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A n understanding of the normal anatomy of the marginal soft tissue and its relationship to tooth contour is indispensable for the proper restoration of moderate to severe recession defects in the presence of cervical tooth lesions. Both periodontal plastic surgery and restorative treatment must be coordinated so that a properly contoured dento-gingival complex can be restored. The following case report demonstrates a unique approach to restoring a healthy mucogingival complex and highlights how the neglect to follow up with restorative treatment in a timely manner can reverse any surgical achievements.

**KEY WORDS:** Mucogingival defect, gingival graft, restoration, healing

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INTRODUCTION
When recession defects are present simultaneously with cervical tooth lesions, both the clinical crown and gingival contour are defective. Attempts to correct these defects with a single discipline can prove ineffective because of the interdependent relationship between the tooth contour and gingival architecture. The gingival architecture shape is influenced by the cervical tooth contour and the ability to achieve a properly finished cervical restoration presupposes anatomically shaped and healthy marginal soft tissue. A combined surgical-restorative approach must be employed and coordinated to correct the defect. The following case report demonstrates how a unique periodontal plastic surgical approach followed by properly executed restorative treatment can successfully convert a defective dento-gingival complex to one that displays excellent esthetics and physiologic contour, provided it is done in a timely manner.

CLINICAL PRESENTATION
A 60 year old female presented to the Nova Southeastern University College of Dental Medicine (NSU-CDM) Postgraduate Periodontology Clinic in May 2012 with a chief complaint, “these teeth look terrible!” She pointed to the maxillary right area. Teeth #’s 4, 5, and 6 presented with unaesthetic, poorly contoured and defective composite restorations which she reported had been placed over 10 years ago (Figure 1). There was severe recession measuring 6-7 mm, clefts of the gingival margin, and minimal attached keratinized tissue. The gingival zeniths came to a sharp point and lacked any semblance of the scalloped gingival morphology typically seen in a normal periodontium. These teeth also had cervical defects on the anatomic crown which made it difficult to identify the cemento-enamel junction. Pocket depths in this region ranged from 2-3 mm with localized bleeding on probing. No clinical mobility was observed. Radiographs revealed interproximal bone levels within normal limits and no periapical pathology.

CASE ANALYSIS & TREATMENT RATIONALE
Studies have shown that when there is marginal tissue recession in the absence of interproximal tissue loss (Miller Class I and II), complete root coverage can be expected. In this case, however, because these recession defects were continuous with a cervical anatomic defect, a root coverage procedure by itself would not completely correct the clinical defect. A new restoration would also be required to properly restore the cervical third of the crown and recreate a physiologic dento-gingival interface. The patient was informed that a combined periodontal plastic-restorative approach was indicated in order to successfully achieve a physiologic and an esthetic result.

The coronally advanced flap alone, or in combination with a sub-epithelial connective tissue graft, an allograft dermal matrix, or a xenograft collagen matrix has been successfully used to achieve root coverage in Miller Class I and II recession defects. They do not, however, predictably augment the zone of attached keratinized tissue. In cases which aim to achieve both root coverage and an increase in the zone of keratinized tissue, a two-step procedure has been recommended. This entails an initial surgery employing a free gingival graft followed by a coronally advanced flap after six weeks of healing. Although predictable, this procedure requires two
surgical procedures, increased morbidity associated with secondary healing at the free gingival graft donor site, and increased healing time.

We formulated an alternative approach that would allow us to achieve our surgical objectives and eliminate some of the disadvantages of the aforementioned two-step procedure. A closer look at the surrounding gingival tissues in this case revealed that there were wide zones of keratinized tissue adjacent to the recession defects. Also noted were the “full” interproximal papilla which were indicative of a good blood supply and which could serve as excellent sites for anchoring the re-positioned tissue. We planned to utilize these wide zones of tissue by employing sliding pedicle grafts combined with a sub-epithelial connective tissue graft.13 In this manner all of our surgical objectives could be achieved in one surgery: root coverage, an increased thickness of gingival tissue and a wider zone of attached keratinized tissue.
The patient was informed that once initial tissue healing is complete, the remaining cervical lesions would be restored with composite restorations.

**SURGICAL PROCEDURE**

The patient was given 2 g Amoxicillin and 800 mg of Ibuprofen prior to the procedure. A straight horizontal incision was made at the level of the estimated cemento-enamel junction just distal to #7 extending to the mesial surface of tooth #3. Oblique incisions were then made paralleling the direction in which each pedicle was going to slide (Figure 2). Full thickness flaps were elevated to the level of the buccal bone crest followed by partial thickness dissection apically leaving intact periosteum for increased blood supply and flap mobilization. The existing composite restorations were completely removed with a diamond bur.14 The exposed root surfaces were then planed with a Rhodes Back-Action Periodontal Chisel in order to reduce the root prominences and bring them within the confines of the alveolar housing (Figure 3).

A sub-epithelial connective tissue graft measuring approximately 30 x 10 x 1.5mm was
harvested from the right palate using a single-incision technique\textsuperscript{15,16} (Figure 4) and secured against the root surfaces and exposed interproximal bone and connective tissue by suturing its coronal aspect to the undisturbed interproximal papillae with 5-0 chromic gut sutures (Figure 5). Periosteal releasing incisions were made to eliminate any tension of the buccal tissue. The pedicles were moved laterally and coronally to cover the graft on top of the root surfaces and were passively stabilized with a combination of simple interrupted and sling sutures. The portion of the connective tissue graft overlying the root surfaces was covered with pedicle tissue and the portion of connective tissue in the inter-radicular areas was left exposed (Figure 6). A periodontal pack was placed over the surgical site in order to prevent trauma to or movement of the surgical site during the initial stages of healing. The patient was instructed to rinse with Peridex twice a day for 2 weeks for plaque control and was prescribed Amoxicillin 500 mg q8h for 7 days and analgesic medication for pain control.

**CLINICAL OUTCOMES**

Postoperative healing of the surgical site progressed uneventfully. There were no signs of infection or delayed healing. After 1 month, the tissue was well adapted to the root surface in a coronal position but the tissue was bulky and uneven with indentations in the area where the incisions were made (Figure 7). After 3 months of healing, a dramatic increase in root coverage, tissue thickness, and attached keratinized tissue was evident. Despite the successful increase in tissue quantity and quality, an angular shape of the marginal gingiva was present; an anatomically normal scalloped shape of the gingival margin was still lacking (Figure 8). The patient was instructed to have the cervical third of her teeth restored with the expectation that with properly contoured restorations, the marginal gingiva would adapt and acquire a scalloped architecture.

