Single molar restoration: Wide implant versus two conventional

Authors: Prof. Amr Abdel Azim, Dr Amamli M. Zaki & Dr Mohamed I. Al-Anwar, Egypt

The single-tooth restoration has become one of the most widely used procedures in implant dentistry. In the posterior region of the oral cavity, bone volume and density are often compromised. Occlusal forces are greater in this region, and with or without parafunctional habits, can easily compromise the stability of the restorations (Fig. 1).1

The single-molar implant-supported restoration has historically presented a challenge in terms of form and function. The mesiodistal dimensions of a molar exceed that of most standard implants (3.75 to 4.0 mm), creating the possibility of functional overload resulting in the failure of the retaining components or the failure of the implant (Figs. 2 & 3).2,3 Wider-diameter implants have a genuine use in smaller molar spaces (8.0 to 11.0 mm) with a crestal width greater than or equal to 8 mm (Fig. 4 a). Clinical parameters governing the proposed restoration should be carefully assessed in light of the availability of implants and components, as they provide a myriad of options in diameter, platform configurations and prosthetic connections. Many of the newer systems for these restorations are showing promising results in recent clinical trials.4,5 It has further been suggested by Davarpanah and others,6 Balshi and others,4 English and others7 and Bahat and Handelsman8 that the use of multiple implants may be the ideal solution for single-molar implant restorations (Figs. 4 b & c).

Most standard implants and their associated prosthetic components, when used to support a double implant molar restoration, will not fit in the space occupied by a molar unless the space has been enlarged (12 mm or larger).9 Moscovitch suggests that the concept of using 2 implants requires the availability of a strong and stable implant having a minimum diameter of 3.5 mm. Additionally, the associated prosthetic components should ideally not exceed this dimension.10

Finite element analysis (FEA) is an engineering method that allows investigators to assess stresses and strains within a solid body.11,12 FEA provides calculation ofstresses and deformations of each element alone and the net of all elements. A finite element model is created by breaking a solid object into a number of discrete elements that are connected at common nodal points. Each element is assigned appropriate material properties that correspond to the properties of the structure to be modeled. Boundary conditions are applied to the model to simulate interactions with the environment.13 This model allows simulated force application to specific points in the system, and it provides the resultant forces in the surrounding structures. FEA is particularly useful in the evaluation of dental prostheses supported by implants.14,15 Two models were subjected to FEA study to compare between a wide implant restoration versus the two implant restoration of lower first molar.

Material and Methods

Three different parts were modeled to simulate the studied cases; the jaw bone, implant/abutment assembly, and crown. Two of these parts (jaw bone and implant/abutment) were drawn in three dimensions by commercial general purpose CAD/CAM software “AutoDesk Inventor” version 8.0. These parts are regular, symmetric, and its dimensions can be simply measured with full details.

On the other hand, crown is too complicated in its geometry therefore it was not possible to draw it in three dimensions with sufficient accuracy. Crown was modeled by using three-dimensional, scalar, Roland MDX-15, to produce cloud of points or triangulations to be trimmed before using in any other application.

The second phase of difficulty might appear for solving the engineering problem, is importing different materials.3 Therefore set of packages deal with parts as shells and connective bones respectively. No critical difference can be noticed on these parts of the system. Generally a crown placed on two implants is weaker than the same crown placed on one implant. This fact is directly reflected on porcelain coating and the least to shear stresses16,17 so considering the difference in compressive stresses less significant, the two implants were found to have a better effect on spongy bone. Contrarily, Figures 6 a & b, showed better performance with cortical bone in case of using one wide implant over using two implants, that, deformations and failures of the retaining components are applied to the model to stimulate interactions with the environment.14

Figure 1: Load distribution during mastication shows marked increase in the molar and premolar area.

Figure 2: Occlusal view showing a missing first molar: The mesio-distal width is very wide and restoration couldn’t compensate it leaving a space distally.

Figure 3: Proximal Contacts shown radiographic view of distal right first molar on standard Brånemark implant with standard abutment (Nobel Biocare).

Figure 4 A: Radiographic view of wide implants used to restore missing lower first molars.

Figure 4 B: Buccal view of 2 standard 20-degree abutments on 3.5 mm Antra Tech implants for restoration of mandible right first molar.

Figure 4 C: Radiographic view of the restoration.

