

## Robert A. Levine, DDS

Dr. Robert Levine maintains a full time private practice at the Pennsylvania Center for Dental Implants and Periodontics in N.E. Philadelphia, limited to Implant Surgical Placement, Cosmetic Periodontal & Regenerative/Reconstructive Procedures, and Adult Orthodontics. He is Chairman Emeritus (1984-2003) of Periodontics at the Albert Einstein Medical Center and presently Clinical Associate Professor in Post-Graduate Periodontics, Implantology and Periodontal Prostheses at the University of Pennsylvania.

## Steven I. Present, DMD

Dr. Steven Present is a native of Brooklyn, N.Y. and a graduate of the University Of Wisconsin and Temple University School of Dentistry. He did postgraduate studies in microbiology and immunology at Thomas Jefferson Medical College and completed a program for the treatment of oral facial pain and temporomandibular disorders at The New Jersey College of Medicine and Dentistry. He has been restoring dental implants since 1988 and lectures on advanced and complex implant reconstruction.



# Utilization of CAD/CAM Technology for Maxillary Bar-Overdenture and Mandibular Fixed-Hybrid Prosthesis. A Case Report of Immediate Implant Placement with Immediate Loading.

## Introduction

Computer aided design (CAD) and computer aided manufacturing (CAM) first developed in the 1970s has evolved and now is used in many fields. In the field of dentistry CAD/CAM technology now has the ability to manufacture extremely accurate dental structures with a truly passive fit with more predictability than traditional laboratory techniques. Since the structures are milled from one solid piece of titanium, the possibility of weakness from porosities, soldering, or laser welding are eliminated.

As with all implant dentistry the proper placement of the implant is essential for predictable

results. For the fixed - hybrid prosthesis the implants should be placed 1 to 3mm lingual to the incisal edge of the anterior teeth and within the occlusal table of the posterior teeth with a minimal 3mm distance between implants. For the removable overdenture, the implants should fall within the borders of the overdenture. It is therefore critical that surgical guide templates are utilized and fabricated from either diagnostic wax ups or a functional wax set up and try in.

The following case report discusses the treatment of a 52 year old female whose final prosthesis will be designed by CAD/CAM technology.

## Patient Presentation

A 52 year old female patient presented to our office for evaluation for a long term restorative solution to her severely debilitated dentition. (figures #1-5)

Her medical history was significant for smoking, hypertension, bipolar disorder, and hypoactive thyroid. Medications included HCTZ, Synthroid, Klonopin, Lexapro and one aspirin per day. A severe medication-related dry mouth (xerostomia) was noted and in conjunction with her poor compliance to routine dental care, smoking habit (1p/d) and poor diet resulted in severe areas of recurrent and new caries. It had been over 3 years between dental visits. Since she was unable to wear a mandibular RPD and she



**Figure 1** Pre-Treatment facial smile. Chief complaint: recent loss of lateral incisors and dental discomfort from multiple decayed teeth.



**Figure 2** Pretreatment: note cervical caries throughout patient's mouth relating to poor diet, poor compliance and medication-related dry mouth



**Figure 3** Pre-Treatment Panorex (10-05). Note areas of severe carious root tips resulting from crown fractures and severe dental caries (006). Vertical bone height appears adequate in the #4-13 and in the mandibular jaw bilaterally



**Figure 4** Pre-treatment occlusal view with root tips noted and severe recurrent caries. (041) Proposed maxillary immediate implant sites were #5,7,19,12.



**Figure 5** Pre-treatment occlusal view mandibular jaw. 2 degree mobilities were noted #23-26 with significant incisal wear. Adequate ridge width was clinically confirmed in her posterior areas with soft and hard tissue palpation



**Figure 6** Surgical guide template for the maxillary arch using a lingual approach.



**Figure 7** Closure of maxillary flaps with 4-0 silk and 6-0 resorbable synthetic material. GBR with Straumann Bone Ceramic mixed with calcium sulphate and covered with a resorbable collagen membrane was used to heal site #5 where a buccal dehiscence of 4 threads was noted after placement. Socket preservation was completed with the same materials for sites #4,6,11,8,9. (058)



**Figure 10** Closure of mandibular flaps with tall RN healing caps covered thinly with triple action antibiotic ointment in preparation for impressions with restorative office later that day. 4-0 silk and 6-0 resorbable sutures are in place. Implant sites #20,21,23,26,28,29 were used. Autogenous bone grafting was harvested from significant anterior vertical ridge reduction and was packed into sockets 22,24,25 and 27 for socket preservation. Today we routinely recommend resorbable suture materials for closure under an immediate loaded restoration for patient and staff ease post-operatively

exhibited a severely worn dentition with vertical height discrepancy of her posterior mandibular ridge to her anterior ridge which holds her remaining natural teeth. As a result she had difficulty eating confining her diet to soft, highly processed foods. This was a major contributor to her being over weight and hypertensive.

