Orthodontics

Occlusion and Temporo-mandibular joint

Occlusion

Orthodontics is the specialty of dentistry concerned with the management and treatment of malocclusion. In the majority of cases, a malocclusion does not in itself represent a disease state, but rather a variation from what is considered ideal. It is therefore important to have a clear definition of what is meant by an ideal occlusion, as this will form a basis for diagnosis and treatment planning.

The term occlusion has both static and dynamic aspects. Static refers to the form, alignment and articulation of teeth within and between dental arches and the relationship of teeth to their supporting structures. Dynamic refers to the function of the stomatognathic system as a whole comprising teeth, supporting structures, temporomandibular joint, and neuromuscular and nutritive systems. The term normal and malocclusion as used in orthodontics refers mainly to the static aspect or the form of the dentition.

Occlusion, plays a crucial role in orthodontics. It is of paramount importance for several reasons:

1. **Functional Efficiency:** Proper occlusion ensures that the teeth fit together in a way that allows for efficient biting and chewing of food. When the teeth are aligned correctly, they distribute forces evenly across the dental arches, reducing the risk of premature wear of teeth.
2. **Speech and Pronunciation:** Occlusion influences speech and pronunciation. Malaligned teeth or improper bite relationships can lead to speech impediments and difficulties in articulating certain sounds and words. Orthodontic treatment can improve speech clarity by correcting these issues.

3. **Oral Health:** Malocclusion can lead to a range of oral health problems. Crowded teeth can be harder to clean, making them more susceptible to caries and gingivitis. Correcting occlusal problems through orthodontic treatment can help maintain better oral hygiene.
4. **Facial Aesthetics:** Occlusion can significantly impact facial aesthetics. A well-aligned smile can enhance a person's facial appearance, boost confidence, and improve overall self-esteem. Orthodontic treatment aims to create a balanced and aesthetically pleasing smile.
5. **Temporomandibular Joint (TMJ) Health:** The alignment of the teeth and jaws affects the function of the temporomandibular joints (TMJ). Malocclusion in some instances may contribute to TMJ disorders, leading to jaw pain, headaches, and discomfort.
6. **Prevention of Tooth Wear:** Proper occlusion helps prevent excessive wear of the teeth. Malocclusion can cause uneven forces on the teeth, leading to abnormal wear patterns, chipping, and fractures. Orthodontic correction can protect the long-term health and integrity of the teeth.
7. **Functional Stability:** Achieving proper occlusion is essential for the long-term stability of orthodontic treatment. If occlusal issues are not addressed, there is a risk of relapse, where the teeth may gradually shift back to their original positions after orthodontic braces or aligners are removed.
8. **Overall Quality of Life:** Correcting malocclusion can enhance a person's overall quality of life by improving oral function, reducing discomfort, and boosting self-confidence. It can also help individuals feel more at ease in social and professional settings.

In orthodontics, achieving normal occlusion is one of the primary goals of treatment. Orthodontists carefully assess a patient's occlusion and bite relationship to create a treatment plan that will align the teeth and jaws properly. Orthodontic appliances such as braces, aligners, and retainers are used to achieve these goals and ensure that the patient enjoys the benefits of a well-balanced and functional occlusion.

Ideal occlusion: Is the harmonious static and dynamic relationship of teeth and jaws that dentists would like to reproduce when restoring a patient's entire mouth to good form and function.

Normal occlusion: Is an absence of large or many facets, bone loss, closed vertical dimension, bruxing habit, freedom from joint pain, and crooked and loose teeth.

Centric Occlusion: It is the maximum intercuspation or contact attained between maxillary and mandibular posterior teeth.

Centric Relation: Centric relation is the most posterior position of the mandible relative to the maxilla at a given vertical dimension.

Centric Relation Occlusion: Centric relation occlusion (when centric relation and centric occlusion coincide) is the simultaneous even contact between maxillary and mandibular teeth into maximum interdigitation with the mandible in centric relation (most retruded position).

