AN INTRODUCTION TO

Diagnosis and Treatment Planning for Predictable Restorative Outcomes

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Abstract

The dilemma in comprehensive dentistry is that dentists are often focused on restoring teeth for esthetic outcomes, and if occlusion is not taken into account during diagnosis and treatment planning, the risk of failure of esthetic restorations is real. Successful indirect and direct restorative dentistry is predicated on performing critical risk assessments and accounting for the findings when treatment planning a case. Unfortunately, many dentists fall into common traps that could potentially result in ongoing breakdown and, ultimately, cosmetic and restorative dentistry failures **(Figs 1 & 2)**. By properly establishing a stable occlusion using simple techniques and technologies, dentists can mitigate risk, reduce unproductive chair time, and increase patient satisfaction. This article provides a basic review of the principles of several essential diagnostic categories that are key to ensuring more predictable esthetic and functional outcomes, with an emphasis on avoiding common occlusal oversights.

Key Words: Occlusion, global diagnosis, joint and muscle diagnosis, functional wear pattern, occlusal traps

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Figure 1: In the case of a patient who presented after losing an anterior bridge that had been placed several years ago, it may be natural to assume that decay caused the current problem.

Figure 2: However, by examining the patient's occlusal scheme and tooth wear, it is clear that there is insufficient occlusal space for the bridge, and the current problem resulted from a force fracture. Therefore, the treatment challenge is restoring the space to avoid the same problem in the future.

Figure 3: An upper arch retracted, as you would see looking at an upper model. It appears appropriate here to lengthen the upper teeth incisally.

Figure 4: Same patient's smile photo. The patient's natural smile is excessively gummy, and her teeth are short, suggesting lengthening the anterior teeth is actually not an appropriate treatment option.

Figure 5: The patient's rest position. The excessive tooth show at rest indicates a more complex problem that would require measurement of lip length and lip dynamics to determine the actual diagnosis.

Introduction

The longevity of esthetic treatments depends upon several factors, including restoring teeth to their proper form and establishing and/or maintaining healthy occlusal function.[1] These requisites essentially underscore the need for dentists to visualize the esthetic and functional treatment outcomes.

Such a concept of "reverse engineering the end" is not new to dentistry, but rather has been widely used to guide how clinicians plan, perform the necessary procedures for, and ultimately deliver treatment outcomes. Unfortunately, even with the end in mind, it may be difficult for dentists to determine exactly where the starting point should be for treating a case. Because the most predictable and durable treatments are those that are diagnostically appropriate, dentists must first and foremost render an accurate—and comprehensive—diagnosis.[2] Rendering a diagnosis of the specific patient's condition and determining the etiology of the problem is the basis for planning appropriate treatment options that result in predictable long-term outcomes that truly restore oral health, not just resolve symptoms.

Global Diagnosis

If a dentist looks only at the teeth, that dentist may decide that a patient with worn anterior teeth requires lengthening of the teeth incisally. What the dentist may not realize is that—if the actual problem is something not seen by looking at the teeth

alone, such as a "gummy smile"—this treatment plan may make the problem worse. A gummy smile is not in itself a diagnosis, and understanding the etiology is key to diagnostically appropriate treatment planning. Consideration must be given to the position of the teeth and the gingival positions in the face. This concept of global diagnosis, as developed by Jeffrey S. Rouse, DDS, and J. William Robbins, DDS, takes into account facial and skeletal proportions, the length of the upper lip and lip mobility, the canting of the maxilla, and dentoalveolar or dentogingival issues affecting the length of the clinical crowns of the maxillary anterior teeth.[3]

Global diagnosis through the use of photography and facial evaluation is crucial for interdisciplinary treatment planning and to ensure proper tooth positioning.[3] For example, in a case that would ultimately benefit from interdisciplinary care (e.g., orthodontics, orthognathic surgery, periodontal surgery, and complex restorative dentistry), examining only the patient's teeth could lead to a diagnosis of excessive wear and potential loss of vertical dimension, and a reasonable conclusion may be made to add length to the teeth incisally to restore what has been lost. Exclusively intraoral or model evaluation gives limited information in these cases **(Fig 3)**. On the other hand, upon evaluating at the full smile **(Fig 4)** and rest position **(Fig 5)** and measuring facial proportions, it becomes readily apparent that the problem would actually be exacerbated by lengthening teeth incisally (e.g., vertical maxillary excess, short upper lip, occlusal misalignment).[4]

