The All-on-4™ protocol applied to the periodontally compromised terminal dentition: Part 1

The first in a series of 6 articles by Drs. John Moorhouse and Frances Trainer offering advice and guidance on this challenging technique

Managing a patient through the psychological and physical trauma of extractions and the provision of an immediate denture is a difficult and frequent challenge in the dental office. The advent of implants has increased patients’ options, with studs and bars to help retain loose dentures, or fixed implants to support bridgework. While the extent of bone loss from progressive periodontal disease in terminal dentition cases can pose problems in identifying potential implant sites, it is often possible to replace lost bone in suitable locations with cortical and sinus grafts. However, many patients do not have the financial resources or the inclination to undergo this type of surgery.

Even if patients consent, the periodontal pathology must be managed, extractions must still be achieved, and the immediate denture stages undergo. Patients must also suffer the embarrassment and inconvenience of not being able to wear their dentures after each surgical intervention. The All-on-4™ (Nobel Biocare™) approach overcomes these difficulties to provide “same-day” patient satisfaction.

This series of six articles offers experience-based advice and a tutorial on the application of the All-on-4™ technique, widely acknowledged to be a difficult procedure, to the replacement of the periodontally compromised terminal dentition, thus enabling an increased success rate and more predictable outcomes. We will introduce implant surgeons and technicians to the Lymn technique of registration using modified Nobel Biocare™ components.

The All-on-4™ protocol

The All-on-4™ protocol, developed by Paulo Maló, provides immediate, temporary, fixed bridgework for the edentulous mandible and edentulous maxilla, which is then converted to definitive bridgework after 6 to 12 months. The essential features of the protocol are maximizing the distal position of the posterior implants using angled implants and abutments to avoid the mental foramina and maxillary sinuses (Figures 1 and 2) and the immediate provision of a temporary acrylic bridge extending to the posterior implant without cantilever (Figures 3 and 4). This is replaced after 6 months by a definitive bridge with a metal framework to splint the implants and provide bilateral dentistry, and oral and maxillofacial surgery before moving into general dental practice. She gained her Fellowship in Dental Surgery from the Royal College of Surgeons of England in 1983. For the past 11 years, she has worked in a variety of dental practices and has been a regular attendee at postgraduate courses. She combines this with Macclesfield District General Hospital where she specializes in the treatment of the disabled patient and the extremely nervous patient. Dr. Trainer has chosen to keep her ties with the family dental practice and is thrilled to be working in the modern environment of Eagle Brow. Since January 2007, Dr. Trainer has been responsible for restoring implants placed at Eagle Brow.
distal cantilevers. A major advantage of this protocol is the facility to wear the temporary bridge again while the definitive bridge undergoes repair or restoration after several years of wear.

Studies have shown a success rate of around 97% for the edentulous mandible, with only 5 implants lost in 5 out of 44 patients in the first 6 months, and with all prostheses surviving after 1 year. Similar results (97.6% success) were achieved for the edentulous maxilla, with only 3 Branemark® implants lost in 3 out of 32 patients. This study revealed a loss of marginal bone level averaging 0.9 mm (SD 1.0 mm) from the implant abutment junction after 1 year. The success rate improved to 98.9% when NobelSpeedy™ Groovy implants were used in both the maxilla (44 patients) and mandible (9 patients). Two implants were lost in 2 patients, who showed an increase in the loss of marginal bone level to, on average, 1.2 mm (SD 1.4 mm) from the implant abutment junction after 1 year. In a 6-year study, Maló reviewed the placing of implants in periodontally compromised sites in 2 groups of patients which included 90 full-arch fixed immediate bridges using the All-on-4™ technique. The first group was comprised of mainly machined Branemark® implants placed over 5 years with a 91% success rate, where 13 of 165 implants were lost in 9 out of 81 patients. There was an increase in the loss of marginal bone level to an average of 1.2 mm (SD 0.9 mm) from the implant abutment junction after 1 year. The second group were all oxidized implants placed prospectively over a year with a 100% success rate. A total of 103 patients were treated with 268 implants using a standardized surgical and maintenance protocol. There was a loss of marginal bone level of an average of 1.1 mm (SD 1.1 mm) from the implant abutment junction after 1 year. The surgical protocol included a regenerative surgical technique, antibiotics, and corticosteroid anti-inflammatory medication, with anti-inflammatory agents used in regression mode. The maintenance protocol included the use of hyaluronic acid in the first 2 months and chlorhexidine between 2 and 4 months. Maló concluded, "Implants may be successfully placed in periodontally compromised situations so long as oxidized surface implants are used and specific clinical protocols are followed, coupled with standardized surgical and maintenance procedures." Patients with healthy edentulous arches can benefit from advances in guided surgery using bone- and tissue-borne stents because of the stability of the reference points, whereas the mobility of the teeth and the irregular pattern of bone loss associated with periodontally compromised terminal dentition prevents the use of surgical guides.

