issn 1616-7390

Vol. 3 • Issue 1/2012

CAD/CAM

international magazine of digital dentistry

1 2012

special
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opinion
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Dear Reader,

Dr Dobrina Mollova

_**CAD/CAM** has revolutionised engineering and manufacture since the 1950s. In the 1980s, such processes were progressively applied and integrated in the field of dentistry. It is no surprise that along with the technological milestones attained within the last decades, computerised dentistry and dental CAD/CAM technology have developed at a rapid rate. The 2011 International Dental Show in Cologne highlighted the unprecedented improvements in CAD/CAM, with exhibitors and attendees indicating that a growing number of manufacturers are joining the market.

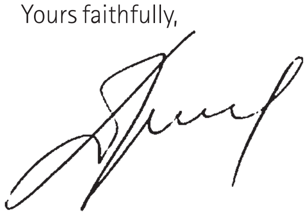
The fast growth in CAD/CAM dentistry alongside new technology, materials and equipment has seen an increasingly rapid integration into both dental offices and laboratories. Without a doubt, digital technology is pivotal for the operational viability of every dental practice and laboratory. Are we prepared to keep up to speed with this growing industry? Can we implement this pool of information and technology in our practices without the proper expertise?

As with all new technologies, education and training are essential. The development rate of computerised technologies is not in sync with the level of training most dental professionals have attained. Evidently, with time, we will have to start implementing such technologies to remain up to date with standards and practices within the field. Companies and professionals specialised in digital dentistry place a great deal of effort and enthusiasm into training dental clinicians, technicians and dental assistants in basic and advanced techniques and procedures. Is this sufficient for the fast-paced and challenging reality they face on a day-to-day basis in their career? Every day, there are questions and uncertainties about approaching diagnostics, treatment plans and the selection of the proper material to obtain the desired outcome. Last but not least, the investment costs and the all-important return on investment have to be taken into consideration.

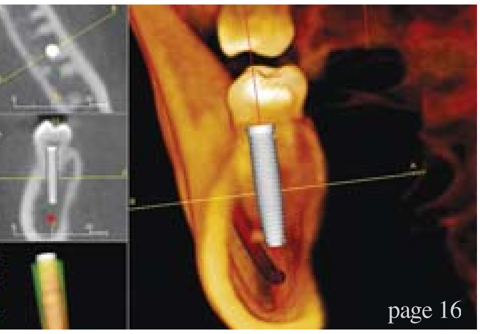
Since CAPP (Center for Advanced Professional Practices) started out in 2006 with the first CAD/CAM & Computerized Dentistry International Conference in Dubai, we have experienced a steady increase in the number of the events we hold and the number of participants and visitors. This year, the CAD/CAM & Computerized Dentistry International Conference will have spring and autumn editions: the sixth conference will take place in Dubai from 3 to 4 May 2012 and the seventh conference will be held in Singapore from 6 to 7 October 2012. This will be the first Asia-Pacific edition of the meeting. We would like to warmly invite all dental professionals to join us for these events. We are very excited to organise events focused entirely on computerised dentistry, aiming to build important bridges between our dental team, dentists, dental technicians and the industry.

In 2012, the CAD/CAM magazine will serve as a platform for education and information exchange with a new rubric—**digital platforms**. Dental schools, societies, associations and companies are invited to announce their course schedules here. More information about this exciting project is available inside this issue.

Yours faithfully,



Dr Dobrina Mollova
Managing Director of CAPP
Dubai, UAE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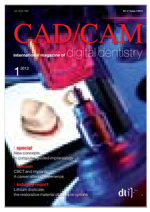

Cover image courtesy of Renishaw.
A Renishaw 98D zirconia billet with frameworks already milled, loaded in a Renishaw incise milling machine.


