



RADIOGRAPHIC DETECTION AND CHARACTERISTIC PATTERNS OF RESIDUAL EXCESS CEMENT ASSOCIATED WITH CEMENT-RETAINED IMPLANT RESTORATIONS: A CLINICAL REPORT

Chandur Wadhvani, BDS, MSD,^a Darrin Rapoport, BDS, MSD,^b Silvia La Rosa, DDS,^c Timothy Hess, DDS,^d and Stefanie Kretschmar, Dr med dent, MSD^e
University of Washington, Seattle, Wash

Residual excess cement (REC) is a common complication of cement-retained prostheses and has been linked to peri-implant disease. Removal of the cement residue may result in resolution of the issue if addressed early in the disease process. However, this is dependent upon the ability to locate and adequately remove the foreign material. This series of patient scenarios describes the ability to detect REC by using dental radiography. Characteristics related to cements and flow patterns specific to implants are addressed. (J Prosthet Dent 2012;107:151-157)

Residual excess cement (REC) is a common complication of cement-retained implant prostheses^{1,2} that can result in a local inflammatory process which has been documented as a cause of periimplant disease.^{3,4} The etiology is not fully understood but is believed to relate to bacterial colonization of the foreign material, which can occur several years after the restoration has been completed.⁵ If the REC is identified and removed, the majority of problems can be resolved.⁵ The prevention of cement extrusion during the restoration process beyond the restorative cement margins cannot be underestimated; however, this may be more difficult than it appears. In vitro model systems have demonstrated the difficulty in controlling and removing REC⁶ by visual and tactile means even when supragingival crown/ abutment margins have been placed.⁷ Radiographic evaluation allows for a noninvasive evaluation of the site to locate REC. Detection is influenced by factors

such as the composition of the cement,^{8,9} the amount, and the site. Other disciplines within dentistry¹⁰ have required radiopacity specifications for cements, but no mandatory minimal standard specification exists for implant cements.¹¹ This clinical report highlights varying degrees of REC detection by using intraoral dental radiographs. The radiographic detection and characteristic patterns of cement flow are also described.

CLINICAL REPORT

Patient 1: Cement superimposition

A 48-year-old man in good general health presented for replacement of the maxillary right central incisor that had been extracted 6 months earlier. Initial impressions were made, followed by diagnostic waxing and the fabrication of a surgical guide. The guide was used to direct the implant placement such that the head of the implant (Standard Plus Implant,

Regular Neck; Straumann, Andover, Mass) was located 3 mm below the proposed facial gingival margin. A 3 mm high healing abutment (Straumann) was placed at the time of surgery, and an interim removable prosthesis was provided for the patient during the healing phase. Four months after the implant placement, clinical and radiographic integration was confirmed, and the patient was referred for the definitive restoration. This consisted of a metal ceramic crown cemented with a zinc oxide and eugenol cement (TempBond, Kerr Corp; Orange, Calif) onto a cast gold custom abutment (SynOcta gold abutment; Straumann).

Seven months after completion of the restoration, the patient presented with a draining sinus tract on the midfacial aspect of the implant site (Fig. 1A). A size 20 ISO gutta percha point (Henry Schein, Melville, NY) was placed into the sinus tract (Fig. 1B), and a radiograph was made. The gutta percha point terminated at the

