

KEY WORDS

Occlusal philosophies, full mouth rehabilitation

LEARNING OBJECTIVE

- To better appreciate the changes in occlusal philosophies for full mouth rehabilitation over the years

AUTHORS

Martin G. Kelleher BDS (Hons), M.Sc., FDSRCPs (Glasg), FDSRCS (Eng), FDSRCS (Edin)

Consultant & Specialist in Restorative Dentistry, King's College Hospital, London, UK

Hui Lynn Ooi BDS (Hons)

Staff Dentist in Acute Dental Care, King's College Hospital, London, UK

Igor R. Blum DDS (Hons), PhD, Dr Med Dent, MSc, MFDS RCS (Eng), MFDS RCS (Edin), FDS (Rest Dent)RCS (Eng), FFGDP (UK), PGCHE, FCGDent, FHEA, LLM (Medico-Legal)

Consultant & Specialist in Restorative Dentistry, King's College Hospital, London, UK; Reader in Primary Dental Care & Advanced General Dental Practice, Faculty of Dentistry, Oral & Craniofacial Sciences, King's College London, London, UK

MARTIN G.D. KELLEHER, HUI LYNN OOI, IGOR R. BLUM

Prim Dent J. 2021;10(1):50-55

CHANGES IN OCCLUSAL PHILOSOPHIES FOR FULL MOUTH REHABILITATION

ABSTRACT

This article reviews some of the main tenets of different occlusal philosophies involved in 'full mouth rehabilitation' and evolved since the late 19th century. This review is not intended as a comprehensive historical review of all the people who wrote, researched, or taught on the topic, and it is certainly not intended to disparage their well-meaning contributions. It is intended to highlight some of the changes that occurred in relation to full mouth rehabilitation occlusal concepts along with the dates when they were articulated.

Introduction

The main objective of 'full mouth rehabilitation' is the restoration of the dentition by establishing new occlusal forms at the correct vertical dimension in order to improve function and appearance, while maintaining the health and harmony of the entire stomatognathic system.^{1,2} Since the late 19th century, various occlusal concepts and philosophies have been articulated in relation to achieving a supposedly 'optimal occlusion'.

Occlusal philosophies from the 1890s onwards

In the 1890s and early part of the twentieth century, von Spee (1890)³ and Gysi (1915)⁴ had done their work in relationship to occlusal schemes for complete dentures. Their fundamental

premise was that the most posterior, superior position of the condyles in the glenoid fossae was the optimal position for setting up *false* teeth when making complete dentures.

In their concept of bilateral *balanced occlusion*, balancing contacts needed to be present during *all* mandibular movements to keep the complete dentures stable during chewing and swallowing. However, those complete denture principles do *not* apply to *natural* teeth, mainly because teeth are held within their functioning and adaptable periodontal ligaments which have exquisitely innervated mechanoreceptors to "programme" jaw movements and jaw positions. Many enthusiastic 'occlusionists' seem blissfully unaware that originally this *bilaterally*

balanced occlusion concept was applied to restoration of *the natural dentition* by means of what was termed 'full mouth rehabilitation'.

Concepts in 'gnathology' and how these changed from the 1920s

In 1924, Dr Beverly B. McCollum described the first positive method of locating the hinge axis, a milestone in dental research. He founded the Gnathological Society in 1926. McCollum and the Gnathological Society's definition of 'gnathology' was as follows: 'Gnathology is the science that treats the biologics of the masticating mechanisms; that is, the morphology, anatomy, histology, physiology, pathology and the therapeutics of the oral organ, especially the jaws and teeth and the vital relations of the organ to the rest of the body'.⁵ McCollum is considered to be 'the father' of gnathology.⁵ Dr Harvey Stallard, an orthodontist, proposed the word 'gnathology'. It is derived from 'gnathos,' meaning jaw and 'ology,' meaning the study of, or knowledge of something.