Four months later, the patient returned for a consultation regarding a different area of her dentition. She still had not gone to have her restorations completed as previously instructed. At
this time, there was an obvious change of the previously augmented gingiva. It was now completely linear from the distal line angle of tooth #4 to the mesial line angle of tooth #5. The marginal gingiva of #6 was also flat. There was also a cleft of the interproximal tissue between teeth #4 and #5 (Figure 9). It appeared as if the previously grafted area was regressing.

Consideration was given to perform a gingivoplasty between teeth #4 and #5 with the intent of providing a fresh connective tissue surface for new epithelial migration to establish tissue continuity. Instead, we decided to delay this until after the restorations were completed. We did not want to plasty the tissue without addressing the underlying cause of this regression.

Shortly thereafter, composite restorations were completed in the NSU-CDM Pre-Doctoral Clinic. The tooth color, contour and emergence profile were restored. After receiving her restorations, the patient presented back to the NSU-CDM Post-Graduate Periodontology Clinic for follow up and gingivoplasty. At this time (10 months post-op), however, the previously flat and linear gingival contours and tissue cleft were no longer present. Instead, the gingival architecture was scalloped and continuous, although the contour by #6 remained flat (Figure 10). The gingivoplasty procedure was deemed unnecessary and the patient was satisfied with the final result.

CONCLUSION
The above case demonstrates that there is an interdependent relationship between the cervical contour of the tooth and the form of the marginal gingiva. The gingiva relies heavily on the cervical contour of the tooth for its shape and if the tooth contour is defective, the gingiva cannot achieve its physiologic shape. A severe combined recession and cervical crown defect on teeth #4-6 was treated with sliding pedicles combined with a sub-epithelial connective tissue graft. This facilitated the achievement of root coverage, an increase in gingival thickness and an increase in keratinized tissue in one surgical visit. Despite the “surgical” success which was achieved, the gingival esthetics was lacking; the gingival margins were flat and angular. As time progressed and the patient neglected to restore the cervical lesions of her teeth, the previously augmented site exhibited signs of regression. It was only after the cervical third of the teeth were restored and proper contours were re-established that the marginal gingiva took on a more physiologic shape and esthetic appearance.

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Disclosure
The authors report no conflicts of interest with anything mentioned in this article.

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Case courtesy of Dr. Mariano Polack and Dr. Joseph Arzadon, Gainesville, VA
The following case report demonstrates a multidisciplinary approach to restore a maxillary anterior dental implant. A combination of restorative and orthodontic treatments were used to prepare the maxillary anterior site for dental implant placement. Following placement of the dental implant, periodontal crown lengthening was performed prior to final prosthetic restoration of the dental implant to achieve a harmonious and esthetic final result that has remained stable for 7 years.

**KEY WORDS:** Dental implants, maxilla, prosthetics, orthodontics

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CASE REPORT

A 44 year old male in good physical condition was admitted to the clinic for a loose crown on left maxillary central incisor (#9). The patient also wished to have a better alignment and esthetics of his anterior teeth. Clinical and radiographic evaluation revealed a fractured tooth that was endodontically treated many years ago (Fig.1). The tooth was deemed non-restorable without undergoing crown lengthening to expose more tooth structure. In doing so, however, the esthetic result would have been severely compromised. The patient agreed and chose to do other available options. Limited orthodontic therapy to better align the anterior teeth followed by extraction, immediate implantation and temporization of tooth #9 was proposed to the patient. The patient concurred and wished to proceed with the treatment plan.

The crown of tooth #9 was removed, an endodontic post was placed (Fig.2), and a temporary composite crown was fabricated on top of the post (Fig.3). Orthodontic brackets with a straight arch wire were placed from tooth #6 to tooth #11 to better align the anterior teeth (Fig.4). After 6 months of limited orthodontic treatment, the patient was satisfied with the alignment of his anterior teeth (Fig.5). Occlusion was checked and remained uneventful. The patient was then prepped for extraction of tooth #9 with immediate implantation. The orthodontic wire was removed and tooth number #9 was carefully elevated out of the socket with minimal trauma by using periosteal instruments and piezoelectric unit. No gingival flap was raised. The socket was left well intact, with a slight buccal dehiscence detected. A titanium dental implant fixture (Dentium Company) of 4.3mm body, 4.5 mm platform, and 10mm in length was inserted into the socket. Excellent primary stability was achieved. The surrounding socket space around the fixture was filled with allograft bone graft material (Oragraft by Salvin Dental) that consists of 50/50 mixture of cortical and cancellous particles of 250 to 500 microns. A collagen membrane was sutured in place with 5-0 chromic gut resorbable suture to cover the socket opening and contain the graft within. Orthodontic arch wire was placed back on the anterior teeth with a temporary crown attached to the wire on the #9 position. A radiograph was taken following surgery (Fig.6),

Figure 1: Pre-surgical radiograph of tooth #9.
and the patient was dismissed with post-operative instructions and antibiotic regimen. A ten day post-surgical check revealed uneventful healing for the patient. At 5 months after the initial placement of implant, the patient was recalled for restorative procedure of implant #9. The orthodontic archwire was removed and a round tissue punch of 4.5 mm in diameter was used to uncover the implant. A final impression was taken at implant level with a transfer post. Gingival depth was measured, and an appropriate shade was selected. The case was sent to a laboratory for fabrication of the final crown. The patient was dismissed with a temporary abutment and a composite temporary crown. The orthodontic arch wire was reattached to the anterior teeth. Ten days later patient was readmitted for final cementation of the crown. A 4.5mm diameter dual abutment (Dentium) and gingival height of 2.5mm was screw retained on to the fixture and the final crown was cemented on to the abutment (Fig7). Gingival recontouring of teeth #’s 7, 8, and 10 was accomplished with an electrosurgical unit for more esthetic gingival architecture (Fig.8). All orthodontic apparatus were removed and the teeth were polished. A radiograph was taken for evaluation prior to cementing to check the fit. The patient was dismissed with a prefabricated orthodontic retainer and instructions for care. Patient was scheduled to be checked at every 6 month interval during the hygiene recall visits. A 3year (Fig.9), and a 7 year post-op radiograph and photograph was taken and shown on record (Fig.10, 11). The patient was very pleased with the final treatment result. The recovery phase of implant therapy was uneventful. Radiographic analysis of subsequent years showed well preserved crestal bone level. Dense cortical formation of the crestal bone surrounding the implant was also evident.
**Figure 4**: Radiograph of orthodontic archwire placement.

