Implant Occlusion in the Digital Age of Dentistry

A look at the state of implant dentistry today with real cases from dentists who utilize technology to manage implant occlusion.
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Arguably one of the most controversial subjects in dentistry, occlusion is not fully covered in dental schools. Postgrad and continuing education groups have differing views on treatment options for occlusal disease, plus a number of different treatment modalities may affect occlusion’s role in implant failures. While one might argue a given philosophy, there is a common thread.

No matter what area of dentistry, occlusion is inevitably going to have an effect on the treatment performed. Vice versa, treatments may affect the occlusion. Dentistry Today¹ cites three golden rules when it comes to occlusion:

1. Bilateral simultaneity
2. Posterior disclusion, or anterior/canine guidance
3. Unobstructed envelope of function

These principles are scientifically supported to help increase the predictability and quality of dental treatments. The teeth should come together evenly when in a centralized position, the posteriors should immediately disclude during chewing cycles, and protrusive and excursive movements should occur without interference. However, who measures that this is working well? And how?

Dr. Sarah Qadeer, International lecturer at Dept. of Prosthodontics, Faculty of Dentistry, Thammasat University in Thailand, suggests that while static occlusal indicators have some descriptive capability on the occlusion, they don’t paint the total picture.

When using static occlusal methods, the concept of “force” is difficult to interpret, because there is one dimension that captures what happens when the teeth occlude: seeing dots and smudges. Small mark = less force, Large mark = more force... Right? How much force on one tooth is relative to the forces on all the other teeth? No one wants to do that math.

How is it possible to quantify dynamic occlusal loading based on surface marks?

“Quantifiable force” is a totally foreign concept to most dental clinicians, but one that would inevitably take treatment paths to a new level. If the clinician is able to see when each tooth comes into contact, they’re able to identify prematurities or occlusal abnormalities. If they’re able to see how much force is applied across the dentition from first contact to MIP, they can identify which teeth are at risk, or see why a patient has a given symptom. Finally, if they’re able to see how teeth fit together as they occlude, they may be able to understand and evaluate potential risks.

“The traditional occlusal indicators used in dental practice are articulation papers, shim-stock foils, elastomeric impression materials, and occlusal wax strips. These static dental materials have been widely believed to have occlusal force descriptive capability. However, modern material studies are challenging the widespread belief that occlusal indicator materials can measure differing occlusal force levels.”

Dr. Sarah Qadeer, International Lecturer at Dept. of Prosthodontics, Faculty of Dentistry. Thammasat University in Thailand
T-Scan™
Digital Occlusal Analysis System

Digital Technology
Measures the Details Analog Methods Cannot

T-Scan is designed to take a bite reading. As the patient’s teeth occlude on the sensor, the information is read by the software, which displays occlusal contacts as they come together and separate. The data is captured in the form of a movie and shows 2D and 3D models of the patient’s occlusion over both arches.

In the digital age of dentistry, occlusion does not have to be one-dimensional. The effectiveness of the treatments on the patients, and the overall success of the dental practice rely on predictably managing occlusal problems. More informed decisions can be made when the clinician understands what is really going on with the dentition.

Dentists are artists and scientists, so they have to use their subjective judgment combined with the objective facts, in order to create an environment that is ideal for the patient’s dental work, given all circumstances. That’s one huge burden to bear. Digital occlusal analysis technology is a solution to minimize all confusion that surrounds occlusion, and one that’s being adopted by clinicians to better inform their treatment plans.
Determine Proper Implant Loading Scheme

Ensure the Implant is Not Receiving the Brunt of the Forces

Identify When the Implant Starts to Load, & with How Much Force

Information Transforming Implant Dentistry

Technology allows clinicians to see the invisible inside the mouth and the head, even in three dimensions, which helps make treatment more predictable, with more effective results. Using 3D intraoral data has undisputed success for the foundation of implant placement: identifying the hard and soft tissues of the mandible and adjacent structures, replicating the surface morphology of the teeth and tissues, determining what implant fixtures to use, etc.

But when it comes to the subject of managing occlusal issues in implant patients, T-Scan is dentistry’s only digital occlusal analysis technology that can provide a comprehensive view. It reveals bite force dynamics using sensor technology to determine the timing and relative forces between occluding surfaces in the mouth, including implants.

“The relative occlusal force and real-time occlusal contact timing data provided by the T-Scan technology can be used to manage the insertion, and the occlusal force design of implant prostheses, as their long-term survivability is tied directly to their installed occlusal function,” says Dr. Jinhwan Kim, contributor to the Handbook of Research on Computerized Occlusal Analysis Technology Applications in Dental Medicine. “…The clinician eliminates the subjectivity involved in using articulating paper alone, ensuring the occlusal design of newly installed implant prostheses are optimal, and improve prosthesis longevity.”
Managing Implant Occlusion: A “Dual” with Nature by Dr. Sangiv Patel

A constant in biology is the duality of nature. This is organizationally magnified in the treatment of partially and fully edentulous dental patients. The clinician must understand, plan, and manage the entire stomatognathic system for functional and esthetic prosthetic success and longevity of dental implants and their restorations. The duality with implant occlusion is that the clinician needs to think about managing two environments simultaneously:

1. The implant restoration
2. The natural teeth with or without restorations

There are significant and numerous variables accountable for implant restoration longevity. Dental implants and their restorations are not adaptable, but are surgically placed and restored with the goal of adaptation by the stomatognathic system around the implant and its restoration. Once adapted, the longevity is primarily determined by management of materials, mechanics, and bacteria that affect the implant restoration. This is based on the fact that implants and their restorations are inorganic, synthetic, and more rigid in contrast to natural teeth and the stomatognathic system, which is organic and resilient.