Figure 5: Crown, implants and bone assembled in a model (FEA software) using in any other application.

Figure 6 A & B: Von Mises stress on crown (A) wide implants; (B) two implants.

Table 1: Table 1: Property of materials.

<table>
<thead>
<tr>
<th>Material</th>
<th>Poisson’s ratio</th>
<th>Young’s modulus MPa</th>
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</thead>
<tbody>
<tr>
<td>Coating (Porcelain)</td>
<td>0.3</td>
<td>67,200</td>
</tr>
<tr>
<td>Restoration (Gold)</td>
<td>0.3</td>
<td>96,000</td>
</tr>
<tr>
<td>Implants (Titanium)</td>
<td>0.35</td>
<td>110,000</td>
</tr>
<tr>
<td>Spongy bone</td>
<td>0.3</td>
<td>150</td>
</tr>
<tr>
<td>Cortical bone</td>
<td>0.26</td>
<td>1,500</td>
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</table>

Table 2: Table 2: Results.

<table>
<thead>
<tr>
<th></th>
<th>Porcelain coating (MPa)</th>
<th>Gold crown</th>
<th>Implants</th>
<th>Spongy bone</th>
<th>Cortical bone</th>
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</thead>
<tbody>
<tr>
<td>Max. stress (MPa)</td>
<td>31.59 -179.99 -179.99</td>
<td>6.72</td>
<td>5.96</td>
<td>-37.17</td>
<td></td>
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<tr>
<td>Strain (1000)</td>
<td>0.71 -33.44 -310.74</td>
<td>-11.24</td>
<td>-70.43</td>
<td>-15.82</td>
<td></td>
</tr>
<tr>
<td>Fatigue limit</td>
<td>-1.26 -108.06 -106.86</td>
<td>-4.75</td>
<td>-31.82</td>
<td>-39.17</td>
<td></td>
</tr>
</tbody>
</table>

Results and Discussion

Results of FEA showed a lot of details about stresses and deformations in all parts of the two models under the scope of this study. Figures 6 a & b showed a graphical comparison between the crowns of the two models which are safe under this range of stresses (porcelain coating, gold crown, and implants showed the same ranges of safety). No critical difference can be noticed on these parts of the system. All differences might be found are due to differences in supporting points and each part volume to absorb load energy (equation 2).**

Generally a crown placed on two implants is weaker than the same crown placed on one implant. This fact is directly reflected on porcelain coating and the least to shear stresses,16,17 so considering the difference in compressive stresses less significant, the two implants were found to have a better effect on spongy bone. Contrarily, Figures 6 a & b, showed better performance with cortical bone in case of using one wide implant over using two implants, that, deformations...
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The most important years in implantology

A personal retrospective

Author: Dr Georg Bach, Germany

_Introduction_

It all started with an inquiry from a well-known professional journal of implantology asking for a contribution to acknowledge their having been in business for fifteen years. This was the incidental telephone call by an academic teacher who had accompanied and supported me in my first steps in implantology. When I asked him about the upcoming publication project, I received a both spontaneous and surprising reply. “The last 15 years—those were the most important years in implantology!” This from a renowned university professor who was instrumental in establishing implantology—I was impressed. Later on I had to ask myself, “Is this really true?” The result of my tracing this development is this article—a personal retrospective.

_Phases of implantology_

If one considers oral implantology with regard to its major developments, three phases are evident: (i) the empirical and experimental phase; (ii) the arrival of implantology in universities and science: (iii) the mass phenomenon of implantology. I would like to add that this is a rough and probably superficial division to some extent. Phase, however, of course, may apply it within the scope of this personal—and not exhaustive—review.

Looking back at these past fifteen years, I will barely touch on phase II, but will discuss phase III fully. This email’s different directions and priority areas that colleagues working in implantology experienced. When I browsed through implantology text-books and journals from this period, I realised even more that implantology had undergone considerable change in this relatively short period of 15 years. I would like to recount my highlights of implantology from this period in the following paragraphs.