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PLANMECA

New concepts in computer-guided implantology

Part I: Thread timing and implant phase

Author_Dr Gian Luigi Telara, Italy


Fig. 1a


Fig. 1b


Fig. 1c


Fig. 1d

Fig. 1a_Components of the bottle-neck device.
Fig. 1b_Embedded sleeve.
Fig. 1c_Ostetomic sleeve.
Fig. 1d_Modified extender to fit the osteotomy sleeve—any hand-free surgical kit will work.

_Accuracy in guided implantology is an issue. The ability to perform implant placement both safely and correctly, in order to load a pre-surgical CAD/CAM bar or cementable metal final framework prosthesis and to digitise the entire procedure, is widely researched. Accuracy is a value also in a classical II-stage protocol and respecting hard and soft tissues for long-term implant site stability.

There is an ongoing debate amongst clinicians regarding which is the best available system. Vercruyssen summarises this debate.[1] The article reviews only some of the published articles on this topic. All of these articles emphasise the error margins and that they can be considered clinically more or less acceptable, and determine accuracy in implant placement by means of superimposition.

Fig. 1e_Bottle-neck.
Figs. 1f–h_Bottle-neck created.
Fig. 1i_Assembly while being screwed.

In mathematical terms, "precision" means the repeatability of a measurement, and "accuracy" refers to the correspondence of this measurement to the truth. In our field, accuracy has been considered the correspondence of the placed implant to the planning.

Fortin defines "accuracy" as an ideal, at present somewhat impractical, when considering a definitive prosthesis for immediate loading, with the present systems only offering predictable results (and as such only long-term reinforced provisionals will be available), but does not quantify a threshold.[2] According to Di Giacomo, at present a post-operative impression appears to be always necessary for immediate loading with a definitive prosthesis.[3] Guided implantology is far better than a free-hand


Fig. 1e


Fig. 1f


Fig. 1g


Fig. 1h

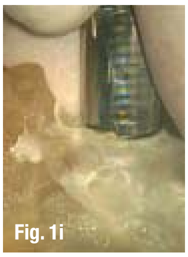
Fig. 1i

approach, however. A guard-rail-like guide is certainly better than nothing.

Many systems are available today, and from a theoretical perspective they have been categorised into semi-active and passive systems. The systems in the first category, whatever the technique used to make the surgical guide (STL or stone surgery), have metal smooth guiding sleeves, which the implant and the implant-driver must pass through, and the second systems, also called navigation systems, do not have any metal sleeves and the surgeon is guided by the monitor. In this category, the surgical handpiece is indexed to spatial markers inside a surgical guide that is inserted into the patient's mouth, but not in the surgical area. These spatial co-ordinates are viewed by an infra-red system, which transfers data to the computer, allowing the clinician to follow the surgical steps on the monitor. Alarm lights and sounds will warn the clinician of deviations from the desired position.

I propose a new definition of a passive system: a passive system must allow any operators (i.e. it must be operator independent) to achieve the same, repeatable results at an acceptable inaccuracy threshold.[4] The accepted inaccuracy must allow clinicians to obtain a good metal-to-metal fit without placing tension on the implants. This "to what extent" predictability can determine the reliability of treatment. In fact, in fixed prostheses on natural teeth, passivity (at an acceptable gap) is about 40 to 50 µ in the arch; the same values could be considered acceptable for prostheses on implants. According to this definition, none of the systems on the market has replicable results, and have metal or virtual smooth sleeves. They must thus be considered metal or virtual smooth semi-active systems.

I have developed a new device according to the mathematical concepts of thread timing and implant phase, which can be applied to the implant movement while being screwed, thus allowing clinicians passivity during implant placement. In the future, owing to the predictability of implant placement, the proposed device could be fundamental to achieving the desired goals in computer-guided implantology.