The success of our own treatments over the last 4 years compares favorably with the results of Maló’s study. We have carried out 97 immediate fixed bridges in periodontally compromised patients using the All-on-4™ technique since July 2006, following the basic All-on-4™ protocol but with subtle differences (to be detailed later). Only 1 implant out of a total of 392 for the 97 patients failed within 6 months, a success rate of 99.8%. This implant has now been replaced without further problems. Any complications we have experienced are discussed below.

**Patient assessment**

Every case must begin with an assessment of the patient’s overall well-being as well as a scrupulous examination of each potential implant site. It is vital to maximize the implant surface area available for bone integration and to optimize the positional

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**Figure 1: Implant position in mandible**

**Figure 2: Implant position in maxilla**

**Figure 3: Temporary bridge, mandible**

**Figure 4: Temporary bridge, maxilla**
restrictions, the overlying bridgework, and surrounding soft tissues. The periodontal pathology also needs to be assessed, managed, and monitored as part of a standard protocol. We follow a standard assessment format, which includes comments relevant to the All-on-4™ technique.

History of present complaint
The most successful clinicians are those who respect each patient as an individual and offer emotional support to those who are perhaps in denial, distressed, or traumatized by the prospect of losing their teeth. The surgeon must attend to the patients’ concerns by listening to their own assessment of the situation as well as explaining the procedures. Such support is best offered away from the dental chair but with an illustrative device, a monitor or x-ray viewer for example, and perhaps a cup of tea and a supply of (preferably) nonsurgical tissues. It’s important to have the patient “onside” and committed to the treatment as a major factor contributing to an improved quality of life post-completion.

Medical history
The usual medical considerations for placing multiple implants apply to the All-on-4™ technique. The irregular nature of the bone loss in periodontally compromised patients, and the need to establish a clean level of bone for osteotomy, often requires a significant amount of bone removal with rongeurs and burs. We therefore use IV sedation, administered by a qualified third party, and the patients need to be assessed, informed, and give their consent.

Dental history
A common predisposing cause of terminal, periodontally compromised dentition is failure to pursue an adequate oral hygiene regimen, and as the condition develops, this situation becomes self-perpetuating. Patients are discouraged when their teeth still appear unattractive even after cleaning, or their teeth have become too loose or too painful to clean. Some patients will have avoided going to the dentist for regular check-ups or declined periodontal therapy because of the painful sequelae. The implant surgeon needs to gently encourage the patient to understand and accept the need for preliminary periodontal care and for a strict postoperative maintenance and monitoring program.

Extra-oral
The presence of mobile, over-erupted, and protruding teeth can complicate assessment of the freeway space (FWS), lip support, and smile lines. Photographs at rest (Figure 5) and full smile (Figure 6), with and without a denture if applicable, are...
essential for planning and to allow the practitioner to relate to the case. The planned implants and abutments must, where possible, be above the smile line to hide the transition from acrylic gumwork to mucosa. This determines the amount of bone to be removed, and by inference, the height of bone available for placement. The skeletal relationship is important in determining the correct occlusion and tooth set-up, especially where teeth have drifted or been replaced with “Class 1” dentures. Patients with Class 2 div II jaws often have narrow anterior ridges (Figure 7), and high lip lines (Figure 8) also make implant placement and planning more difficult.

