

# The invisible world of occlusion

**Helen Harrison** considers the importance of perfecting patients' occlusion during implant treatment, and looks at the parameters for adjustment

**P**erfecting the occlusion or 'bite' of the teeth during the provision of restorations and implants is an undisputed necessity to ensure patient comfort and long-term stability of their dentistry. But how 'perfect' does this need to be and what are the parameters for our adjustments?

Richard Hammond recently presented a fascinating series of BBC programmes entitled *Invisible Worlds*. He used imaging technologies to discover secrets beyond the limits of human vision, transforming our understanding of what is happening around us, from lightning clusters to plant behaviour. By stretching time to reveal the sequence of events in minute detail, a completely different picture can emerge that can explain inconsistencies and anomalies of function and behaviour (Figure 1).

Implementation of imaging technology in the form of the T-Scan device in my clinical practice has revealed much of the 'invisible world' of occlusion and associated diagnostic capability. Many of the most influential tooth contacts in occlusion are so subtle that they cannot be identified through simple observation. The clinical challenge is to prevent the consequences of occlusal discrepancies by making appropriate, evidence-based and minimal adjustments to deliver a realistic treatment with reliable outcomes.

## Achieving closure

According to the Academy of Prosthodontics (2005), occlusion is 'the act or process of closure' – a dynamic event that is not simply the position in which the teeth make maximum contact. Each tooth contact that occurs as part of the closure sequence can be characterised in



**Helen Harrison, BDS, MFGDP,** qualified in 1985 from the Royal London Hospital and has worked mostly in general dental practice ever since. She gained the diploma in general dental practice from the Royal College of Surgeons in 1995. Helen's particular interests and skills are in providing high quality repairs and replacements for teeth, together with prevention of dental problems. She has a particular interest in the functional aspects of the teeth and jaw joints, and their relationship with general health and fitness.

## Aims and objectives

The aim of this article is to explain the importance of perfecting patients' occlusion during implant treatment.

The reader will:

- Look at the parameters for adjustment
- Understand that occlusion is a dynamic event and not simply the position in which teeth make the maximum contact
- Learn about a device that can document a patient's occlusion precisely.

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terms of its strength, direction and duration. The pattern, sequence and balance of these contacts are determined by the path of closure. Static bite registration and study casts, whether hand articulated or mounted on an articulator, cannot reproduce all of these factors meaningfully because occlusion relies on sensory motor integration to co-ordinate the activities of the muscles of mastication (Kubota K, 1977). Tooth inclines may guide muscles, because learned patterns and muscles will determine the path of closure.

The presence of a tooth/restoration contact that prevents stable intercuspation of the rest of the dental arch may be easily detected with articulating paper. The magnitude of the force, timing and balance can only be judged by experienced interpretation of articulating paper marks and retention of Shimstock foils.

Research shows that there is little correlation between the appearance of articulating paper marks and the contact force that they represent (Carey JP et al, 2007) (Figure 2). Patients will exhibit a much wider range of responses to occlusal imbalance than can be explained by the accuracy of the adjustments. Every dentist has had the distressing experience of a patient who persistently experiences discomfort, and even pain, following the fitting of a restoration, and subsequent repeated occlusal adjustments. Often the new restoration in this situation has been adjusted to the point where there no longer appears to be any contact and yet the patient still complains. It is tempting to suggest that these patients have some other problem or are experiencing a form of phantom limb syndrome. However, 'invisible' contacts in the occlusion may be causing these symptoms.

During mastication there is usually a bolus of food present between the teeth and the consequent tooth contact time is very short. Chewing only accounts for between seven and 11 minutes of tooth contact time in any 24-hour period, and much of this is not in the intercuspal position.

Tooth contact initiates a sensory stimulation in the periodontal ligament that shuts off the motor stimulation to the powerful jaw closure muscles, temporalis and masseter. This is precisely to prevent damage to dental structures. Wear and breakage of teeth appears to occur as the outcome of prolonged activity of these muscles, resulting in extended periods of intense tooth contact. If the occlusion is not characterised by almost simultaneous, balanced tooth contacts, the muscle activity during each closing cycle is extended, as the time taken from first tooth contact to full intercuspal tooth contact can range from less than 0.2 seconds (consistent with healthy muscle function) to over 0.8 seconds, causing a 400% increase in muscle activity (Stevens C, 2004).

The mechanoreceptors that detect tooth contact are incredibly sensitive, as evidenced by the detection of a hair between teeth, which can have a diameter of as little as 17µm. If this contact is sufficient to trigger a reflex response, then only brief glancing contacts elsewhere in the dentition during occlusion will cause competing sensory input from the teeth.

