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Review Clinical issues in occlusion – Part I $\stackrel{\scriptstyle ightarrow}{=}$



Aws Alani^{*}, Mahul Patel

Department of Restorative Dentistry and Traumatology, Kings College Hospital, Denmark Hill, London SE5 9RS, UK

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ABSTRACT

Good occlusal practise provides an important cornerstone to optimal patient care. Occlusal problems can manifest in different areas of dentistry but these are more apparent when there are restorative aspects to the patient's problem. This review highlights areas of restorative dentistry where the appreciation of occlusal aspects can optimise diagnosis and follow up care.

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Introduction

The Glossary of Prosthodontic Terms defines Occlusion as 'the act or process of closure or of being closed or shut off' or 'the static relationship between the incising or masticating surfaces of the maxillary or mandibular teeth or tooth analogues' [1].

However, it is both static and dynamic relationships between different components of the masticatory system that are usually considered simultaneously when occlusion is examined or recorded. In essence, this describes the relationship between the opposing masticating surfaces of teeth and the movements of the mandible dictated by way of the temporomandibular joint and associated orofacial musculature. Therefore, occlusion represents a spectrum of anatomical and physiological principles varying in their complexity and intricacies. These principles can lack robust evidence to advocate their usage and as such,

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E-mail address: awsalani@hotmail.com (A. Alani).

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confusion and uncertainty can result. Recreating the occlusal relationships inaccurately outside of the mouth can result in frustration for the dentist, technician and most importantly the patient. In contrast there maybe situations (with appropriate planning) where restorations maybe cemented at an increased vertical dimension which may otherwise be considered unconventional.

The awareness of occlusal aspects when examining a patient as well as associating these with signs and symptoms provides information for optimal management. This ethos should be considered on a backdrop of changes in patient demographics, social pressures and increased patient expectations. The first part in this series will look at specific occlusal problems and their aetiology and diagnosis. The second part will illustrate occlusal registration techniques and subsequent management.

Occlusion and tooth surface loss (TSL)

Attrition results from tooth-to-tooth contact resulting in welldefined wear facets on the occluding surfaces of teeth which correspond between the maxilla and the mandible (Fig. 1). Physiological tooth wear is expected to a certain level when taking into account the age of the patient. Pathological toothwear (where the rate is greater than that expected physiologically) as a result of parafunctional activity results in the accelerated loss of tooth tissue, threatens pulp health and can result in axial tooth movement that will make future restorative management difficult due to changes in interocclusal relationships, potential differential tooth movement and loss of interocclusal space. In its mildest form faceting within enamel may provide early signs of attrition. In the latter stages tooth tissue may become significantly damaged resulting in difficulties in restoration and pulpal involvement (Table 1). The key in these situations is to identify patients with parafunctional activity, recognising this at the planning stages of any procedure and protecting tooth structure and restorations by way of individual design characteristics or considerations for long term appliance therapy. If such parafunctional activity is allowed to progress the prognosis for survival of teeth and their associated restorations is likely to diminish (Table 2).



Fig. 1 – A 28 year old patient presenting with attrition, amelogenesis and hypodontia.

One notable risk factor for parafunctional activity is psychological stress [2]. Current research shows that psychological stress is increasing in the general population and this is more often than not associated with vocation related pressures [3]. In such cases a thorough social history is likely to inform the treatment planning process and aide delivery of care. Other much cited risk factors include occlusal relationships such as the retruded contact-, intercuspal position slide and lateral guidance pathways such as canine or group function [4,5]. There is no evidence to suggest that any occlusal relationship will result in a greater likelihood of parafunction or indeed temporomandibular dysfunction [4,5].

General conservative management of attrition type TSL would be the provision of a stabilisation splint in the first instance in order to prevent further hard tissue surface loss. Parafunction against the splint would lead to favourable attrition of the acrylic splint material [6]. A upper soft bite guard could be made in acute cases as a quick urgent way of relief.