Intra-oral

This is the point when mobility and CPITN scores (Community Peridontal Index of Treatment Needs) need to be recorded. The periodontal condition inevitably dictates a full periodontal charting according to the CPITN. The patient can be spared the trauma of pocket depth measurements of the teeth that are Class 3 mobile and clearly need to be extracted. The usual indicators of bleeding and plaque should be carried out for any teeth that will remain to determine the future periodontal plan and serve to motivate the patient’s hygiene regimen. The presence of sinuses and any signs of acute infection should be noted, especially in potential implant sites.

The condition of the pre-existing teeth must be assessed on two counts. The first is how they will impact on measuring FWS, recording lip support, midline position, and line of arch for construction of the temporary bridge. The second is how the teeth remaining after extraction will occlude against the bridge in terms of FWS, mobility, posterior support, anterior guidance, over-eruption, and longevity.

Edentulous saddles in the premolar area of the opposing arch should be assessed to restore posterior support where necessary.

Details of the occlusion need to be noted, and indicators of disharmony such as facets and abfraction lesions recorded. The temporary bridge should follow the anterior and lateral guidance prescription of the natural teeth as far as possible.

The labio/buccolingual/palatal ridge width is recorded at each site between the first molars. The ridge width is palpated at a higher, more apical, level to ensure adequate width for the full length of the proposed implant site. Palpation can normally be carried out with finger and thumb pressure. The degree of loss of buccal cortical plate over a compromised tooth can be assessed by moving the tooth laterally during palpation.
Radiographic examination
A panoramic radiograph (Figure 9) can be regarded as part of the routine assessment for this type of case. It not only provides essential data but is a useful aid for explaining problems and treatment planning to the patient.

The height of the alveolar ridge is recorded between the first molars, taking account of the maxillary sinuses, nasal cavity, and inferior dental canals. A large incisive canal will also impact possible implant placement. The extent of bone loss due to periodontal and periapical lesions is noted. Even advanced periodontal bone loss could have little impact on implant placement if the patient has a high lip line and the ridge has to be recontoured above the affected bone, so long as sufficient bone volume remains to allow placement. Extensive periapical or buccal bone loss may mean that an adjacent site needs to be chosen, or indicate the need for augmentation.

Periapical radiographs are required when the dental panoramic tomography (DPT) does not provide sufficient definition for accurate diagnosis. A CT scan is mandatory if the examination indicates inadequate alveolar ridge volume. The patient must understand that the scan may show there is inadequate bone volume for the All-on-4™ procedure to be viable, and an alternative, possibly unacceptable, surgical approach may be indicated.

To avoid unnecessary exposure, CT scans should be taken only after the patient has indicated a clear wish to continue with the All-on-4™ plan, and understands the procedure, the time frame, and financial implications.

Treatment options and provisional plan
As part of the dentist’s medico-legal and ethical responsibilities, the patient must be made aware of all the possible treatment options. Anatomical models of the mandible and maxilla (Salvin® Dental Specialties) and the sinus lift model are helpful as educational aids, and we also use a maxillary model with four NobelSpeedy™ Groovy dummy implants and multiunits in place. We provide a short PowerPoint® presentation showing the Nobel Biocare™ All-on-4™ slides with clinical photographs as well as radiographs of our own cases. We also keep a list of previous All-on-4™ patients who are happy to talk to prospective patients to allay their fears and provide a patient’s perspective of the treatment process.

Type of implant
The All-on-4™ protocol recommends the use of a minimum 4.0-mm diameter NobelSpeedy™ Groovy implants whose solid nature and aggressive thread provide a robust primary fixation. The TiUnite™ surface has been shown to be reliable in these types of cases. These implants are available in convenient lengths of 7, 8.5, 10, 11.5, 13, 15, and 18 mm. The full NobelSpeedy™ Groovy range includes 5.0- and 6.0-mm diameter units, although the 3.5-mm diameter implants are supplied only in lengths of 10, 11.5, 13, and 15 mm. We keep a stock of four of each length of the 4.0-mm, regular platform (RP) with two 3.5-mm length, 13-mm length, and one 15-mm for situations where the ridge proves to be narrower than expected.

