Diagnosis, equilibration, and restoration of an orthodontic failure

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This case report illustrates how an interdisciplinary team diagnosis led to occlusal correction of a significant postorthodontic malocclusion. The patient had received complete orthodontics twice previously, from different orthodontists. She could not close without pain or chew comfortably and was concerned about progressive gingival recession. A comprehensive clinical examination, occlusal analysis with diagnostic casts verified in centric relation, bite splint therapy, and full-mouth equilibration were completed prior to limited restorative dentistry. The patient has been comfortable with a stable occlusion for three years.

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Interdisciplinary dentofacial therapy (IDT) refers to coordinating the expertise of each team member to produce the optimum dental result for the patient. Diagnostic data, treatment planning, and therapeutic procedures are organized to facilitate thorough communication between team members and the patient. Diagnosis and treatment planning are the most important phases of IDT, as subsequent therapy is based on these initial decisions. Each team member must be aware of the knowledge and technical skills of the other members so that the patient will be referred to the appropriate individual. Since a number of possible treatment plans are available for each dental problem, there must be open communication among the team members so that all options are discussed before the most appropriate treatment plan can be recommended to the patient.

This case report describes how interdisciplinary team diagnosis was utilized for occlusal correction of a significant postorthodontic malocclusion. The orthodontist made the referral based on the restorative dentist’s experience in comprehensive care and occlusal analysis. Optimum care requires that both the orthodontist and the restorative dentist possess a thorough knowledge of occlusion.

Examination and diagnosis
A 40-year-old woman stated her chief concerns as “inability to close or chew comfortably for five years after orthodontics” and “progressive gum and bone loss.” Her medical history was unremarkable. She had received complete orthodontics twice, from different orthodontists, and was unhappy with the result because of pain on closing, progressive gingival recession, maxillary incisor mobility, and obvious infraocclusion of teeth No. 20 and 31. Her consults with three new orthodontists yielded three recommendations: complete orthodontic retreatment, orthognathic surgery and orthodontic retreatment, or referral to a restorative dentist for comprehensive examination and no orthodontic treatment at all.

The preclinical interview was the first step toward understanding the patient and her problem. The patient was given time to tell her story until her history was complete and her concerns could be summarized by the dentist. She was frustrated with previous orthodontic treatment and did not know which of the current orthodontists’ recommendations to choose.

The clinical examination was conducted in a codiagnosis fashion, in which the dentist explains what he or she is doing, observing, and thinking, and the patient is encouraged to ask questions and asked to confirm that he or she sees and understands what the dentist is describing. The dentist showed her each aspect of her mouth with a magnifying mirror, explaining the significance of healthy and problem areas. The patient had a well-balanced face with a normal straight facial profile (Fig. 1 and 2). Her smile exposed the full length of enamel and she displayed a gingival asymmetry from a combination of maxillary canine and right lateral incisor recessions and overerupted maxillary central incisors (Fig. 3). Soft tissue pathology, caries, fractures, defective restorations, and deep periodontal probes were absent. Full-mouth radiographs showed apical root resorption on the maxillary incisors (Fig. 4). Mobility of these teeth ranged from Class I to Class II, depending on where the composite splint was intact or fractured.
Both maxillary and mandibular arches were well-shaped without crowding, except for the distal tilted tooth No. 22 over the infraoccluded tooth No. 20. Mandibular closure in maximum intercuspation (MI) was bilateral angle Class II canine and molar. Tooth No. 3 had a pronounced arc of closure interference in MI on the mesiopalatal cusp, separating all other posterior teeth occlusally (Fig. 5 and 6).

Palatal gingival recessions in teeth No. 3 (2.0 mm) and 14 (3.5 mm) correlated to nonworking excursion occlusal interferences. Ultrasound examination (TMJ Doppler, Great Lakes Orthodontics Ltd.) revealed a reciprocal click during lateral and protrusive excursions from a lateral pole disc displacement of the right temporomandibular joint (TMJ). The left TMJ was normal.

An example of diagnostic casts with similar occlusal problems was shown to the patient. The dentist demonstrated the details involved in brushing and flossing the teeth and asked the patient to perform those steps. Oral hygiene instruction by the dentist on the first appointment, prior to the hygienist visit, emphasizes the priority of prevention with meticulous home care.