_Materials and methods

The implants were placed using the bottle-neck-like device, which begins implant rotation before it can touch the bone, thereby avoiding bone interference with implant movement owing to bone density gradients ("bone guidance"). The prototype of the device (Fig. 1a) consists of:

_an internally threaded sleeve ("embedded sleeve", with a "helical gear" feature at its top that is useful during implant placement; Fig. 1b);
_an externally threaded sleeve ("osteotomy sleeve"), which has to be inserted into the embedded sleeve and serves as a regular sleeve for the osteotomy drills (because it is internally smooth; Fig. 1c);
_a modified extender for drills (Fig. 1d);
_an externally threaded sleeve, longer than the osteotomy sleeve, that acts as a "bottle-neck" and

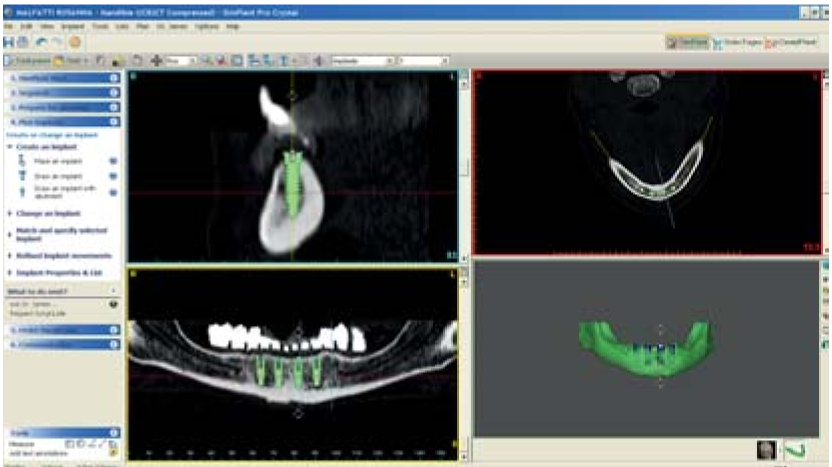

Fig. 2

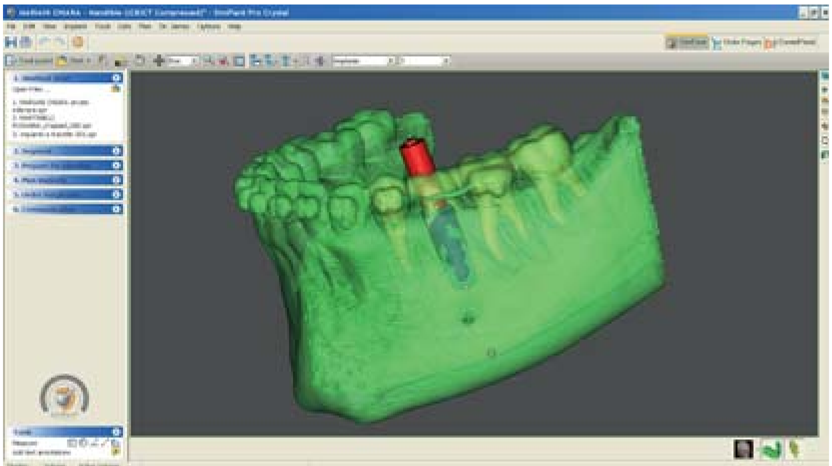

Fig. 3a

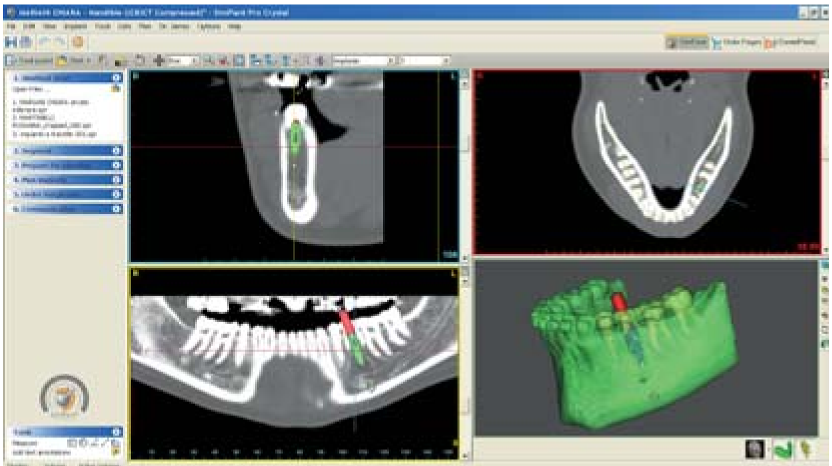

Fig. 3b

Fig. 2_Surgery planning for the STL case.
Figs. 3a & b_Surgery planning for the stone case.


Fig. 4

Fig. 5

Fig. 6

Fig. 4_Analogues in the STL model.
Figs. 5 & 6_Surgical guide created for stone surgery.

Figs. 7a & b_Assembly.
Fig. 7c_Assembly in the stone-based surgical guide.
Fig. 7d_Assembly in the STL-based surgical guide.
Fig. 8a_Surgical guide in the mouth.
Fig. 8b_Surgical guide in the mouth, showing the helical gear in particular.

is screwed into it (Fig. 1e); and
_the "bottle-plug", which is screwed onto the bottle-neck (Figs. 1f–h).

For the osteotomy, I used a regular surgical kit, not a dedicated one to precision, just modifying a plain extender to fit any osteotomy surgical kits (general and not guided surgical kits). The extender should match up with the sleeve before the drill touches the bone. The prototype was realised with no endo-stop features in the extender; only lines indicate depth.


Fig. 7a


Fig. 7b


Fig. 7c


Fig. 7d


Fig. 8a

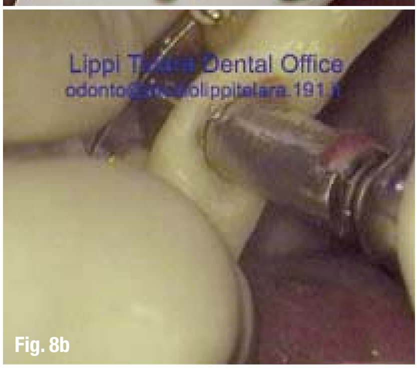