_Farewell to the tristesse of papers_

A seemingly minor issue to start with: the variety and quality of dentistry-specific print media and of digital media, particularly print layout, has developed substantially during the past 15 years. This holds true not only for implantology, but also for dentistry as a whole. The appearance of some professional journals up until the mid-1990s was reminiscent of an official legal amendment, but amazing things have happened since. The quality of colour printing (which is the norm now, but used to be very rare), the page layout for authors who wanted to include colour images), the accuracy of images, the paper—all of these can make a high quality appearance and leave a lasting impression on the reader. This has clearly been an advantage also for implantology because now highly complex correlations can be more easily conveyed and “sometimes a picture is worth a thousand words”. Ideally, e-learning and electronic professional journals supplement the current training needs of the younger generation of dentists especially.

_The end of dogmas_

While implantology was marked by many dogmas from its beginning and the mid-1990s, this had changed at the time when our 15-year observation period begins. However, implantology was later called into question in its entirety. Whether it was healing times, waiting times after augmentation or prosthestic concepts—everything underwent scrutiny. On the one hand, some of these dogmas did in fact prove to be no longer sustainable because of remarkable developments, especially improvements in implant surfaces. On the other hand, the mark was at times overlooked in the elimination of other dogmas, creating the need to backtrack. This was a painful experience for both patients and implantologists.

One dogma that we encountered in the observation period was that of a strict refusal of immediate implant placement. There is general consensus today, however, that under suitable conditions an immediate implant placement can be a high quality and sustainable alternative to established procedures. One clinical case shows an immediate implant placement in the maxillary anterior teeth: the extraction and the immediate implant placement of a maxillary anterior tooth that was not worth preserving under the guidance of a drilling template and implant position (Fig. 1), transfer into the oral cavity (Fig. 2), and the condition immediately after insertion of the implant crown (Fig. 3).

_The prospering of the implant market_

A welcome variety of new implants, implant forms and prosthetic options has become a reality in the past 15 years. Special implants were developed for special indications so that now even a mandibular molar can be replaced by a corresponding sized implant, followed by insertion of a corresponding sized implant crown. Figures 4 to 7 show the clinical and dental appearance of these in a patient. Implantologists who placed several hundred implants annually were considered the big players on the implant market in the 1990s. Achieving the mark of 100,000 implants placed per year in Germany signified that the peak had been reached. This was not the case, since the one-million mark was also reached within the scope of a rapid, almost unimpeded development. While the increase has been slower in recent years and global economic developments even caused a brief decline, today we can assume that the implant market will continue to grow.

The maximum growth phase falls into our observed period.

_Development in the eyes of implant manufacturers_

From manufacturer to global player—this would be an accurate description of the development of some implant manufacturers. The development of some of these companies over the past 15 years, the size of their companies and the number of their employees today are indeed impressive. And these prosperous companies share other characteristics as well: the acquisition of products and entire firms in order to expand or supplement their product port-folio and their pressing on to the field of digital dental (CAD/CAM, planning, etc.), into which these global players invest large sums of money. Revenues must be generated so that these investments can be made—and they are still made, albeit declining owing to the economic crisis.

Still, the implant market is booming. Although the consistently two-digit annual growth rates some implant manufacturers had started to become used to have become more moderate today, a great deal of money can be made with implants. As a result, an ever-increasing number of implant suppliers and systems make it impossible for the individual user to keep track. Aside from new systems, an increasing number of generics are being launched on the market.

_Focus on red-white aesthetics_

The President of the German Society for Dental Implantology (Deutsche Gesellschaft für Zahnärztliche Implantologie), Prof. Frank Palm, aptly remarked, “What was celebrated as a triumph for some colleagues 20 years ago is today taken for granted.” Dentists today are not prepared to find themselves confronted with a debate that had spread from North America to Europe: that of red-white aesthetics. This new focus on achieving the highest possible aesthetics for implant-prosthetic treatment was linked to implantology and distanced itself from surgery, which had been dominant up until that time.

In the early phase of implantology, the main focus was on safe placement and the best possible placement in the bone, sometimes even at the expense of subsequent prostheses treatment owing to unfavourable design of the artificial abutment teeth. Now, however, prosthetic standards and issues have become the centre of the discussion. Current techniques were modified and new techniques were established in order to satisfy these requirements. Patients no longer, or at least less, want to accept suboptimal and complex cases like the following case.