Therapeutic Occlusion: It is an occlusion that has been modified by appropriate therapeutic modalities in order to change a nonphysiological occlusion to one that is at least physiologic, if not ideal.

Traumatic Occlusion: Traumatic occlusion is an abnormal occlusal stress, which is capable of producing or has produced an injury to the periodontium.

Types of Cusps:

The human dentitions present two types of cusps and are as follows:

- **Centric Holding Cusp/Stamp Cusp/Supporting Cusp**

  The palatal cusps of the maxillary posterior teeth and the buccal cusps of the mandibular posterior teeth are referred to as supporting cusps. Supporting cusps are also called as centric holding cusps or stamp cusps and they occlude into the central fossa and marginal ridges of opposing teeth (Figure 1).

- **Guiding Cusp/Shear Cusp/Non-supporting Cusp**

The buccal cusps of the maxillary posterior teeth and the lingual cusps of the mandibular posterior teeth are called Non-supporting cusps. These are also called as guiding or shear cusps and they guide the mandible during lateral excursions and the shear food during mastication (Figure 2).

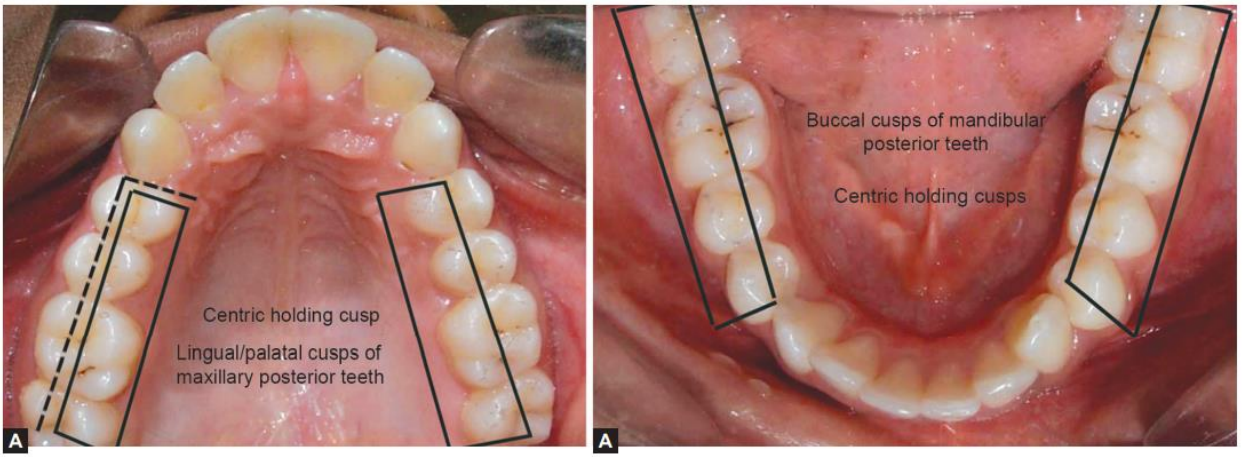


Figure 1: Supporting cusp/centric holding cusp/stamp cusp.