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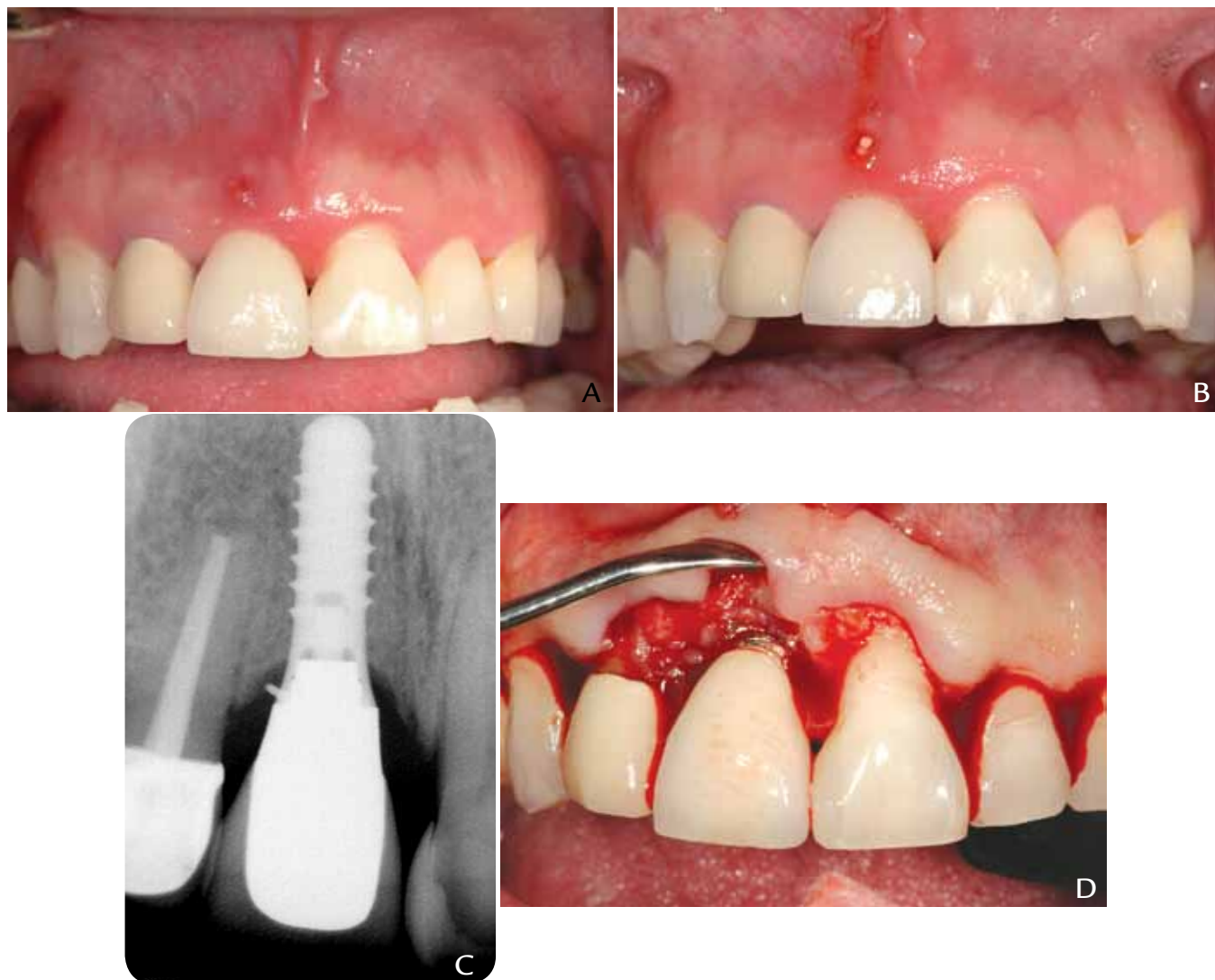
^aPrivate practice, Bellevue, Washington and Affiliate Faculty, Department of Restorative Dentistry.

^bPrivate practice, Tukwila, Washington.

^cPrivate practice, Tacoma and Gig Harbor, Washington.

^dPrivate practice, Auburn, Washington.

^ePrivate practice, Stuttgart, Germany.



1 A, Seven months post cementation of implant crown. B, Gutta percha point placed into sinus tract. C, Radiograph, gutta percha point visible. D, Full thickness flap raised, exposing cement residue.

abutment/crown interface (Fig. 1C). Initial nonsurgical attempts to debride the site under local anesthesia were unsuccessful, and it was decided to treat the area surgically. Full thickness facial and lingual flaps were elevated to reveal residual subgingival REC deposits at the crown/abutment interface (Fig. 1D). The REC was located predominantly on the facial aspect, such that the superimposition of the cement on the metal implant components rendered the cement almost impossible to detect radiographically.