Both implants in the anterior maxillary region were placed too far buccally, and there was a gap of 5.5 mm between the implant shoulder and the cemento-enamel junction of the adjacent teeth (Figs. 8–10). Treatment with a long-term temporary restoration would only have yielded an unsatisfactory aesthetic result. However, under certain surgical and dental conditions—as shown in our second example—superior results and stability for a period of ten years can be achieved even with challenging initial situations. In 1999, an immediate implant was placed in region 12. The following images show the steps of treatment (Figs. 11–13). The last image shows the condition after ten years (Fig. 14).

This development was made possible mainly by massive improvements in the area of augmentations, which can now be performed with significantly higher predictability. This development was further enhanced by a considerable improvement in the training of implantologists. These improvements are significant for both undergraduate study and postgraduate training. Thus, the training of dental and professional associations who have contributed immensely in this area deserve much credit in this respect.

The battle of healing times

It was but an episode, yet one that caused an incredible favor at the time: the debate about shortened healing times. Stimulated by a media hype in which the specialised press only played second fiddle and the lay press
appeared to be in the lead, the healing times and the implant manufacturers were inflated. Values were corrected downwards almost on a daily basis. Some manufacturers went along with it, while others resisted from the start. Some participants felt they needed to be at the forefront, others stayed out of it. A short but remarkable ascent was followed by a rapid crash.

A personal highlight for me was an article in a tabloid newspaper that said the morning directly followed by augmentation and implantation—a firmly seated supra-construction implemented at lunchtime. "It has been agreed upon. As can be seen from this euphoric statement, some got carried away, while others had to painfully back-track. What remains is the realisation that, owing to improved surfaces and other conditions, the long healing times recommended in the early phase of implantology can in fact be reduced considerably, but not at any cost.

**New options for improving the implant site**

The afore-mentioned dominance of prosthetic implantology was only possible because many new and safer augmentation procedures were established during the observation period, enabling dentists to design the overall plan for the implant as desired. Revolutionary augmentation procedures in the area of the maxillary posterior teeth, which had been the focus of discussions, achieved good results. The treatment of simple cases usually does not require the use of these techniques. In fact, they should not be used in such cases owing to the radiation exposure when obtaining 3-D data.

**Of promises and realities**

Themes of the congresses during the first decade of the observation period contained generally positive statements and depicted new opportunities in implantology, which exceeded the then current options by far and expressed an idea in boundless growth. This coincided with many positive statements and evaluations by implant manufactures and distributors. However, all this changed considerably during the past five years.

Suddenly, new topics were given priority, which shaped specialists’ conventions—topics that had previously been partially suppressed or not neglected. I remember only too well the implant congress held by a very important American implant manufacturer in Frankfurt/Main in 1998, where I reported on a concept for the treatment of peri-implantitis developed at the University of Freiburg and was then rebuked by the main speaker, who was from the USA, during the ensuing panel discussion. He asserted that he had "not seen one case of peri-implantitis in twenty years of implantology"—this phenomenon does not even exist. If it occurs, it can only be attributed to a lack in skill on the part of the implantologists.”

How times have changed. However, trouble-shooting and complications in implantology and even the word "failure" have been mentioned in the themes of many congresses held by leading professionals of implantology in the past years.

**Patients’ expectations**

While a consistently positive and at times even euphoric tone prevailed regarding the topic of implants for many years, a few critical voices and later increasing criticism emerged at the beginning of the observation period. This was—concurrent with a noticeable increase in the number of implants—based on the considerable increase in implantology failures and complications. The following images depict total implantological failure—the loss of a purely implantoperiodontal complete maxillary restoration caused by an infant peri-implantitis (Figs. 15–17), leaving profound osseous defects.

However, in line with the consistently positive evaluation of implants and the persisting promise that the use of implants would yield optimum results always—and often publicised by the lay press—our patients’ expectations have increased considerably in the past 15 years. Patients assumed that, regardless of the individual situation, he or she would always receive the optimum results. In this regard, it seems reasonable to maintain a self-critical attitude and to concede that we do not always contradict this general assumption vehemently enough.

And then what was bound to happen, happened at times, the result was not what the patient had expected. An awkward situation arises when the dentist, based on the initial diagnosis, considers the result to be successful and the patient considers it a failure. A long-time legal expert sums up this situation accurately by stating that, “Two-thirds of all pending court proceedings were filed by patients whose expectations were disappointed.” Rather unfortunately, the increasing number of court proceedings are mostly related to implantology. It cannot be of chance that the premiums for mandatory professional liability insurance have increased considerably.