Occlusion and restoring/increasing the occlusal vertical dimension (OVD)

In cases of severe TSL due to a combination of attritive or erosive processes there may be extensive loss of the dental hard tissues, and commonly the teeth appear to look grossly shorter in clinical crown height from gingival aspect to the incisal edge or occlusal surface. It could appear that there is a loss of OVD here, however in most cases in dentate patients this is not the case due to physiological dentoalveolar compensation that occurs [7]. The compensatory mechanism is noticeable due to the varied position of the gingival zeniths of the anterior segment (Fig. 1). If the rate of tooth destruction occurs at a faster rate than compensation, an open bite can occur.

In cases where compensation has occurred there is a loss of interocclusal space, increasing the existing OVD is a treatment strategy that may be considered. Other more drastic treatment methods have been proposed such as elective extraction, surgical crown lengthening and orthodontic intrusion. These techniques vary in their invasiveness and as such irreversible damage. Although considered invasive and damaging to sound tooth tissue and supporting structures these techniques can still be considered with appropriate care and planning. A technique routinely utilised in the UK is increasing the OVD using a method modelled on a concept first illustrated by Dahl [8]. Dahl and colleagues were the first to discover this phenomenon in the 1970s by utilising a removable cobalt chromium intrusion appliance with a bite platform anteriorly. This concept was developed further in the 1990s in the UK by utilising composite resin to restore worn teeth (Fig. 2). This involves the placement of composite restorations at an increased OVD on anterior teeth leaving posterior teeth with no occlusal contacts. A period of occlusal adaptation results with a combination of intrusion of the anterior teeth and vertical migration of posterior teeth resulting in the relinquishing of contacts over time.

This treatment modality shows good short to medium term results although the requirement for maintenance maybe high [9]. Despite this, the advent of placement of

Table 1-Smith & Knight TSL Index				
Score	Surface	Criterion		
0	BLOI C	No loss of enamel surface characteristics No change of contour		
1	BLOI C	Loss of enamel surface characteristics Minimal loss of contour		
2	BLO I C	Enamel loss just exposing dentine <1/3 of the surface Enamel loss just exposing dentine Defect less than 1 mm deep		
3	BLO I C	Enamel loss just exposing dentine >1/3 of the surface Enamel loss and substantial dentine loss but no pulp exposure Defect 1-2 mm deep		
4	BLO I C	Complete enamel loss or pulp exposure or secondary dentine exposure Pulp exposure or secondary dentine exposure Defect more than 2 mm deep, or pulp exposure or secondary dentine exposure		

Each surface of each tooth is given a score between 0 and 4 according to its appearance. $B{=}buccal \ or \ labial, \ L{=}lingual \ or \ palatal, \ O{=}occlusal, \ I{=}incisal, \ C{=}cervical.$

Table 2		
Occlusal Problem	Clinical presentation	Management
Tooth surface loss	Shortened teeth Wear faceting Dentine sensitivity	 Preventive Splint therapy Patient education Invasive Provision of composite restorations at an increased occlusal vertical dimension
Restoration of teeth with limited interocclusal space and tooth surface loss	The need to create space for restorations that will be functional and aesthetic	 Dahl technique Surgical crown lengthening Orthodontic intrusion Elective extraction
Crack/fracturing of teeth	Teeth with large restorations which restore marginal ridges or those with decay resulting in poor support of remaining tooth tissue	• Provision of cuspal coverage restoration such as an overlaid plastic restoration or an extra-coronal restoration such as a crown or onlay
Protecting non-vital teeth	The reduction in tooth tissue as above coupled with the presence of an access cavity for endodontics results in significant weakening of the remaining crown	 Provision of a copper band or an orthodontic band during endodontic therapy Provision of an extra-coronal restoration on completion of root canal treatment
Occlusal trauma and periodontal disease	Periodontal disease may be exacerbated by the presence of occlusal trauma. The evidence for occlusal factors causing periodontal inflammation is very weak	Management of periodontal disease as per required without the instigation of occlusal adjustment/ modification
Occlusion and TMJD	 Pain associated with the muscles of mastication and the TMJ Signs of wear or faceting Clicking of TMJ Locking of TMJ 	 Conservative management involving patient education on risk factors for TMJD and how to minimise these The reduction of stress, avoidance of habitual chewing such as nail biting, avoidance of a poor posture, and the prescription of TMJ joint exercises should always be the first line of treatment
Occlusion and the ageing population	These cohort of patients are likely to have increased needs for complete denture prosthodontics and maintenance of these prostheses	When deciding the occlusal scheme it maybe more advisable to maintain certain aspects such as the OVD from previous prostheses for purposes of adaptability. There is weak evidence advocating one occlusal scheme such as bilateral balanced over others when considering functionality of the prostheses