**Figure 5**: Anterior tooth alignment after 6 months of orthodontic treatment.

**Figure 6**: Radiograph following dental implant and bone allograft placement at site #9.
Figure 7: Radiograph immediately following delivery of abutment and permanent crown.

Figure 8: Gingivectomy of teeth 7, 8, and 10.

Figure 9: Radiograph at 3 years after treatment.
Figure 10: Radiograph at 7 years after treatment.

Figure 11: Clinical presentation at 7 years after treatment.

Disclosure
The author reports no conflicts of interest with anything mentioned in this article.

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In Vivo Immunohistochemical Investigation of Bone Deposition at Amelogenin Coated Ti Implant Surface

Dr. Bushra Habeeb Al-Molla¹ • Dr. Nada Al-Ghaban² • Dr. Abbas Taher³

Abstract

Background: A dental implant is an artificial tooth root fixed into the jaws to hold a replacement tooth or bridge. Functional surface modifications by organic material such as amelogenin coating seem to enhance early peri-implant bone formation. The aim of the study was to study the expression of osteocalcin and collagen I as bone formation markers in amelogenin coated and uncoated implant in interval periods (1, 2, 4 and 6 weeks).

Materials and Methods: Commercially pure Titanium (cpTi) implants, coated with amelogenin protein, were placed in the tibias of 40 New Zealand white rabbits, histological and immunohistochemical tests for detection of expression of osteocalcin and collagen I were performed on all the implants of both control and experimental groups for (1, 2, 4 and 6 weeks) healing intervals.

Results: Histological finding for coated titanium implant with amelogenin illustrated an early bone formation, mineralization and maturation in comparison to control. Immunohistochemical finding showed that positive reaction for osteocalcin and collagen I was expressed by osteoblast cells (OB) at implants coated with amelogenin, indicating that bone formation & maturation was accelerated by adding biological materials as a modification modality of implant surface.

Conclusion: the present study concludes that coating of implants with amelogenin showed increment in osseointegration in a short interval period.

KEY WORDS: Amelogenin, dental implant, biochemical bone markers, osteocalcin, collagen I, osseointegration.

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INTRODUCTION
Dental implant is an artificial tooth root fixed into the jaws to hold a replacement tooth or bridge.\(^1\) Titanium is widely used for dental implants because of its biocompatibility, mechanical strength and plasticity for prosthetic design. When titanium is implanted into live bone tissue, it actually integrates with the bone.\(^2\) Bone healing around implants involves the activation of a sequence of osteogenetic, vascular and immunological events that are similar to those occurring during bone healing.\(^3\) Osseointegration refers to the growth of bone as it incorporates surgically implanted materials.\(^4\) In order to enhance bone formation, implants have been coated with bone specific biomolecules.\(^5\) Many kinds of bioactive materials used to coat the surfaces of dental implants.\(^6\) Amelogenins are the major organic component in the enamel matrix of developing teeth and play an important role in enamel biomineralization.\(^7\) Amelogenins are hydrophobic enamel proteins secreted by ectodermal cells, ameloblasts, during enamel. Osteoblasts, odontoblasts and bone marrow stromal cells also express the amelogenin gene, suggesting that osteoblasts and odontoblasts come into contact with full-length amelogenin and amelogenin cleavage products.\(^8\) Cells treated with tyrosine-rich amelogenin peptide (TRAP) were evaluated for cell proliferation, gene expression for osteocalcin. Low molecular mass amelogenin-related polypeptides extracted from mineralized dentin have the ability to affect the differentiation pathway of embryonic muscle fibroblasts in culture and lead to the formation of mineralized matrix in vivo implants.\(^9\) Amelogenins self-assemble to form a non-soluble protein scaffold in the form of nanospheres which are thought to play a central role in controlling crystal growth and tissue architecture during enamel formation.\(^10\)

Osteocalcin, the \(\gamma\)-carboxyglutamic acid-containing protein, which in most species is the predominant noncollagenous protein of bone and dentin, has been postulated to play roles in bone formation and remodeling.\(^11\) Osteocalcin is secreted solely by osteoblasts and is pro-osteoblastic, or bone building, by nature. It is also implicated in bone mineralization and calcium ion homeostasis.\(^12\)

Type I collagen (COL1) is the major organic component of the mineralized bone matrix. By immunohistochemical staining they could detect its expression in bone matrix.\(^13\) Type I collagen fibers are the most abundant organic constituent and they may be involved in aligning the mineral crystals.\(^14\)

MATERIAL & METHODS

Materials

1. 80 screw shaped implants, 3.5mm in diameter & a total length of 8mm (threaded part is 5mm & smooth part is 3mm)
2. Amelx (amelogenin) protein (His tag) (ab139212) Abcam UK
3. Anti-Osteocalcin antibody (ab13418) Abcam UK
4. Anti-collagen-I antibody(ab90395) Abcam UK
5. Detection Kits System (ab 94740) Abcam UK
6. Protein Block 15 Enhancer
7. Naphthol Phosphate
8. Fast Red Chromogen
9. AP-Conjugate
10. Co-factor Enhancer
Methods
Forty New Zealand rabbits aged 10-12 months were used in this study, they were divided into four groups for (1, 2, 4 and 6 weeks) healing intervals, 10 animals for each period. Animals were generally anaesthetized & atraumatic surgical technique was performed to prepare two holes in the tibia, amelogenin coated implant was inserted in one hole & uncoated implant (control) placed in the second one. All tissue specimens, samples and controls, were fixed in 10% neutral formalin and processed in a routine paraffin blocks. Each formalin-fixed paraffin-embedded specimen had serial sections were prepared as follows: 5μm thickness sections were mounted on clean glass slides for routine Haematoxylin and Eosin staining (H&E), from each block of the stud-

Figure 1: Thread show bone trabeculae in A – implant at 1w interval, H&E X 20.