Joint & Muscle Diagnosis

Dentists must be mindful not to focus exclusively on esthetics, but rather also render a joint and muscle diagnosis in order to identify potential functional issues. Although a patient may present without any pain or symptoms, an estimated 33% of asymptomatic patients have disc displacement in at least one joint.[5] If the presence (or absence) of a joint derangement or inflammation is not confirmed prior to initiating any occlusal alterations, the proposed treatment could create a risk for future joint noise, ongoing breakdown, and/or pain that the patient never experienced before. The joint is the first determinant of not only a stable occlusion but also the manner in which the case will be treated overall.[6] Therefore, it is essential for dentists to diagnose the temporomandibular joint; identify where the disc is located (e.g., healthy position between the condyle and glenoid fossa); and determine whether there is inflammation in different areas of the joint space (e.g., capsule, synovial fluid, retrodiscal tissue) or the muscles that could signal overuse and/or active breakdown.[7]

Discovering Disc Position

The gold standard for diagnosing disc position is magnetic resonance imaging (MRI), which shows contrast between hard and soft tissues and enables dentists to see the position of the disc relative to the condyle in closed and open mouth positions. Although cone beam computed tomography (CBCT) allows visualization of the condylar bone, glenoid fossa, and articular eminence, it does not differentiate the soft tissue and therefore is not useful for identifying disc position.

Joint vibration analysis (JVA) is a digital diagnostic tool that can be used to objectively analyze disc position. Demonstrating over 90% diagnostic accuracy between clinicians, use of this technology is based on the fact that when smooth surfaces rub together, little friction (i.e., vibration) is created.[8] When the disc is properly located between the condyle and fossa, the joint movement is smooth and quiet. This technology works on the basis that when the disc is out of place, there is more friction and, hence, vibration, which is recorded in the software.

Another method for diagnosing the temporomandibular joint is using a doppler or stethoscope for joint auscultation. Although far more subjective and with much lower diagnostic accuracy (e.g., below 50%) that is dependent upon operator experience, listening to the joints is a good starting point to understand their condition.[9] With practice, dentists can learn to differentiate background noise and crepitation.

Diagnostic Records

To gain a comprehensive understanding of the masticatory system, beyond single teeth, diagnostic records should be taken for evaluation in a seated condylar position once muscles have been deprogrammed, known as centric relation (CR). A simple way to think of CR is that it is a repeatable position independent of tooth contacts where the lateral pterygoid muscle is relaxed, the elevator muscles are contracted, and the disc is properly interposed between the condyle and the glenoid fossa. In contrast, maximum intercuspal position (MIP) is defined as the "complete intercuspation of the opposing teeth independent of condylar position."[10] MIP is commonly called habitual occlusion.[11]

It is important to recognize that only taking records in MIP ignores the joint position, and any positions occluding more distal than MIP would be missed (e.g., CR and everything in between). Thorough diagnostic records include CR bite records, facebow **(Fig 6)**, impressions or scans, models for mounting on a semi-adjustable articulator **(Fig 7)** or digital articulation. Protrusive bites can be used to set the condylar angle on the articulator to enable visualization of the pathways of mandibular movement with greater accuracy.[12]
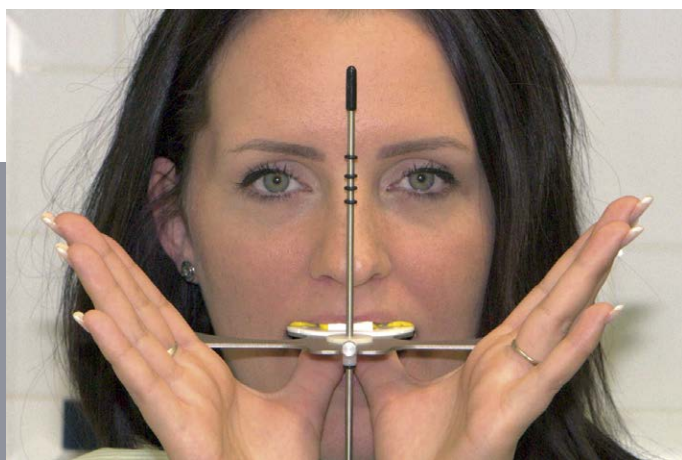

Figure 6: Without a facebow, the maxilla is mounted in an arbitrary position on the articulator.