Fig. 2 – Direct composite restorations placed on the upper and lower anteriors at an increased occlusal vertical dimension.

composite restorations at an increased OVD is biologically the kindest treatment modality when directly comparing to crowns, surgical crown lengthening or orthodontic intrusion.

Occlusion and mechanical failure of teeth

The cracking or fracture of teeth is a problem that is increasing and is notoriously difficult to diagnose in the early stages especially when the clinical picture does not always consistently correlate with the symptoms of the patient [10]. More often than not patients may present with parafunctional tendencies that are likely to stress and strain teeth prior to inception of a crack or fracture (Fig. 3). Other patients may give a history of trauma related to biting into something very hard at the inception of symptoms or fairly specific symptoms associated with pain on release, biting certain foods or biting in a certain way [9]. Cracks and fractures of teeth are significantly associated with large restorations and also mandibular molars [11,12]. The prevalence increases in patients forty years or older with women being more affected than men [13]. The incidence of complete fractures is approximately 5% in the adult population with the overwhelming majority being posterior teeth [13]. Of the 5% of complete fractures 15% result in pulpal involvement or extraction [13]. Aetiological factors associated with fractured teeth are numerous. These can be split into local and general factors. General factors are likely to be associated with parafunctional activity or attrition placing teeth under significant loads for long periods. Local factors include morphology and the tooth's restorative status. Teeth with steep cuspal inclines maybe naturally more prone to cracking when put under stress or strain [14]. This is in part associated with the wedging effect of the cusp fossa relationship putting teeth under tensile and internal shearing stresses [14]. Further to this teeth with large restorations and cusps that are poorly supported with an absence of underlying tooth tissue [15]. As tooth bulk decreases so does the remaining tissues ability to resist force and prevent fracture [15]. This is best illustrated by mesial occlusal distal (MOD) restorations on premolar teeth. Vale and colleagues discovered that with increased width of restoration isthmus a decreased resistance resulted. Where unsupported cusps are involved in



Fig. 3 – Lower right 6 with a fractured lingual cusp. The tooth was still responsive to sensibility testing. The fracture was investigated and found to be subgingival but within normal limits of restorability. This tooth was restored with an onlay restoration.



Fig. 4 – This patient complained of pain on release and on eating certain types of granary bread. Utilisation of disclosing solution on the upper left 5 revealed a crack that ran from mesial to the distal portion of the tooth.

non-working side interferences this is likely to compound the risk of fracture [16]. Despite the effect of reduction of tooth tissue a recent study found that the split between restored and unrestored teeth that suffered with cracks was approximately 50% [17] (Figs. 4 and 5).