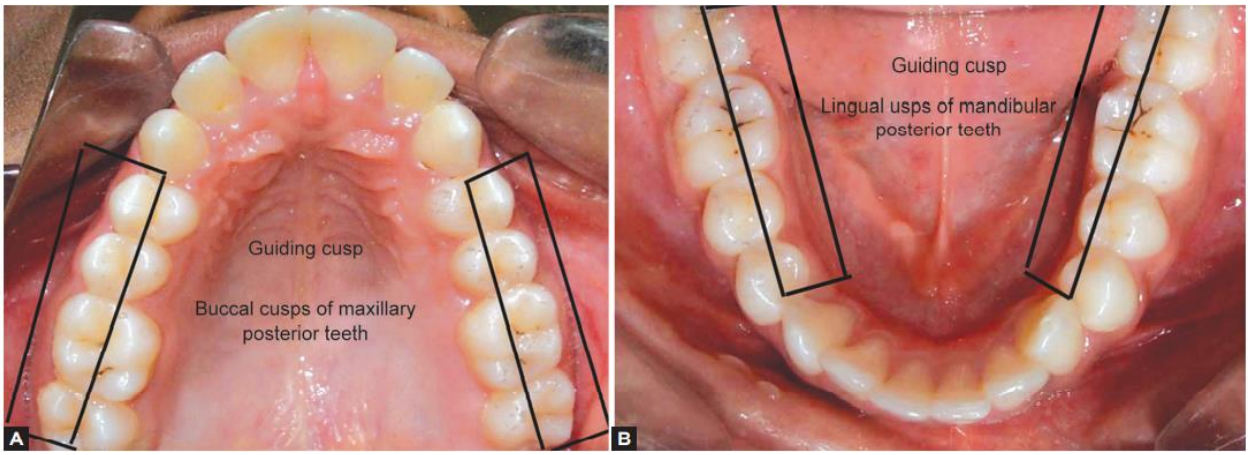


Figure 2: Non-supporting cusp/guiding cusp/shear cusp.

CENTRIC OCCLUSAL CONTACTS

One scheme of occlusal contacts, presented by Hellman included 138 points of possible occlusal contacts for 32 teeth (Figure 3). Concepts of ideal occlusion are used primarily in orthodontics and even in restorative dentistry. Centric occlusal contacts are classified into anterior centric occlusal contacts and posterior centric occlusal contacts points

Anterior Centric Occlusal Contacts

Anterior centric occlusal contacts consist of the labial and lingual range of contacts of maxillary and mandibular anterior teeth and are in line with the buccal range of posterior centric contacts. Anterior centric occlusal contacts are listed below: „

- Palatal surfaces of maxillary incisors and canines—6 „
- Labial surfaces of mandibular incisors and canines—6.

Posterior Centric Occlusal Contacts

Posterior centric occlusal contacts consist of the buccal range of contacts and the lingual range of contacts of maxillary and mandibular posteriors.



Figure 3: Occlusal contacts for the Maxillary arch and the Mandibular arch.

Cusp-Fossa Occlusion: The supporting cusp of one tooth occludes in a single fossa of a single opposing tooth are referred to as cusp-fossa occlusion or tooth-to-tooth arrangement (Figure 4).

Cusp-Embrasure Occlusion: When a tooth occludes with two opposing teeth, it is called cusp-embrasure occlusion or tooth to two teeth occlusion (Figure 4).

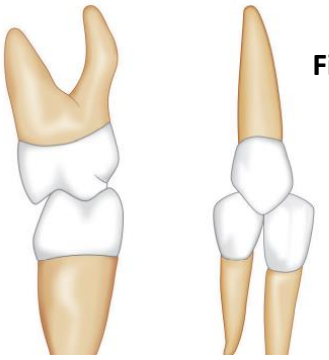


Figure 4: Cusp-Fossae (left), Cusp-embrasure (right).

IMAGINARY OCCLUSAL PLANES AND CURVES

Curve of Spee (Anteroposterior Curve/the Curve of Occlusal Plane)

lt refers to the anteroposterior curvature of the occlusal surfaces, beginning at the tip of the lower cuspid and following cusp tip of the bicuspids and molars continuing as an arc through to the condyle. If the curve were extended, it would form a circle of about 4 inches diameter. The curve of the maxillary arch is convex and that of the mandibular arch is concave (Figure 5).

Curve of Wilson (Side-to-Side Curve)

When viewed from anterior aspect with the mouth slightly open, the cusp tips of the posterior teeth follow a gradual curve from the left side to the right side (Figure 6). The curve of the maxillary arch is convex while the curve of the mandibular arch is concave. Thus, the lingual cusps of the posterior teeth are aligned at a lower level than the buccal cusps on both sides and in both arches.

