't get enough irrigation and you will burn the bone." We all know dentists are certainly varied in their opinions. And although some of those statements have some truth to them, I have found a way to smoothly and profitably implement guided implant surgery in my practice. On any given day, most guided implant cases in my office can be many times easier than placing a post in a tooth root, or performing rotary endodontics.

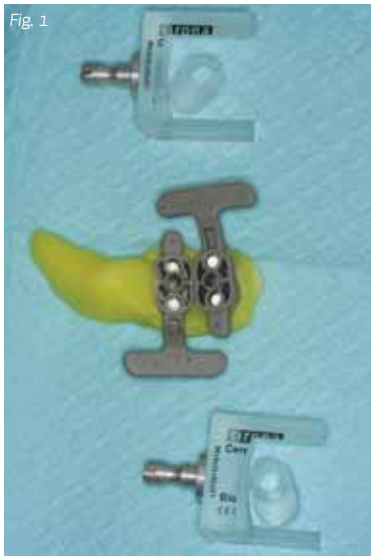
Advantages

There are many advantages to guided implant surgery. Guided surgery can be accurate up to close to .45mm.[1] Many times the gingiva only needs a 3.5 to 6mm punch rather than a large flap, preserving the blood supply to the bone (Fig. 2). Flapless surgery may lead to significantly less post-op bone loss than conventional flap surgery.[2] In regard to nerves, teeth and other structures, guided surgery can help the user to avoid these. Post-op pain from most cases is minimal and soft tissue healing can be rapid if punches or minimal flaps are used. Paralleling options in most implant software programs can allow for the use of stock abutments and greatly reduce the difficulty in restoring complex cases (Fig. 3). Finally, guided surgery might allow new users to place implants with the accuracy comparable to those surgeons with greater experience.

Disadvantages

There are disadvantages of guided surgery as well. There is an increased cost in manufacturing the radiographic and surgical guides. Along with that comes the possibility of one or multiple extra appointments. CBCT machines are expensive to own and deliver a higher dose of radiation than most 2D digital options. More irrigation than conventional implant surgery is needed to reach the osteotomy through the closed system of the surgical guide. In cases of limited opening, guided surgery may not be an option as the drills are at least 10mm longer than conventional implant drills (Fig. 4). Finally there is a decrease in visualization through the surgical guide to the edentulous site.

Fig. 1: Components of a chairside milled surgical guide.
Fig. 2: Punched tissue.
Fig. 3: Stock abutments/impression copings
Fig. 4: The guided pilot drill with the head of the handpiece is over 42mm long. The subsequent guided drills are much shorter.



Guided implant surgery involves using a CBCT scan and implant software via a surgical guide to place implants in the mouth. Besides a warm body missing a tooth you need five things to perform guided surgery:

1. A CBCT scan
2. A radiographic guide or some means of relating the patient to the scan
3. A surgical guide
4. A guided implant kit
5. A compatible implant

In order to perform guided surgery you need to unite three "worlds." The first is the patient. The second is a stone or virtual CAD/CAM model. The third is the 3D virtual world of the CBCT scan. In the CBCT scan with implant software, an implant is placed in a 3D coordinate system, known as the

1. *Clin Implant Dent Relat Res. 2011 Dec 15. doi: 10.1111/j.1708-8208.2011.00406.x. [Epub ahead of print] Three-Dimensional Accuracy of Guided Implant Placement: Indirect Assessment of Clinical Outcomes. Platzer S, Bertha G, Heschl A, Wegscheider WA, Lorenzoni M.*
2. *Year : 2008 | Volume : 19 | Issue : 4 | Page : 320-325 In vivo evaluation of crestal bone heights following implant placement with 'flapless' and 'with-flap' techniques in sites of immediately loaded implants Shibu Job, Vinaya Bhat, E Munirathnam Naidu Department of Prosthodontics, Meenakshi Ammal Dental College, Chennai, India*

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Cartesian Coordinate system, giving it a value in the x, y and z axis. Somehow this information needs to be translated and transferred back to the patient so an implant can be placed in a hole (osteotomy) that is drilled to the exact depth, width and angulation (Fig. 5). How is this done? In many systems a radiographic guide is worn by the patient during the scan. Markers known as fiducials contain radio opaque material and can be read in the scan by the software. Fiducials can be made of zirconia, alumina glass or even gutta percha (Fig. 6). These fiducials allow the software to relate the planned implant into a controlled coordinate system that can be transferred back to the patient via a CAD/CAM milling machine and the resultant guide (Fig. 7). The numbers that correspond to the implant position are known as a matrix. In the case of an edentulous guide, how the radiographic guide is made greatly affects the restorative outcome of the case.

