Apply the Force to your Consultations!

Dental Clinicians can use the knowledge of the force to identify potential restoration limitations.

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Background

Bite force is a key indicator of a healthy masticatory system, in that a deficiency or surplus is implicated in multiple disorders and dental complications. Amongst others, these disorders and complications are Tempo-ro-Mandibular Disorder (TMD),[1] bruxism,[2] restoration failure,[3] bone resorption,[4] and neurological diseases.[5] Of particular interest to clinicians is oral pain and the failure of dental restorations, the latter of which is chiefly caused by occlusal loading conditions, including bite force.[6]

As many as 35% of restorations fail,[6-8] which is a clinician's worst nightmare[9] because most of the time, the clinicians redo the work pro bono. The estimated costs of reparation during its lifetime can be as much as $12,000 per restoration that cannot always be recouped.[4] Additionally, there is an innumerable cost to a clinician's reputation, as the majority of patients suffering from failures consult a different practitioner.[10]

Currently, clinicians rely on a qualitative evaluation of a patient's bite force in order to provide a treatment plan. However, this measure is subjective and does not adequately characterize the magnitude of force generated by the patient. A clear understanding of this value will assist the dental clinician in designing a personalized solution that adequately considers the imposed limitations of these occlusal loads.

Understanding Bite Force

The forces from the masticatory muscles transfer their strength through the dentition during occlusion, and while some vertical load is applied, the principal action is axially.[11,12]

This load acts on the occlusal contact area and has been shown to be up to three times greater in the posterior jaw versus the anterior. When occlusal contact area is decreased (i.e.: missing teeth or malocclusion) there can be up to 20% decrease in bite force.[13,14] Bite force for all ages and genders vary greatly between 10 to 2000 N,[15] however, men are consistently found to have up to twice the levels found in women.[16,17] The average total bite force has been found to be 650 N and 500 N for adult male and female patients, respectively, decreasing gradually through to old age.[13,18] Also, single tooth average bite forces have been estimated to being 300 N for males and 250 N for females,[12,19] with maxima of as much as 1600 N.[20]

The age of dentate patients was closely tied to the maximal bite force, with a lower force recorded in children and the elderly, and a maximal force in early adulthood tapering off with increasing age, attributed to the decline in musculature with age.[16,21] It has been shown that the molar regions exhibit higher forces regardless of gender and age.[16,22]

These regions experience the highest force values, with as much as 67% of the total bite force in the posterior of the oral cavity,[12,14] and up to 58% of the whole arch bite force on the preferred chewing side.[23] Despite loss of dentition, the region could exert similar forces upon restorations due to comparable muscle function to dentate patients.[24] Despite varied levels of bite force in the general population, a clear understanding of the service conditions must be considered during the placement of the dental restoration.[25]

Crucial among these service conditions is the maximum bite force, which dictates the capacity a dental restoration should be able to withstand during regular use, to ultimately reduce the risk of failures.

Bite Force and Failure in Dental Restorations

For clinicians to provide dental restorative treatments to patients, the bite force must be known in order to avoid restoration failures, which can be costly to repair and negatively impact reputations.[4] Amongst the etiological causes of restoration failures the highest remains mechanical fracture.[3],[26-30] The cause of any material fracture is excessive stress on the component due to unfavorable loading conditions.

Under in vitro static loading conditions, a standard crown restoration fractures at a load of approximately 900 to 2400 N depending on the material used, type of preparation and many other factors.[31,32] Implants fracture at a load of approximately 150 to well over 1000 N.[33]

Bite force values of this magnitude are uncommon on a single tooth, however, under in vitro cyclical forces, the fatigue corrected loading conditions required to cause failure could be as low as 400 N,[34,35] which is within the range of most patients.[12] The cyclical nature of chewing implies that an occlusal load is applied to restorations as many as 3500 times daily,[36] which is an important factor in fatigue failure of material due to crack propagation.[28,31,37-39]

This is exacerbated by the environment in vivo which is both moist and cyclically heated, two parameters that can decrease the fatigue strength of dental materials by as much as 25%.[40-42] The translation to years of service for some dental restoration, as a result of this environment, can be less than 1 year.[43]

Thus, when force is being applied to the restoration that exceeds the materials' fatigue strengths, failure can occur earlier than its prescribed service life.

This means bite force must be considered when choosing the correct treatment plan for the patient in order to prevent dental restoration failures by assuring the choice of material can withstand the service conditions during its prescribed lifetime.