The curve helps in two ways

1. Teeth aligned parallel to the direction of medial pterygoid for optimum resistance to masticatory forces.
2. The elevated buccal cusps prevent food from going 'past the occlusal table.

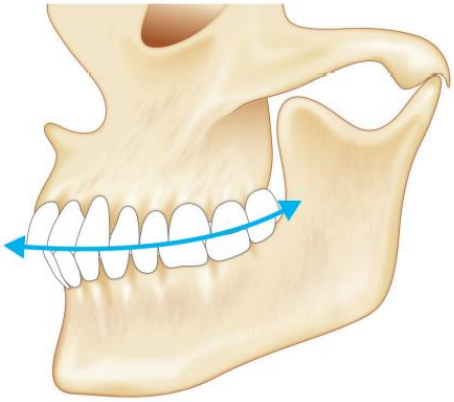


Figure 5: Curve of Spee.

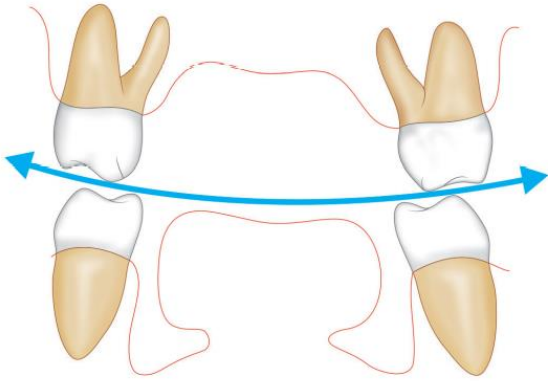


Figure 6: Curve of Wilson.

Occlusion in orthodontics

The concept and philosophy of “normal” occlusion in orthodontics developed in relation to the teeth having a “specific arrangement” in the dental arches (intra-arch) and in relation to opposing arches (inter-arch). The well-aligned dental arches that have “normal” labial and buccal overjet, some overbite, and a “normal” anteroposterior relationship between maxillary and mandibular arches constitute normal occlusion. Historically, cusp-to-fossa relationships of upper and lower teeth were regarded as being of special significance. In the late nineteenth and early twentieth centuries, Angle (1899) emphasized the relationship of the mesiobuccal cusp of the maxillary first molar to the buccal groove of the mandibular first molar as the “key factor” in the establishment of a class I molar “normal” relationship. He considered the maxillary first molar to be a stable tooth, which occupied a distinct relationship in the maxillary bone. The position of each dental unit in the arch was also described in terms of its unique “axial inclination”.

Clinical observations on occlusion were considered both within an arch and in relation to the opposing arches. Within the arch the following were considered: tight proximal contacts,

labiolingual and buccolingual placement, rotation, and labiolingual and mesiodistal inclination. Angle also believed that a full complement of teeth was essential for teeth to be in balance with facial harmony.

Following Angle, clinical research evidence was considered. Studies from the University of Illinois reported that the maxillary first molar did not always have a distinct relationship with the key ridge in the maxilla. The research by Begg (1954) on the occlusion of Australian Aborigines suggested that reduction in tooth substance by proximal and occlusal wear was physiological. Tweed (1954) considered the face and the occlusion from the perspective of axial inclination of the lower incisors and their relationship with the mandibular plane as a guide for determining normal or abnormal relationships of other dental units to their basal bones.