Figure 2: Thread show no bone trabeculae in uncoated implant at 1w interval, H&E X 20.

Figure 3: Thread show thick bone trabeculae in A – coated implant at 2w interval, H&E X 20.

Figure 4: Thread show bone trabeculae in uncoated implant at 2w interval, H&E X 20.
ied sample and the control group for histopathological re-examination. Other 4 sections of 5μm thickness were mounted on positively charged microscopic slides to obtain a greater tissue adherence for immunohistochemistry. The procedure of the IHC assay adapted by this study was carried out in accordance with the manufacturer instructions (Abcam UK).

RESULTS
A: Histological examination
1 week postoperatively
In the amelogenin coated implant, In the thread area bone trabeculae appeared and the osteoblast cells arranged in a single raw at the edges of these trabeculae, osteocytes were occupying their large lacunae and they were more in number in the newly formed bone (figure1), in uncoated
implants the marrow space showed large number of fatty tissue with granulation tissue with large blood vessels, no woven bone shown (figure 2).

2 weeks postoperatively
In amelogenin coated implants histological finding showed threads represented the screw shape with thick bone trabeculae and reticulo-fiber tissue in between them, large number of osteocytes and osteoblasts appeared in (figure 3), in control group, a number of active osteoblast and progenitor cells scattered within woven bone, with few thin bone trabeculae involve preosteocytes and osteocytes (figure 4).

4 weeks postoperatively
Amelogenin coated implants show Calcified bone tissue was viewed at implant site
after 2 weeks of implantation, few osteoblasts lined the small cavities presented with large number of osteocytes (figure 5), control one show threads formed at the site of the implant with thin bone trabeculae and reticulofiber tissue in between them (figure 6).

6 weeks postoperatively
Mature bone thread at the site of the implant coated with amelogenin appeared (figure 7), bone deposit around uncoated implant (control) in a form of thread with thick bone trabeculae in control group (figure 8).
B: Immuno-histochemical examination for: - osteocalcin(OC)expression

1 week postoperatively

The OC expression was strong positive in the osteoblasts, osteoclasts, osteocytes, progenitor cells and extracellular matrix in A-coated implants (figure 9). Negative expression of OC monoclonal antibody on uncoated implant in progenitor, fatty cells and extracellular matrix (figure 10).
Figure 17: View for strong positive AP- conjugate red stain for localization of COLL1 in thread site of A-coated implant, red stain with counter stain hematoxylin, X 20.

Figure 18: View for weak positive AP- conjugate red stain for localization of COLL1 in thread site of uncoated implant, red stain with counter stain hematoxylin, X 20.

Figure 19: View for weak positive AP- conjugate red stain for localization of COLL1 in thread site of A-coated implant, red stain with counter stain hematoxylin, X 20.

Figure 20: View for strong positive AP- conjugate red stain for localization of COLL1 in thread site of uncoated implant, red stain with counter stain hematoxylin, X 20.

2 weeks postoperatively
The OC expression was negative in them, while still weak positive in some osteoblasts cells and extracellular matrix in marrow space in A-coated implants (figure 11). That OC expression was strong positive in the osteoblasts, osteoclasts, osteocytes in control group (figure 12).

4 weeks postoperatively
OC localization was negative expression in osteoblasts and osteocytes in A-coated (figure 13) while in control group the OC localization was moderate positive expression in osteoblasts and osteocytes, progenitor cell and extracellular matrix (figure 14).
Figure 21: View for negative expression AP- conjugate red stain for localization of COLL1 at 4 weeks interval of A-coated implant, red stain with counter stain hematoxylin, X 20.

Figure 22: View for moderate positive AP- conjugate red stain for localization of COLL1 in thread site of uncoated implant, red stain with counter stain hematoxylin, X 2.0.

Figure 23: View for weak positive AP- conjugate red stain for localization of COLL1 in thread site of uncoated implant, red stain with counter stain hematoxylin, X 20.

C: Collagen I expression

1 week postoperatively

Immunohistochemical staining with COLL1 showed was strong positive expression in the osteoblasts, osteoclasts, osteocytes, progenitor cells and extracellular matrix in A-coated implant (figure 17) while the uncoated implant showed weak positive expression of COLL1 (figure 18).

2 weeks postoperatively

At 2 weeks of healing periods and when there was increased in osteocytes and osteoblasts, the COLL1 expression was weak positive in them, and strong positive expression in extracellular matrix with progenitor cells in marrow space in A group (figure 19). Uncoated implant, the COLL1 expression was strong positive in the osteoblastes, osteoclasts, osteocytes, progenitor cells and extracellular matrix (figure 20).

4 & 6 weeks postoperatively

Negative expression in A group in 4 and 6
weeks intervals (figure 21). For uncoated implants, COL11 localization was moderate positive expression in osteoblasts at 4 weeks interval and weakly positive expression at last interval period (figures 22, 23).

**DISCUSSION**

The results of this study showed that osseointegration can be obtained when implants are inserted in a living bone and when a suitable biological environment for bone formation is created. The strength of the bond between osseointegrated implant and the bone increases with time since during healing and remodeling, an increase in the degree of bone implant contact and maturation of bone occurs, this result coincides with finding of Wennerberg and Albrektsson.15 Successful attachment on artificial surface is prerequisite for inducing new bone formation locally at the site of implantation. Protein-coated surfaces may influence the biocompatibility of implant materials by initiating and supporting osteogenesis.16 Januario et al,17 observed a process of cortical thickening which they called corticalization. In studied groups of the present study, following insertion of a biocompatible cpTi implant into cortical bone the implants were not submitted to any load, in most of the implants the presence of such thickening (corticalization) process was observed, in agreement with the finding of Hammad et al.18 The uncoated implants, at one week duration, showed embryonic connective tissue with active collagen fiber deposition were showed around implant this result agreement with finding of Jamel,19 who reported that within one week, embryonic connective tissue with active collagen fiber around the implant which represented organic constitution of bone would be formed. Uncoated Ti implant in rabbit tibia after two weeks of implantation shows a number of active osteoblast and progenitor cells scattered within woven bone, with few thin bone trabeculae. These finding supported by the result of Niehaus,20 who found more osteons had uptake of bone marker on day 14 than at any other time during the study new bone was visible within the area between the threads of the control screws. At four weeks duration, according to the study conducted by Yoshinari,21 the micrographs of the implant–bone interfaces at 4 weeks after implantation show that bone tissue has grown on the implant surface, while after six weeks duration thick bone trabeculae and large number of bone forming cells on the border of bone trabeculae and this agree with Depprich,22 who found that when the healing period was near the 6 weeks,