The multiunit abutments are specific for each diameter and are available as either straight, 17-degree, or 30-degree options. There are limited multiunit gingival height options available for the narrow and wide platforms, and these are shown in Table 1.

Planning implant sites
Manipulating digital radiographs using software such as Kodak’s dental

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<th>Table 1—Multiunit abutments</th>
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<tr>
<td><strong>NP (narrow)</strong></td>
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<tr>
<td>Straight</td>
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<tr>
<td>17 degree</td>
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<td>30 degree</td>
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Figure 13: Posterior implant position, mandible
Figure 14: Positioning of virtual implants
imaging version 6.6.3.0 (Carestream Dental) allows the surgeon to alter the position, angulation, length, and diameter of virtual implants on the screen in two dimensions. This not only simplifies planning but also helps to explain the procedure to the patient. CT scan software such as SimPlant® (Materialise Dental) offers the same facility in three dimensions and also provides a bone-density reading in the proposed implant site.

Nobel Biocare™ produces an acetate for NobelSpeedy™ Groovy implants in magnifications of 100%, 130%, and 170%. Wherever possible, 5-mm ball bearings should be used to calibrate DPTs at each implant site, but the angled nature of the posterior implants means that the guides should remain merely guides and not be taken entirely on trust.

If digital imaging software is not available, a print should be made of the DPT and used as the basis for construction drawings. Conventional DPT radiographs can be covered with a fixed sheet of transparent paper for the same purpose.

The starting point for planning implant placement is to use the diagrams or monitor to draw a real or virtual line at the level to which the bone will be trimmed. In the mandible, the level is found after the alveolar bone supporting the periodontally compromised teeth is removed. The same procedure applies to the maxilla, but the level must always be just above the smile line to ensure the acrylic gumwork—mucosa junction is hidden (Figures 10 and 11). This consideration occasionally applies to the mandible when patients reveal their lower anterior teeth and gum when speaking. Further bone reduction is indicated if there is insufficient intermaxillary space, although this can be limited below the sinus.

The position of the implants is then determined using the new baseline and the previous labio/buccolingual/palatal dimension readings. The posterior implants are positioned as far distally as possible and mesial to the anterior wall of the sinus in the maxilla, and mesial to the mental foramen and anterior loop of the interdental (ID) canal in the mandible, using a maximum angulation of 45 degrees with 30-degree abutments. Their length is determined by the sinus and floor of the nose in the maxilla and the lower border in the mandible (Figures 12 and 13).

Ideally, the anterior implants will be positioned in the lateral incisor sites for more even support of the future bridgework and to allow sufficient bulk of acrylic between the abutments to prevent the temporary bridge from fracturing under load (Figure 14). The angulation of the anterior implant abutments is decided by the patient’s skeletal relationship and the position of the remaining ridge relative to the cingula of the incisor teeth of the bridgework. The cingula are the optimum point of access to the retaining screws because this minimizes the bulk of supporting acrylic around the temporary abutments and maintains the integrity, and therefore the esthetics, of the labial face of the incisor teeth. The bulk of acrylic is difficult to avoid in extreme Class 2 div I cases where it is necessary to provide a bite plane for occlusion with the lower incisors. The retroinclined nature of the incisors in a pronounced Class 2 div II set up also complicates the planning of the implant position relative to the cingula and the choice of multi-abutment abutment, and this is not made easier by the narrow nature of the ridge in this type of skeletal relationship.

In cases with limited bone volume in the maxilla, it may be necessary to shorten the posterior implant to prevent contact with the anterior implant, and this will mean planning an abutment with a different angle.

When there is limited bone volume in the mandible, there is often little available bone above the mental foramen. In such cases, the angulation of the posterior implants is planned primarily to avoid the anterior loop of the IDB/c with the appropriate (usually straight or 17-degree) angled abutments.

At this point, the patient needs to be informed of the costs and different characteristics of the materials available for construction of the definitive bridgework, and give written consent for the actual treatment to begin.

References