An edentulous Radiographic Guide is a copy of the tooth arrangement of the final prosthesis (Fig. 8). If the patient is happy with the fit and the aesthetics of their existing denture, an acrylic duplicate denture can be made. If the patient does not like their denture, a new tooth set up must be finalized and a duplicate made of that. The duplicate can be simple acrylic impregnated with barium sulfate (Fig. 9). Care must be taken to use a more radio dense barium sulfate in the teeth, and less radio opaque in the denture base.

This will help identify in the software where the flange is located in the denture (Fig. 10).

In many implant software programs, a separate radiographic guide is not needed. The computer can recognize teeth shape on a stone or CAD/CAM virtual model via a process known as model stitching. A stone model of the patient can be scanned via an optical scanner and imported into the implant software using a specific file format. The computer may then prompt the user to mark similar landmarks between the model and the CBCT scan (Fig. 11). One can even scan a denture and stitch it to a CBCT scan on a patient wearing a radiographic guide containing barium sulfate containing acrylic teeth (Fig.12). Model stitching may not work on patients that contain a lot of

Fig. 5

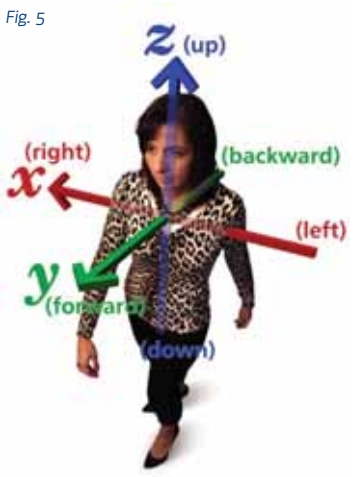


Fig. 6

Fig. 7

Fig. 8

Fig. 9

Fig. 10

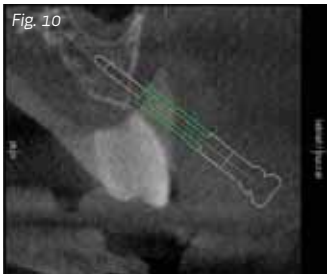


Fig. 11

Fig. 12

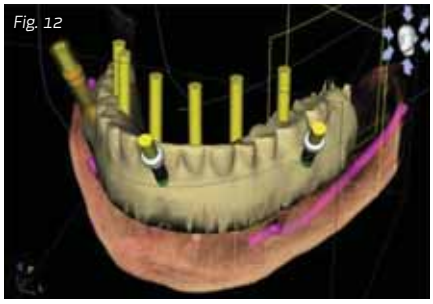


Fig. 5: The Cartesian Coordinate system contains an x, y and z value.
Fig. 6: Fiducial markers show up as white spheres in a 3D scan.
Fig. 7: The matrix coordinate is sent to a CAD/CAM-controlled device that manufactures the surgical guide.
Fig. 8: A copy of the patient's denture made in acrylic and impregnated with barium sulfate can serve as a radiographic guide.
Fig. 9: The barium sulfate teeth show up in the 3D scan and can greatly aid in the angulation and arrangement of implants.
Fig. 10: Having two densities of barium sulfate aids in the placement of stabilization pins.
Fig. 11: Sometimes no radiographic guide is needed and the patients model can be matched directly to the scan.
Fig.12: You can see that the patients denture is incorporated in the scan and its clear where the denture base and the teeth are. This is particularly helpful on the linguals of the anterior where screw access holes may be placed. One can also easily see the tripod configuration of the stabilization pins.

metal- or zirconia-based restorations due to metal-based artifacts in the scan.