Though the frequency of reported failures among dental restorations remains high,[6] compounding effects can increase the total failure rate to as much as 34%.[9,44]

A survey of dentists in the Dental Practice-Base Research Network[10] have shown that more than 50% of all failures occurred in the posterior region, where the largest of forces are applied, and dental amalgams fail in more than 50% of restorative failures, which is considered amongst the weaker dental restorative materials.[45]

These results have been demonstrated separately using a similarly large cohort, which objectively shows that failures are region specific and material specific.[46] This strongly suggests that material and loading conditions play a crucial role in the service life of a restorative treatment plan.

These failure rates are based on curated reviews of clinical cases, while in practice, where most variables cannot be controlled, failure can occur more often.[47] While failure can be multifactorial, an implant[35] or crown[48] material whose fatigue strength is exceeded from an excessive bite force will not have a high survival rate.

Although an understanding of the restoration geometry is important for its application, a lack of understanding in material strength and forces increases the risk of a restoration's failure. To draw a professional parallel, engineers could not provide safe structural solutions for a bridge without accounting for the loading conditions and the materials assuming the load.

Currently, a dental clinician must not only choose the correct materials from a plethora of choices,[49] they must also assume the patient's loading conditions using uniquely qualitative clinical judgment, with very little quantitative information.

Though qualitative evaluation can be crucial in the installation of successful dental restorations, the high instances of failure may be avoided with a quantitative understanding

A failed dental restoration costs time and money, with as much as $12,000 in lifetime repair costs,[4] and approximately 30 minutes per repair of potentially unbillable work.[51] Most importantly, the reputation of the clinician is negatively impacted, which usually cannot be recouped, as the majority of reparation of dental restorations are performed are effected by different clinicians.[10]

A Case for Night Guards

The average patient applies approximately 800 N voluntarily on a single bite,[12,24] with potentially larger forces applied involuntarily during sleep parafunction events (e.g.: bruxism).[2] As some patients may exceed these average voluntary bite force values, so too does their bite force increase during bruxism events.[52]

As the magnitude and frequency of force is increased, there is an increased risk to dental restorations. In a review of the survival rate for dental implants in people with bruxism, it was found that there was two to four time odd ratio of implant failure in bruxers than those without bruxism.[53]

As the cost of dental restorations in time and money is significant, for patient and clinician,[54,55] effective protection is a welcomed addition to any dental restoration treatment plan, especially in instances of elevated bite force value.

Solution: Personalized Bite Force Assessment

The Innobyte™ is the first total bite force measurement device on the market . With the Innobyte's patent pending technology, the clinician is able to measure the whole arch loading from 0 to 3000 Newtons.

Using the pressure of an incompressible fluid, the Innobyte is able to convert this value to an easy-to-read, easy-to-interpret, digital read-out of the calibrated force in Newtons (1 Newton is equal to 0.225-pound force). Due to the soft nature of the medical grade silicone of the bite surface, patients do not risk pain or damage to teeth or gingiva, and are able to apply their maximal load.[56]

The intermolar separation of the Innobyte's Mouthpiece is specially designed in order to mininimize elevator muscle bias, where fewer muscle fibers are recruited during large jaw separations,[57,58] as well as simulating the clinically relevant average food morsel size. The Innobyte's Mouthpiece is a one-size-fits-all flexible unit, so there is no need to worry about the fit with each patient.

The Innobyte is simplistic in design and operation, with no complex accessories and components, with an intuitive user interface. It has never been so easy to assess the maximum voluntary bite force of a patient.

Accuracy, Precision and Reproducibility

The Innobyte associates the pressure from a proprietary calibration system in order to provide precise and reproducible results. This is achieved by using calibrated system sensors and load cells that are based on ISO 17025 precision standards with less than 1% variation, for a compounded accuracy of greater than 95% (see Figure 1). This translates to a maximum variation of 20 Newtons or 5-pound force, or less than the force required to tap a key on a keyboard, which is quite impressive when the average human bite is well over 500 Newtons of force. Additionally, the Mouthpiece has four carefully designed guides for precise Mouthpiece placement that allows the clinician to obtain reproducible results, every time (see Figure 2). Differences in the measured bite force can be confidently associated with a successful treatment plan.