In 1927, Stallard articulated his view that in assessing malocclusions, from an orthodontic perspective, that the teeth dictated the arc of closure and the position of the mandible in maximum occlusion.⁵ If articulators were to be used to reveal mal-positioned teeth, which at that time were deemed to be causing the problems, then inter-occlusal records were required to mount plaster casts, made from impressions of the teeth, in the centric relation position, i.e. before any of the teeth touched one another.

The prevailing view at the time seemed to have been that the feedback mechanisms from the teeth were *fundamentally bad* and had to be avoided by using inter-occlusal registrations without the teeth being in contact. In other words, the interocclusal registrations were taken at a slightly opened jaw position before any teeth met one another and before they could cause the jaw to deviate into the patient's normal intercuspal position.

In 1930, Dr Charles Stuart and Dr McCollum developed the first semi-adjustable articulator called the McCollum Gnathoscope. By 1933,



Figure 1: The McCollum Gnathograph. Copyright © American College of Prosthodontists. Reproduced with permission

Charlie Stuart (a prosthodontist) had become the leader of the McCollum group. One of his devices was, in effect, an early pantograph, which allowed the tracing of various mandibular movements. In 1934, McCollum and Stuart produced the first mandibular movement recorder known as the 'McCollum Gnathograph' (Figure 1).

In 1934, Dr Stuart demonstrated his mandibular movement recorder at the University of Southern California Alumni meeting. It differed from today's recorder in that anteriorly it had a sagittal plate with a horizontal stylus. It could record the entire capacity of mandibular movements.⁵ These movements were later described by Posselt, as the 'envelope of motion'. The night after his presentation, Stuart realized, whilst driving home, that he could make a recording apparatus, put it on a patient, record the mandibular movements, transfer that information on to an articulator and then set the articulator. He created this and demonstrated it at the Pacific Coast Dental Conference in 1935 at Long Beach, California. This resulted in a surge of interest in the new 'science of gnathology'.⁵

The gnathology group put great store on the importance of recording the transverse hinge axis in the condylar regions. Mandibular movements were described in great detail by them. They emphasised the absolute necessity for meticulous recording of maxillo-mandibular relationships. Various inter-occlusal records ('check bites') were

used to programme an arcon *fully adjustable* articulator in order to make the multiple restorations that were deemed to be required.⁶ The gnathologists' views were that the condylar paths involved in jaw opening and closing were a fixed entity in adults.

'Anterior guidance' describes the contacts made between the labial and incisal aspects of the lower front teeth contacting the palatal and incisal anatomy of the upper front teeth during protrusive movements of the mandible. Gnathologists believed that *anterior guidance* was independent of the condylar path movements.⁷

Originally, the gnathologists' beliefs seemed to have been that the shapes or positions of the teeth were 'wrong' and that the occlusal surfaces of the natural teeth should be changed. More appropriate restorations needed to be made on an elaborate *arcon* articulator in order to achieve their preferred goal at that time, which was to have a *bilaterally balanced* occlusion. However, partly due to excessive occlusal wear that was noted subsequently on following up many of those full mouth 'reconstructions', the bilaterally balanced occlusion philosophy began to be questioned by McCollum and Schuyler as well as other clinicians.^{6,8} It was only when the fallacy of applying the 'bilaterally balanced occlusion' concept to natural teeth was exposed by the multiple clinical failures (which was probably caused by frictional wear of their 'occlusal rehabilitations') that Schuyler, Stuart^{9,10} and others quietly abandoned their dogmatic approach and developed new occlusal philosophies.