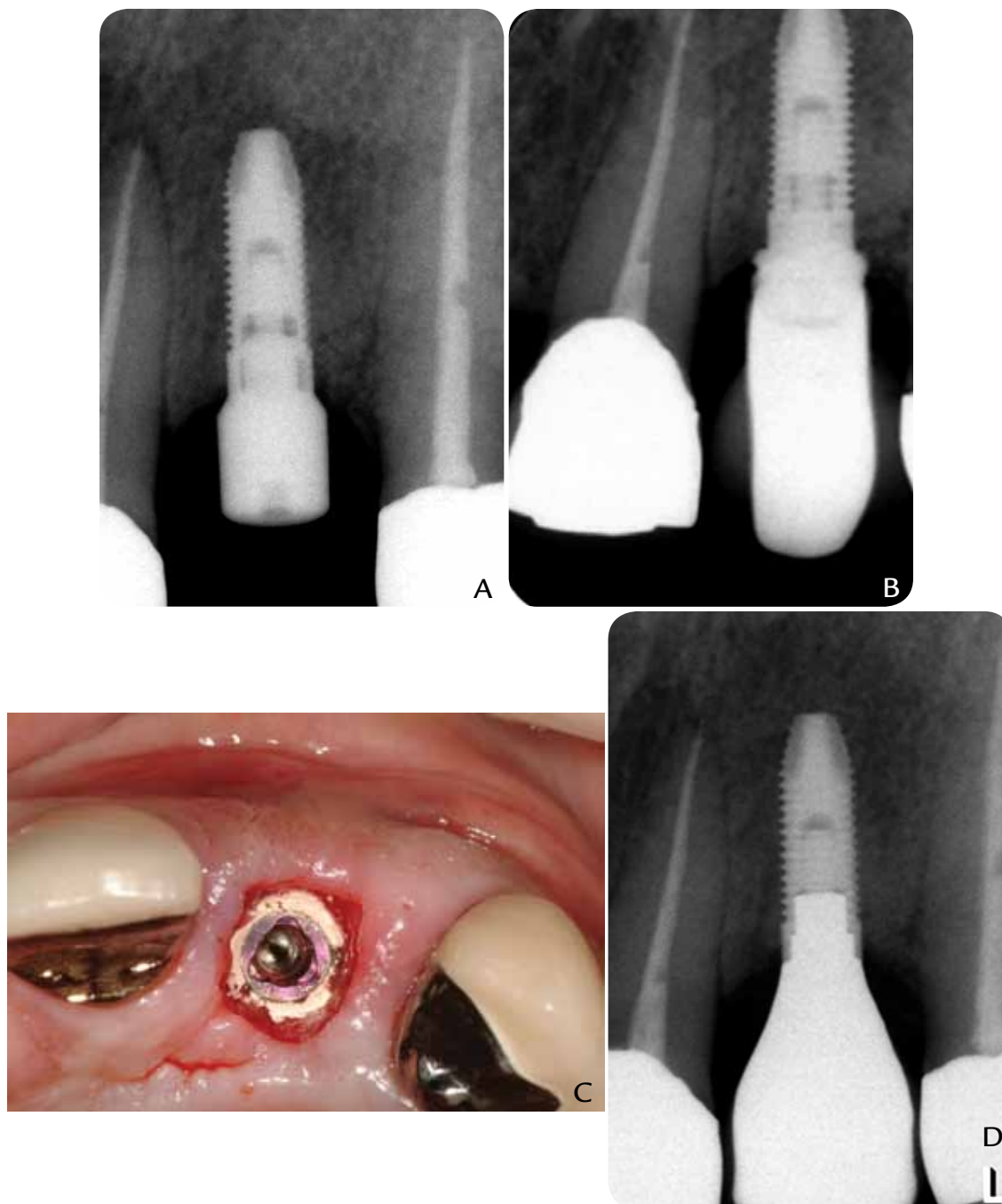
The residual cement was removed with hand scalers, (Implacare tip curettes: Columbia 4r/4l, 204s, h6/h7; Hu-Friedy, Chicago, Ill) taking care to avoid damaging the implant sur-

face. An autogenous connective tissue graft was harvested from the right palatal vault area and secured over the facial aspect of the implant. The sinus tract resolved completely within 6 months, and the patient was placed on a 4 month interval recall program, including probing depth monitoring and annual radiographs.