**Emerging criticism**

German periodontists Dr Thomas Kocher referred to implantology as "the red light district of dentistry”. Whether this evaluation is justified is a matter to be decided individually. Personally, I do not agree with this evaluation, but a grain of truth might be found in its reference to overtreatment. In this regard, the extraction of teeth in favour of implants, even when not indicated, is a concern voiced increasingly by periodontists and those in favour of conservative treatment. We have to address this issue by individual evaluation of each patient, as well as through academic discussion. Implant versus tooth preservation has been a frequent debate at conventions and implant symposia in recent years. In my opinion, this would not have been possible ten years ago.

**Trouble-shooting concepts**

Unexpected complications, such as implant fracture and failure of implant supra-structure connections (Figs. 18–21), necessitated the development of surgical and prosthetic trouble-shooting concepts and modification of constructions in implant and abutment design. However, these new concepts were not ready available and have not yet been finally agreed upon. In other words, they cannot be said to be common knowledge in implantology, at least not in the treatment of peri-implantitis. Similar statements can be made with regard to pre-implantation arguments, where a pleasing variety of surgical techniques and materials is listed, but no generally valid scheme has been agreed upon.

**The fact that need to develop and convey these trouble-shooting concepts is generally recognised today and that these concepts are yet widely supported by the practitioners on the implant market is gratifying. The specialist press has made a valuable contribution.**

**Digital implantology**

I consider the establishment of 3-D diagnostic imaging, with all associated possibilities, to be the significant development during the 15-year observation period. It is true that only implantologists used the new 3-D technology during the initial phase of dental volume tomography (because they made up the group of dentists who could actually afford this expensive equipment); nevertheless, 3-D technology constituted a quantum leap for dental diagnostic imaging as a whole.

Today, we have almost unbelievable possibilities at our disposal that even the greatest optimists would not have considered possible 15 years ago: highly complex patient cases can now receive minimally invasive treatment and implant planning placed even without the need for augmentation.

Our first case shows a highly anticipated mandible in which four implants could be placed without any prior augmentation owing to 3-D data and planning (Figs. 22–24). Three-dimensional diagnostics are sometimes also employed to clarify facts when complications have arisen, for example neural lesions after implantation (Figs. 25 & 26) and bone necrosis after administration of bisphosphonates, and erroneously diagnosed as peri-implantitis (Fig. 27).

**My personal conclusions**

It is difficult to draw a conclusion regarding the development of implantology, which has not improved over the past 15 years because it has been so multifaceted and rapid. To conclude, I would therefore like to quote my academic teacher and former supervisor, Prof. Wilfried Schilli, who, as a founding member of the International Team for Implantology, was undoubtedly among the pioneers of implantology and has contributed to improving implantology through his university work. “Who would have thought that implantology could develop like it did in less than twenty years.”

This very true statement encompasses many aspects: the admiration and appreciation of what has been achieved, the satisfaction with having contributed to the improvement of implantology—a thought that was not so—numerous articles that received a great deal of attention during the past 15 years are those that dealt with implantology and implant-prosthetic trouble-shooting.

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Fabrication of a customised implant abutment using CAD/CAM: A solution specific to each clinical case

Author: Dr. Thierry Lachkar, France

...The multiplicity and sophistication of the offering in the field of prosthetic elements in implantology allow the practitioner to make a choice appropriate to the clinical particularities of each case. If the practitioner chooses a standard implant abutment, the dental technician will have to make adjustments, which implies considerable losses in precision and time. Moreover, with such abutments it is difficult to create an anatomical emergence profile because it cannot be modified and the base of the abutment cannot be changed. This observation is equally applicable to the angulation, which might even be selected by default.

A customised abutment created with CAD/CAM is the most accurate and simplest solution for an optimal result. The abutment is individually designed in order to ensure the homothety of the thickness of the materials and therefore the overall strength of the prosthesis. The dental technician has in this case maximum freedom in terms of design in order to create an abutment with the optimum emergence profile and angulation. In this manner, the abutment is specifically designed and fabricated for each patient.

Titanium has been established in dental implantology as the reference material owing to its biomechanical properties and its biocompatibility. Today, we are able to benefit from over 40 years of clinical and experimental experience in implantology. Customised abutments can be fabricated from titanium, zirconia or hybrid materials, such as a combination of titanium and zirconia, which in certain clinical circumstances improves the aesthetics of the visible areas while respecting the requirements of biocompatibility and bio-mechanics.

