Functional Occlusion in Orthodontics

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Abstract  
Orthodontic treatment has the capacity to change static and functional occlusal relationship fundamentally. The aim of this article is to discuss the goals of an ideal functional occlusion as well as how teeth react after the orthodontic appliances are removed. We wish to discuss the evidence in literature about RCP and ICP coinciding and the various occlusal schemes that we could consider after orthodontic treatment. The role of interference in occlusion after orthodontic treatment leading to relapse as well as occlusal equilibration is discussed. We also present a case in which the steps for debonding as advocated by Roth are illustrated.

Keywords  
Functional occlusion, Retruded cuspal position, Intercuspal position.

The features that constitute an ideal functional occlusion have not been conclusively established. Orthodontic treatment has the capacity to change static and functional occlusal relationship fundamentally. It is generally assumed that an ideal static occlusal relationship is compatible with an ideal functional occlusion, but this is not necessarily so. The post treatment maintenance of a healthy stomatognathic system and attainment of the stability of the post-orthodontic treatment results are no small tasks to be taken lightly.

Criteria for an ideal Functional Occlusion (as advocated by Roth):

1) Teeth should reach maximum intercuspation with the mandible centered to the cranium so that the condyles are seated in the superior most relationship that is clinically attainable.

2) Upon closure into occlusion the stress upon the posterior teeth should be directed as nearly as possible down the long axis of the posterior teeth so that the resultant stresses are transmitted as tension to the periodontal ligament and the lamina dura.

3) The posterior teeth should contact equally and evenly upon closure into the occlusion with no actual contact of the anterior teeth (clearance .005 inch) to avoid lateral stresses on the anterior teeth and supporting structures, while the mandible is in the ideal condyle fossa relationship.

4) There should be minimum overjet and overbite, but effective overbite so that upon movements in any direction out of full occlusion, the anterior teeth act as a group with the cuspids as the main guiding inlines to gently but immediately disengage or disocclude the posterior teeth. The lift or guidance of the anterior teeth should be in harmony with the movement pattern that is dictated by the temporomandibular joint so that minimal lateral stresses can be applied to the anterior teeth during mandibular movement.

5) The pattern of occlusion or occlusal scheme with regards cusp height, fossa depth, ridge and groove direction and cusp placement should be as nearly as possible in total harmony with the characteristics
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of the full extent of mandibular movements in all directions. This will provide the minimal amount of interference of the teeth with the possible movement patterns of the mandible as dictated by the temporomandibular joints.

**Occlusal harmony and post treatment tooth movement**

Overcorrecting of certain aspects is required because of the physiological rebound phenomenon. What needs to be considered are a variety of possible causes of relapse due to inadequate detailing of the tooth positions resulting from the untoward occlusal forces that tend to move teeth from their treated positions.

**Specific areas requiring overcorrecting are**

1. Complete leveling to the flat curve of Spee
2. Slight uprighting of the mandibular teeth in the buccal segments with a hint of distal rotation of the mandibular first premolars
3. Overcorrected torque of the maxillary anteriors
4. Slight overcorrecting of lingual crown torque of the maxillary molars
5. Overcorrecting of the antero-posterior relationship of the upper to lower teeth towards Class III relationship of the buccal segments and an edge to edge relationship of the anteriors.

This encourages the settling of teeth into centric relation. According to Roth, orthodontists tend to think of treating to centric relation only in terms of antero posterior overcorrecting. However if the buccolingual crown torque of the molars is incorrect, or if arch width and forms not coordinated, a centric discrepancy may occur.

**Common areas of centric prematurities in post treatment orthodontic cases are**:

a) the buccal cusps of the mandibular first or second bicuspid with the mesial inner incline of the lingual cusp of the maxillary first or second bicuspid
b) The mesial inner incline of the distobuccal cusp of the maxillary first molar with the distal outer incline of the middle buccal cusp of the mandibular first molar
c) The mesial inner incline of the mesiolingual cusp of the maxillary first molar with the distal inner incline of the middle buccal cusp of the mandibular first molar
d) The mesial inner incline of the maxillary second molar with the distal inner incline of the mesiobuccal cusp of the mandibular second molar and
e) The lingual surface of the maxillary mesiobuccal cusp of the first and second molar with the distal inner incline of the mesiolingual cusp of the mandibular first and second molars.

Another discrepancy most commonly observed is the relapse to Class II after treatment completion. More often than not the Class II was never corrected but the mandible only postured forward during appliance therapy as a response to contracture of the lateral pterygoids, elastic pull and occlusal interdigitation. Upon release from the appliance the condyles tend to seat into the fossa. A similar situation occurs in skeletal open bite where anterior up and down elastics are usually employed to close the anterior open bite will result in subluxation of the condyles and a fulcruming of the mandible over the molars to occlude the bicuspid and anteriors. In cases of facial asymmetry, which go unrecognized before treatment, and later magnify with growth, failures are usually encountered.