Patient 2: Highly radiopaque cement

A 55-year old woman was referred for an implant restoration to replace the maxillary left lateral incisor. The tooth had been extracted 2 years previously and replaced with a provisional removable prosthesis. The patient reported no medical problems or known allergies at the time of

consultation. Clinical evaluation revealed a buccolingual concavity at the proposed implant site. Radiographically, a crestal deficiency was noted in relation to the mesial aspect of the adjacent canine. An implant (Nobel-Speedy; Nobel Biocare, Yorba Linda, Calif) (Fig. 2A) was placed with a simultaneous addition of bone graft material - a combination of 50% xenograft (Bio-Oss; Osteohealth, Shirley, NY) and 50% allograft cortical particulate mineralized FDBA, (LifeNet Health Inc, Virginia Beach, Va) on the buccal aspect of the implant. The bony defect noted on the adjacent maxillary left canine was managed with the same augmentation materials. A collagen membrane (Bio-Gide; Osteohealth) and an autogenous connec-



2 A, Prerestoration radiograph. Implant considered integrated. B, Post insertion radiograph. Restoration with radiopacity noted. C, Crown and abutment removed, cement encircling abutment visible. D, Post treatment radiograph, note replacement with screw-retained restoration.

tive tissue graft harvested from the left palate to provide additional ridge augmentation were placed over the hard tissue augmentation site. The patient continued to wear the removable provisional prosthesis for an additional 4 months, allowing the site to heal. Once the implant had achieved clinical and radiographic osseointegration (Fig. 2A), the patient was referred to a restorative dentist for

definitive treatment. One week after the definitive restoration was placed, the patient returned for a soft tissue and radiographic post restoration evaluation. The soft tissue appeared pale pink with no signs of inflammation. However, a radiograph revealed the presence of REC (Fig. 2B). On removing the crown and the abutment, the implant platform was found to be encircled by cement (Fig. 2C), which

was subsequently removed. A new healing abutment was placed, and the restoring dentist was asked to reconsider the restorative options available. Because the implant position was favorable, the subsequent restoration was screw-retained (Fig. 2D), which eliminated the issues associated with cement. The patient was then provided with supportive periodontal therapy and annual implant assessment

including radiographic, occlusal, and soft tissue evaluation.