The amelogenin (A) coated implants at one and two weeks duration, the histological view illustrates woven bone in the thread area which was followed the screw shape with bone trabeculae appeared and the osteoblast cells arranged at the periphery of these trabeculae, osteocytes were embedded within the newly formed bone. These result were indicated that the amelogenin has good biocompatibility that enhances osteoblast precursor cell in bone marrow to activate and to differentiate to a specialized cell. This result agreement with Nakayama23 and Shimizu,24 who showed that the Recombinant amelogenin (1μg/ml) increased bone sialoprotein mRNA levels which is an early phenotypic marker of osteoblast differentiation. At four and six weeks duration, amelogenin expression in osteocytes, osteoblasts, osteoclasts, bone marrow cells, and cartilage cells, together with the
accumulating data indicating amelogenin induction of osteogenesis and inhibition of osteoclastogenesis. Hatakeyama et al., suggest that amelogenin has a crucial role in the processes of bone development and remodeling.

Osteocalcin (OC) expression was strong positive in the active mitotic osteoblast, and progenitor cells in all experimental groups at 1 week interval. OC seems to have a role in the early stages of bone formation and some studies by Al-Ghani et al., suggest that is a chemotactic for osteoclast and regulate osteoblast activity too. Our results show a greater number of positive cells indicate a more rapid tissue reaction on implant surface. Novaes et al., who reported that osteocalcin, as one of the important indicators of osteogenic differentiation and bone tissue formation, have been shown to express at higher levels on modified titanium surfaces. In vitro studies demonstrated that mRNA of collagen type I is expressed during the initial period of proliferation and extracellular-matrix biosynthesis, since it is hypothesized that enhanced expression of osteogenic markers in vitro leads to more and more expeditious bone formation at the bone–biomaterial interface in vivo. Once differentiated, osteoblasts produce several proteins, such as type I collagen, osteocalcin, and alkaline phosphatase, which will generate newly formed bone, and then undergo differentiation under an osteocyte phenotype. Therefore, Coll1 is a bone marker associated with the differentiation of osteocyte, and this agree with the results in this study where the osteocyte express Coll1.

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References
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Many think of dental implant procedures as an advanced futuristic development in dentistry but conventional dental implants are not the ideal solution for replacing missing teeth as the healing process extends from 3-9 months and there is an additional failure rate varying from 5 to 10%, depending on patients’ general health as well as the quantity and quality of the bone at the recipient site. Moreover, some dental implants are estimated to last for about 15-20 years in general. Despite much advancement in implant technology conventional titanium implants do not provide a long-lasting solution for a missing tooth. In this article different futuristic aspects of dental implantology are discussed which will completely change this most advanced aspect of dental treatment.

**KEY WORDS:** Dental implants, surface modifications, metal free dental implants, stem cells

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FUTURE CONSIDERATIONS FOR IMPLANT DENTISTRY

Surface Modifications
Surface modification is the new frontier in implant dentistry research. Bioengineering, tissue engineering and nanotechnology are expected to revolutionize implant dentistry in a dramatic way over the next two decades. The primary focus of these emerging research frontiers will be aimed at exploring innovative ways of enhancing bone regeneration and osseointegration, modulation of the host immune response, reducing healing time and preventing peri-implant disease.

Bioengineering is clearly setting the tone in innovative research. The arrival of nanotechnology has opened up new opportunities for the development and manipulation of implant surface topography. Bio mimicking the nano patterned surface topography of the extracellular matrix components of bone tissue could promote cell attachment, proliferation and differentiation, thereby significantly enhancing new bone formation and attachment to implant surfaces.

Tissue engineering, and in particular mesenchymal stem cell therapy, has the potential to offer enormous opportunities in the areas of alveolar bone and soft tissue regeneration and repair to deliver predictable implant site development and implant therapy to compromised patients. In addition, stem cell therapy could reduce donor site morbidity because it would replace autogenous tissue harvesting.

Nanotechnology will have an impact across the entire practice of implant dentistry. A new generation of ‘bio-active’ implants is capable of modulating cellular responses at the molecular level. Beside the advances to implant surface topography itself, nanotechnology offers useful possibilities with regard to diagnostic imaging methodologies, implant site preparation, restoration and aesthetics, wound healing, delivery of modulating therapeutic molecules and drugs, management of peri-implant disease and surgical and restorative techniques. As nanotechnologies mature, they will become more customized, allowing them to be guided towards specific patients, treatment sites or clinical indications.

Implant Surface Coatings
Various coatings have been developed to improve an implant’s ability to bond to living tissues, particularly bone. The idea is to apply a thin ceramic layer that will bond both to the implant and to the surrounding tissue while promoting bone apposition. Candidate coating materials are bioactive compounds able to promote cell attachment, differentiation, and bone formation. The most prevalent bioactive materials are calcium phosphates, such as hydroxyapatite or tricalcium phosphate and bioactive glasses. When implanted, these bioactive ceramics form a carbonated apatite layer on their surfaces through dissolution and precipitation. This phase is equivalent in composition and structure to the mineral phase of osseous tissue. At the same time, collagen fibrils can be incorporated into the apatite agglomerates. The sequence of events is poorly understood but appears to be: adsorption of biological moieties and action of macrophages, attachment of stem cells and differentiation, formation of matrix, and, finally, complete mineralization.

Coating/implant adherence: Most reports indicate that currently available coating tech-
Techniques provide inadequate adherence of CP coatings to Ti alloys. Quoted bond strengths, 15–30 MPa, are very low. Systematic studies of the chemical and microstructural factors that control the interfacial strength and toughness are needed to optimize the mechanical stability of the coatings. Key principles for bonding ceramics to metals, elucidated over the past decade, can guide such an investigation but we still need to develop standard procedures to test adhesion, and a clear understanding of the mechanisms of interfacial failure in the body environment.