**RCP and ICP coincidence - Is it a rational goal??**

Most orthodontic literature promotes the concept that an ideal treatment goal should be coincidence of intercuspal position and the retruded contact position. As epidemiological studies fail to find this type of occlusion in natural dentition, the question arises that is such a goal acceptable and rational. The argument put forward is that non-coincidence of the two positions (ICP and RCP) is associated with temporomandibular disorders. However, the evidence is inconclusive. Early workers in this field examined the electromyographic activity in the muscles of mastication in individuals with occlusal interferences. The use of EMG was centered on the concept that muscle activity during function should be equal bilaterally. However as no proper description of the EMG activity in masticatory muscles exists, the interpretation of data from such studies is of very limited value.

Cross sectional population studies have been carried out inconclusively to clarify the relationship between occlusal discrepancy in the RCP-ICP range and temporomandibular disorders. Few of the studies have
used control groups, and the signs and symptoms used to describe TMD remain inconsistent and diverse. Furthermore the definition of and evaluation of occlusal discrepancies in these studies lack consensus and agreement. So our interpretation of currently available data would suggest that an intercuspal position that does not exactly coincide with the retruded contact position should be considered as normal. Conversely there is no evidence that there is any disadvantage to the patient of having a retruded contact position, but treatment need not be unduly lengthened to achieve this goal

**Occlusal schemes**

**Balanced Occlusion**: During the entire lateral movement, posterior teeth on both the working and the non-working side are in contact. Early workers in the field of occlusion assumed that this type of occlusal construction was necessary to achieve the best results for both complete dentures and the natural dentition. Present day thinking has completely dismissed this concept for restoring the natural dentition. Present day thinking has completely dismissed this concept for restoring the natural dentition, although it is still useful in complete denture construction.

**Group Function Occlusion**: During lateral movement, the buccal cusps of the posterior teeth on the working side are in contact. There is no contact on the non-working side.

**Canine Protected Occlusion**: During the lateral excursion contact occurs only between the upper and lower canines and first premolar on the working side. The theory of canine protected occlusion is attributed to D'Amico, Nagao and Shaw and is based on the impression that the canine tooth is the guide to mandibular excursion. There are a number of reasons why this might be so:

1. The canine has a good crown: root ratio, capable of tolerating high occlusal forces.
2. The canine root has a greater surface area than adjacent teeth, providing greater proprioception.
3. The shape of the palatal surface of the upper canine is concave and is suitable for guiding lateral movements.

In the specialty of restorative dentistry, where it is possible to introduce a specific occlusal scheme during occlusal rehabilitation, attempts have been made to establish a rational basis for choosing between guidance and group function. The studies on occlusal contact patterns during lateral excursions report contradictory results but this may reflect that the methodologies were different. Ideally such investigations should consider the tooth contacts from the intercuspal position through the entire range of functional lateral movements, but this is difficult to achieve clinically and tooth contact patterns have therefore been recorded at various static mandibular positions. As it is common to find lateral excursions that are initiated by group function, but terminate in canine contact only at the lateral edge to edge position, it is essential that investigators specify at which tooth position tooth contact recordings are made. Inconsistent results of occlusal contacts have included impression material, occlusal indicator wax, articulating paper, dental floss and direct vision. Williamson and Lundquist examined electromyographically the activity of the temporalis and masseter muscle during lateral excursions in individuals with canine guidance.

The evidence in favour of one type of occlusal scheme over another is scarce. Pragmatically, however, it is worth considering that a canine protected occlusion is far less likely to be associated with occlusal interference on the non-working side than a group function occlusion due to the steeply inclined palatal surface of the canine.

A cusp fossa relationship is preferred for centric stability. In a Class I occlusion the only cusp marginal ridge relationship that exists are the buccal cusps of the mandibular bicuspids with the adjacent marginal ridges of the maxillary bicuspids, the mandibular first bicuspid with the mesial marginal ridge of the maxillary first bicuspid and lingual concavity on the distal of the maxillary cusp and the distolingual cusp of the maxillary first molar with the opposing adjacent marginal ridges of the mandibular molars. The rest of the centric contacts are cusp fossa relationships in a Class I occlusion.