Patient 3: The circumferential effect

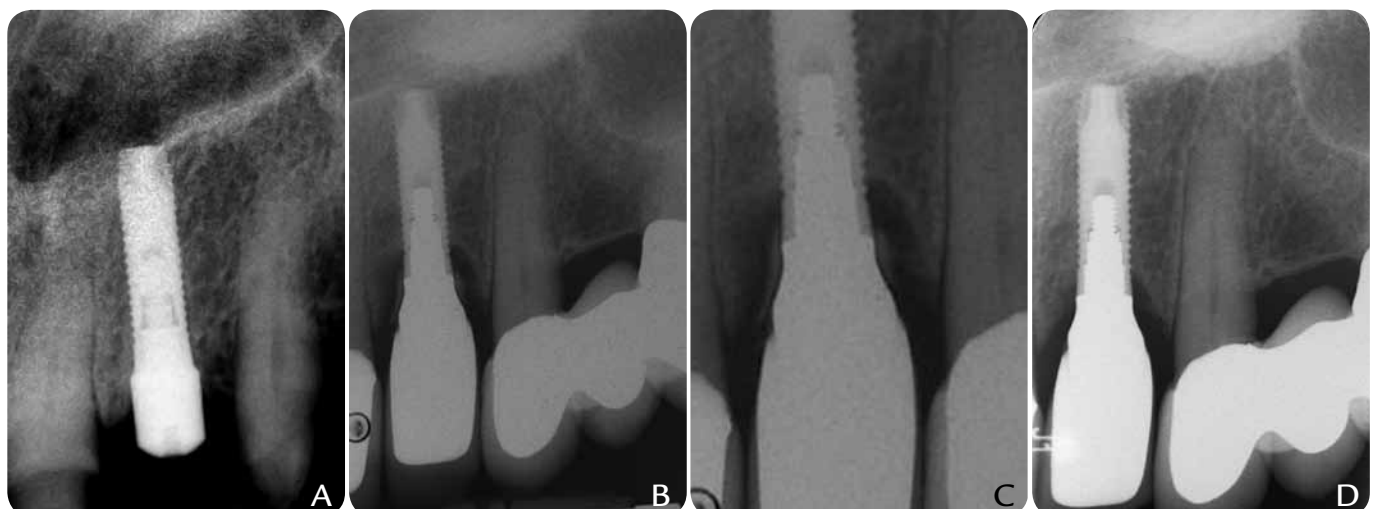
A 68-year-old woman presented with a Type IV fracture of the left lateral incisor. After clinical and radiographic assessment, the treatment option chosen was to extract the tooth remnant and evaluate for possible immediate implant placement. The tooth was extracted by gentle elevation, leaving an intact facial bony alveolar socket wall. An immediate implant (Osseotite MicroMiniplant, 3.25/3.4; Biomet 3i, Palm Beach Gardens, Fla) was placed along with a healing abutment (Fig. 3A). No graft material was used as the gap between the implant and the facial bony wall was less than 2 mm. An invisible retainer (Clear Splint Biocryl 0.75 mm; Great Lakes Orthodontics Ltd, Tonawanda, NY) containing an acrylic resin denture tooth (Trublend; Dentsply Intl, York, Pa) was used for a provisional restoration. The healing was uneventful, and 10 months postoperatively a screw-retained acrylic resin provisional crown was attached to the implant to contour the soft tissue emergence profile. It remained fixed to the implant for 6 months. The definitive restoration chosen was a metal ceramic crown, cemented onto a custom abutment (Atlantis, Astra Tech Inc,

Waltham, Mass) with resin reinforced glass ionomer cement (Vitremer; 3M ESPE, St Paul, Minn). Nine months after placement of the final restoration the patient presented complaining of a bad taste originating at the implant area. The site was evaluated, and supuration was expressed upon gentle finger pressure around the soft tissues adjacent to the implant. A radiograph revealed a radiopacity immediately adjacent to the implant restoration complex with associated interproximal bone loss (Fig. 3B). The radiographic appearance of the REC was indicative of a thin circumferential layer of cement, which was magnified by tangential exposure to the radiographic beam (Fig. 3C). The site was subsequently treated by closed debridement. The follow-up radiograph (Fig. 3D) and clinical examination failed to reveal residual cement, and no signs or symptoms of inflammation were detected. The patient was observed 1 month later and then at 3 monthly intervals for the first year; no further issues relating to the implant site were found.