Diagnostic casts were mounted on a semiadjustable articulator (8500 Series Articulator, Whip Mix) with a facebow, a centric relation (CR) record, and a protrusive record. An anterior acrylic platform and
bimanual guidance were used to verify that the interocclusal record was taken in CR so that the casts replicated the anatomic occlusal relationship of the patient (Fig. 7).2–4 Both TMJs were comfortable during firm condylar load testing with bimanual guidance in CR and lateral excursions. The CR mounting revealed a bilateral angle Class II canine and molar relationship (Fig. 8 and 9). The pronounced arc of closure interference on tooth No. 3 created a significant anterior open occlusal relationship and a horizontal slide of 4 mm from CR into MI (Fig. 10–12). The endpoint of this slide resulted in the splinted maxillary incisors making contact with the mandibular incisors. Nonworking interferences on teeth No. 3 and 14 separated the teeth on the working side during lateral excursion. Recessions on teeth No. 3 and 14 correlated with arc of closure and nonworking interferences on the diagnostic casts.

Occlusal trauma from the postorthodontic malocclusion was diagnosed as the reason for the patient’s pain on closing. The maxillary incisor root resorption was typical of orthodontic origin. The infraocclusion of teeth No. 20 and 31 resulted from orthodontic movement, as seen by comparing photos taken before and after the second orthodontic treatment (Fig. 13 and 14).

**Treatment planning**

Occlusal analysis requires that once all problems are identified, an appropriate solution is formulated. In this case, the patient asked if
there was an alternative to her undergoing a third course of orthodontics. Duplicate maxillary and mandibular casts were mounted on an identical articulator, with the same facebow and CR record. Trial equilibration was done only on the maxillary cast to determine if the anterior teeth could contact in CR (for proper anterior guidance) and if the posterior teeth could contact evenly (for proper vertical support).

The posterior teeth were reduced on the cast until the mandibular incisors contacted the composite splint on the palatal surface of the maxillary anterior teeth. This amount of reduction represented the maximum tooth structure lost if only equilibration was used to eliminate the occlusal interferences. The amount of reduction needs to be quantified to determine the best therapy: equilibration, equilibration with restorations to cover exposed dentin, jaw surgery, or orthodontic repositioning to avoid extensive loss of tooth structure. It is always best for the dentist to perform a trial equilibration to confirm that all occlusal requirements can be fulfilled by equilibration or whether additional procedures will be needed. This is especially important in cases with a large arc of closure interferences (which requires more tooth reduction) or cases that may result in an anterior open occlusal relationship that cannot provide optimal anterior guidance. A possible exception is a minimal arc of closure interference (<0.5 mm), which requires minimal tooth reduction and a highly experienced operator.5

A 2005 article by the author described a simple technique for measuring the volume of lost tooth structure during trial equilibration.6 Following that technique, an occlusal matrix record was fabricated on the diagnostic cast with acrylic resin (Jet, Lang Dental Manufacturing Company, Inc.) and relined with the same acrylic resin for accuracy. After polymerization, escape channels were placed palatal to the teeth (Fig. 15 and 16). Low-resistance vinyl polysiloxane (VPS) bite registration material (BluMousse, Parkell) was placed in the record and seated on the trial equilibrated model. Excess material flowed through the escape channels to prevent displacement and inaccuracy of the record. After polymerization, the VPS material was measured with a caliper; its thickness represented...
the amount and location of tooth structure that was removed during the trial equilibration (Fig. 17–19).

The thickness of the record at the mesial palatal cusp of tooth No. 3 (1.2 mm) was compared to the vertical dimension of the anterior open occlusal relationship, from the mandibular lateral incisor edge to the palatal surface of the maxillary incisor (2.5 mm)—a ratio of approximately 1:2. For each 1 mm of tooth structure reduced by equilibration on tooth No. 3, a corresponding 2 mm of space would be closed at the incisors during arc of closure. Conversely, adding 0.5 mm of composite resin to the palatal surface of the maxillary central incisors would require 1 mm less reduction of the posterior teeth to achieve anterior tooth contact. Since enamel thickness on molars is typically 2 mm at the cusp tip (tapering down to 0.5 mm in the central groove), it was determined that no dentin would be exposed as a result of enamel reduction. Equilibration was an option for correcting the malocclusion without the need for crowns to cover exposed dentin.