Fig. 8b

The bottom end of the bottle-plug is provided with a helical gear (to match up with the corresponding embedded sleeve's helical gear; Fig. 1i). The bottle-plug in the prototype device consists of two components, the cylindrical screwed part and the lid, and they are fastened together with a joint. The lid is integrated into the implant mounting component; thus, while the bottle-plug is being screwed onto the neck, the implant mount is entering inside the bottle-neck, forcing the implant downwards.

The implant mount has a hollow to allow for an implant fastening screw (the same as used to fix implants and abutments, just longer, to allow for minimal screwdriver length, when it is necessary to unfasten the components at the end). The mount also has a gauge for a wrench at its top (but it can work for a handpiece driver as well). Once implant placement has been carried out, the mount can be unscrewed from the implant and vertically unfastened from the bottle-plug. At this point, the surgical guide can be removed easily, with no risk of hex undercuts.

The device must resist the vertical dislodging torque created when screwing the implant into the bone. A screwed bottle-neck performs well for this purpose and the lid must be fastened to the vertical part of the bottle-plug.

SimPlant Pro Crystal (Materialise Dental) was used only to plan the implant position (Figs. 2–3a & b), but instead of using a surgical guide, a STL digital cast with analogue implant holes for placing analogues was used in the first case reported (Fig. 4). A plain stone model with a (presumably) correct analogue position was used for the second case reported (Fig. 5). In both cases, the analogues were, screwed to the device, and then the device was secured to a bite-like thing (using plain relining resin for the provisionals) to obtain a surgical guide (no surgical guide fixation to the bone was considered; Fig. 6).