### Treatment Plan

A team approach (1,2,3) to treatment planning was developed between the periodontist's office, the restorative office and the dental lab with a prosthetically-guided focus. Attention to detail with a clear concept of the desired final result was reviewed with the patient at separate consultation visits from both a prosthetic and surgical vantage point so her future experience between offices would be seamless. The issue of



**Figure 8** Surgical guide template for the mandibular arch using a lingual approach



**Figure 11** 5 days post-op with maxillary immediate FUD and mandibular immediate loaded screw-retained metal-reinforced lab-processed provisional in place

smoking, diet, and her history of poor compliance was addressed. History of diabetes (father) and periodontal disease (mother) was also revealed through discussion. A thorough risk-factor analysis is necessary to be shared with the patient to avoid any future misunderstandings if not seriously and properly addressed prior.(4) She was committed to quit smoking (1p/d) (5) and improve her compliance to prevention(6) and diet in the future.

For financial and bone availability reasons in the maxillae a CAD/CAM fabricated bar-retained overdenture supported by four Straumann implants was planned for the maxillae with an immediate transitional FUD and a CAD/CAM fixed-hybrid prosthesis supported by six Straumann implants was planned for the mandible with an immediately loaded fixed provisional to be delivered within 24 hours post-surgery.(7,8,9)

Clear acrylic surgical guide templates were fabricated from a diagnostic wax up for both jaws. Thorough discussions were made with the dental lab prior to coordinate this procedure with their lab in the fabrication of the mandibular immediate load provisional and the maxillary immediate FUD and the corresponding surgical guide templates. The implant instillation surgery was planned to be completed in one surgical visit under oral sedation. Oral medications included a NSAID, CHG rinse, Amoxicillin, steroid dosepack



**Figure 9** Implant carriers in place with surgical guide template showing the near parallelism of the implants which is most frequently impossible to achieve in the maxillary jaw due to bone profile and resorptive pattern differences between arches. (069)



**Figure 12** Facial smile of patient at 5-days post-op

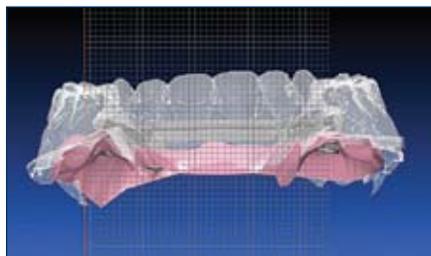
and hydrocodone with acetaminophen (narcotic). She was to start the antibiotic and NSAID with CHG rinse prior to surgery with steroids immediately post-surgery (first day dose at one time) and oral narcotics as needed.

### Surgical Phase

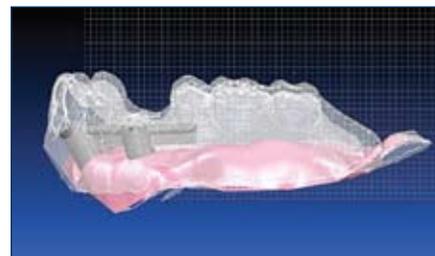
In one surgical visit under oral sedation the patient was anesthetized with local anesthesia in both jaws. Commencing with the maxillae full-thickness flaps were raised and the buccal flaps were sutured to the buccal mucosa to aid in visualization and to minimize surgical trauma to the buccal tissues from #3-14. The teeth were gently removed with minimal trauma and 4 RN 12mm TE 4.1X4.8 Straumann implants were placed using sites #5, 7, 10, 12 using "Esthetic Zone" principles for proper implant placement in 3 dimensions (10-12) with the aid of the surgical guide template.(figures 6). GBR was necessary to promote healing of a 4-thread buccal dehiscence involving site #5 using Straumann Bone Ceramic mixed with surgical grade calcium sulphate and covered with a resorbable collagen membrane. In addition socket preservation was completed for extraction sites # 4, 6, 8, 9, 11 to help maintain buccal plates of bone and bony profile. In addition, if a future desire is to replace the removable case with a fixed restoration requiring more implants and ovate pontic development