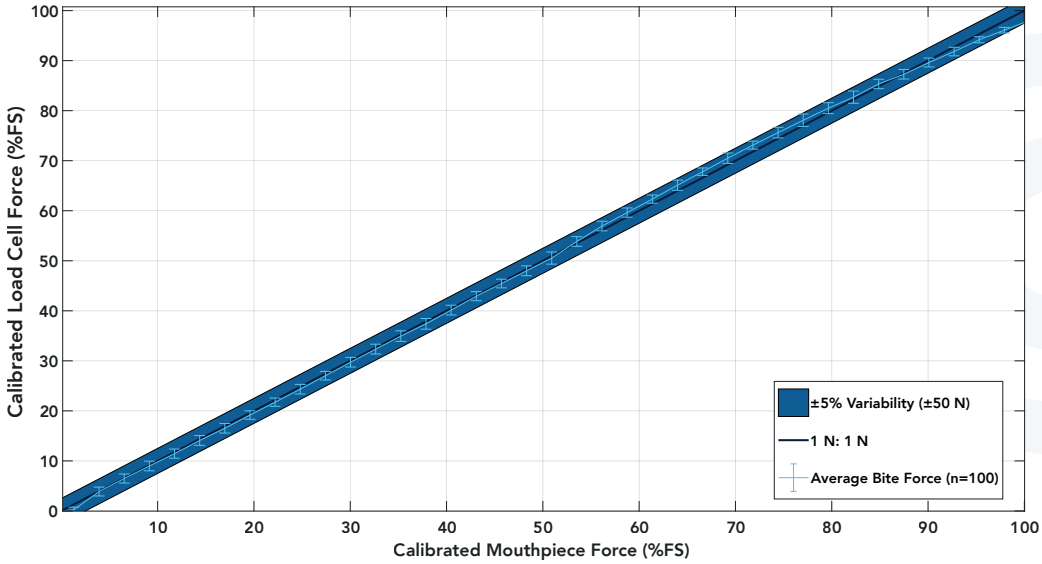

Figure 1. Calibration Curves for InnobyteTM Mouthpieces from 0-100% of Full Scale (2000N).

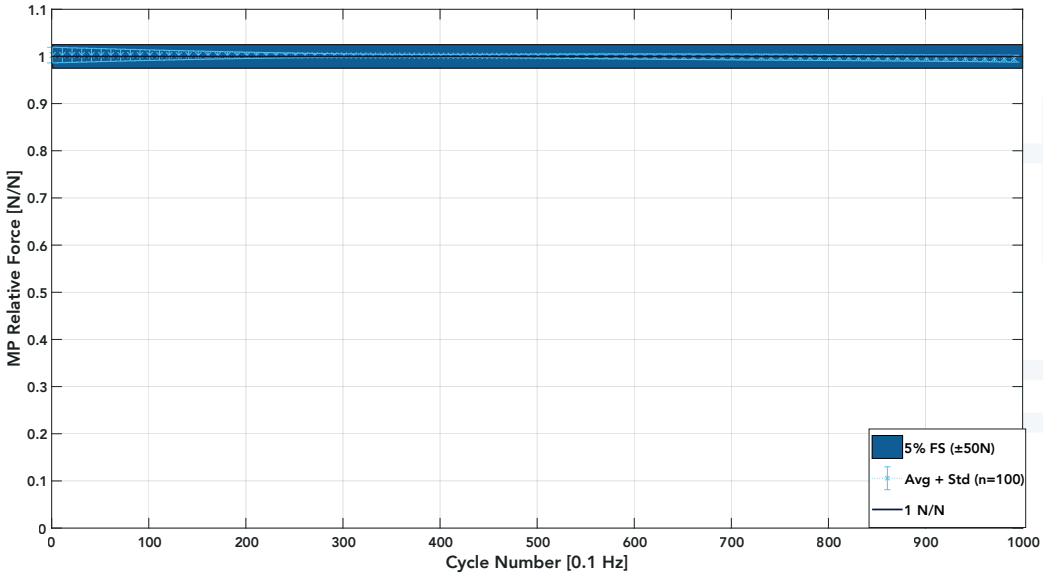

Figure 2. Repeatability of Bite Forces over entire lifecycle of InnobyteTM Mouthpiece (1000 cycles).

Conclusion

The inclusion of bite force in clinical practice is an invaluable tool, which can help convince the patient that the proposed treatment plan is the correct course. Prior to the Innobyte, clinicians did not have all the tools to make a data driven decision for treatment plans. And due to its operating principles and ease of use, the Innobyte™ adds valuable objective information related to masticatory function in everyday clinical practice. Furthermore, bite force measurement can be easily integrated in everyday practice with the Innobyte™ to help in the detection and monitoring of the oral health of the clinician's patients.

HIGHLY PRECISE

This high precision measuring device is over 95% accurate

EDUCATIONAL

Use data to educate your patients

USER FRIENDLY

Only press one button to get a precise bite force measure

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