Cuspal coverage of teeth with reduced tooth tissue provides a means to reduce the likelihood of fracturing or cracking. Cuspal coverage has been shown to provide greater resistance to fracture than non-cuspal coverage restorations and unrestored teeth [16]. These results were echoed by Salis and colleagues who found that MOD restorations weakened teeth when lacking an overlaying [18] (Fig. 6). Further aspects that may make teeth prone to fracture include the position within the arch. Frequently first molars have been cited due to their close proximity to the muscles of mastication and the temporomandibular joint making the forces exerted upon them greater than teeth further away [17]. Indeed the decision to provide cuspal coverage can be difficult to make. Where an extra-coronal restoration maybe indicated the removal of more tooth tissue, hence making the tooth even weaker, will be required prior to the provision of a



Fig. 5 – Upon removal of the restoration the crack ran along the floor of the cavity. This tooth was restored with a minimally invasive onlay restoration.



Fig. 6 – An amalgam overlay restoration provided for the lower left six.

crown. As yet there seems to be no objective consensus as to when to provide cuspal coverage to protect the remaining tooth tissue in vital teeth. This of course needs to be weighed against the greater probability of irreversible pulpal damage by the preparation [19]. In comparison the literature for cuspal coverage of non-vital teeth is more robust [20].

The need to protect non-vital teeth

Non-vital teeth have a significantly decreased ability to withstand occlusal loads when compared to vital teeth [21]. The pulp is likely to provide proprioceptive feedback that allows the masticatory system to avoid overloading and thus catastrophic fracture. This was illustrated in a classical study by Randow and Glantz where cantilevered loads were applied to vital and non-vital teeth. Pain perception by the patient manifested with occlusal loads that were twice as high for non-vital than vital teeth [22]. These differences were not present when the teeth were anaesthetised. This study illustrated the likelihood of mechanoreceptor function of the pulp and detection of occlusal loads. Once loss of vitality is established and root canal treatment is required the presence of an endodontic access cavity weakens teeth and so affects structural integrity [23]. The relative stiffness of a tooth reduces with an occlusal access cavity which increases

significantly if marginal integrity is broken [23]. Reeh and coworkers found that an MOD cavity preparation reduced tooth stiffness by 63%. The defining factor in resisting occlusal loads of both vital and non-vital teeth seems to be the amount of remaining tooth tissue and as such minimising tissue removal during access cavity preparation is advised. Further to this chemo-mechanical endodontic procedures weaken teeth. The utilisation of hypochlorite and EDTA significantly weakened teeth and increased tooth surface strain [24,25]. These biomechanical factors need to be considered in tandem with the need for optimal coronal seal as lack of tooth tissue will not only make teeth susceptible to fracture but also compromise post root canal treatment failure due to re-infection [20].

Occlusion and the periodontium

Occlusal trauma is defined as 'trauma to the periodontium from functional or parafunctional forces causing damage to the attachment apparatus of the periodontium by exceeding its adaptive and reparative capacities. It may be self-limiting or progressive' [2] (Figs. 7 and 8). What seems clear within the literature and in practice is the need to distinguish between association and causation [26]. Periodontitis may be associated with a multitude of local, general or patient based factors ranging from overhanging restorations to inflammatory systematic diseases manifesting in the periodontium [26].

Few clinical studies have identified a link between trauma from occlusion and inflammatory periodontitis in man [27]. Although both processes cause destruction of the apparatus in different ways the exact mechanisms and whether there is true synergy between the two pathological processes is yet to be realised. It may be fair to say that occlusal trauma may exacerbate already present periodontal inflammation whereas orthodontic force is unlikely to exacerbate periodontal tissue loss. Where frank plaque induced periodontitis and occlusal trauma is present gradual widening of the periodontal ligament space with mobility and angular bone loss can be



Fig. 7 – Primary occlusal trauma affecting the upper left 5. Note the marked gingival inflammation localised to this tooth. There was pocketing of greater than 4 mm circumferentially.



Fig. 8 – In intercuspal position the tooth exhibited significant fremitus.

expected. In the absence of periodontitis occlusal trauma does not result in attachment loss but does result in tooth mobility which is reversed once the trauma is removed.