**Figure 13** Panorex taken at 5 days confirming seating of screw-retained provisional restoration with temporary titanium abutments with a metal-reinforced framework for strength



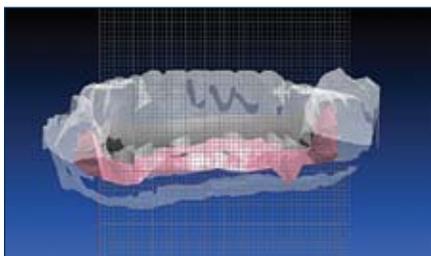
**Figure 14** Lingual view of virtual design of maxillary Hader bar



**Figure 15** Lateral view of virtual design of maxillary Hader bar



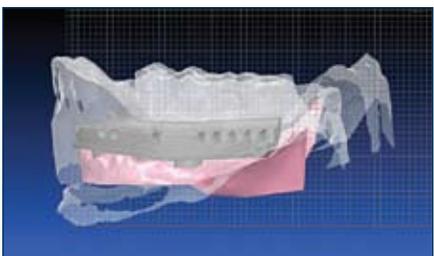
**Figure 16** Occlusal view of virtual design of maxillary Hader bar



**Figure 17** Lingual view of virtual design of mandibular substructure



**Figure 18** Occlusal view of virtual design of mandibular substructure



**Figure 19** Lateral view of virtual design of mandibular substructure



**Figure 20** Mandibular CAD/CAM one-piece substructure on laboratory model



**Figure 21** Final case in place: maxillary 4-implant CAD/CAM fabricated bar-overdenture

the augmented sites will be available(13-17) Tall beveled esthetic healing caps were placed and the tissues were closed with combination of 4-0 silk and resorbable 6-0 sutures. (figure #7)The maxillary FUD was inserted and would be used with the mandibular surgical guide template for mandibular implant placement.

After full thickness flaps from #19-30 and suturing of the buccal flaps to the buccal mucosa, the remaining lower teeth were gently removed. Due to the roller-coaster bony profile anterior to posterior the anterior ridge was significantly reduced and leveled to the similar height of the posterior levels for prosthetic and future patient ease for

maintenance care. The osseous chips were saved, milled and was used for socket preservation for anterior sites not being implanted (#22, 24, 25 27). With the aid of the surgical guide template 6 Straumann implants were placed with 12mm RN (sites #21, 23, 26, 28) and 8mm RNs (sites #20, 29).(figures #8-10) Our surgical goal is to have all implant shoulders at approximately the same vertical height for prosthetic and patient ease. A distance of at least 3mm is desired between implants to avoid implant proximity problems which can jeopardize patient plaque control and esthetics of the case. The Straumann bone profiler was used for all sites except #5 (which was covered for GBR). It is important to remove

any bone which may be at the level or above the implant shoulder to allow proper seating of the impression copings, healing caps, and the final case. This is especially important for immediate extraction with immediate implant placement where the implant shoulders may be placed slightly apical to interproximal osseous heights and a critical fit is necessary in the provisional phase to avoid micro motion.

Closure was similar to that used in the maxillae using 4-0 silk and 6-0 resorbable sutures. The patient was then scheduled for post-op after placement of the lower fixed provisional in 5 days. She was instructed to eat a soft diet for 4-6 weeks to



**Figure 22** Final maxillary case showing thin palatal CAD/CAM fabricated framework for support for the U-shaped overdenture



**Figure 23** Final maxillary case undersurface showing enclosed CAD/CAM fabricated framework and bar attachments



**Figure 24** Maxillary CAD/CAM fabricated framework Hader bar in place



**Figure 25** Mandibular screw-retained CAD/CAM fabricated framework fixed-hybrid restoration in place



**Figure 26** Final facial smile



**Figure 27** Post-treatment Panorex showing fully seated CAD/CAM fabricated frameworks

prevent over loading of the mandibular immediately loaded implants. Post-operative visits were scheduled at 2-3 week frequencies with plaque removal and review of plaque control procedures by the patient. An anticipated 3-4 month healing phase was discussed for the lower and additional time for the upper jaw as an uncovering procedure for site #5 would be needed at 4-5 months requiring an additional 3-4 weeks for soft tissue maturation prior to final impressions. Reverse torque at 35Ncm is routinely done prior to final impressions along with periapical and panorex examinations to confirm bone healing. A recommended 3 month alternating periodontal maintenance frequency was recommended due to her periodontal risk factors discussed above.