1960 onwards

Stuart and Stallard abandoned the bilaterally balanced occlusion concept for natural teeth and espoused a new set of principles.¹¹ The main principles included that the upper palatal cusps should make firm, even, contacts in the fossae of the lower teeth when the patient bit into their intercuspal position (ICP). The lower incisors and canines were to make firm contacts with their opposite numbers. The buccal cusps of the lower premolars and molars were to be designed to stamp themselves into their opposing upper fossae.¹¹

Their new belief was that this combination of occlusal contacts would

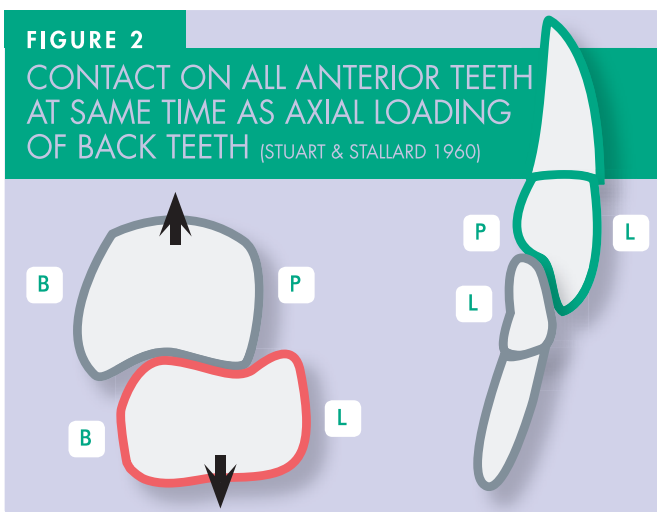


FIGURE 2
CONTACT ON ALL ANTERIOR TEETH
AT SAME TIME AS AXIAL LOADING
OF BACK TEETH (STUART & STALLARD 1960)

provide the *ideal* intercuspal position. In other words, all the teeth should meet together at the same time in ICP with the mandible being in the 'retruded axis' position (Figure 2).

During lateral movements of the mandible from ICP, only the canines were to contact. When the jaw moved, e.g. to the left-hand side, the contacts between canines should be sufficiently positive to *disclude* (i.e. stop any contact occurring) between *all* the other back teeth on both the left and right hand sides.

The side towards which jaw movement occurred was called the 'working side'; in this example that would be the left side. The other side of the mandible in that movement, i.e. the right side of the mandible, was then called the 'non-working side'.¹¹ Conversely, when the jaw moved to the right, the right side of the jaw would then be described as the 'working side' and the left side would then become the 'non-working side'.

There was to be *no* contact on the teeth on the non-working sides during any lateral movements of the mandible.

In other words, this arrangement of restorations would produce *canine guided occlusion* during lateral movements. That was very similar in concept to the *canine guidance* concept which had been described by D'Amico in 1958 in a Californian dental journal¹² and again in 1961.¹³ D'Amico claimed that this was a 'new concept' but, in fact, that was not correct.

Earlier history of the importance of canines

Various versions of 'canine guidance' had been described in 1890 by von Spee who had referred to the vertical overlap/'overbite' of the canine teeth.³ Gysi was probably the first to describe the concept of canine-protected occlusion in greater detail.⁴ However, as often happens in various areas of dentistry, a good idea falls out of fashion only for it to be allegedly 're-discovered' a generation or two later. In this instance, it took until 1958 for D'Amico to re-emphasise the concept of just the opposing canines contacting during lateral movements of the mandible, which he presented, fallaciously, as a *new* 'concept of canine guidance'.¹² In the *canine guided occlusal philosophy*, the claimed benefits of this arrangement included preventing any force being applied to the opposing incisors, premolars and molars other than along their long axes.¹³

Avoiding non-working contacts on teeth

In the late 1950s and early 1960s, avoiding non-axial loading of periodontal ligaments was deemed to be highly desirable. That was because many dentists and many periodontists, at that time, thought that non-working side occlusal contacts were involved in helping to create infra bony defects on posterior teeth in those patients who were susceptible to periodontal disease. Adjustments to the occlusion to remove non-working interferences were deemed to be an important part of comprehensive periodontal therapy.¹⁴⁻¹⁷

Following a comprehensive review of all the evidence available in 2006, that concept was discredited by Lindhe et al.¹⁸