After the scan is taken, the user can then begin to plan their implant case. CBCT viewer programs, as well as implant software are usually divided into four windows. Three of the windows that display 2D slices of the CT scan are known as orthographic views. These are the panoramic, the axial, and the cross sectional. The fourth window is the 3D view aka the 3D rendering (Fig.13). Implant software is very similar to 3D animation or CAD programs and share a similar layout. Programs such as 3D Studio Max or Maya are used to make video games, or animation such as those used in Pixar movies (Fig.14).

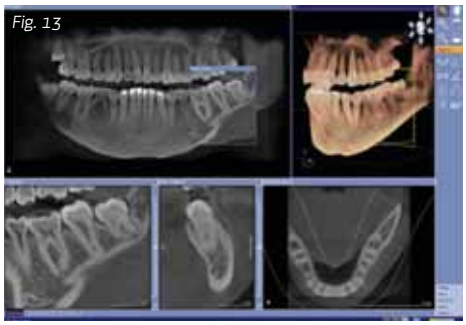
Within all implant programs the user must define a "track" known as the panoramic curve (Fig. 15). The panoramic curve is simply an arch in which slices are made either perpendicular to (cross sectional, Fig. 16) or parallel to (panoramic, Fig.16). Care must be made to define this "track" or the resultant 2D images may be distorted. Furthermore, unless the program has the ability to correct for this, patient positioning and head tilt may also result in distortion of the 2D views (Fig. 17).

Luckily, the 3D view is independent of patient positioning or the panoramic curve and usually carries little distortion.

For better or worse, the implant software transfers your plan of where you want the implant exactly, to the resultant surgical guide. Without landmarks, its easy to place an implant off course. Within most programs, virtual extensions known as drill paths extend out the long axis of the virtual implant helping you know where your drill will go, but more importantly, to allow you to achieve parallelism (Fig. 18). Virtual guide sleeves (to be explained later) simulate the channel in the guide where your drill will pass (Fig. 19).

Finally, virtual teeth or Barium Sulfate teeth are the ultimate in restorative-driven planning and allow you to place the implant where the restoration will ultimately reside (Fig. 20).

When you place implants, you need to learn the lingo. And guided surgery has its own language as well. The surgical guide is an acrylic stent containing holes (guide sleeves) that help direct drills (guided drills/guided twist drills) via inserts (drill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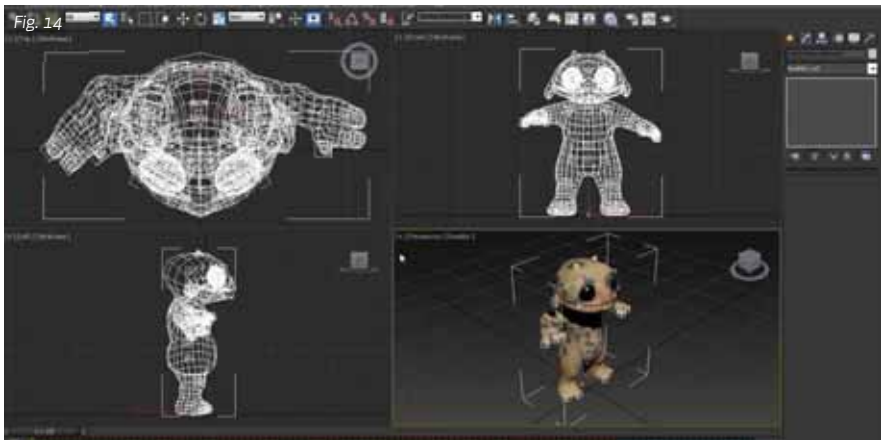
Fig. 14