### Restorative Phase

Immediately following her surgery the patient returned to the restorative dentist's office where the maxillary denture was relined with tissue conditioner (Coe Comfort®-GC America-Alisp, IL 800-323-7063) and a synOcta impression of the mandibular fixtures and a facebow record was taken. Twenty four hours after implant surgery the mandibular screw-retained metal-reinforced provisional bridge on synOcta temporary posts was delivered.

(figures #11-13) Triple action antibiotic ointment was placed around the abutments, the occlusion was adjusted, and the screws hand tightened. The access holes were sealed with cotton and Tempit® light cured resin (Centrix-Centrix, Inc Shelton, CT 203-929-5582).

During the healing period of approximately 14 weeks the tissue conditioner in the maxillary interim denture was changed every two weeks to ensure a soft interfacing contact to the healing caps of the maxillary implants. After successful implant integration as confirmed by radiographic and reverse torque application of all implants, final synOcta impressions were made of both the maxilla and mandible. Occlusal rims were fabricated, bite registration, and facebow registration were taken.

Following the wax try-in of the maxillary and mandibular dentures where occlusion, phonetics, and esthetics are evaluated, the verification jig was placed. Since the accuracy of the master cast is crucial for the fabrication of the CAD/CAM precision milled framework and bar (CAM StructSURE® 3i) the utilization of a verification index is mandatory.

The verification index is fabricated on the master cast in the laboratory with GC pattern resin® (GC America Alisp, IL 800-323-7063) with the synOcta abutments and the temporary post for the synOcta abutment. The verification index is checked intraorally. If there are any discrepancies, the index is sectioned and luted back together intraorally with the GC pattern resin. The laboratory then must reposition the misaligned analogs.

The laboratory then sends the master cast with the synOcta abutments and the wax set ups for the design and fabrication of the mandibular fixed-hybrid framework and maxillary Hader bar. Once received (3i ARCHITECH PSR/CAM Struct-

SURE® (Biomet 3i Palm Beach Gardens, FL 800-342-5454), the models with the synOcta abutments on the analogs and the wax set ups are optically scanned. The framework is then designed depending upon the position of the wax set up. A virtual three dimensional image of the framework design is then e-mailed to the laboratory to be evaluated and approved by the technician and doctor.(figures #14-19) Upon approval the framework and Hader bar are milled out of one solid piece of titanium. The completed framework is returned for try in to verify the accuracy of the fit, both on the cast and intraorally. (figure #20) The clinician will immediately notice the true passivity of the fit.

The mandibular fixed-hybrid denture set up is then transferred to the framework followed by an additional maxillary and mandibular try in to verify the jaw relation records. The restorations were then processed and finished taking into account the A-P spread of the mandibular fixtures.

At delivery the synOcta abutments were torqued to 35 Ncm, occlusion verified and adjusted where necessary, the mandibular hybrid prosthesis screws were tightened to 15Ncm, and access holes were sealed with cotton and light cured composite resin. The maxillary Hader Bar was seated on the synOcta abutments and the screws were tightened to 15ncm, sealed with cotton and Tempit® (Centrix, Inc. Shelton, CT. 203-929-5582) and the overdenture delivered. (figures #21-27)

### Discussion

Implant supported and/or retained prostheses can truly be life altering for our patients, having the potential for not only improving their quality of life, a person's self-esteem but also potentially having a dramatic impact on their overall health. Patients presenting for extensive rehabilitation frequently are embarrassed to smile or speak in public as was the present case. She was overweight, had high blood pressure and a number of periodontal risk factors including a 1p/d smoking habit. Her inability to adequately masticate forced her to eat soft, highly refined processed foods, which are higher in calories, saturated and trans-fats coupled with her smoking, poor compliance and severe medication-related xerostomia made her very caries susceptible causing her to loose and fracture existing teeth. Dental implants are frequently a solution for these patients due to titanium's caries resistant properties.

Within 24 hours of dental implant surgery, the mandibular provisional restoration was placed and she was able eat more healthful foods including salads and soft vegetables which she was previously unable eat. This resulted in an immediate loss of weight and a reduction of her blood pressure. In addition, after delivery of the final restorations the patient stated that her friends said she looked ten years younger as her self-esteem was greatly improved and she couldn't be happier with the final prosthetic results.