Occlusal tooth contact competition can induce muscle hyperactivity in the orofacial region as jaw muscles become overworked. This may cause pain in these muscles and may provoke parafunctional activity. Reduced competition for muscle recruitment may explain why the elimination of occlusal interferences



Figure 1: A freeze-frame high-speed photograph of liquid reveals a pattern of droplets invisible to the naked eye



Figure 2: Articulating paper marks do not differentiate between light and heavy forces



Figure 3: Competition between tooth contacts is very short, almost always resulting in a 'photo finish'

can increase the speed of lateral jaw excursions, reduce muscle hyperactivity and alter bruxing behaviours (Trovato F, Orlando B, Bosco M, 2009). The problem is that the competition between these tooth contacts is very short – almost always resulting in a 'photo finish' that makes a sprint race look leisurely (Figure 3).

In his textbook of occlusion, Dawson observed: 'It appears that, regardless of the cause, the most effective treatment for the effects of bruxism is perfection of the occlusion.'

In many patients, bruxism involves lateral and/or protrusive grinding of the teeth, which is not part of the healthy masticatory pattern. As the teeth move away from the intercuspal position, the forces applied to the teeth may no longer be directed down the long axis of the

root or perpendicular to the surface of the tooth, and this increases the potential for damage to the dental structures (Figure 4).

Anterior guidance built into an occlusal scheme seeks to cause a disclusion of the posterior teeth, transferring the contact to the anterior teeth as quickly as possible once a lateral excursion commences. Transfer of contact to the anterior teeth immediately reduces the contraction force of the muscles due to a much higher density of mechanoreceptors in the periodontal ligament of anterior teeth than posterior teeth (Byers MR, Dong WK, 1989).

Studies show that there is a correlation between patients who exhibit muscle hyperactivity and symptoms of parafunction and a posterior disclusion time of over 0.4

seconds (Kerstein RB, 1994). So, rather like an engine, high performance and smooth running of even the most precisely engineered system is dependent on the timing.

### Precise measurement

The T-scan device is used to document a patient's occlusion precisely (Figure 7). The sensor is comparable to a horseshoe of articulating paper, which is supported in the handle and connects directly to a computer via USB.

A piezo-sensitive ink captures the position and intensity of the force as the teeth occlude at 0.001 second intervals. The data is displayed as a movie with colour-coded contour images (Figure 8). Replay of the sequence allows the first and subsequent tooth contacts to be identified.