The diagnostic workup by the restorative dentist with trial equilibration of CR verified diagnostic casts that specified the occlusal problem and the invasiveness of the restorative solution. Discussion with the orthodontist could now answer specific questions about the advantages and limitations of possible therapies: equilibration, restoration, orthodontics, and orthognathic surgery. Information from the preclinical interview, examination, full-mouth radiographs, and diagnostic casts was used to compile a “problems list” (see Table 1). Each point on the problems list was reviewed and a “solutions list” (see Table 2) was generated in response.

Orthodontic retreatment or equilibration and limited restoration were both appropriate solutions.
that would address all points on the problems list. Advantages and limitations of each approach were discussed at the specialist/restorative dentist consult appointment so that the patient would receive the specific information necessary to make a decision. Multiple treatment plans may be acceptable, depending on the patient’s preferences and priorities.

The problems list and treatment options were reviewed with the patient until she could visualize and completely understand each problem. The patient declined orthognathic surgery, since changing her profile was not a concern and she wanted a more conservative way to improve her occlusion. Her priority was to eliminate the pain on tooth contact and to stabilize the progression of recessions. She was concerned about the mobility of the maxillary incisors and the short roots were shown to her on the radiographs. Both the pronounced arc of closure interference and the CR to MI slide were demonstrated on the diagnostic casts. The protective neuromuscular response—to avoid occlusal trauma on a single posterior tooth and move the jaw anteriorly onto the mobile incisor teeth—was discussed. Limited evidence suggests that orthodontic retreatment can be performed safely on teeth with a history of root resorption. However, the patient declined orthodontics due to the time involved and because her previous orthodontic experience had not been successful or predictable. She was not concerned about the gingival asymmetry of the maxillary anterior teeth.

The mounted diagnostic and trial equilibration casts were compared to demonstrate optimal force distribution on closure and on excursions with a programmed occlusion. As a first step, the dentist suggested using a maxillary occlusal bite splint (OBS) to protect the mobile maxillary incisors and create a noninvasive preview of proper occlusion. After a successful result with OBS therapy, the same occlusal scheme could be obtained with equilibration. A porcelain bonded crown on tooth No. 20 could then be placed into this stable occlusal relationship. Tooth No. 31 could be monitored for eruption toward the occlusal plane, initially by creating an occlusal contact on the bite splint, then by relieving this contact against the OBS, to see if recontact occurred.

**Treatment**

Using clear Jet acrylic resin, a flat-plane OBS was fabricated on duplicated mounted diagnostic casts and the occlusion was refined with even occlusal point contacts on all posterior teeth and smooth anterior teeth guidance prior to delivery. The OBS was refined with the same acrylic resin intraorally to ensure a snap fit with zero mobility. During polymerization of the resin material, the OBS was repeatedly rotated down on one side. When the resin material was fully hardened, removal would require rotation along this path. This creates a “click” on vertical seating and retention of the OBS. The occlusion was refined so that the anterior teeth did not contact with more force than the posterior teeth, the left and right sides contacted evenly on a 20 µ articulating ribbon (Accufilm, Parkell) on closure, and the anterior teeth glided smoothly in all directions while separating the posterior teeth slightly. This occlusal design was refined with rubber wheel polishing at the postoperative appointments (Fig. 20). The patient responded to the OBS by saying, “It feels even. I wish my own bite felt like that.”