In the 1960s, in places like Michigan, non-working interferences were also deemed to be *causative* of temporomandibular joint TMJ problems and of clenching and bruxism. Removing those non-working interferences by occlusal adjustments or by occlusal reconstructions was deemed to be important in alleviating TMJ pain dysfunction syndrome (TMJPDS).¹⁹

Occlusal splint therapy involves making devices that have no non-working contacts as well as having even contacts on the posterior parts of the device and even contacts of the lower teeth on the anterior part of the device during mandibular protrusion. Prolonged wear of such a device was deemed to be required to make TMJ movements reproducible, as judged by pantographic tracings, before then undertaking a 'full mouth rehabilitation' to produce an 'ideal occlusion' as outlined above. That concept still survives in the concept of fabricating a 'Michigan splint' for patients with TMJPDS, even though TMJPDS is widely now regarded as having a multifactorial aetiology.

In fact, the World Health Organization (WHO) recognises tooth grinding (bruxism) in its ICD-10 code as a somatoform disorder under the 'mental and behavioural disorders' sub-classification. Bruxism is classified by the WHO as 'being closely related to other psychogenic conditions such as pruritis (itching), neck stiffness, dysphagia and dysmenorrhoea'.²⁰ It is clear that the WHO define bruxism as a *psychogenic condition* and by inference not particularly amenable to correction through the sort of destructive dental treatment that is involved in 'full mouth rehabilitation'.²¹

Mutually protected occlusion

In a mutually protected occlusion, the cusps of the back teeth should close together into centric occlusion (CO) with the mandible in the centric jaw relation (CR).¹¹

In that occlusal scheme:

1. The posterior teeth should protect the anterior teeth in maximal

- intercuspal position without any deflective occlusal contacts occurring which might cause an anterior slide in to the intercuspal position (ICP).
- The anterior teeth should be crowned so that they would protect the restored posterior teeth during eccentric movements of the mandible.
 - The variation in philosophy here was that crowned front teeth were to be *barely out of contact* (25 microns) when the back teeth were in maximum intercuspal position (ICP) (Figure 3).
 - In protrusive movements of the mandible, only the anterior teeth were to contact one another, without any parts of the occlusal anatomy of the posterior teeth meeting during mandibular protrusion (Figure 4).
 - In lateral excursions of the mandible, only the opposing canines should contact one another with all the other teeth *not* contacting when those lateral jaw movements were occurring, i.e. there should be canine guidance during lateral jaw movements.

What does centric relation mean to different 'authorities'?

Recording the centric jaw relationship correctly was deemed to be vitally important if all of the remaining natural teeth were to be grossly reduced in order to provide a 'full mouth rehabilitation'. That is because there were no recognisable pairs of sound natural teeth left to articulate the working casts. However, the fact is that this very real and difficult clinical problem was, and is, created by the extensive tooth preparations which were involved in the first place.

In 2013, Palaskar and co-workers reviewed the extensive literature on centric jaw relation definitions and terminology from the 1920s onwards.²² In their elegant review article they noted that there had been decades of controversy about what 'centric relation' actually meant and how to determine it.

In summary, confusion reigned about where precisely centric relation was and its alleged effects on the design of the occlusal surfaces of the multiple restorations that were involved. Palaskar and co-workers then proposed their own definition as: 'Centric jaw relation is the most retruded position of the mandible to

the maxilla at an established vertical dimension which is repeatable and recordable'.²²

'Freedom in centric' controversies and semantics

Clyde Schuyler, recognising the difficulties in providing very precise occlusal contacts on restorations, proposed his concept of 'Freedom in Centric'. He stated that 'there is a flat area in the central fossae of teeth upon which opposing cusps should contact, which permits a degree of freedom (0.5–1 mm) in eccentric movements which is uninfluenced by tooth inclines'.²³ This meant that the cusps should meet on a flat area rather than immediately contacting other cusps. Schuyler's view was that incisal guidance without freedom for teeth to move from a centric relation occlusion

to a more anterior tooth position would 'lock-in' the posterior occlusion.²³

Peter Dawson used the term 'long centric' to describe a roughly similar concept to 'freedom in centric'. Dawson taught that this was rarely to be more than half a millimetre (Figure 5).²⁴