Fixation to bone: Knowledge of biological processes occurring at the biomaterial-tissue interface is of utmost importance in predicting implant integration and host response. Two primary modes of attachment are: (1) mechanical, in which the implant has a rough, porous surface into which bone grows (often supplemented by use of a bone cement); and (2) chemical, in which bone “bonds” to the implant material. Here it is difficult to decouple the effect of coating chemistry and topography. Dissolution of calcium and phosphorus from the coating may promote mineralization and bone formation but it is not clear how much coating solubility contributes to the best fixation, and excessive resorption can limit implant lifetimes.

Programmed dissolution rates: A critical goal in the design of noble coatings is the programming of their dissolution (biore sorption) rates. The role of solubility of coatings in the body is poorly understood. The presence of highly soluble phases markedly decreases the mechanical stability of the coating in vivo, but some solubility of coating material expedites fixation. These results suggest that graded coatings designed with a soluble surface to facilitate bonding to bone and an insoluble layer in contact with the metal to provide adhesion, corrosion resistance, and long-term mechanical stability could offer a significant improvement over current materials. Both the composition and thickness of the graded coating layers can be controlled to manipulate their resorption rates. Their resorption can be programmed to match healing rates and to expose different micro architectures, chemical patterns, and porosities at different times to optimize the biomaterial coating surface for different periods of the healing-in phase.

Drug delivery: Inflammatory responses to implants are a significant problem in the health care industry. Typically, medications are given to a patient following surgery to suppress
inflammation and to enable the intended performance of the implanted medical device. Although generally helpful, in many cases this approach is insufficient or entirely ineffective.\textsuperscript{18,19,20} A different approach is to provide a local dose of anti-inflammatory agents gradually released from a coating on the surface of the implanted device. The main advantage of this approach over traditional means of administering the drug is that the drug can be directly released at the implant site without having to go through the bloodstream. This lowers the amount of drug needed, reducing the overall toxicity and side effects. In addition, growth factors that are known to encourage tissue-implant integration, such as TGF-β may be delivered locally using this platform. These chemicals could be incorporated into the porosity of micro- and nano-porous coatings or could be dispersed in biodegradable polymers, and combined with the bioactive glass/CP coatings. Developing the right platform to control the release rate is the key, and closely related to the control of the degradation rates.

**Metal-Free Dental Implants**

For decades, dentists and oral surgeons have searched for a way to replace missing teeth in a way that is sustainable, comfortable, aesthetically pleasing and conducive to general oral health. Finally, metal-free dental implants give patients everything they need in a replacement tooth without compromise. Whereas traditional titanium dental implants can leave an unsightly dark ring around the edge of the crown, metal-free implants look healthy and natural because of the high-grade zirconium with which they are crafted. Additional benefits associated with metal-free dental implants include: 1) Biocompatibility with surrounding gum tissue; 2) Improved resistance to the buildup of plaque and tartar, primary culprits of gum disease; 3) Preferable alternative for patients who are sensitive to titanium; 4) Better choice for patients who prefer a holistic approach to oral health.
The recent discovery that stem cells exist in teeth has the potential to transform dentistry and the future of medical treatments. Researchers use stem cells to create living dental implants. Further technological advancements could possibly become more common worldwide, perhaps in few years’ time, Titanium implants could be a thing of the past and stem cell dental implants may become the most prominent tooth replacement option. It is likely that this knowledge will enable all cosmetic dentists to regenerate missing teeth within the patients’ mouth as an alternative to Conventional dental implants that have involved placing a screw in the jaw, which is attached to a "post" with a porcelain replacement tooth.

Stem Cell grafting is the latest technology in helping bone to grow in deficient parts of the jaw. The stem cells used are derived from tissues originating from the tip of the removed tooth root, called root apical papilla. These stem cells have the capability to reproduce and develop other tissue such as bone, cartilage and skin. Stem cells are collected by needle aspiration from the hipbone and placed against the receiving site in the jawbone. This technology means people previously unable to have implants, or who could have them only after lengthy surgeries, can now be given “new” teeth in less than nine weeks from initial implantation. Unlike current dental implants, these teeth adapt to changes that occur to the jaw bone over time, limiting the need for costly and time consuming adjustments or replacement implants. New developments in stem cell research are presented almost every day, just as new ground is being made with dental implant procedures in dentistry, and using these advances researchers are able to extract stem cells from wisdom teeth which are then banked and used to preserve and protect patient’s teeth and smile in a special cryogenic storage facility.

**CONCLUSION**

The ultimate goal of future research initiatives is to produce biomaterials and therapies that will improve current standards of care, customized to patient’s preferences and specific needs and improve quality of life. This will require greater integrated and interdisciplinary team work between the fields of bioengineering, tissue engineering, material sciences, biology and clinical sciences. Research in implant dentistry is not without problems and challenges. Studies in dental implantology are expensive to conduct, difficult to blind, require prolonged follow-up and frequently impossible to undertake owing to ethical constraints. Funding for research will increasingly become...
a major challenge for researchers. Pooling resources through multicentre trials and collaborative efforts are some of the innovative methods of addressing this challenge.

**Disclosure**

The authors report no conflicts of interest with anything mentioned in this article.

**References**

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Background: The aim of this paper was to obtain an objective, quantitative assessment of the clinical performance achieved with a specific implant line that was extensively used in an implantological office setting. A retrospective chart review was conducted with the aim to clarify whether the subjective good experience with the used Titanium implant line is supported by clinical results.

Methods: The clinical performance of implants with hydrophilic (INICELL) and hydrophobic (TST) enossal surfaces was compared. The cumulative implant survival rate was calculated.

Results: The data of 1063 patients that received 2918 implants (1337 Inicell, 1581 TST) has been included in the chart review. The average follow up time was 2.1 (1.1 - 5.4) years for INICELL and 4.5 (1.3 - 5.9) years for TST implants. In the reported period 7 implants with INICELL (0.5 %) and 23 TST implants (1.5 %) have failed. This difference is statistically highly significant.