Fig. 15

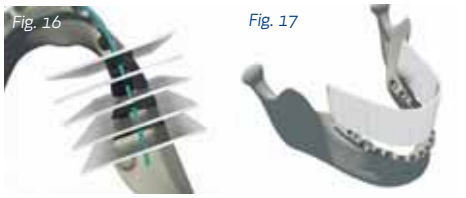
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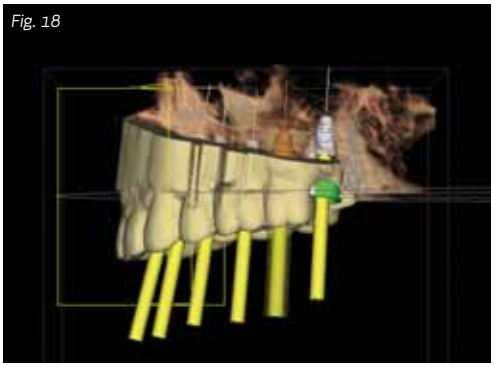
Fig. 17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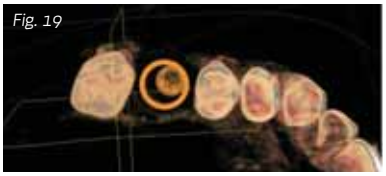
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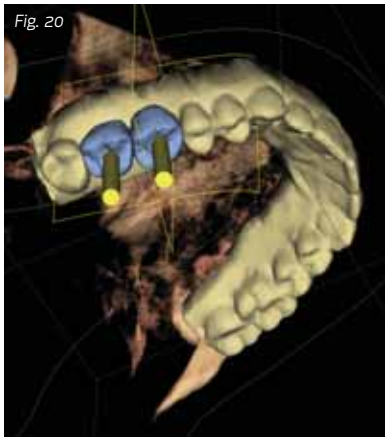
Fig. 20

Fig. 13: Screen arrangement of a guided surgery/CBCT viewer.
Fig. 14: Similar set up in a 3D animation/CAD program known as 3D Studio Max.
Fig. 15: The panoramic curve is a user defined "track."
Fig. 16: Cross sectional slices are taken at right angles to the panoramic curve.
Fig. 17: Slices in the 3D panoramic are made parallel to the panoramic curve.
Fig. 18: Drill paths
Fig. 19: Guide sleeve
Fig. 20: Virtual teeth

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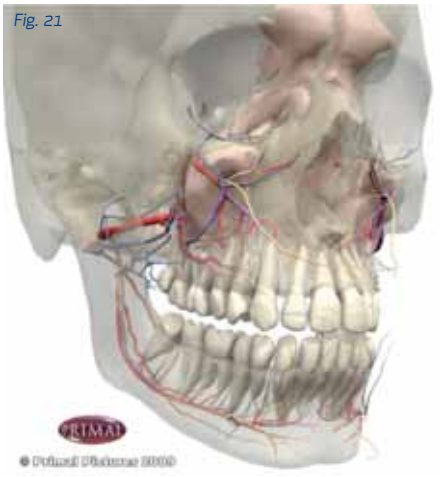
guides or keys). Stabilization pins can affix the surgical guide in place when there are few or no teeth to support it. The guide platform is a flat area around the guide sleeve that either serves as a stop or a visual guide to when your drill is at length. In a fully guided system, a guided implant mount allows the user to place an implant through the surgical guide, controlling the trajectory of the implant and ultimately the depth with a stop (Fig. 26). The guided implant mount usually has a mark denoting when the correct internal feature of the implant is pointing in the correct orientation, known as indexing (Fig. 27).

One thing I love about guided implant surgery is the ability to see and quantify measurements made between the implants and the surrounding structures. The CBCT scan gives you the ability to clearly see the patient's anatomy and avoid it if necessary (Fig. 21). We know that implants must be at least 1.5mm away from adjacent teeth (Fig. 22). Implants must be at least 3mm away from each other (Fig. 23). An implant should be no more than 2mm away from any nerves (Figure 24). Finally the implant must have at least 2mm of bone on the buccal and lingual side of the implant (Fig. 25).[3] Seeing this on the scan greatly improves my confidence in the procedure.