The periodontist Ramfjord and the prosthodontist Ash, who were working together at Michigan, also advocated the idea of a horizontal 'long centric'.²⁵ Pullinger et al.²⁶ suggested that an intercuspal position anterior to the retruded contact position, provided it was delivered with bilateral occlusal stability, would be desirable.

To many interested observers these semantic changes in ideology and terminology now sounded very much like

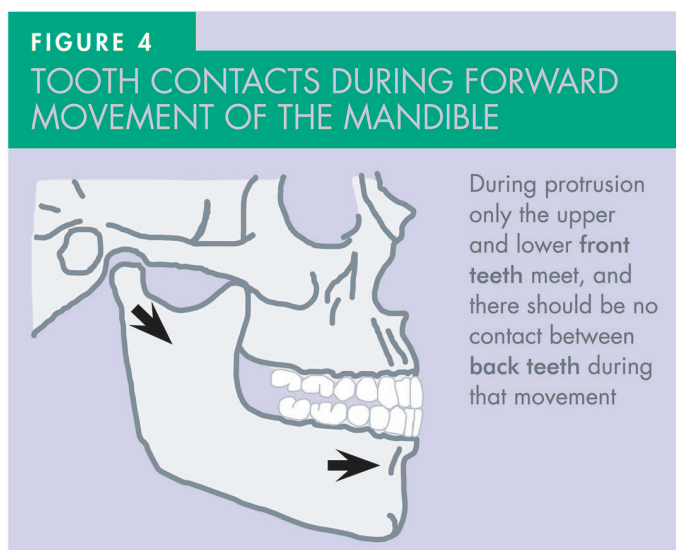
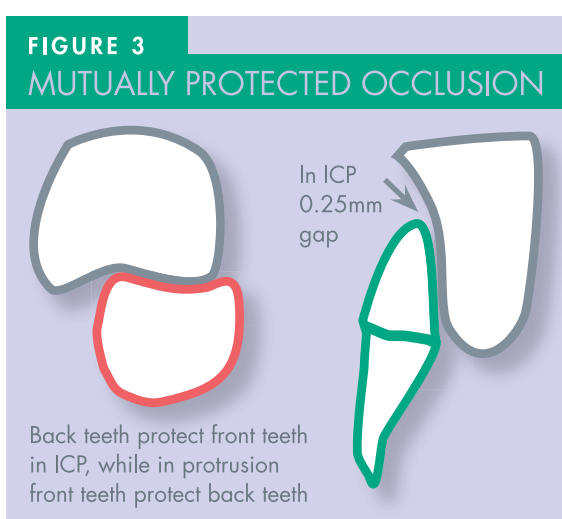
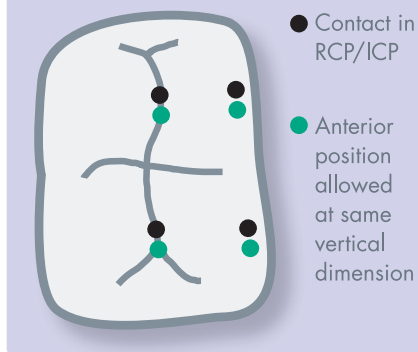


FIGURE 5
FREEDOM IN CENTRIC
 = **LONG CENTRIC** (DAWSON)



a quiet excuse. That was probably because the original waxing techniques involved in the development of elaborate cuspal designs, which were done on rigid models mounted on elaborate articulators, proved not to deliver that level of precision when placed in the mouth. That might well have been because the teeth had exquisitely innervated periodontal ligament mechano receptors which were largely responsible for programming the patient's new jaw movements with those restorations.