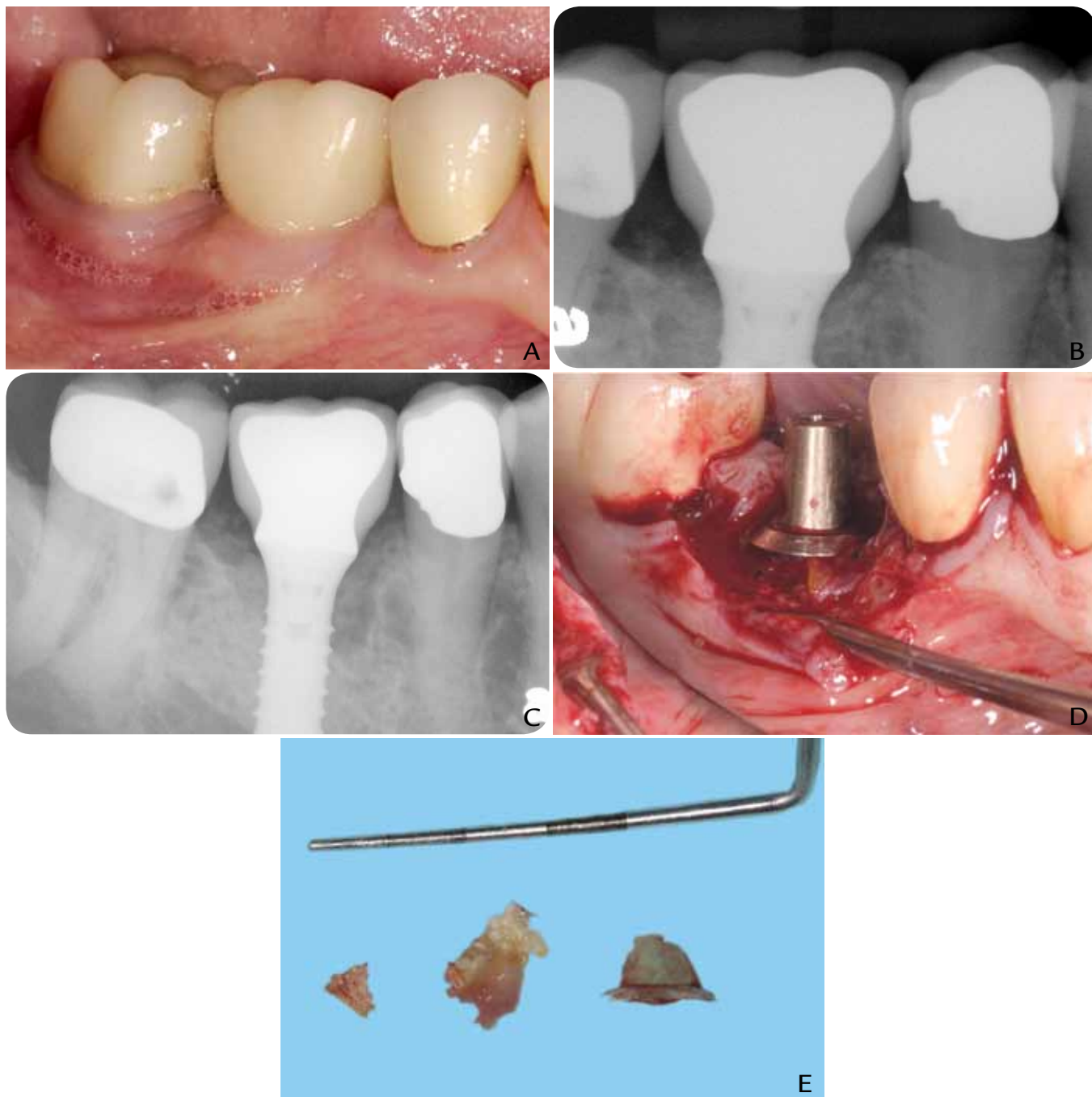
Patient 4: Radiolucent cement

A 58-year-old man with a history of colon cancer and smoking presented with failing endodontic treatment on the distal root of the mandibular right first molar. The prognosis for

the tooth was hopeless, and it was extracted. The extraction socket site allowed for immediate implant (Wide Neck implant; Straumann) placement with simultaneous hard tissue allograft bone augmentation (Puros; Zimmer Dental Inc, Carlsbad, Calif). The platform of the implant was such that the buccal margin was placed 1 mm below the existing gingival margin. The implant site remained unrestored for 7 months with uneventful healing. Once clinical osseointegration was confirmed, a stock abutment (Wide Neck solid abutment; Straumann) was placed, and a torque of 35 Ncm was applied. A closed tray impression technique followed. A metal ceramic crown was fabricated, evaluated for fit, occlusion, and color, and then cemented with an implant specific acrylic urethane cement (Premier Implant Cement (applicable to batches manufactured prior to November 2011); Premier Dental, Plymouth Meeting, Pa) (Fig. 4A). A radiograph was made after cementation to verify the complete seating of the restoration and the removal of REC. The patient was placed on a 3 month alternating hygiene schedule with the restorative dentist and periodontist. Routine periimplant probing measurements and radiographs made 14 months after final restoration were unremarkable (Fig. 4B) and with no



3 A, Prerestoration radiograph of implant. B, Radiograph indicating “peripheral egg shell” effect—(layer of REC). C, Magnified view of 3B. D, Post treatment radiograph with cement removed.