Key Differences Between how Natural Teeth Differ from Inorganic, Synthetic Implants

1. Natural teeth and roots are a modified bone tissue, while implant fixtures are made of titanium.
2. Natural teeth have a periodontal ligament, while implants are ankylosed to the bone without a periodontal ligament.
3. Natural teeth are protected via an enamel cover with a very specific stress strain curve for adaptation, while implant restorations vary in materials. These materials are usually more rigid and unadaptable.
4. Natural teeth have an organic bond between dentin and enamel, while implant restorations are cement retained or screw retained.
5. Natural dentition is resilient via individual teeth and root systems for each tooth type that allows for resilient energy transfer and vitality, while implant restorations are a rigid, non-vital, single rooted solution that is often splinted for full arch restorations.
6. The principles of mandibular flexure is compromised with splinted full arch restorations, especially magnified in implant restorations.
7. There is a statistically significant increase in parafunction noted with dental implants.
The greatest and most immediate adaptive capacity of the stomatognathic system is lost with implant restorations due to a lack of the periodontal ligament. The periodontal ligament is a highly cellular fibrous connection between the cementum of the tooth and alveolar bone via the principal fibers. Functionally, there is a very specific neural, vascular, and hydrodynamic fluid exchange that is responsible for the adaptive capacity. The shock absorbing effect is a multistage mechanism, and the initial "cushioning" to light occlusal forces is provided by intravascular fluid leaving the blood vessels within the periodontal ligament.

Moderate occlusal loads are managed by extravascular fluid leaving the periodontal ligament space and entering the bone marrow. Once these two hydrodynamic mechanisms are exhausted, the principal fibers then engage to accept and manage the heaviest occlusal loads. They do this by converting compressive forces into tensile forces, secondary to the specific orientation of the fibers involved in function within the periodontal ligament.

The periodontal ligament is innervated by proprioceptive fibers that provide a functional biofeedback loop for the temporomandibular joints and muscles of mastication, as well as nociceptive fibers that elicit pain secondary to inflammation and infection. Finally, it is important to comprehend that the most resilient part of the stomatognathic system is the periodontal ligament. It has the highest concentration of undifferentiated ectomesenchymal stem cells lining the blood vessels in the periodontal ligament. This provides the ability to model and remodel teeth and bone via formation of necessary blast and clast cells, in response to the environmental stressors.

The moment a tooth is extracted, the primary proprioception, nociception, biomechanical load management, and adaptive capacity are lost and never regained. Insertion of a non-vital inorganic titanium fixture may provide secondary proprioception via the transmission of energy through the bone into the osteocytes, which can serve as a feedback loop; however the accuracy and efficiency are vastly diminished. There is also a statistically significant increase parafuncton that is documented secondary to dental implant restorations, and may be related to the loss of proprioception in the periodontal ligament.

"implant-protected occlusion has been proposed strictly for implant prostheses (Misch & Bidez 1994). This concept is designed to reduce occlusal force on implant prostheses and thus to protect implants. For this, several modifications from conventional occlusal concepts have been proposed, which include providing load sharing occlusal contacts, modifications of the occlusal table and anatomy, correction of load direction, increasing of implant surface areas, and elimination or reduction of occlusal contacts in implants with unfavorable biomechanics. Also, occlusal morphology guiding occlusal force to the apical direction, utilization of cross-bite occlusion, a narrowed occlusal table, reduced cusp inclination, and a reduced length of cantilever in mesio-distal and bucco-lingual dimension have all been suggested as factors to consider when establishing implant occlusion.

Basic Principles of Implant Occlusion:

1. Bilateral stability in centric (habitual) occlusion
2. Evenly distributed occlusal contacts and force
3. No interferences between retruded position and centric (habitual) position
4. Wide freedom in centric (habitual) occlusion
5. Anterior guidance whenever possible
6. Smooth, even, lateral excursive movements without working/non-working interferences
Managing Rigid vs Resilient Duality of Time-Delayed Loading of Dental Implants

The rationale is based on the data that natural teeth move 56-108 microns laterally and depress 28 microns vertically (Parfitt), while implants only move 10-50 microns laterally and depress 5 microns vertically (Sekine). It is based on these statistics that splinting of natural teeth to dental implants has fallen out of favor. Time-delayed loading of dental implants enhances the principles of IPO and assures that all dental implant restorations are in function with respect to physiology.