The indentation on the center of each indicates the proper direction known as indexing. There are two methods for controlling depth in guided implant surgery. In some systems there are no physical stops on the drills. Laser markings or bands on the implant drills signify a length. When this laser mark reaches the

3. *Abstract Journal of Periodontology September 2004, Vol. 75, No. 9, Pages 1242-1246 , DOI 10.1902/jop.2004.75.9.1242 (doi:10.1902/jop.2004.75.9.1242) Effect of the Vertical and Horizontal Distances Between Adjacent Implants and Between a Tooth and an Implant on the Incidence of Interproximal Papilla Jose Fabio Gastaldo Department of Periodontics and Implantology, School of Dentistry, University of Santo Amaro, Santo Amaro, Brazil. Dr. Patricia Ramos Cury Department of Oral Pathology, School of Dentistry, University of São Paulo, São Paulo, Brazil. Wilson Roberto Sendyk Department of Periodontics and Implantology, School of Dentistry, University of Santo Amaro, Santo Amaro, Brazil.*



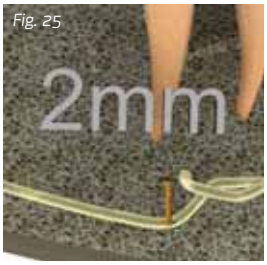


Fig. 21: A CBCT scan allows you to look inside the patients skull. One can see sinuses, channels surrounding nerves, teeth, and sometimes, vascular structures.
Fig. 22: Minimum tooth to implant distance is 1.5mm.
Fig. 23: Minimum inter-implant distance is 3mm.
Fig. 24: Minimum amount of bone on the buccal and lingual of an implant is 2mm.
Fig. 25: The minimum distance of an implant to a nerve is 2mm.
Fig. 26a-c: a. The guide platform b. Stabilization pin c. Guided implant mount
Fig. 27: Guided implant mounts. Each color represents a different diameter implant.
Fig. 28: Guides produced by stereolithography.
Fig. 29: Surgical guide being milled by a chairside CAD/CAM unit.

guide platform, it is up to the user to stop drilling any further apically (Fig. 30). Drills with stops are certainly more convenient. The operator either drills until the stop hits the drill guide or key, or the guide platform itself (Fig. 31). In a non-fully guided system, the surgical guide is removed and the implants placed through the punch in the tissue into the osteotomy. In a fully guided system, the implant is placed through the guide and the guided implant mount contains a stop at the correct depth (Fig. 32).

This surgical guide can be manufactured a number of ways. In some cases the surgical guide is copied, along with the information from the implant software program via a process known as steriolithography (Fig. 28). In other systems, the matrix (the number sequence of the planned implant) is given to a CAD/CAM controlled drill which then alters the radiographic guide itself. Another method is to mill the surgical guide via a CAD/CAM milling machine out of a large solid cylinder of acrylic. Most recently, via CAD/CAM chairside units, dentists now have the ability to mill surgical guides in their own offices (Fig. 29).

The act of surgically placing implants via guided surgery is actually quite simple. The patient is anesthetized and the surgical guide is tried in an evaluated for fit (Fig. 33). If this patient is edentulous, stabilization pins may be placed (Fig. 34). Tissue punches are then performed if the case is to be done flapless (Fig. 35). After removing the flapped tissue, a counterbore may be used if the implant is to be placed slightly subcrestal. A counterbore usually begins a slight countersink in the bone where a pilot drill may be used.

The pilot drill is usually between 2.0 and 2.3mm in width and does most of the work in the osteotomy (Fig. 36). After the pilot, it is a good idea to place an angulation pin and check the trajectory of the osteotomy. A subsequent series of guided implant drills follows depending on the width of the implant

Fig. 30

Fig. 31

Fig. 32

Fig. 33

Fig. 34

Fig. 35

Fig. 36

Fig. 30: Laser markings on the drill visually indicated when you are length.
Fig. 31: Many guided kits have drills with hard stops that engage the guide platform when at length.
Fig. 32: In a fully guided system, the guided implant mount controls the direction and depth of the implant through the guide.
Fig. 33: The Guide is tried in. It should be stable and relate to the arch in the same orientation as the radiographic guide.
Fig. 34: Stabilization pin drill being inserted into the guide. The pins have stops to prevent over insertion.
Fig. 35: Secure guide ready for tissue punches.
Fig. 36: The pilot drill is inserted through the drill guide (2.0).