In 1972 Andrew's Six Keys of Occlusion to Normal occlusion can be best defined as the contact of the upper and lower teeth in the centric relationship. But the concept of "normal occlusion" is still not clear. Different authors defined normal occlusion but no single definition could be found as yet

The concepts, which are described here, are based on Lawrence Andrew's works on 120 nonorthodontic models based upon which he gave six keys to normal occlusion and developed the "straight wire appliance." These are:

KEY I Molar relationship (Figure 7): The molar relationship should be such that the distal surface of the distal marginal ridge of the upper first permanent molar contacts and occludes with the mesial surface of the mesial marginal ridge of the lower second molar. Secondly, the mesiobuccal cusp of the upper first permanent molar falls within the groove between the mesial and middle cusps of the lower first permanent molar. Also, the mesiolingual cusp of the upper first molar seats in the central fossa of the lower first molar.

KEY II Crown angulation (Figure 8): The mesiodistal "tip". In normally occluded teeth, the gingival portion of the long axis (the line bisecting the clinical crown mesiodistally or the line passing through the most prominent part of the labial or buccaI surface of a tooth) of each crown is distal to the occlusal portion of that axis. The degree of tip varies with each tooth type.

KEY III Crown inclination (Figure 9): The labiolingual or buccolingual, "torque". Crown inclination is the angle between a line 90 degrees to the occlusal plane, and a line tangent to the middle of the labial or buccal surface of the clinical crown. The crowns of the maxillary incisors are so placed that the incisal portion of the labial surface is labial to the gingival portion of the clinical crown. In all other crowns, the occlusal portion of the labial or buccal surface is lingual to the gingival portion. In the maxillary molars the lingual crown inclination is slightly more pronounced as compared to the cuspids and bicuspids. In the mandibular posterior teeth the lingual inclination progressively increases.

KEY IV Absence of Rotations (Figure 10): Teeth should be free of undesirable rotations. If rotated, a molar or bicuspid occupies more space than it would normally. A rotated incisor can occupy less space than normal.

KEY V Tight contacts (Figure 11). In the absence of such abnormalities as genuine tooth-size discrepancies, contact points should be tight.

KEY VI Flat curve of Spee (Figure 12). A flat occlusal plane is a must for stability of occlusion., no curve deeper than 1.5 mm is acceptable from a stand point of stability. A deep curve of Spee results in a more contained area for the Upper teeth, making normal occlusion impossible.



Figure 7

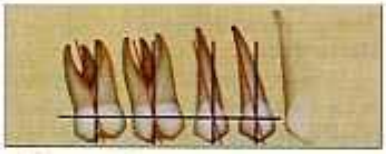


Figure 8

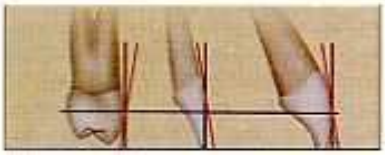


Figure 9

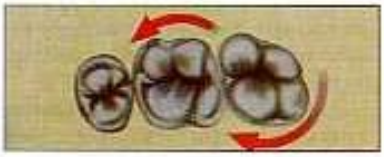


Figure 10



Figure 11



Figure 12

Temporo-mandibular joint (TMJ) examination

It is important to note the presence of any signs of pathology in the TMJ and muscles of mastication during the orthodontic assessment. Any tenderness, clicks, crepitus, and locking should be noted, as well as recording the range of movement and maximum opening. There is no strong evidence to suggest that TMJ disorders are either associated with malocclusions or cured by orthodontic treatment. However, if signs or symptoms are detected then they must be recorded and it may be worth referring the patient to a specialist before commencing orthodontic treatment.

Dentition

Humans have two sets of dentition namely, deciduous and permanent, which contain 20 and 32 teeth respectively. The formation and eruption of these teeth follow a definite pattern and fairly consistent timetable.

Knowledge of the calcification times of the permanent dentition is invaluable if one wishes to impress patients and colleagues. It is also helpful for assessing dental as opposed to chronological age; for determining whether a developing tooth not present on radiographic examination can be considered absent; and for estimating the timing of any possible causes of localized hypocalcification or hypoplasia.