...Seating a four-unit bridge on three anatomical implant abutments

Clinical case

A 40-year-old male patient presented for treatment. He had no particular medical conditions or any contraindications concerning the placement of implants. In 2009, the patient had undergone a sinus lift (an increase of the maxillary bone volume and the displacement of the sinus membrane to ensure implant success by increasing the height of the available bone) at a hospital prior to the placement of implants to replace teeth 15–25. Owing to the constraints related to the angulation of the implants in regions 23–25, the extraction of tooth 26, and seating of a four-unit bridge as the final prosthetic solution. As the height of the available bone around tooth 26 was insufficient, I would not place an implant in that area but a tooth extension (a sinus lift would otherwise have been essential). The treatment plan was accepted by the patient two weeks later, and teeth 23 and 25 were extracted at the end of January 2012 for implant placement: two implants (NobelReplace RP, Nobel Biocare) with a diameter of 4.5 mm and a length of 13 mm for regions 23 and 24, and one implant (NobelReplace WP) with a diameter of 5 mm and a length of 10 mm for region 25. Tooth 26 was extracted on the same day without placement of an implant as already mentioned.

In May 2012, implant-level impressions were taken (open-tray impression technique), and a stone model was recorded using silicone and a bite tray. Owing to the constraints related to the angulation of the implants in regions 24 and 25, I opted for titanium abutments. The angle of the implant in region 23 allowed for the insertion of a titanium–zirconia abutment for good gingival grip and a better aesthetic result.

Ten days later, two titanium abutments (ANA. T, Laboratoire Dentaire Crown Ceram) and one titanium–zirconia abutment (ANA. TZ, Laboratoire Dentaire Crown Ceram) were screwed onto the implants at a torque of 35 N, and sealed with composite.

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A 40-year-old male patient presented for treatment. He had no particular medical conditions or any contraindications concerning the placement of implants. In 2009, the patient had undergone a sinus lift (an increase of the maxillary bone volume and the displacement of the sinus membrane to ensure implant success by increasing the height of the available bone) at a hospital prior to the placement of implants to replace teeth 15–25. Owing to the constraints related to the angulation of the implants in regions 23–25, the extraction of tooth 26, and seating of a four-unit bridge as the final prosthetic solution. As the height of the available bone around tooth 26 was insufficient, I would not place an implant in that area but a tooth extension (a sinus lift would otherwise have been essential). The treatment plan was accepted by the patient two weeks later, and teeth 23 and 25 were extracted at the end of January 2012 for implant placement: two implants (NobelReplace RP, Nobel Biocare) with a diameter of 4.5 mm and a length of 13 mm for regions 23 and 24, and one implant (NobelReplace WP) with a diameter of 5 mm and a length of 10 mm for region 25. Tooth 26 was extracted on the same day without placement of an implant as already mentioned.

In May 2012, implant-level impressions were taken (open-tray impression technique), and a stone model was recorded using silicone and a bite tray. Owing to the constraints related to the angulation of the implants in regions 24 and 25, I opted for titanium abutments. The angle of the implant in region 23 allowed for the insertion of a titanium–zirconia abutment for good gingival grip and a better aesthetic result.

Ten days later, two titanium abutments (ANA. T, Laboratoire Dentaire Crown Ceram) and one titanium–zirconia abutment (ANA. TZ, Laboratoire Dentaire Crown Ceram) were screwed onto the implants at a torque of 35 N, and sealed with composite. An adjustment check of the contact points and of the occlusion was performed, followed by cementation of a ceramic bridge with a zirconia framework. A follow-up visit took place three days later.

Technique

For this case, it was possible to use abutments made from different materials according to the angulation of the implant: titanium for the greater accuracy can be achieved. In addition, only two appointments are necessary: one for impression taking and another for seating of the bridge.
Guided implant surgical placement with CAD/CAM CEREC crown

Author, Dr Nilesh Parmar, UK

Guided surgery has been around for a long time. However, very few dentists in the United Kingdom place implants using surgical guides. The reasons for this are multiple, ranging from dentists not wanting to follow the procedure, or not having confidence in the procedure, the increased costs of guide fabrication, and the time delay and extra appointments needed to obtain a fully functional and reliable surgical guide.