Figure 7: An articulator is invaluable for undertaking a functional analysis, which is necessary in cases involving symptomatic patients, unphysiologic occlusion, and/or restorative needs.

Figure 8: View of a patient with untreated GERD, the prevalence of which ranges from 11.6% to 45.3%.[15]

Etiology of Wear—Diagnostics & Functional Treatment Planning

There are three broad categories of wear etiology: functional, erosive, and parafunctional. Interestingly, beyond a restricted envelope of function, dentists typically do not see true functional wear since tooth contact during function does not actually occur.[13]

Erosive wear is commonly caused by gastroesophageal reflux disease (GERD) and is usually considered to be "heartburn." The wear pattern created by GERD typically appears as smooth cupped lesions of the occlusal surfaces of the lower molars, where the dentin is more worn than the enamel, and thin enamel on anterior teeth with smooth cupped lesions into the dentin.[14] It is important to understand that the prevalence of silent (asymptomatic) GERD may be up to 45% **(Fig 8)**, which means the acid will continue to erode any exposed tooth surfaces in untreated patients.[15] Patients who don't report heartburn but show this unique wear pattern should be tested for GERD. In many cases, the only clue that the disease exists is the condition of the teeth.[16] It is imperative that patients are treated medically for the underlying cause of the erosion. This will help to ensure that erosive wear of any exposed tooth surfaces does not continue after restorative treatment, in addition to improving the patient's overall health and reducing their long-term risk of morbidity due to GERD. Today, studies show a potential link between GERD, bruxism, and restricted inhalation/collapsed airway conditions, so investigating the airway is also important in patients exhibiting both GERD and bruxism.[17,18]

In erosion caused by eating disorders such as bulimia, studies have shown that up to 30% of patients continue to engage in recurrent binge-eating or purging behaviors after 10 years.[19] Smooth lingual wear of the maxillary anterior teeth is typical of the clinical presentation of bulimia patients. As clinicians, it is important to establish a relationship of safety and trust with these patients and to know whether the purging behavior is still active. In ongoing bulimia cases, burying the lingual gingival margins of restorations is an appropriate treatment plan in order to hide exposed tooth surfaces from ongoing acid injury **(Fig 9)**.

Parafunctional wear typically appears in a pattern that is dependent upon the patient's direction of movement of opposing tooth surfaces.[20,21] Diagnosing the wear pattern is an essential component of an overall functional diagnosis and is key to appropriate treatment planning. Even in the case of dental implants, occlusal overload is the primary cause of late implant complications.[22]

Force-related anterior wear can be categorized as pathway, end-to-end, and crossover wear **(Table 1)**.[18,20,23] Patients whose parafunction occurs in a combination of pathway and end-to-end movements are the most challenging to treat. These are the patients where overbite is critical, and steepening the guidance may result in wear, dentin exposure, abfractions, and/or fractured porcelain. Posterior wear, on the other hand, most commonly occurs as a result of gastroesophageal reflux, and can also occur when patients seat their condyles and brux on the posterior teeth.