Five weeks later, the composite splinting was removed from the maxillary anterior teeth. The arc of closure interference on the mesiopalatal cusp of tooth No. 3 was identical to that on the diagnostic casts (Fig. 21). Full-mouth equilibration was completed with composite bonding of the maxillary canines and central incisors. Composite resin was bonded only on the palatal aspect, so that dental floss could access the area normally. The OBS was relieved in the areas where composite resin was added to teeth, to permit complete seating. The OBS served as a precise and durable maxillary orthodontic retainer. The occlusion was refined
using the same design as the bite splint (Fig. 22 and 23). Infraoccluded teeth No. 20 and 31 did not mark against the opposing teeth. No fremitus was detected on the maxillary incisors after firm closure. The short roots of these teeth would not be able to tolerate excess occlusal force. Even bilateral posterior tooth contact on closure with posterior tooth disclusion in all excursions eliminated the occlusal interference that precipitated the occlusal trauma (Fig. 24–26).14–17 Smooth anterior guidance was confirmed by continuous marked lines on the maxillary central incisors and canines. The patient reported no discomfort, fremitus, or “catches,” especially on the maxillary central incisors with resorbed roots.18 The maxillary lateral incisors were relieved of any excursive contact due to their small remaining root surface area.

Even posterior tooth contact was confirmed through a combination of patient feedback and the appearance of uniform Accufilm marks on cusp tips, fossa, and marginal ridges. There were no remaining incline marks on posterior teeth that would create a destructive lateral vector of force. No dentin was exposed following posterior tooth reduction. The patient was pleased with the result. Minor postoperative adjustments maintained a comfortable occlusion after the rebound of tooth position due to dimensional change of the periodontal ligaments.

Tooth No. 20 was prepared for a conservative-bonded all-porcelain onlay without anesthesia, since all surfaces were intraenamel. No occlusal reduction was needed and a minimal circumferential reduction of 1 mm ensured porcelain strength (Fig. 27 and 28). Reduction of the adjacent tipped teeth was limited to enamel and permitted occlusal draw. No provisional restoration was needed, since no dentin was exposed and the interproximal contacts remained in enamel.

The porcelain onlay was conditioned with 9.5% hydrofluoric acid (PorcelEtch, Cosmedent Inc.), cleaned with 37.5% phosphoric acid (EnamelEtch, Cosmedent Inc.), and coated with silane (Silanator, Cosmedent Inc.) and unfilled composite resin (Clearfil SE Bond, Kuraray Dental). The enamel was conditioned with EnamelEtch and coated with Clearfil SE Bond prior to bonding the onlay to the tooth with flowable composite resin (StarFlow, Danville Engineering). The occlusion was refined to contact on the cusp tips or flat ridges in CR with no contact during excursions or on cusp inclines (Fig. 29 and 30). This occlusal scheme preserved vertical force distribution in line with
the long axis of the tooth during function and eliminated lateral vectors of force.

Patient feedback was solicited to confirm that the occlusal refinement was complete. She said that both sides hit evenly and that she felt much more comfortable than before. The patient wears the OBS at night and has been comfortable with a stable occlusion (verified by identical Accufilm marking) for three years. Equilibration ensured that occlusal contact in MI could be distributed comfortably by multiple posterior teeth (Fig. 31 and 32). There is no mobility on the non-splinted maxillary incisors.

**Discussion**

Failure in dentistry can be divided into two types of cases: those that fail to meet objective criteria for success and those that meet objective criteria for success but do not satisfy the patient. The first category implies that the dentist should have addressed the deficiencies during treatment, while the second implies that the patient may not be reasonable.

In the present case, the patient was satisfied with each step of the restorative dentistry as the occlusal problems were solved. Referral to another orthodontist or a restorative dentist during previous orthodontic treatment may have avoided the patient's initial pain and frustration. Interdisciplinary diagnosis and treatment solved the deficiencies created by previous unidisciplinary orthodontic treatment.
All dentists need to understand how occlusion affects the gnathostomatic system and create proper force distribution on teeth during their procedures. Optimum dentistry requires that occlusal procedures are an integral part of practice. Postorthodontic occlusal evaluation and equilibration should be referred to the interdisciplinary team member who is best qualified to treat the problem. In many cases, this member is the restorative dentist, especially if restorations are needed and occlusal correction is a routine, predictable office procedure.19

Diagnosis of the presence and extent of occlusal problems cannot be done accurately by intraoral examination; diagnostic casts verified in CR are required.20-22 For teeth in traumatic occlusion, tooth intrusion on contact and protective jaw displacement when closing can mask the true maxillomandibular relationship in CR. Teeth in traumatic occlusion are slightly depressible and will intrude on closing so that the adjacent teeth touch. The teeth on diagnostic casts are not depressible and will demonstrate the occlusal interference accurately.