	Calcification commences (weeks *in utero*)	Eruption (months)
Primary dentition		
Central incisors	12–16	6–7
Lateral incisors	13–16	7–8
Canines	15–18	18–20
First molars	14–17	12–15
Second molars	16–23	24–36
Root development complete 1–1½ years after eruption		

	Calcification commences (months)	Eruption (years)
Permanent dentition		
Mand. central incisors	3–4	6–7
Mand. lateral incisors	3–4	7–8
Mand. canines	4–5	9–10
Mand. first premolars	21–24	10–12
Mand. second premolars	27–30	11–12
Mand. first molars	Around birth	5–6
Mand. second molars	30–36	12–13
Mand. third molars	96–120	17–25
Max. central incisors	3–4	7–8
Max. lateral incisors	10–12	8–9
Max. canines	4–5	11–12
Max. first premolars	18–21	10–11
Max. second premolars	24–27	10–12
Max. first molars	Around birth	5–6
Max. second molars	30–36	12–13
Max. third molars	84–108	17–25
Root development complete 2–3 years after eruption.		

Temporo-mandibular joint dysfunction (TMD) and Orthodontics

The aetiology and management of TMD has caused considerable controversy in all branches of dentistry. TMD comprises a group of related disorders with multifactorial aetiology including psychological, hormonal, genetic, traumatic, and occlusal factors. Studies suggests that depression, stress, and sleep disorders are major factors in the aetiology of TMD and that parafunctional activity, for example bruxism, can contribute to muscle pain and spasm. Some authors suggested that minor occlusal imperfections can lead to abnormal paths of closure and/or bruxism, which then result in the development of TMD; however if this were the case, a much higher prevalence of TMD would be expected to reflect the level of malocclusion in the population.

The role of orthodontics in TMD has been extensively debated, with some authors claiming that orthodontic treatment can cause TMD, while others advocate appliance therapy to manage TMD. After considerable discussion in the literature, the consensus view is that orthodontic treatment, either alone or in combination with extractions, cannot be reliably shown to either 'cause' or 'cure' TMD. The alleged success of a wide assortment of treatment modalities for TMD highlights both the multifactorial aetiology and the self-limiting nature of the condition. Given this, conservative and reversible approaches are advised to manage TMD in the first instance. It is advisable to carry out a TMD screen for all potential orthodontic patients, including questions about symptoms, examination of the temporo-mandibular joint and associated muscles, and a record of the range of opening and movement.

Therefore, if patients present with signs/symptoms of a TMD condition, clinicians will be faced with two choices. They can either manage the TMD problem for this patient prior to initiating prolongs interventions, or they may refer to a colleague with expertise in the field of TMD and orofacial pain. If the choice is made to manage this individual, then it should be done in accordance with currently accepted guidelines for TMD diagnosis and treatment.

The history portion of a TMD assessment should be similar to that conducted by all dental practitioners.

1) Chief complaint

The chief complaints as presented in the patient's own words. These complaints should be documented in the order of severity as expressed by the patient, and details of each complaint are elicited in a systematic manner. This is then followed by the history of the chief complaint which should include such information as the location of the pain(s), date of onset, event onset (spontaneous or stimulus induced), quality, frequency, duration, and intensity.

2) A TMD Screen Examination

The screening examination should include the palpation of facial muscle, and the TMJs as well as observations of jaw movement.

Muscle Palpation

Several important muscles of the masticatory system are palpated for pain or tenderness during the screening examination. The temporalis (Figure 13) and masseter muscles (Figure 14) are palpated bilaterally. Palpation of the muscle is accomplished mainly by the palmar surface of the middle finger, with the index finger and forefinger testing the adjacent areas. Soft but firm pressure is applied to the designated muscles, the fingers compressing the adjacent tissues in a small circular motion. A single firm thrust of 1 or 2 seconds duration is usually better than several light thrusts. During palpation, the patient is asked whether it hurts or is just uncomfortable.



Figure 13: Palpation of the temporalis.