In this case report, I shall demonstrate a surgical guide manufactured in-house using the CEREC Bluecam (Sirona). These guides do not require any impressions to be sent to a third party and can be made rather cheaply in the surgery within 30 minutes. The guide can then be used in conjunction with specific drill keys, which are compatible with the guided surgery drill sets from all leading implant manufacturers.

In this particular case, Facilitate (Astra Tech/DENTSPLY Implants) was used to place the implant. Once the implant was osseointegrated, the final restoration was fabricated chairside using the CEREC MC XL milling machine (Sirona) and an IPS e.max CAD block (Ivoclar Vivadent).

Figure 1: Reference body with CEREC Guide mill block.

Figure 2: Thermoplastice warmed in hot water and placed over the working model.

Figure 3: Reference body and thermoplastic surgical guide.

Figure 4: Reference body and thermoplastic guide in-situ prior to CBCT scan.

Figure 5: CBCT with reference body and CEREC proposal overlay.

Figure 6: CEREC Guide in-situ.

Figure 7: AstraTech (DENTSPLY Implants) fixture biopsy punch used through CEREC Guide.

Figure 8: Soft tissue removed.

Figure 9: Directional indicator to assess osteotomy position.

Figure 10: Implant placement.

Figure 11A: Placement of a 4 mm healing abutment at stage 1.

Figure 11B: Post-op RTG view.

Figure 12: Fixture level open-tray impression.

Figure 13: Standard abutment with 3 mm of occlusal clearance.

Figure 14: Soft tissue profile after two months healing.

Figure 15: CEREC image of the abutment.

Figure 16: CEREC image of final restoration.

Figure 17: CEREC image of the block.

Figure 18: Screw retained E-max crown.

Figure 19: Milled E-max CAD/CAM crown with screw hole.

Figure 20: Screw retained E-max crown.

Figure 21 & 22: Final restoration in-situ.

Figure 23: CEREC image of final restoration.

Case report

A young female patient had lost tooth 36 a few years ago and wanted an implant solution. Her medical history was clear and she had a mildly restored dentition with no current dental pathology. Her BPE scores were low, with excellent oral hygiene.

The patient was scanned using the CEREC Bluecam and a proposal for the missing tooth was created. A cephalometric CBCT scan of the lower jaw was taken using GALILEOS (Sirona) with a CEREC Guide reference body set in thermoplastic over the edentulous area. The reference body is identified by the software and the edentulous area is prepared in accordance with a standard sterile protocol and the area anaesthetised as one would for a regular implant placement. The surgical guide snaps firmly over the existing teeth, expanding over-and-undercuts, becoming a very stable platform through which to drill. The Facilitate soft-tissue punch was used to remove the overlying soft tissue, and a standard drilling protocol using the Sirona drill keys was followed.

The patient healed with no pain, no swelling and no discomfort. The post-operative long-cone periapical radiograph corresponded well with the preoperative planning with an ideal angulation for a screw-retained crown. After two months of healing, a fixture-level open-tray impression was taken and cast up using an Astra Tech replica. A standard metal abutment was prepared in accordance with a standard sterile protocol and the area anaesthetised as one would for a regular implant placement. The surgical guide snaps firmly over the existing teeth, expanding over-and-undercuts, becoming a very stable platform through which to drill. The Facilitate soft-tissue punch was used to remove the overlying soft tissue, and a standard drilling protocol using the Sirona drill keys was followed.

A high primary stability of 40 Ncm was obtained and a 4 mm healing abutment was placed immediately. The patient healed with no pain, no swelling and no discomfort. The post-operative long-cone periapical radiograph corresponded well with the preoperative planning with an ideal angulation for a screw-retained crown. After two months of healing, a fixture-level open-tray impression was taken and cast up using an Astra Tech replica. A standard metal abutment was prepared in accordance with a standard sterile protocol and the area anaesthetised as one would for a regular implant placement. The surgical guide snaps firmly over the existing teeth, expanding over-and-undercuts, becoming a very stable platform through which to drill. The Facilitate soft-tissue punch was used to remove the overlying soft tissue, and a standard drilling protocol using the Sirona drill keys was followed.

Once the implant position had been decided, the information was ported to the CEREC software and using a CEREC Guide Bloc a drill body was milled by the CEREC MC XL milling machine. Once this has been milled, it will lock tightly into the thermoplastic drilling template. At this point, the surgical guide is complete and can be used on the patient.