A good articulation of all anterior teeth with a gentle lift in protrusive helps support the retracted incisor stability, because with sufficient torque of the incisors the six anterior teeth of the maxilla will articulate evenly with the six mandibular anteriors and the maxillary cuspids will articulate with the mandibular first bicuspids. In this way the stress is distributed over 14 teeth without interfering with the forward mandibular
glide path to any great extent. It must be kept in mind that to provide disocclusion of the posterior teeth upon lateral and protrusive movement with minimum overbite of the anteriors, the curve of Spee should be level and the cant of the occlusal plane divergent from the slope of the eminencia. This holds true for both lateral and protrusive excursions. In addition improper torque of the maxillary molars, particularly the second molar, is still necessary to eliminate the balancing interference. Good stress distribution is a necessity for stability of the post orthodontic result.\textsuperscript{4,5,29,30}

**Centric relation**

The concept of centric relation seems to have shown a paradigm shift in the course of the century and needs to be understood. In the 1950's it was "the most retracted relationship of the mandible to the maxilla when the condyles are in their most posterior unstrained positions in the glenoid fossa from which lateral movements could be made, at any degree of jaw separation". In the 1980's "RUM" the rearmost uppermost and midmost position was the definition of centric. According to glossary of prosthodontic terms (2001) centric relation (CR) is the maxillomandibular relation in which the condyles articulate with the thinnest avascular portion of their respective discs with the complex in the anterior-superior position against the shapes of the articular eminences. This position is independent of tooth contact. This position is clinically discernible when the mandible is directed superiorly and anteriorly. It is restricted to a purely rotary movement about the transverse horizontal axis.\textsuperscript{31-38}

**Occlusal interferences**

According to Ash and Ramfjord\textsuperscript{39} the term occlusal interference refers to an occlusal contact relationship that interferes in a meaningful way with function or parafunction. A number of workers reached on a consensus on the features of occlusion likely to interfere with function or parafunction by giving rise to signs or symptoms of TMD. These features are

- Occlusal contacts on the non working side
- Unilateral contacts in the retruded contact position
- Long slides (greater than 1 mm) between the retruded contact position and the intercuspal position
- Asymmetry in the slide between the retruded contact position and the intercuspal position

The limitations of these studies include the lack of agreement among authors on which features constitute of TMD. Lack of consistency in diagnosing occlusal interference and lack of any control groups. Presence of occlusal interference is widespread in all population groups, and that there are more people with non-ideal functional occlusal relationships than people with signs and symptoms of functional occlusal disorders. Possible consequences of occlusal interference, such as bruxism and toothwear and relapse of tooth position may also occur some time after completion of orthodontic treatment, but may nevertheless be triggered by interferences induced by orthodontic treatment.\textsuperscript{19-40}

According to Roth\textsuperscript{1} only after checking the patient intraorally, if the patient will not make gliding excursions into protrusive and keep the anterior teeth in contact, you are sure that posterior interference exists. Also if patient cannot make lateral excursions and keep the cuspids together or the patient will not readily allow mandibular manipulation interference exist. Individual tooth positioning needs to be gauged so that they can be moved to achieve an ideal anatomical and functional goal.\textsuperscript{49,59}

**Occlusal equilibration**

Two principles are to be followed

1) Post treatment cases should not be equilibrated until growth has been completed. The changes with growth are likely to alter the results of equilibration.

2) Equilibration should always be done when proper indication exists

- To eliminate centric and excursive prematurities and interferences in the presence of occlusal disharmony.
- To alleviate temporomandibular pain dysfunction syndrome
- To eliminate occlusal wear
- To better distribute stress to the periodontium in the presence of symptomatology of periodontal disease
- To alleviate sensitivity due to occlusal interferences
- To eliminate jiggling of teeth and unstable tooth positions due to occlusal interferences
- To eliminate centric and excursive interferences prior to placement of gold crowns, bridges etc.
- To eliminate adaptive tongue thrust if the cause is occlusal interferences

**Goals of equilibration**

1. To establish a positive one-place closure in which centric relation and occlusion are one and the same
with equalized occlusal stops for all posterior centric cusps.
2. To establish proper coupling of anterior teeth and as ideal as possible anterior guidance for posterior disocclusion
3. To organize the posterior occlusion so as to harmonize ridges and groove direction with mandibular border movements.
4. To maintain maximum cusp height
5. To remove a minimum amount of tooth material
6. To achieve stability of centric relation.

Roth technique before debonding
- A Clinical report

An 18-year-old female patient reported to our OPD with a complaint of protrusive upper and lower lips. On examination extraorally she presented with midface convexity (Fig 1) and intraorally a Class I bimaxillary protrusion (Fig 2). After routine cephalometric, facial and model analysis it was decided to extract all first premolars. The patient was to be treated with standard edgewise mechanotherapy (.022 X .028) as a maximum anchorage case. The Nance button in the upper arch and the lingual arch in the lower arch were used as adjuncts to conserve the anchorage. Separate canine retraction was done after achieving the levelling, alignment and anchorage preparation followed by separate incisor retraction. Once the extraction spaces were closed torque was incorporated in the upper archwire to compensate for the torque loss encountered due to carrying out the retraction in a .021 X .025 wire in the .022X .028 slot. An OPG was taken and root paralleling was carried out with bends in the archwire.