No guided tapping drill was used. This is something that should be considered, especially in high

Fig. 9a Fig. 9b Fig. 9c

Figs. 9a & b_Jig created in the mouth for the STL case.
Fig. 9c_Jig verified against the model in the STL case.

density bone. It could imitate the implant, with sharp threads and narrow body, to be screwed to the bottle-plug, or a bottle-plug dedicated to the tapping step, with the tapping part integral to the bottle-plug itself.

In both clinical cases, the device was assembled chairside to allow for minimal vertical clearance (Figs. 7a–d). A base-plate resin was then used to create jigs to check accuracy between the models and the mouth.

_Results

The case results were satisfactory. The device was easy to use (Figs. 8a & b) and jig correspondence between the abutments screwed on the analogue models and the clinical implant positions was obtained.

For the STL case, four abutments were modelled on the STL model, the resin jig was created directly in the mouth, and then its correspondence to the same abutments was checked on the STL model (Figs. 9a–c). For the stone case, a transfer was screwed onto the analogue, the resin jig was created, and then its correspondence was clinically checked (Figs. 10a & b).

_Discussion

The present systems do not offer sufficient and reliable accuracy because they do not consider the concepts of thread timing and implant phase. Their weak point is the smooth sleeve (whether metal or virtual), which does not have any control over the mechanics of a screw, which an implant is. Shooting a bullet makes sense, but shooting a screw does NOT.

Smooth sleeve-dependent inaccuracy

The first element to be considered is the gap between the implant mount and the sleeve. A twisting implant apex is the natural effect. When the implant is guided by a smooth sleeve, the position in the arch will be correct only if the implant mount does not ever touch the sleeve during the process, but when the dentist is working there will always be contact, which will results in an error in B-L and M-V position. This is what I call the "position paradox effect" of a guiding smooth sleeve (similar to a guard-rail).

Since the sleeve has a top and a bottom plane, this paradox effect is reproduced in both these two planes, and an axis deviation is a natural consequence (what I call the "axis paradox effect of a smooth sleeve"). The gap affects position and axis: these parameters go hand in hand. Depending on the gap entity, it is possible to calculate the implant apex twisting entity, using simple proportionality (Fig. 11a). At a 20 mm depth from the top of the sleeve (approximately 13 mm below the ridge), the linear deviation will be 0.8 mm (1.6 mm on the diameter that is the possible implant apex twisting entity). Trigonometry is an easy way to calculate the deviation angle of the implant axis (sine/cosine and tan/cot rules). If the gap is 0.1 mm (0.2 on the diameter), the axis deviation will be a deviation of 2° 20' (Figs. 11b–d).

Tapered implants can engage bone at an even greater angle, particularly if the driver is conical at its first part. Consequently, it will work only at the end of the implant placement phase. According to the previous considerations, I suggest that it does not work efficiently. This cone-shaped driver limits too large an insertion torque because it may be damaging; however, the larger the axis deviation, the

Fig. 10a_Jig created on the stone model in the stone case.
Fig. 10b_Jig verified in the mouth in the stone case.

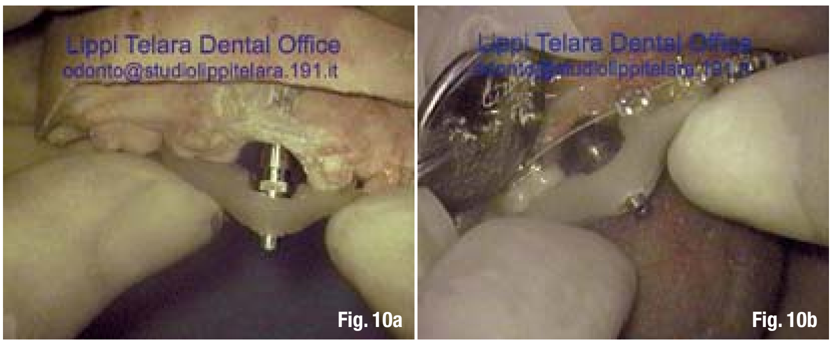

Fig. 10a Fig. 10b