Are We Asking Function to Follow Form?
Introduction
Cosmetic cases are treated in nearly every dental office. The most successful practitioners compile a list of records in advance of care. These records include photographs, as well as information on tooth shape, tooth color, and midline position. To be complete, records also should include incisal edge length, tissue modification requirements, stickbite registration, and an evaluation of temporomandibular joint (TMJ) stability. These items help to ensure that the patient will receive successful care. Fortunately, most patients do.

Unfortunately, some patients may not. When a case is initially unsuccessful, many dentists tend to ask themselves, “What should I do to fix it?” Perhaps, however, the first question actually should be, “Why did it fail?” Then, an appropriate response to the failure can be determined.

In the author’s experience, failures usually can be traced back to a lack of respect for function. Unfortunately, when we plan a cosmetic case, design for esthetics too often outweighs design for function. Although it is hoped that the patient’s function can adapt and/or tolerate the planned esthetic form, sometimes the patient cannot tolerate the changes. In these cases, restorations can break or symptoms such as jaw or muscle pain or dental sensitivities can occur.

In the author’s opinion, most cases have a functional plan developed according to the doctor’s or laboratory’s preference of articulators. This type of plan generally considers lateral and protrusive excursions, often critical to the success of a case. However, this design frequently is based only upon average settings of the articulator being used and not the actual functional requirements of a particular patient.

One means of understanding the potential impact that function will have on esthetic changes is to design provisionals that can be tested functionally. Mastication analysis is considered the truest method of functional evaluation. As such, measuring the ability to function under masticatory demands with the provisionals should give the clinician insight into the patient’s ability to function with the final restorations.
Case Study
A 62-year-old man wished to esthetically enhance his smile. His periodontal health was within normal limits. After gathering complete records, it was clear that he presented several challenges regarding enhanced esthetic design. These challenges included unilateral crossbite on the left side, significant maxillary cant, reverse anterior Curve of Spee, deep posterior Curve of Spee, midline discrepancy, and moderate tooth wear (Figs 1-2b).

Findings
TMJ stability was evaluated by using joint vibration analysis (BioJVA, BioResearch Associates; Milwaukee, WI). Minimal vibrations were evident, and, because this analysis has a specificity of 98%, his TMJs were considered normal. Because the treatment plan intended to enhance the left buccal corridor by reversing the crossbite, mastication traces were also obtained (Fig 3). These traces are obtained through utilization of a jaw-tracking device recording movement of a magnet affixed to the patient’s mandible (Fig 4). The movements recorded include vertical, anteroposterior, and lateral jaw motions. Once the jaw tracker and magnet are placed, a recording is generated by asking the patient to place pre-softened gum on their tongue (Fig 5). The recording is started and the patient is asked to chew either on the left or the right side. Analysis of the recording can then be completed. Mastication patterns can be used to analyze TMJ function as well as chewing function. In this case, mastication patterns also supported the initial impression of normal TMJs.

As anticipated from physical examination, the chewing pattern on the left was reversed in a crossbite situation. The patient opened laterally and closed medially (Fig 6). His turning point was on the appropriate side. It was not clear, however, if he would be able to function with a new occlusal scheme if his crossbite relationship was altered. In other words, after so many years in a reversed chewing pattern, it needed to be determined whether the patient would be able to adapt to and function with a normal occlusal relationship. The chewing pattern of the right side was normal, other than an increase in the maximum lateral width. As expected, the patient opened medially, had a turning point on the right side, and closed laterally to chew on the right side (Fig 7).

Treatment Options
After the records were obtained and evaluated, treatment options were discussed. It was explained to the patient that the cant and the midline discrepancy could not be corrected without orthodontic interven-
Figure 3: Example of normal left-sided chewing function. This is an average chewing pattern of 10 to 15 cycles. While no two cycles of chewing are the same, averaging a sequence can reveal the underlying pattern of movement as normal, altered by TMJ dysfunction or altered by malocclusion. The red line is opening; the blue line is closing.

Figure 4: A patient with jaw tracker in place. Note the magnet is affixed to the gingival tissue of the mandibular anterior teeth. Movement of the magnet is tracked within the sensors on the jaw tracker.

Figure 5: After placement of the magnet, a recording is generated by placing pre-softened gum on the patient’s tongue. The recording is started, the gum is moved to the side being tested, and the patient chews the gum for 15 seconds.