1. The natural teeth and dentition should be loaded first.

2. Next, the implant restorations engage.

3. Lastly, all teeth and restorations are loaded fully without hyper-occlusion, premature contacts, and excursive interferences with a the most acceptable concurrent center of force trajectory as possible, based on the patient’s physiology.

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With the T-Scan data, the dentist was able to adjust the implant in order to produce more even occlusal contact.

Images courtesy of Dr. Patel.

Dr. Sangiv I. Patel, DDS is the founder and developer of The Innovative Smile. He is a general dentist in private practice since 1993, has served as faculty at the Advanced Dental Implant Institute’s AAID Maxicourse in Puerto Rico, and formerly served on the faculty at Loyola University of Chicago- School of Dentistry and Brevard Community College. He is among 30 clinicians worldwide to have received Mastership in Dental Biometrics. He is a published author and international lecturer. He has served as a beta tester for BioRESEARCH Inc., Tekscan Inc., and CEREC 3D by Sirona, and collaborated with Carestream the manufacturers of CBCT technology. His experience in cutting-edge dentistry runs long and deep. Dr. Patel offers a physics-based model on the principles of rigid vs. resilient dynamics in the stomatognathic system, that paves a road for logical, predictable, and evidenced based diagnostics and restorative single-visit dentistry.
Implant Cases Solved with T-Scan
The patient is an interior designer in her early 60s, with very high aesthetic demands. She was in the middle of treatment when she presented for a second opinion with Dr. Keith. During this initial visit, there was no sign of active infection, and while her occlusal discomfort annoyed her, treatment at the time was not an emergent situation.

- Had implants placed, but had concerns her teeth did not fit correctly.
- Reported constant headaches. In fact, she removed the provisional bridge on her right side in order to sleep at night, but would wear it during the day.

After a little more than three years, the patient contacted Dr. Keith once again.

The patient reported she had completed treatment which involved the removal of two implants in the posterior maxilla and placement of four additional implants. Once the final prostheses were delivered, she had returned to the office multiple times for repeated adjustment of her bite. Unfortunately, she reported that she still had a feeling that her face was crooked, her smile was off, and it was interfering with her quality of life.

The patient reported that she’s very self-conscious and thinks people look at her funny because her bite is off. We completed a new clinical examination and made a new Panoramic Radiograph. In addition to the bilateral Maxillary posterior implant-supported fixed dental prostheses, the patient had a tooth supported FDP from 18 x x 21 and was now missing first and second molars on the lower right as well.
A 54-year-old patient had an edentulous space at the #19 area where the first molar was extracted as an emergency about six months previously. He came to the office with a desire for replacement.

- **Had a bridge on the lower right side** and did not like how food became impacted every time he ate. Thus, he searched implants and found our website.

- **There was no convincing him implant replacement was a good option.**

- **Primary concern was the patient’s smoking habit.** Smoking does not eliminate the implant option, but I always tell smokers they need to be aware that nicotine and bi-products of cigarettes have an adverse effect on the healing process. But, the patient chose the implant option

The implant prosthesis replaced tooth #19, between two natural teeth.

Dr. Stevens used a 4.7 diameter, 10 mm length Legacy 3 (Implant Direct International, LLC) implant. After healing and crown cementation, Dr. Stevens used T-Scan to capture the patient’s bite force dynamics, so he could check the occlusal load on that crown.

> Download the Case Example

PDF
A 56-year-old male patient with a recent history of a lower right first molar that had fractured and was deemed unrestorable.

- The patient was advised by his periodontist to do a dental implant (not another bridge) in order to regain function.

- The molar was consequentially removed and the site received a bone graft.

- A dental implant was placed by the periodontist after the bone graft healed.

The patient knew about our facility and advanced dental technology, including CEREC CAD/CAM and T-Scan technology. Dr. Patel’s care, in conjunction with the application of these technologies, was the primary reason for the patient selecting his practice for his restorative care.

The patient requested restoration of the lower right posterior quadrant. Upon examination of the area and occlusion, a limited treatment plan was generated, reviewed, and consented, for restorative care with CEREC CAD/CAM restorations in conjunction with T-Scan equilibration and occlusal load management.
Conclusion

While traditional occlusal indicators have some descriptive capability, they don’t paint the whole picture.

Occlusal data is multi-dimensional, which allows the clinician to see the force, timing, and location of occlusal contacts. In three clinical cases, T-Scan data was used to help describe the occlusal condition of each patient. This allowed the doctors to understand the occlusal environment in which the implant lives. In these cases, it was essential to understanding how the implant restorations will survive in the mouth over the long term.

Information is the cornerstone of any diagnosis. Using this information, these doctors were able to quickly and effectively balance the occlusion, protect the implant, and send the patient home confident in their treatment.

Occlusion management is key for implants, but also for other dental applications, whether it is cosmetics, TMD, hygiene, splint therapy, etc. Using technology will not only support diagnosis and treatment plans with solid, objective data, but also differentiates the doctor and practice.
References