Sadly, very little mention seems to have been made about the very many teeth that needed to be damaged electively to provide those semantic occlusal differences. In all probability, a patient's ability to adapt to occlusal changes, largely due to feedback from their periodontal ligament mechanoreceptors, was probably as important then, as it is now, but that required adaptive capacity by patients scarcely got a mention.

Pankey-Mann-Schuyler rehabilitation principles

In 1960, a different approach to oral rehabilitation was introduced by Pankey and Mann^{27,28} utilizing some of the principles of occlusion as advocated previously by Schuyler.^{8,9} That became known as the Pankey-Mann-Schuyler (PMS) philosophy of oral rehabilitation.²⁹ The principle change here was that the PMS philosophy involved what they termed 'group function' during lateral mandibular movements (as opposed to canine guidance during those movements). During mandibular

excursions, their view was there was to be simultaneous contacts on a group of the canine and premolar and molar teeth on the side towards which the mandible was moving. There was to be no occlusal contacts on the non-working side. In summary, their method of achieving this outcome involved the following:

1. Multiple preparations were to be undertaken for full coverage crowns. The incisal guidance was to be developed intraorally with acrylic resin in temporary crowns to 'satisfy the patient's aesthetic and functional requirements'. Those shapes were then to be copied when making the supposedly 'permanent' crowns.
2. Only anterior teeth were to contact during mandibular protrusive movements.^{27,28} The idea was that this arrangement would spare the crowned back teeth from contacting one another during mandibular protrusion.
3. Before beginning the reconstruction of the posterior teeth, both maxillary canines had to be in good functional contact with the opposing lower canines in centric and in eccentric positions.
4. The mandibular posterior teeth were then to be restored in harmony with the anterior guidance in such a way that they did not interfere with the condylar guidance.
5. The anatomy and shapes of the *maxillary posterior occlusal surfaces* were then to be developed *after* the completion of mandibular restorations by the functionally generated path technique (FGP) which had been described by Meyer in 1938.³⁰
6. The PMS philosophy advocated the use of a non-arcon articulator.

Versions of this occlusal philosophy were further popularised by Peter Dawson,²⁴ but, once again, little attention seems to have been drawn to the long-term biologic consequences of these extensive tooth preparations being undertaken in order to achieve those questionable occlusal goals.

Simplifying the occlusal scheme?

Wiskott and Belser proposed a simplified occlusal scheme which reduced the overall number of occlusal contacts.³¹

One occlusal contact per tooth—usually one which had a cusp-fossa relationship—was deemed to be sufficient, if coupled with good anterior guidance. That approach could accommodate varying degrees of group function with only minor occlusal adjustment being required.³¹

Some other philosophies proposed in different cultures and countries

In Japan, Hobo and Takayama took a different view to the gnathologists. Their belief was that anterior guidance influenced the working condylar path and that they were mutually dependent factors.³² They offered their 'twin-tables technique'. In this technique, molar disclusion was to be achieved using two incisal tables. The first incisal guide table, which was labelled the incisal table *without disclusion*, was used to make the restorations for the posterior teeth. The second incisal table termed the *incisal table with disclusion* was used to achieve incisal guidance with posterior disclusion.³²⁻³⁴

Occlusal philosophies for patients with reduced periodontal support for their remaining teeth

Youdelis et al.¹⁵ proposed an occlusal scheme for patients with advanced, but treated, periodontitis. The aim here was to achieve simultaneous inter-occlusal contact of posterior teeth in the centric relation position, with the majority of the biting forces being directed axially.

Anterior disclusion was to be provided during protrusive excursions and canine disclusion was to be provided during lateral excursions. The cuspal anatomy was to be so arranged in such a way that if the canine disclusion were to be lost through wear or by tooth movement, then the posterior teeth should drop into group function.