4 A, Post insertion photograph of implant placed in mandibular right first molar site. B, Fourteen months post restoration radiograph, no evidence of bone loss around implant. C, Thirty-two months post insertion radiograph, bone loss evident, no indication of residual cement. D, Surgical exposure of REC. E, Cement remnants removed compared to periodontal probe with 3.

signs or symptoms of any pathological events. However, at 32 months, after completion of the restoration, clinical evidence of inflammation was noted. Bleeding on probing, an increase in periimplant probing depths, and a radiograph indicated bone loss associated with the implant (Fig. 4C). Treatment was initiated by removing the crown but leaving the stock abut-

ment in place. The periodontist prepared a full thickness flap to expose the residual REC circumferentially around the implant (Fig. 4D, 4E). Debridement of the inflammatory tissue was performed with both hand and ultrasonic instrumentation by using a piezoelectric unit (Piezon Master 600; Electro Medical Systems, Dallas, Texas) with a plastic coated im-

plant cleaning tip (PI, Piezon Implant Cleaning, Electro Medical Systems). The implant surface was treated with sterile saline (0.9% sodium chloride; Salvin Dental Specialties Inc, Charlotte, NC) before grafting the residual defect with an allograft material (Puros; Zimmer Dental Inc). This was followed by flap closure.

DISCUSSION

REC results from extrusion of cement during the restoration placement process. Factors that determine the quantity and location of the REC are beyond the scope of this report. However, they include: amount of cement used, viscosity and flow properties of the cement, forces during placement, margin integrity, ability to remove unset cement, abutment material, texture, and shape.

The association of cement remnants with periimplant diseases requires that any REC beneath the tissues around an implant be detected and removed. However, the detection and removal of REC by visual and tactile methods has been shown to be problematic^{4,5} even when the implant crown cement finish line height is controlled. The influence of margin location on the amount of undetected cement excess after insertion of cement-retained implant restorations was noted even when margins were placed 1 mm above the soft tissue level. The results indicated a significant difference among each test group for all but the deepest 2 groups, with margin depths ranging from -3 mm to 1 mm above the soft tissues at 1 mm intervals. It was reported that the -2 mm and -3 mm level soft tissue margins showed the greatest cement excess weight of all groups. The margins of the patients reported were all 1 to 2 mm below their respective free gingival margins, with the exception of patient 3 where the margin was 3 mm below.

The radiograph relating to patient 3 also indicates the crown failed to seat completely, leaving a margin that would have allowed greater excess cement to be extruded during placement. This may have occurred because of too much cement within the crown, tight proximal contact, tight fit of the crown, inadequate cement space, not following cement manufacturer recommendations regarding working and setting time, or inadequate pressure application while seating the crown. Some of these issues

are seen on a precementation radiograph and can be corrected, before complete seating.

There are no minimum specific radiographic standards for implant cements.¹¹ The radiopacity of some commonly used cements has been documented⁸ and a large variation in radiographic detection ability has been reported. Some cements have high radiographic density which allows for easy radiographic detection; others cannot be detected even at 2 mm thickness. The radiographic opacity of a material varies directly with the third power of the atomic number of the absorber elements.⁹ For this reason the zinc found in zinc phosphate and zinc oxide/eugenol cements is highly detectable (patient 2). This is in contrast to the low atomic number elements found in acrylic urethane cements that are difficult to detect radiographically (patient 4) unless the manufacturer purposefully adds agents containing higher atomic numbers to increase the radiopacity.