The utilisation of occlusal adjustment to reduce non-axial loading of teeth in an attempt to prevent occlusal trauma and so periodontal disease is controversial with poor or limited evidence to support it. The removal of sound tooth tissue to aide what is an inflammatory process fuelled by the presence of bacteria is difficult to recommend. In a randomised controlled trial two groups of patients underwent periodontal therapy with and without occlusal adjustment. There was no effect of occlusal adjustment on changes in pocket depth [28]. These findings were later confirmed by way of a Cochrane systematic review [29].

Occlusion and temporomandibular joint dysfunction (TMJD)

The role of occlusion in the development of TMJD is controversial as the majority of reasoning behind causation is based upon anecdotal rather than scientific evidence. Weak evidence between occlusal scheme and TMID development has been identified [30,31]. In a series of studies by Seligman and Pullinger an overjet of greater than 5 mm, unilateral posterior crossbite and retruded contact position intercuspal position slides of greater than 1.75 mm were associated with TMJD although this was statistically weak. The fact that this was an association and not implication also requires some thought. Further to these findings Clark and colleagues in a systematic review found that the introduction of occlusal interferences did not result in significant evidence for development of TMJD [32]. Aetiology based on occlusal scheme does not stand up to scrutiny when considering fibromyalgic patients - 75% of which may present with TMJD regardless of occlusal scheme [33]. Indeed there is limited evidence for either occlusal splint therapy or occlusal adjustment in the treatment of TMJD [34]. In a systematic review examining both modalities the benefit of occlusal splint therapy was unclear, and none of the twenty studies included in the analysis could provide beneficial evidence for occlusal adjustment [35].

Due to the above findings it seems unsurprising that the authors recommend a conservative approach to TMJD treatment that are reversible and do not remove sound tooth tissue. The provision of an occlusal stabilisation splint, although reversible, does not provide significant benefit over ultra-conservative treatment [35]. In a randomised controlled trial comparing splint therapy to patient education and muscle exercise there was no detectable benefit of splint provision [35]. The emerging evidence shows that patient education coupled with jaw exercises provide patients with measurable improvements especially in patient centred outcome studies [36,37].

The current evidence is too weak to advocate occlusal adjustment and relatively ambiguous to advocate routine stabilisation splint therapy prescription. Conservative modalities such as patient education and muscle exercises seem to be the assured way of treatment at the current time [38].

Occlusion and the ageing patient

Our patients are living longer. As we age our adaptive capacity to changes decreases and this maybe the case with



Fig. 9 – This 92 year old patient presented complaining of old and worn dentures which he had been wearing for 40 years. A new set of dentures were provided with an increased occlusal vertical dimension and improved extensions. Unfortunately despite these 'improvements' the patient was unable to tolerate these changes and requested his old set of dentures be copied.



Fig. 10 – Due to the loss of maxillary teeth vertical migration of the mandibular molars has resulted in loss of interocclusal space for a removable prosthesis.

occlusal modifications. Where complete dentures require replacement the adaptive capacity of the patient may need consideration when deciding on provision of a conventional prosthesis or simply copying the current dentures and modifying where required (Fig. 9). Other aspects include the loss of interocclusal space in isolated areas due to the overeruption of opposing teeth making prosthetic rehabilitation difficult to achieve. In such situations localised intrusion devices maybe utilised to recreate space for future restorations (Fig. 10).

When considering the prescription of occlusal scheme for complete dentures the evidence seems unequivocal. When examining the true advantage of bilateral balanced tooth set up there was no detectable advantage functionally in the majority of studies examined in a systematic review [39].

Summary

Some may argue that occlusion plays an integral part in many situations. The presence of occlusal problems may not be readily apparent when examining clinically and as such further analysis maybe required (Table 2). The mounting of models to aide in diagnosis and treatment planning is invaluable especially where multiple restorations are planned. Virtual planning on models by way of adjustments or wax-ups provides the clinician with foresight as to the achievability and predictability of a chosen plan. These techniques will be described in further detail in Part II of this series.

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