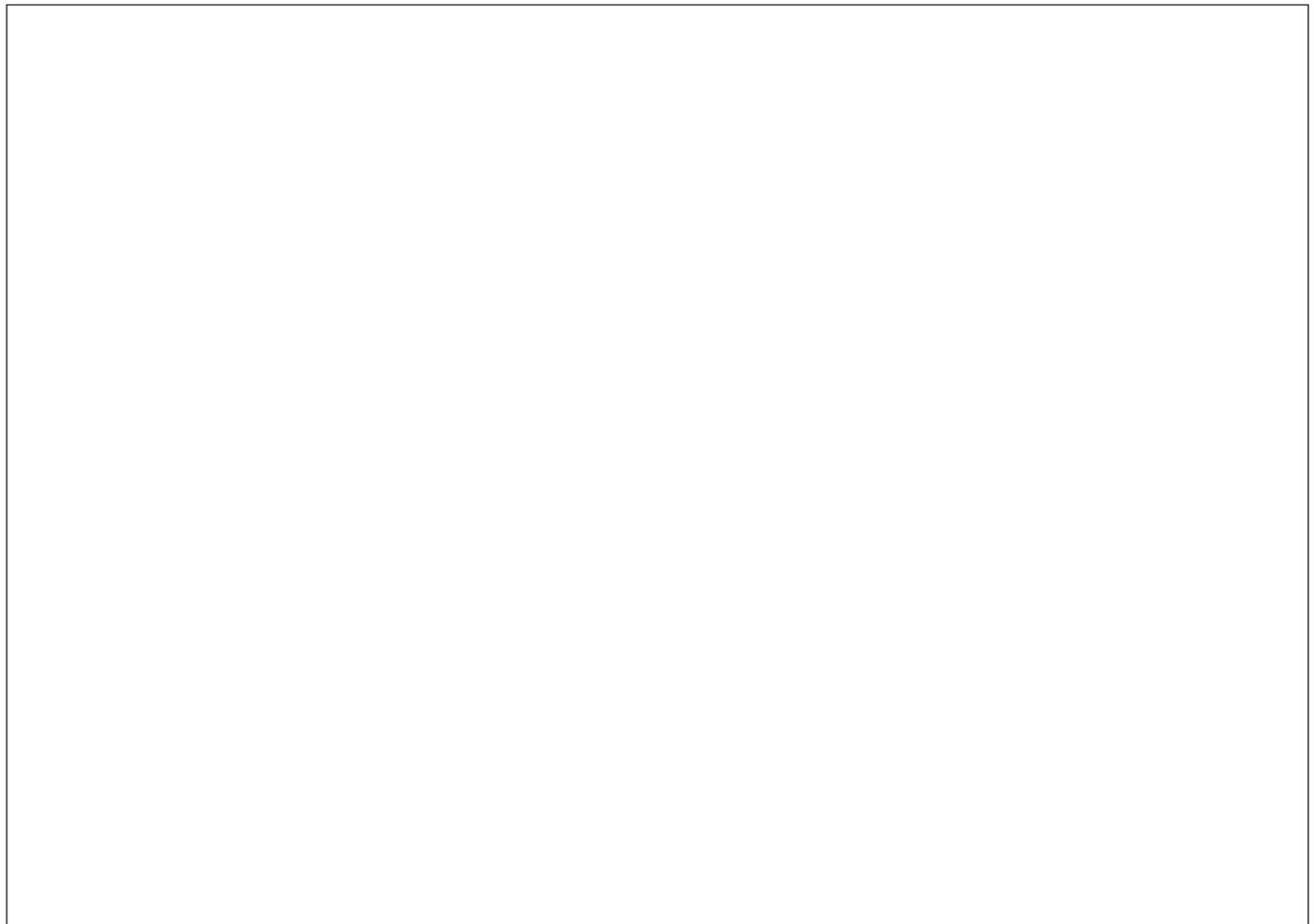




Figure 4: Excessive tooth-wear seen in a bruxing patient



Figure 5: Canine guidance



Figure 6: Anterior guidance should achieve a fast, complete and efficient transfer of forces from posterior to anterior teeth, much like a successful baton pass



Figure 7: The T-scan handpiece

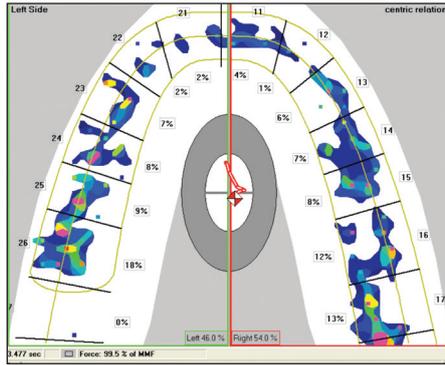


Figure 8: Screen representation of tooth contacts

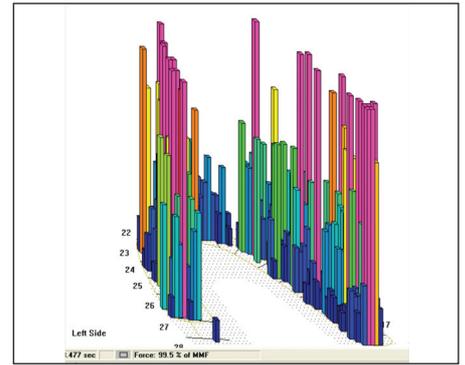


Figure 9: Bar chart depiction of the relative pressure of tooth contacts

The thickness of the sensor (80µm) generates a deprogramming effect to allow the muscle-guided initial tooth contacts to be displayed. The force at each contact is displayed as a proportion of the total force, allowing a clear assessment of occlusal balance regardless of muscle tone variation between patients (Figure 9). The sensor allows for multiple repeat recordings. These sequences are automatically stored and provide an instant and accurate record of the diagnostic findings, and any adjustments are carried out.

Use of the T-scan is revelatory in much the same way as modern car engine management systems. I expect the speed and level of diagnostic precision achieved when the garage mechanic attaches my vehicle to the computer, but he still needs to utilise his skills to repair the problem. Our patients are now expecting comparable levels of technological tools to diagnose, document and manage their dentition. Identification of simple issues such as the cause of a food trap, tooth fracture or cheek biting problem to detailed management and finishing of complex implant restorative cases benefit from reproducible, fully recorded, detailed information. The particular concerns with implants of altered sensations (Dario LJ, 1995), limited capacity to displace axially (Schulte W, 1995), increased susceptibility to lateral forces (Rangert B, Jemt T, Jörneus L, 1989) and maintenance of the osseointegration justify the use of T-scan in these cases.

### Conclusion

'Perfect' occlusion is an elusive concept in a system based upon neuromuscular control that is constantly adapting and responding to function, trauma and higher central nervous system control. The accuracy and quantity of information delivered by the T-Scan device will probably always exceed the practical ability to correct the occlusion. However, it does illuminate key information that would otherwise be overlooked, helping to identify patterns of occlusal function that are amenable to clinical correction. The benefits to the

patients of these adjustments appear to extend beyond improving the predictability of dental restorations into some of the underlying causes of bruxism and tooth wear that are increasing issues in dental practice. **I**

Helen Harrison regularly presents lectures and hands-on seminars on the practical application of occlusion and TMJ function for general practice dentistry. Please visit the websites [www.occlusion.co.uk](http://www.occlusion.co.uk) and [www.s4sdental.com](http://www.s4sdental.com) for details of events in the near future.

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