Conclusions: The analysis of cases treated in a single implantological office for almost 6 years confirmed the very good clinical outcome that was achieved with both used implant lines. Within the limitations of this retrospective analysis, the overall early failure rate of the hydrophilic implants was significantly lower than that of hydrophobic implants. The use of hydrophilic implants allows the clinician to obtain less early failures, hence the interest of an up-to-date surface for the daily work of an implant practice.

KEY WORDS: Dental implants, failure rate, case series, enossal surface, hydrophilic, hydrophobic

1. Private practice, France
BACKGROUND
The reconstruction of missing teeth by Titanium dental implants is currently the gold standard in dental rehabilitation.\cite{1,2} Their clinical performance has been documented for certain brands but currently there is a wide variety of dental implants with limited, or even no clinical documentation. Ever since the first studies showing the clinical interest of the peculiar affinity of bone tissue for titanium industry has invested a lot in order to improve the implant surfaces.\cite{3} This is why, in the course of time, clinicians had at their disposal implants simply machined, then in the 80s rough implants through plasma spray, which resulted in an improved rate of osseointegration. Later on, the microstructured, or moderately rough, surfaces realized through sand-blasting and etching have become the gold standard with failure rates as low as 1%.\cite{1} Recent developments should even improve osseointegration, especially by rendering the surfaces to become hydrophilic. Such is the case of INICELL which is created immediately before implantation by exposing the standard surface TST to the conditioning liquid and thus raising the surface energy. This modification has no influence on surface roughness. The advantage of hydrophilic enossal surfaces is in the earlier osseointegration.\cite{4} The performance of the surfaces was evaluated first mechanically (removal torques) histomorphometric analyses allowed to determine the rate of contact between bone and implant (BIC) assuring a good quality of osseointegration.\cite{4} Last but not least clinical studies observe the behavior of these implants loaded earlier and earlier, for instance at 3 weeks.\cite{5} The clinician may wonder about the interest for his patient to use implants that can be loaded at 3 weeks whereas those at 2 months work perfectly, unless the failure rate can be diminished and the marginal bone loss reduced.

The aim of this paper was to obtain an objective, quantitative assessment of the clinical performance achieved with a specific implant line. A retrospective chart review was conducted with the aim to clarify whether the subjective good experience with the used Titanium implant line is supported by clinical results. Implants with hydrophilic (INICELL) and hydrophobic (TST) enossal surfaces was compared.

METHODS
In 2007, the author started using titanium ELEMENT RC implants (cylindrical enossal shape, self-cutting threads, 1 mm polished collar for optimal esthetic results; Thommen Medical AG, Grenchen, Switzerland). At that time the implants had a state-of-the-art moderately rough enossal surface (sand-blasted-acid etched; TST). In 2010 the author “switched” to use the same implant line with a super-hydrophilic (INICELL®) surface (Thommen Medical, Grenchen, Switzerland).

Due to the retrospective data analysis the patients have not been exposed to any additional risk, therefore an Ethical Committee approval was not sought for. All measures have been taken in order not to disclose any patient personal data. Included are all patients that have received implants, no exclusion from the analysis was done e.g. for known risk factors, such as smoking, findings in medical history, etc. The retrospective results represent the review of all consecutively placed implants in a specialized center for oral implantology. As for the surgical implant bed prepara-
tion technique, the manufacturer instructions have been followed. Patients that received both INICELL and TST implants underwent the following treatment protocols:

1) immediate loading; 2) immediate temporization with bone grafting, mainly for simultaneous and two-stage sinus lifting using DBBM (Bio-Oss, Geistlich, Switzerland) or calcium triphosphate (TCP, CEROS, Thommen Medical AG. Waldenburg, Switzerland); 3) guided bone regeneration using either autogenous bone from the retromolar area or autologous bone (TBF, France). Augmentation surgery has been performed prior to the implant placement. The bone healing time was 4 months when autogenous bone was used, 5 months when patients received allogeneic bone, and 6 months or more with the bovine bone.

Based on the recorded implant survival, the cumulative implant survival rate was calculated. The differences in (early) implant failure rate were statistically tested (Fisher’s exact test).

**RESULTS**

The follow up data of 1063 patients that received 2918 implants has been included in the chart review. The patients have been treated i.e. implants inserted between October 2007 and July 2012. 1337 (45.8%) of the reported implants had INICELL and 1581 (54.2%) TST enossal surfaces. As mentioned above, the hydrophilicity / hydrophobicity of the enossal surface was the only difference between both implant types.
34% of the patients have received 1 implant, 29% two, 13% three and 24% of patients received 3 - 15 (1 patient) implants (Fig. 1) i.e. most frequently placed were 1 - 2 implants per patient. Of the INICELL implants, 56% were inserted in the maxilla and 44% in the mandible. Similarly, 57% TST were placed in the upper and 43% in the lower jaw (Fig. 2). The replacement pattern between the INICELL and TST groups was quite similar, thereby validating the homogeneity of the presented sample. The replacement of individual tooth positions was balanced (Fig. 2). Both INICELL and TST implants had platform diameters (PF Ø) 3.5 - 6.0mm and they were 6.5 - 14.0mm long (Fig. 3).

Immediate loading was the case in 75 (7.1%) edentulous patients that have received 493 (16.9) implants (267 (20%) INICELL and 226 (14.3%) TST). Immediate temporization was done in 74 (7.0%) patients. These patients received 35 (2.6%) INICELL and 39 (2.5%) TST implants. Bone grafting material was used with 258 (8.8 %; INICELL and TST)
implants. calcium triphosphate (TCP, CEROS) was used in 122 (11.5%), whereas Bio-Oss in 136 (12.8%) cases. Both bone grafting materials were used mainly for simultaneous and two-stage sinus lifting (29 (2.7%) and 53 (5.4%) cases respectively), sinus lift according to Summers5 (158 cases i.e. 14.9%) and guided bone regeneration (92 cases i.e. 8.7%). Autogenous bone was used in 36 (3.4%) cases, from the retromolar area and autologous bone (TBF, France) in 6 (0.6%) cases. In 56 (5.3%) cases an augmentation surgery has been performed prior to the implant placement. The bone healing time was 4 months when autogenous bone was used, 5 months when patients received allogeneic bone, and 6 months or more with the bovine bone.