Figure 14: Palpation of the masseter muscle

Temporomandibular Joint Palpation

The TMJs are examined for any signs or symptoms associated with pain and dysfunction. Pain or tenderness of the TMJs is determined by digital palpation of the joints when the mandible is both stationary and during dynamic movement, fingertips are placed over the lateral aspects of both joint areas simultaneously (Figure 15). The patient is asked to report any symptoms, once the symptoms are recorded in a static position, the patient opens and closes, and any symptoms associated with this movement are recorded. As the patient opens maximally, the fingers should be rotated slightly posteriorly to apply force to the posterior aspect of the condyle. Posterior capsulitis and retrodiscitis are clinically evaluated in this manner.

Joint sounds are recorded as either clicks or crepitation. A click is a single sound of short duration. If it is relatively loud, it is sometimes referred to as a pop. Crepitation is a multiple, gravel-like sound described as “grating” and “complicated.” A more careful examination can be performed by placing a stethoscope over the joint area. Not only should the character of any joint sounds be recorded (clicking or crepitation), but also the degree of mouth opening associated with the sound. Of equal importance is whether the sound occurs during opening or closing or can be heard during both these movements.



Figure 15: Palpation of TMJ in closed, opened and fully opened mouth position.

Range of Mandibular Movement

A screening examination should also include evaluation of the patient's range of mandibular movement. The normal range of mouth opening when interincisally measured is between 53 and 58mm. Even a 6-year-old child can normally open a maximum 40mm or more. The patient is asked to open slowly until pain is first felt (Figure 16). At that point, the distance between the incisal edges of the maxillary and mandibular anterior teeth is measured. This is the maximum comfortable opening. The patient is next asked to open the mouth maximally. This is recorded as the maximum opening. In the absence of pain, the maximum comfortable opening and maximum opening are the same. A restricted mouth-opening is considered to be any distance less than 40mm. Only 1.2% of young adults open less than 40mm. Less than 40mm of mouth opening, therefore, seems to represent a reasonable point to designate restriction; however, one should always consider the patient's age and body size. The patient is next instructed to move his mandible laterally. A lateral movement less than 8mm is recorded as a restricted movement. Protrusive movement is also evaluated in a similar manner.

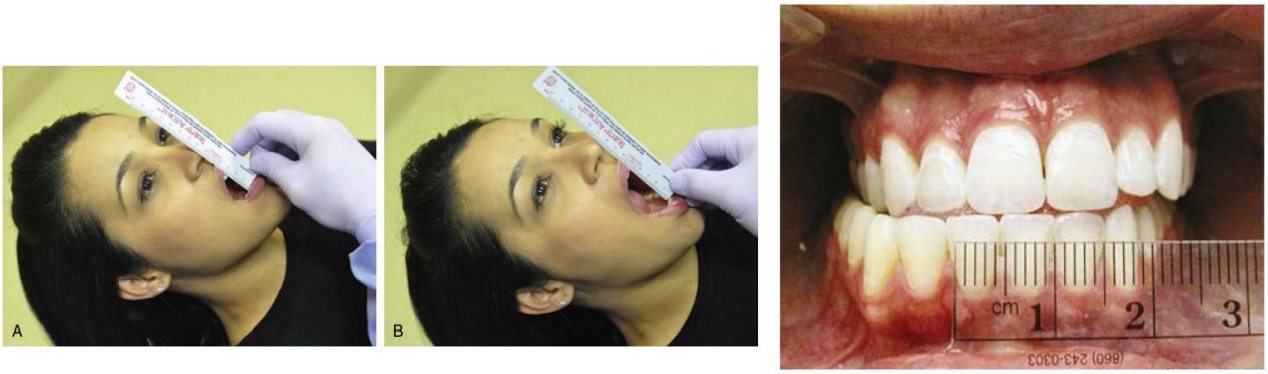


Figure 16: Measuring the amount of mouth opening and lateral eccentric movement.

Good Luck