Figure 6: Preoperatively, the left side has a reversed sequence of opening and closing patterns. Note that the opening trace is lateral (red) and the closing trace is medial (light blue), due to the crossbite.
tion. The patient rejected this option due to the length of treatment. Furthermore, he understood that orthodontics would not change the shape and color of his teeth. A second option of fewer veneers (primarily #7-10), whitening, and orthodontics was also not an option due to the treatment time of the orthodontics. The patient did accept, however, the option of care on 21 teeth.

The patient was told that functional mastication testing of the crossbite would be evaluated prior to designing the final restorations. The wax-up and thus the provisionals would reverse the crossbite. The patient’s mastication patterns while in provisionals would be recorded, evaluated, and compared to the pretreatment traces. If the mastication traces demonstrated no difficulty with function then the final restorations could be designed to reverse the crossbite and enhance the buccal corridor. The patient understood he would need to return to a left-sided crossbite if function dictated it.

Treatment
A white wax-up was completed on 21 teeth, including #4-14 on the maxillary arch and #20-29 on the mandibular arch. Tooth #14 would be brought into an edge-to-edge position and, from there, a normal relationship was designed. Phonetic and esthetic testing for incisal edge position determination demonstrated the current position of the distal-incisal edge of #8 was an appropriate length and the wax-up was made accordingly.

Preparations were performed in the normal manner, with all 21 teeth prepared in a single visit. After the proper depth of the preparations was ensured using a reduction guide, core shades of the preparations were obtained with a Stumpf shade guide (Ivoclar Vivadent; Amherst, NY). Provisionals were fabricated using a polyvinyl siloxane-lined Sil-Tech matrix (Ivoclar Vivadent) filled with Luxatemp (Zenith/DMG; Englewood, NJ). The occlusion of the provisionals was adjusted, the provisionals were polished, and the patient was dismissed (Fig 8).

After five days in the provisionals, the patient returned to the office for follow-up mastication testing. The crossbite was “corrected” esthetically and functionally. The occlusal design allowed the patient to continue his habitual reverse sequence, as the patterns were consistent with those observed in the pretreatment traces (Fig 9). Had the left-sided crossbite been blindly corrected, there would have been concern about functional adaptation. However, because the provisionals were tested and it was demonstrated that the patient could function with them, they could serve...
as a “road map” for the final restorations. The author expected that, as this patient was older, it might be more difficult for him to change his function from a reverse sequence to a normal movement pattern. More studies are needed to analyze the ability to change from reverse to normal sequencing.

It should be noted that mastication is not used to design the occlusal scheme of the wax-up and thus the provisionals; rather, it is a method used to test the occlusal design. In other words, it is a method to assess how well the design is working within that particular patient’s physiology. As it is a measure of the actual function of the patient, it is more reliable than static entities like articulating paper or shimstock.

The final restorations were fabricated using IPS Empress (Ivoclar Vivadent). The provisionals were removed, the preparations were scrubbed, and the final restorations were tried in place for fit, contacts, shape, and color. After approval by the patient, a rubber dam was placed for isolation. Using proper adhesive techniques, the restorations were seated using RelyX Veneer (3M ESPE; St. Paul, MN). Cleanup of excess bonding resin was completed, preliminary occlusal adjustments were made, and the patient was rescheduled for final adjustments (Figs 10 & 11).

The patient was scheduled for mastication analysis one month post-insertion. Chewing traces again were obtained using both gum and licorice as a bolus. The patterns were consistent with those observed in the pretreatment traces (Fig 12). Furthermore, the patient reported no concerns with the final outcome and tolerated the change in his occlusal scheme without incident. At the one-year follow-up appointment, all restorations were intact and the patient was functioning without difficulty.

Conclusion

Much of today’s dentistry can be performed with incredible predictability. However, some cases may be less predictable, especially when the intent is to change the occlusal environment to enhance esthetics. Nearly all of these cases affect physiology—at times positively and at times negatively. When physiology is negatively affected, clinicians may see fractured restorations and patients may report TMJ-type symptoms. In these cases, function needs to be considered as a source of the problem. Fortunately, through the use of advanced measurement protocols, dentists can now test and monitor function before designing the final restorations.
Acknowledgment

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References


Figure 11: Unretracted view of the final restorations. The patient was very pleased with the final esthetics.

Figure 12: Mastication trace chewing on the left with the final restorations in place. Note that the pattern is again similar to the preoperative trace.

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