CAD/CAM technology now allows us the opportunity to provide our patients with a superior product and the dentist to become more productive in delivering implant supported and/or retained restorations. Since the inaccuracies of waxing and casting large frameworks and bars no longer exists, the need for cutting, soldering, or remakes are eliminated.

Since the completion of this case Straumann has acquired Etkon, a leader in dental CAD/CAM technology. Unlike some other systems, Ekton is capable of not only milling bars and substructures, but metal free single restorations, copings, bridge frameworks up to 16 units, and custom implant abutments in metal or zirconium with an accuracy of 5 to 10 microns. Another advantage is that the laboratory technician and doctor are in total control of the design process. Since the scanning (es1® Ekton laser scanner) and design (Etkon 3.0® design software) are done in the laboratory, the original models, wax-ups, and records do not have to be sent to another facility for scanning and design. Your design is simply up loaded to Etkon USA (Dallas, TX) for the milling process. This saves time, money, and increases office productivity. We have truly progressed from 19th century technology for the fabrication of our restorations into the 21st.

## Bibliography

- Rosseini, KD, Teaming up for successful implant dentistry. *Functional Esthet and Restorative Dent* 2007 (#2: series 1 Dental Implants)12-14.
- Spear, FM. It's about relationships. *Advanced Esthet and Interdisciplinary Dent.* 2005; 1:1.
- Daher, S. The implant treatment planning process: management of bone, blood and time. *Functional Esthet and Restorative Dent* 2007; series 1, number 2: 8-10.
- Levine, RA, Shanaman, RH. Translating clinical outcomes to patient value: an evidence-based treatment approach. *Int J Periodontics Restorative Dent.* 1995; 15: 186-200.
- Moy, PK, Medina, D, Shetty, V, et al. Dental implant failure rates and associated risk factors. *Int J Oral Maxillofac Implants.* 2005; 20:569-577.
- Levine, RA, Wilson, TG., Compliance as a major risk factor in periodontal disease progression. *Compend Cont Ed Dent.*1992; 13:1072-1076.
- Morton, D, Jaffin, R, Weber, HP Immediate restoration and loading of dental implants: clinical considerations and protocols. *Int J Oral Maxillofac Implants.* 2004; 19(Suppl): 103-108.
- Norkin, FJ, Ganeles, J, Sekler, J, Zfoz, S. Immediate loading of endosseous dental implants: a review of the evidence. *Functional Esthet and Restorative Dent.* 2007; Series1, number 2: 38-44.
- Jaffin, RA. Rehabilitating the failing dentition: full-arch immediate placement, immediate load therapy. *Functional Esthet and Restorative Dent.* 2007: Series 1, number 2: 46-52.
- Buser, D, Martin, W, Belser, UC. Optimizing esthetics for implant restorations in the anterior maxillae: anatomic and surgical considerations. *Int J Oral Maxillofac Implants.* 2004: 19 (Suppl): 43-61.
- Levine, RA. Soft tissue considerations for optimizing implant esthetics. *Functional Esthet and Restorative Dent.* 2007; Series1, number 2: 54-62.
- Tarnow, DP, Cho, SC, Wallace, SS. The effect of inter-implant distance on the height of inter-implant bone crest. *J Periodontol.* 2000; 71: 546-549.
- Nevins, M, Camelo, M, De Paoli, S, et al. A study of the fate of the buccal wall of extraction sockets of teeth with prominent roots. *Int J Periodontics Restorative Dent.* 2006; 26: 19-29.
- Iasella, JM, Greenwell, H, Miller, RL, et al. Ridge preservation with freeze-dried bone allograft and a collagen membrane compared to extraction alone for implant site development: a clinical and histologic study in humans. *J Periodontol.* 2003; 74: 990-999.
- Levine, RA, Horowitz, RA. Bone reconstructive surgery for implant site preparation. *Functional Esthet and Restorative Dent.* 2007; Series1, number 2: 20-28.
- Spear, FM. The use of implants and ovate pontics in the esthetic zone. *Functional Esthet and Restorative Dent.* 2007; Series1, number 2: 64-69.
- Higginbottom, F, Belser, UC, Jones JD, et al. Prosthetic management of implants in the esthetic zone. *Int J Oral Maxillofac Implants.* 2004; 19 (Suppl): 62-72.