Nyman and Lindhe³⁵ described schemes for managing extremely advanced periodontitis cases using extensive bridgework which involved even contact being provided in the intercuspal position. No great emphasis was placed upon the other types of contacts that should occur. When there were long tooth-borne cantilevered restorations being made, their aim was to achieve

simultaneous working and non-working side contacts on the cantilevered sections, a sort of posterior balanced occlusion, but with anterior disclusion during mandibular protrusion.³⁵

Summary

There was little proper science supporting the justification for many of those full mouth rehabilitation/occlusal views in the past, or indeed at present. However, many of the advocates for those, seemingly ever-changing, occlusal philosophies were very articulate, literate, strong characters with very persuasive skills about the supposed benefits of their occlusal beliefs.

One needs to remember that undertaking extensive dentistry was interesting, demanded high levels of clinical and technical precision as well as requiring lots of expensive gadgets. It was also lucrative to provide it. All, or some, of

those attractions might have reinforced those belief systems.

Those same drivers are now back in fashion in various aspects of destructive allegedly 'just cosmetic' and also 'digital dentistry'. These are often being promoted with gushing enthusiasm by some dentists with their stated objective being to provide an allegedly 'perfect occlusion' and/or a currently fashionable supposedly 'perfect smile'.

Nauseatingly self-congratulatory websites and postings on platforms such as Facebook, Instagram etc. now show wholesale destruction of reasonably healthy teeth in order to achieve some spurious occlusal outcome, or to cure patients of their alleged 'cosmetic dental disease', usually by means of some 'porcelain pornography'.³⁶ Other 'specialist' publications and narcissistic, self-promotional, commercially driven websites now show inappropriate dental

mutilations being undertaken just to clear the required area for the provision of the long-term unproven 'all-on-4' implant system.

Biologically aware, responsible, ethical dental professionals need to resist the current attempts by some to try to justify the use of new 'digital dentistry' technology, involving unnecessary destruction of sound teeth, which is being promoted on new media to achieve a supposed 'ideal occlusion'. Sadly, some of those nauseatingly destructive 'full mouth rehabilitations' might be better described as being a 'full mouth mutilectomy'.

There is now copious evidence available that patients adapt readily to changes in their occlusion by additive, rather than subtractive, bonding techniques. That important and relevant information needs to be understood by any patient for their consent to be valid.