Table 1: Force-Related Anterior Wear Patterns

| Pathway Wear	End-to-End Wear	Crossover Wear
Occurs from right, left, and protrusive movements in patients with a restricted envelope of function, resulting in a vertical wear pattern and noticeable wear on the palatals of the upper and facials of the lower teeth **(Fig 10)**. These patients need freedom of movement (i.e., more overjet). Restricting the envelope of function may cause wear, migration, fremitus, and mobility.[23]	Occurs when the patient moves their teeth across the incisal edges, leaving teeth looking worn flat. These patients need broad, flat, and smooth contacts in protrusive and lateral excursions. Note that airway could be a potential cause, and the patient should be screened for a sleep-related breathing disorder.[18]	Occurs when the patient moves their teeth beyond the incisal edges, leaving the appearance of chipping of the upper facial and lower lingual edges. These patients require a smooth transition beyond the end-to-end position. "Destroyers" require protective appliances, and the airway should be considered.[20]
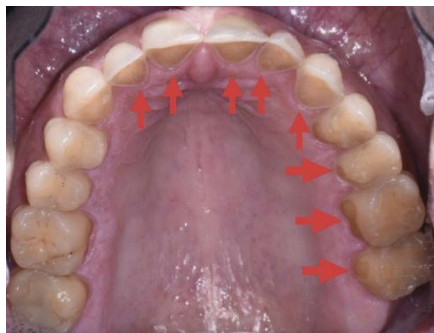
Figure 9: Palatal view of a patient with active bulimia; recurrent purging of stomach contents results in acid erosion of the lingual surfaces of the maxillary teeth.
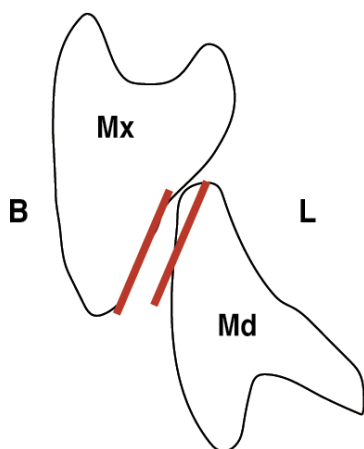

Figure 10: Diagram of pathway wear: vertical wear pattern evident on the palatals of the upper and facials of the lower teeth (areas of wear marked in red on diagram).

Diagnosing the wear pattern and not putting ceramic in the way of function or parafunction is important to enable patients to continue moving in the same way even after restorative treatment.[20] Additionally, creating anterior guidance and eliminating posterior contact in excursions reduces risk of failure in most situations when canines are healthy and intact, because muscle force is increased when posterior teeth are in contact.[24]

Conclusion

Dentists undertake the planning process in collaboration with their patients in order to satisfy their esthetic needs and wants as well as meet their overall treatment expectations. Predictable treatment and longevity of treatment outcomes rely on accurate diagnosis and appropriate treatment planning. Fortunately, a variety of techniques, tools, and educational opportunities can help dentists develop their skills in treatment planning after rendering a comprehensive diagnosis.

It's important to remember that a comprehensive diagnosis encompasses several components, including a global diagnosis, joint and muscle diagnosis, and a diagnosis of functional wear pattern and the patient's existing guidance. This is of course in addition to the standard biology (caries, periodontal disease, endodontic infections, etc.). However, the diagnosis of the etiology of any existing occlusal disease is also essential and must be addressed and subsequently incorporated into appropriate treatment plans that address all diagnosed conditions.[25] Therefore, it behooves dentists to remember and avoid the occlusal traps that could otherwise derail a predictable, diagnostically driven treatment.

TIPS FOR CLINICIANS

Introductory

- Pursue continuing education to master the principles of comprehensively evaluating patients, including airway, joints, muscles, teeth, etc.

- Perform a comprehensive joint and muscle exam, including thorough history, palpations, and range of motion measurements.

- Keep a diagnostic records checklist to ensure completion of CR bite records; facebow; impressions for mounting models on semi-adjustable articulators for evaluation; and protrusive bites to set condylar angle on articulator.

Intermediate

- Undertake esthetic treatment planning to put the incisal edges in the correct position relative to the face.

- Utilize Doppler auscultation to listen to joints for crepitation combined with a comprehensive exam to determine whether potentially more severe conditions exist.

- Use digital tools (e.g., Digital Smile Design or Keynote) to evaluate facial and occlusal planes and facebow records.

Advanced

- Utilize the principles of global diagnosis (e.g., evaluating facial height; lip length and mobility; gingival positions and tooth length; location of the cementoenamel junction) in order to sequence an appropriate treatment plan for addressing problems affecting gingival positions and the smile frame.

- Utilize JVA in combination with a comprehensive exam to more accurately diagnose joint conditions and evaluate joints in various positions.

- Perform a functional diagnosis and treatment plan to identify and treat underlying conditions or to allow function in a specific range of movement to continue without future damage.

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