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(Fig. 37). Finally, the implant is then placed in the osteotomy (Fig. 38). If the implant does not go to length, dense bone drills, or screw taps may be employed to further widen the osteotomy. It's up to the surgeon or the prescribing dentist whether the implants are then loaded (Fig. 39).

Guided surgery in my practice has proven time and time again to be a safe, predictable and efficient procedure. By carefully planning where the implant should go, taking into account the bone and the adjacent teeth, inexpensive stock abutments can be used to make final restorations with contours and anatomy that mimic natural teeth (Fig. 40).

Using a fully guided implant system, the osteotomy can be drilled with safety and the implant placed with the proper angulation and depth. With the proper training and attention to the necessary steps, placing simple implants in good bone on healthy patients is well within the skill set of most general dentists. ■

Fig. 37: Guided drills may be inserted through drill guides or directly into the guide sleeve.
Fig. 38: Implants inserted. Impression copings inserted to show parallelism.
Fig. 39: Implants may be loaded or the denture may be relived.
Fig. 40: Numbers 3 and 4 placed with guided surgery. Note the position and emergence profile. When the implant is placed in the ideal position and angulation, restoration is easy.

Author's Bio

Dr. August de Oliveira is the author of "Implants Made Easy," a book geared toward starting your first implant. He has just released, "Guided Implantology Made Easy," a book on the basics of guided implant surgery. Dr. de Oliveira has lectured nationally on cone beam technology, dental implants and CAD/CAM technology. He has been a software beta tester for Sirona, Blue Sky Bio, Anatomage and Implant Direct. He is currently a moderator and regular contributor to Dentaltown.com's Implantology and Mini Implants Section. Dr. de Oliveira practices general dentistry in Encino California. To find out more about implants and Guided Surgery, go to www.implantsmadeeasy.com.

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1. The advantages of guided implant surgery are:
   a. Less expense, slower procedure, more post-op pain.
   b. Less post-op pain, possibly less bone loss, smaller incisions.
   c. More pain, larger incisions, less accuracy.
   d. All of the above.

2. The disadvantages of guided implant surgery are:
   a. Long drills, difficult irrigation, increased cost.
   b. There are no disadvantages.
   c. Drills, decreased cost, no irrigation.
   d. All of the above.

3. CBCT stands for:
   a. Cat barium computed tomography.
   b. Collimated back cranial tesselation.
   c. Cone beam computed tomography.
   d. None of the above.

4. The Cartesian Coordinate system is:
   a. An ancient system of reading maps.
   b. A new style of Brazilian mathematics.
   c. The X, Y and Z coordinate system used in 3D imaging and animation.
   d. A popular pastry in Europe.

5. The screen of most 3D viewer and implant software is set up as:
   a. Multiple 2D orthographic views and a 3D view.
   b. One large 3D view.
   c. No 3D view, just a series of 2D slices on large sheets of film.
   d. None of the above.

6. Many implant software programs are similar to:
   a. Dental practice management systems.
   b. Intra-oral camera programs
   c. 3D animation or CAD programs used in the video game and movie industries.
   d. Coleco vision.

7. The proper tooth-to-implant minimal distance is:
   a. 6mm.
   b. 1.5mm.
   c. 4mm.
   d. The width of a finger.

8. The guided implant mount does what?
   a. Keeps the implant in its container.
   b. Keeps the implant sterile.
   c. Guides the implant through the surgical guide to the proper depth and angulation.
   d. Keeps the implant from getting lint on it.

9. What is indexing?
   a. An older way of organizing library books.
   b. The section in the back of a book with a lot of numbers on it.
   c. Orienting the implant so that the proper direction of the internal connection faces to the buccal or whichever direction required.
   d. None of the above.

10. Stabilization pins are used for:
    a. Securing and stabilizing a surgical guide.
    b. Affixing a flap on to the underside of the guide.
    c. Keeping the irrigation tubing secure on the handpiece.
    d. Keep the implants secure for temporization.

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- ❑ Radiology
- ❑ Speaker
- ❑ TMD Specialist
- ❑ Other