Patients will not close consistently on a tooth that is the arc of closure interference. The protective neuro-muscular reflex programs the lateral pterygoid muscles to posture the mandible in a protrusive and lateral direction so that more teeth touch, distributing the force on closing more comfortably through multiple teeth instead of traumatizing a single tooth.

CR has been defined as the optimum position of the mandibular condyle, because that is where the elevator muscles’ contraction vector consistently seats the condyle in anatomic harmony with the avascular portion of the disc against the mandibular fossa.23,24 Displacement from this position is common in cases of malocclusion, when protective jaw displacement and muscle splinting avoid force overload on a single tooth.

In the present case, the mandible slid forward to increase the number of teeth in contact and avoid occlusal trauma to tooth No. 3. Evaluation of anterior tooth contact and guidance is directly affected when the extent of a retrognathic occlusal relationship is unknown because the occlusion is not accurately examined with CR-verified diagnostic casts.25-29 To obtain a predictable result from equilibration or restoration, the dentist must know the true relationship of the anterior teeth when the condyle is completely seated in the mandibular fossa. Since the mandible closes in an arc, any premature contact on a posterior tooth creates an anterior open occlusal relationship. Restoring anterior teeth to fit this malocclusion would result in excessive thickness, while ignoring the premature contact can expose a normal contoured restoration to occlusal trauma.

In the present case, the arc of closure interference on tooth No. 3 and the resulting anterior open occlusal relationship was determined accurately. The OBS confirmed the diagnosis as well as the comfort and stability of the planned occlusion. Equilibration was predictable, comfortable, and conservative, as composite resin augmentation of the anterior teeth diminished the amount of enamel reduction in the posterior teeth. Although the patient chose the successful non-orthodontic solution, an ideal result from a third course of orthodontics would have avoided restoration of tooth No. 20. The treatment plan the patient selected was practical, predictable, and ethical, since equilibration would have been recommended after a third course of orthodontics and the restorative phase was very conservative.

It is common for orthodontists and restorative dentists to treat cases based on diagnosis in MI and not CR.20,21 It is not reasonable to expect the orthodontics, orthognathic surgery, equilibration, or restoration to provide an optimum occlusion when the pretreatment occlusion was not assessed accurately. The author defines optimum dentistry as the education and treatment of the patient, using the most appropriate procedures, so that comfort, function, and esthetics are restored for the long-term with minimal maintenance. Controlling destructive forces throughout the gnathostomatic system by controlling the occlusion is prerequisite to achieving this goal. Interdisciplinary care involves the diagnosis and treatment of all factors that could break down in the long run.

In the author’s experience, all postorthodontic cases would benefit from accurate occlusal analysis and equilibration to eliminate destructive interferences and optimize the occlusion.30-38 Nothing in the literature shows that natural teeth are designed to fit as perfectly as a manufactured denture tooth setup and that an ideal occlusion can be generated from orthodontics alone. Orthodontic movement via tipping, rotation, and bodily displacement cannot provide an interocclusal fit as precisely as equilibrating the dentition.

The degree of remaining malocclusion after orthodontics determines the forces distributed to the teeth during closure and excursive contacts, which directly affects the teeth, muscles, periodontium, and TMJs. Postorthodontic equilibration enhances orthodontic stability and comfort of the entire gnathostomatic system by eliminating adverse lateral force vectors on the teeth.39-40
Summary
This article described a case involving interdisciplinary diagnosis and restorative correction of a postorthodontic malocclusion. Diagnostic casts verified in CR and accurate assessment of the trial equilibration were used to confirm that a conservative treatment plan was an appropriate alternative to further orthodontic treatment. The proposed equilibration and restoration were previewed noninvasively by verifying the diagnosis with an ideal occlusion on the OBS. Based on the present case, postorthodontic occlusal analysis and equilibration can optimize the distribution of force on teeth for stability and comfort.

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Disclaimer
The author has no relationship with any of the manufacturers cited in this article.

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