Apart from the composition of the cement, the location and pattern of cement extrusion around the restoration may alter the ability to detect the excess. Patient 1 is an example of the use of a highly radiopaque cement (containing zinc) that extruded facially to the implant surface, making

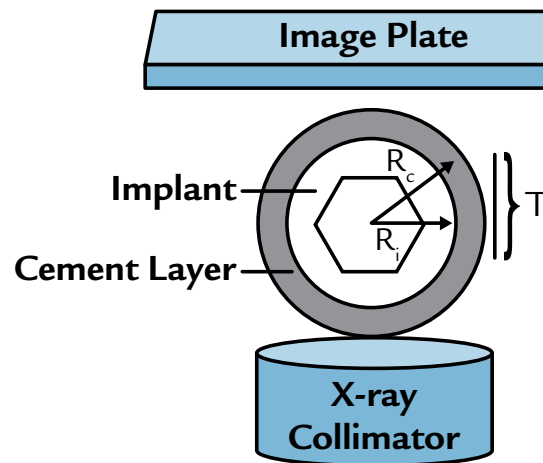
detection problematic. The use of a radiographic tracer marker highlighted the origin of the tract which, upon surgical exposure, revealed the REC.

The site of extrusion may, under the right conditions of cement flow, enhance radiographic detection. Patient 3 is an example of a cement (resin modified glass ionomer) that is less radiopaque than a zinc cement, and that was detectable even though a minimal layer was used. This is because implants are generally circular in cross section, and when the cement flow follows this shape, a circumferential layer results. Because the radiographic beam passes tangentially through the thickness of the thin cement layer many times, an observed attenuation results (the peripheral egg-shell effect) (Fig. 5).⁹

Differing radiographic appearances of REC extrusion into the periimplant tissues have been demonstrated. These detection patterns are a result of the amount, site, and radiographic density of cements used.

SUMMARY

This article describes 4 patterns found with intraoral radiography when evaluating areas for REC. The clinical report presented demonstrates the varying degrees of radiopacity



5 “Peripheral egg shell” effect, x-ray beam and radiographic plate are perpendicular to cement film, exposing increased thickness of cement. T: Tangential depth, Rc: Radius of implant plus cement, Ri: Radius of Implant. Calculation: $T = 2\sqrt{Rc^2 - Ri^2}$.

found in cements used for implant restorations and describes the circumstances under which the characteristic radiographic image was produced. By understanding these issues, the clinician may be able to diagnose problems earlier and better select a cement for implant restorations.

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Corresponding author:

Dr Chandur Wadhvani
1200 116th Ave, NE, #A
Bellevue WA 98004
Fax: 425-462-1878
E-mail: cpkw@uw.edu

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NOTEWORTHY ABSTRACTS OF THE CURRENT LITERATURE

Clinical performance of porcelain laminate veneers for up to 20 years

Beier US, Kapferer I, Burtscher D, Dumfahrt H.
Int J Prosthodont 2012;25:79-85.

Purpose: The aim of this clinical retrospective study was to evaluate the clinical quality, success rate, and estimated survival rate of anterior veneers made of silicate glass-ceramic in a long-term analysis of up to 20 years.

Material and methods: Anterior teeth in the maxillae and mandibles of 84 patients (38 men, 46 women) were restored with 318 porcelain veneer restorations between 1987 and 2009 at the Medical University Innsbruck, Innsbruck, Austria. Clinical examination was performed during patients' regularly scheduled maintenance appointments. Esthetic match, porcelain surface, marginal discoloration, and integrity were evaluated following modified California Dental Association/Ryge criteria. Veneer failures and reasons for failure were recorded. The study population included 42 (50.0%) patients diagnosed with bruxism and 23 (27.38%) smokers. The success rate was determined using Kaplan-Meier survival analysis.

Results: The mean observation time was 118 ± 63 months. Twenty-nine failures (absolute: 82.76%, relative: 17.24%) were recorded. The main reason for failure was fracture of the ceramic (44.83%). The estimated survival rate was 94.4% after 5 years, 93.5% at 10 years, and 82.93% at 20 years. Nonvital teeth showed a significantly higher failure risk ($P=.0012$). There was a 7.7-times greater risk of failure associated with existing parafunction (bruxism, $P=.0004$). Marginal discoloration was significantly greater in smokers ($P \leq .01$).

Conclusion: Porcelain laminate veneers offer a predictable and successful restoration with an estimated survival probability of 93.5% over 10 years. Significantly increased failure rates were associated with bruxism and nonvital teeth, and marginal discoloration was worse in patients who smoked.

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