Once the case was clinically and radiologically nearly complete we proceeded with the steps required for debonding according to Roth's functional setup (Fig 3). Now the upper and lower impressions were made and were duplicated. Prior to the mounting the centric was recorded and interocclusal records for centric, lateral and protrusive mandibular movements were taken (Fig 4). Bimanual technique (Dawson) was used with fingers at right angles with upward pressure thumbs on chin with downward pressure. The mandible was manipulated into pure hinge movement. This technique to record centric is accurate and has been supported in the literature. Interposing recording medium between occlusal rims made direct interocclusal records. It is recommended because of its simplicity, but the accuracy is dependent on clinical judgement of the orthodontist. Careful trimming of the interocclusal recording material is critical because the soft tissue is recorded in a compressed state. The stone casts record the soft tissue in an uncompressed state. The two areas that must be trimmed are the gingival tissues of the maxillary teeth (palatal) and the distal tissue of the terminal maxillary tooth. Elastomeric material is stable, easy to use and acceptable accuracy. Semi-adjustable Whip Mix articulator was used, along with arbitrary facebows for mounting the casts (Fig 5). After transfer of the maxillary cast the lower model is articulated along with the interocclusal record (Fig 6). Using articulating paper or carbon paper we can now visualize the interferences on the casts (Fig 7). It can be seen that the mesiobuccal cusp of both the maxillary molars showed prematurity along with the lingual aspects as well as the incisal edges of the upper anterior. In the mandibular arch there were prematurities in the distobuccal cusp of the left first molar as well as the buccal cusps of the second and third molars. Prematurity was also seen along the incisal edges of the anteriors and canines. The interference in the second and third molars were equilibrated while those in the first molar to anterior part of the arch were corrected by bends in the archwires (Roth strongly believes that better tooth positioning can eliminate 80% of the equilibrations.). Buccal root torque was incorporated in the upper arch in the molar region (progressive torque) while lingual root torque was incorporated along with tip back for the lower left first molar. Bite opening was done to eliminate the prematurities in the anterior teeth. The corrections could be achieved in 4 months following which the case was debonded (Fig 8,9). The models were again made and mounted as before and tooth positioners were fabricated in centric (Fig 10).

The purpose of a hinge axis positioner is to settle teeth so that occlusion is closer to centric relation, rather than to allow them to settle on their own. Thus it aims to control the settling process so the occlusion is closer to centric by utilizing the available band space and some buccolingual adjustment of the teeth to get to a centrically related occlusion in a case that has been set up orthodontically so that teeth can fit into centric. In addition it closes the band space and tones the gingival tissue. It can be used as a passive retainer if so desired. The hinge axis positioner is also used to control the settling of the anterior teeth and to help develop an idealized anterior guidance. The tooth setup for such a case requires the skill and temperament of
Figure 1 - Pretreatment extraoral photographs of the patient

Figure 2 - Pretreatment intraoral photographs of the patient

Figure 3 - Introral photographs of the patient after space closure and radiologically acceptable root positions.

Figure 4 - Introral photographs with interocclusal records in centric
Figure 5 - Mounting of the maxillary cast after facebow transfer to the Whip mix articulator

Figure 6 - Mounting of the mandibular cast with the interocclusal records in centric

Figure 7 - Upper and lower member of the Whip mix articulator showing the maxillary and mandibular casts with prematurities marked with the articulating paper
Figure 8 - Post treatment extraoral photographs of the patient. Note the reduction in mid face convexity.

Figure 9 - Post treatment intraoral photographs of the patient.

Figure 10 - Positioner made for the patient for final finishing & detailing.

Figure 11 - Six months followup centric and lateral excursive records for equilibrating any prematurities.
someone who has a knowledge of anatomical and functional requirements of an ideal occlusion. A canine guidance was given to the patient with a canine protected occlusal scheme. After 3 weeks of positioner wear the patient was given Begg type of retainers for maintaining the occlusal relationships attained.

Six months after debonding, new centric, lateral and protrusive records were made and interferences if any were eliminated (Fig 11). Thus a stable functional occlusion was achieved. Though the above-described procedure appears to be very cumbersome, it can be useful in selective cases to achieve a stable occlusion not only static but also functional.

Communications

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References

27. Belser UC, Hannam AG. The influence of altered working side interferences on masticatory muscles