In this particular case, an Osseo-Speed TX implant (DENTSPLY Implants) (4.0 x 11 mm) was placed using the surgical guide. The patient was跟着 up using an Astra Tech replica. A standard metal abutment was prepared in accordance with a standard sterile protocol and the area anaesthetised as one would for a regular implant placement. The surgical guide snaps firmly over the existing teeth, expanding over-and-undercuts, becoming a very stable platform through which to drill. The Facilitate soft-tissue punch was used to remove the overlying soft tissue, and a standard drilling protocol using the Sirona drill keys was followed.

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In cortical bone are less by 20% while the stresses are less by about 40%. The stresses and displacements were significantly higher in the two implant model due to having two close holes, which results in weak area in-between.

**Conclusions**

This study showed various results between cortical and spongy bone. It was expected that the maximum stresses in the cortical bone was placed in the week area between the two implants. In addition to be higher than the case of using one wide implant. Although the middle part of spongy bone was stressed to the same level in the two cases, using two implants resulted in more volume of the spongy bone absorbed the load energy** which led to reduction of stress concentration and rate of stress deterioration by moving away from implants. This is considered better distribution of stresses from the mechanics point of view, which may result in longer lifetime. Porcelain coating showed a reduction in stress cases in two implants, longer life for the brittle coating material is expected. Contrarily more stresses were found on the gold crown placed on two implants due to its volume reduction (less material under the same load). This is clearly seen in increasing stresses on the two implants, that more load effect was transferred through the weak crown to the two implants. That showed maximum stresses in the area under the crown, while the wide implant showed maximum stresses at its tip. Looking to energy** absorption and stress concentration on whole system starting from coating to cortical and spongy bone, although the stress levels found was too low and far from cracking danger, the following conclusions can be pointed out; the total results favorise the two implants sussdesign and intermediate space can put this stress values in safe, acceptable, and controllable region under higher levels of loading. **

** The area under the _curve up to a given value of strain is the total mechanical energy per unit volume consumed by the material in straining it to that value (Fig. 9). This is easily shown as follows in equation 2:

\[
\text{Stress energy} = \int \text{area under stress strain curve.}
\]

**

**Summary**

Restoration of single molar using implants encounters many problems; mesio-distal cantilever due to very occlusal table is the most prominent. An increased occlusal force posteriorly worsens the problem and increases failures. To overcome the overload, the use of wide diameter implants or two regular sized implants were suggested. The aim of this study was to verify the best solution that has the best effect on alveolar bone under distributed vertical loading.

Therefore, a virtual experiment using Finite Element Analysis was done using ANSYS version 9. A simplified simulation of spongy and cortical bones of the jaw as two co-axial cylinders was utilized. Full detailed with high accuracy simulation for implant, crown, and coating was implemented. The comparison included different types of stresses and deformations of both wide implant and two regular implants under the same boundary conditions and load application.

The three main stresses compression, tensile, shear and the equivalent stresses in addition to the vertical deformity and the total deformities were considered in the comparison between the two models. The results were obtained as percentages using the wide implant as a reference. The spongy bone showed about 5% less stresses in the two implants model than the one wide diameter implant. The exceptions are the relatively increase in maximum compressive stresses and deformations of order 12 % and 0.3 % respectively.

The stresses and displacements on the cortical bone are higher in the two implant model due to having two close holes, which results in weak area in-between. The spongy bone response to the two implants was found to be better considering the stress distribution (energy absorbed by spongy bone**). Therefore, it was concluded that, using the wide diameter implant or two average ones as a solution depends on the case primarily. Provided that the available bone width is sufficient mesio-distally and buccolingually, the choice will depend on the type of bone. The harder D1 types having harder bone quality and thicker cortical plates are more convenient to the wide implant choice. The D1 types consist of more spongy and less cortical bone, are more suitable to the two implant solution.

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**Contact Info**

Dr Thierry Lachkar is a dental surgeon (Paris Diderot University) and has been a practitioner for 15 years. He is a general practitioner and he works at a dental surgery in Paris. He has specialist postgraduate training in conservative dentistry and endodontics. He can be contacted at thierry.lachkar@orange.fr.

**Editorial Note:** A complete list of references is available from the author.