The implant healing time recommendations of the manufacturer were also followed. Typically, it was 3 and 8 weeks for INICELL and 6 or 12 weeks for TST implants that were restored as single crowns. In edentulous patients, imme-

Figure 3: Overview of used implants by diameter and length.
Immediate loading was done whenever possible, or temporary (non-occlusal) crown was attached immediately after implantation (see above).

The average follow up time was 2.1 (1.1 - 5.4) years for INICELL and 4.5 (1.3 - 5.9) years for TST implants. In the reported period 7 (0.5%) implants with INICELL and 23 (1.5%) TST implants have failed. This difference is statistically highly significant (Table 1, Fisher’s exact test). All implant failures occurred early i.e. before functional implant loading at the radiological check of the osseointegration at 2 months after implant placement. As implants have been loaded immediately, the check of integration was done at 2 months later by X-ray and clinically after removing the provisional crown. Among the 7 failed INICELL implants, 3 were with reduced diameter (PFØ 3.5mm), 2 were immediately loaded, 1 was provisionally loaded and 1 implant failed in an edentulous patient with immediate loading. Of the 23 failed TST implants 5 were with reduced diameter (PFØ 3.5mm), 6 were lost in 4 immediately loaded, edentulous patients, 3 implants were lost in 2 patients with sinus lift. 9 implants have been lost in patients with immediate temporization. The reported implant failures resulted in an overall cumulative survival rate of 99.0%. This is quite satisfactory considering the mean observation period of 4 (1.1-5.9) years. For INICELL the cumulative survival rate was 99.5%, for TST implants it was 98.5%. The apparently lower CSR of the TST implants (Table 1) was not attributable to the longer observation time of TST 4.5 (1.3 - 5.9) years as compared to INICELL implants 2.1 (1.1-5.4) years, as all of the failures occurred before implant loading. The lower early survival rate of INICELL implants was also mirrored in the survival rate recorded for individual indications:

Table 1: Cumulative Survival Rate

<table>
<thead>
<tr>
<th>Failed Implants</th>
<th>CSR</th>
<th>Observation period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>30</td>
<td>99</td>
</tr>
<tr>
<td>INICELL</td>
<td>7*</td>
<td>99.5</td>
</tr>
<tr>
<td>TST</td>
<td>23*</td>
<td>98.5</td>
</tr>
</tbody>
</table>

Standard cases: within the reported population 640 patients received 968 INICELL and 1064 TST implants. In standard cases implants have been placed after performing a full thickness flap and preparation of the implant bed by using the drilling sequence (recommended by the manufacturer). Most of the time a healing screw was placed and sutures done. 6 weeks later the permanent crown was fabricated and screw-attached with the torque recommended by the manufacturer (25 N for platforms between 4 and 6 mm and 15N for the 3.5mm). Early failures have occurred with only 1 INICELL and 9 TST implants. This difference was also statistically significant (p < 0.05; Fisher’s exact test).
Edentulous cases: 75 edentulous patients received 493 immediately loaded implants (267 INICELL and 226 TST). Of these 2 INICELL and 6 TST implants have failed early. In some of these patients the implants have been placed with the help of navigated surgery.\(^7\)

Immediate loading: immediate non-occlusal loading of single tooth was done in 74 patients with 35 INICELL and 39 TST implants. Only 1 INICELL implant failed early.

Sinus floor elevation: Consecutive and simultaneous sinus lift was done in 240 patients that have received 86 INICELL and 141 TST implants. Only 3 TST implants failed early.

Reduced diameter implants: from the 228 INICELL and 203 TST inserted reduced diameter (PFØ 3.5mm) implants early failures occurred with 5 TST and 3 INICELL implants (this difference is not statistically significant).

**DISCUSSION**

Most recent studies suggested a low early failure rate of < 1% and a success rate of > 95% at 10 years for non-smokers.\(^8\) Garcia-Bellostá et al.\(^9\) reported the long term survival of 980 implants that were inserted in 323 patients a periodontal practice. After 5 years follow up the CSR was 96.2%. The authors were not able to detect any significant influence of smoking on implant survival. The reported CSR is also comparable with the results obtained in a similar retrospective evaluation of the TST implants.\(^10\) The authors have compared the survival of TST implants with reduced and standard diameters. Their report comprised 332 patients which received 736 TST implants in three practices in Switzerland. The main finding was that the CSR of TST implants with reduced diameter (99.5%) was no different from the CSR of standard diameter implants (99.7%). The average follow up time was 20 months. Olate et al.\(^11\) demonstrated that implant length and position in frontal regions correlated significantly with early failure rate. This finding was not confirmed in the presented study as the overall number of failed implants was quite low. The overall as well as individual INICELL and TST (early) failure rates reported in the presented retrospective analysis are therefore very well comparable with that of other implant systems.

The analysis of cases treated in a single implantological office for almost 6 years confirmed the very good clinical outcome that was achieved with both used implant lines (ELEMENT® RC INICELL or TST). Only early failures have been observed with 7 INICELL and 23 TST implants. As a result of careful case evaluation, diagnosis and planning, a high overall survival rate of 99.0% was achieved after an average follow up period of 4 years. This compares well to other implant systems for which the survival rate was investigated in prospective clinical trials that usually exclude complex cases. The optimal interplay of all components of the used implant line very likely contributed to the outstanding survival rate. INICELL, the newly introduced hydrophilic enossal surface is very well suited for early loading.\(^12\) It has also lead to significantly improved early failure rate. In spite of the limitations of this chart review analysis, the paper has achieved its goal i.e. the results of this quantitative long term assessment help to objectively assess the success rate of the implant treatment.
CONCLUSIONS
Within the limitations of this retrospective analysis, the overall early failure rate of the hydrophilic implants was significantly lower than that of hydrophobic implants. A large number of patients and implants has been followed long-term. The monitored implants had identical geometry, they differed only in the physico-chemical properties of their enossal surfaces i.e. hydrophilic (INICELL) and hydrophobic (TST) enossal surfaces have been compared. The use of hydrophilic implants allows the clinician to obtain less early failures, hence the interest of an up-to-date surface for the daily work of an implant office setting.

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Disclosure
The author reports no conflicts of interest with anything mentioned in this article.

References
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