REFERENCES

- Kazis H, Kazis AJ. Complete mouth rehabilitation through fixed partial denture prosthodontics. *J Prosthet Dent.* 1960;10:296-303.
- Tiwari B, Ladha K, Lalit A, et al. Occlusal Concepts in Full Mouth Rehabilitation: An Overview. *J Indian Prosthodont Soc.* 2014;14:344-351.
- von Spee FG. The condylar path of the mandible in the glenoid fossa. Kiel, Germany: 1890.
- Gysi AA. Masticating efficiency in natural and artificial teeth. *Dent Digest.* 1915;21:74.
- International Academy of Gnathology. American Section. [Internet]. <https://www.gnathologyusa.org/About/History/> [Accessed on 12 November 2020].
- McCullum BB. Fundamentals involved in prescribing restorative dental remedies. *Dent Items Interest.* 1939;61:641-648.
- McCullum BB, Stuart CE. A research report. South Padasena: Scientific Press; 1955.
- Schuyler CH. Fundamental principles in the correction of occlusal disharmony, natural and artificial. *J Am Dent Assoc.* 1935;22:1193-1202.
- Schuyler CH. Factors of occlusion applicable to restorative dentistry. *J Prosthet Dent.* 1953;3:772-782.
- Stuart CE. The contributions of gnathology to prosthodontics. *J Prosthet Dent.* 1973;30:607-608.
- Stuart CE, Stallard H. Principles involved in restoring occlusion to natural teeth. *J Prosthet Dent.* 1960;10:304-313.
- D'Amico A. Canine teeth-normal functional relation of the natural teeth of man. *J South Calif Dent Assoc.* 1958;26:239-241.
- D'Amico A. Functional occlusion of the natural teeth of man. *J Prosthet Dent.* 1961;11:899-915.
- Glickman I, Smulow JB. Effect of excessive occlusal forces upon the pathway of gingival inflammation in humans. *J Periodontol.* 1965;36:141-147.
- Yuodelis RA, Mann MV. The prevalence and possible role of non-working contacts in periodontal disease. *Periodontics.* 1965;3:219-223.
- Rieder CE. The prevalence and magnitude of mandibular displacement in a survey population. *J Prosthet Dent.* 1978;39:324-329.
- Schluger S, Yuodelis RA, Page RC, et al. Periodontal disease: basic phenomena, clinical management, and occlusal and restorative relationships. Philadelphia, USA: Lea Febiger; 1977.
- Lindhe J, Ericsson I. Trauma from Occlusion. In: *Clinical Periodontology and Implant Dentistry.* London: John Wiley & Sons; 2015.
- Ramfjord SP. Dysfunctional temporomandibular joint and muscle pain. *J Prosthet Dent.* 1961;11:353-374.
- World Health Organization (WHO). Health topics: Oral health. [internet]. Geneva: WHO; 2020. Available at https://www.who.int/health-topics/oral-health/#tab=tab_1 [Accessed on 13 November 2020].
- Kelleher M, Ray-Chaudhuri A, Khawaja N. Patients' priorities and attitudes towards their temporomandibular disorders. *Prim Dent J.* 2015;5(4):17-21.
- Palaskar JN, Murali R, Bansal S. Centric relation definition: a historical and contemporary prosthodontic perspective. *J Indian Prosthodont Soc.* 2013;13:149-154.
- Schuyler CH. Freedom in centric. *Dent Clin North Am.* 1969;13:681-686.
- Dawson PE. Evaluation, diagnosis, and treatment of occlusal problems. St. Louis, USA: Mosby; 1975.
- Ash MM, Ramfjord SP. An introduction to functional occlusion. Philadelphia, USA: WB Saunders Company; 1982.
- Pullinger AG, Seligman DA, Solberg WK. Temporomandibular disorders. Part II: Occlusal factors associated with temporomandibular joint tenderness and dysfunction. *J Prosthet Dent.* 1988;59:363-367.
- Mann AW, Pankey LD. Oral rehabilitation: part I. Use of the P-M instrument in treatment planning and in restoring lower posterior teeth. *J Prosthet Dent.* 1960;10:135-150.
- Pankey LD, Mann AW. Oral rehabilitation: part II. Reconstruction of the upper teeth using a functionally generated path technique. *J Prosthet Dent.* 1960;10:151-162.
- Dawson PE. (Ed). Evaluation, diagnosis, and treatment of occlusal problems. Second ed. St. Louis, USA: Mosby; 1989.
- Meyer FS. Can the plane line articulator meet all the demands of balanced and functional occlusion in all restorative work? *J Colo Dent Assoc.* 1938;17:6-16.
- Wiskott HA, Belsler UC. A rationale for a simplified occlusal design in restorative dentistry: historical review and clinical guidelines. *J Prosthet Dent.* 1995;73:169-183.
- Hobo S, Takayama H. Oral rehabilitation: clinical determination of occlusion. Berlin, Germany; Quintessence Pub. Co; 1997.
- Hobo S. Twin-tables technique for occlusal rehabilitation: part I—mechanism of anterior guidance. *J Prosthet Dent.* 1991;66:299-303.
- Hobo S. Twin-tables technique for occlusal rehabilitation: Part II—Clinical procedures. *J Prosthet Dent.* 1991;66:471-477.
- Nyman S, Lindhe J. Considerations on the design of occlusion in prosthetic rehabilitation of patients with advanced periodontal disease. *J Clin Periodontol.* 1977;4:1-15.
- Kelleher M. Porcelain Pornography. *Faculty Dental Journal – Royal College of Surgeons of England.* 2011;2(3):134-141.