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Neuromuscular Relaxation Using Anterior Leaf Gauge to Quick Guide the Condyles in Proper Position

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Abstract

To confirm the centric relation (CR), the leaf gauge can be used to load the TMJ. A load test will yield a negative result for a healthy TMJ. Nonetheless, the joint or muscles may be the reason of TMJ disorders if the patient experiences pain, tension, or tenderness, particularly in the region in front of the ear or nearby. In addition, the mandible can be in a centric relationship using a leaf gauge, which is made up of several plastic leaves. The leaf gauge helps the patient retrude the mandible by positioning it between the anterior teeth. The condyles tend to be moved against their menisci by the biting force. Therefore, this review study aims to describe the importance of the leaf gauge for neuromuscular relaxation to quick guide the condyles in CR position, to assist the recording of a reproducible jaw position during prosthodontic treatment.

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Centric relation plays a significant role in occlusion and clinical practice to accomplish the relations between joints, muscles, and teeth. Moreover, it has direct effects on maintenance of oral health, prosthetic rehabilitation, orthodontic and maxillofacial planning, temporomandibular disorder (TMD) therapy, and occlusal rehabilitation. Thus, using a CR technique that produces the highest reproducibility of condylar positions in CR is essential [1].

The current definition of centric relation is "a maxillomandibular relationship, independent of tooth contact, in which the condyles articulate in the anterior-superior position against the posterior slopes of the articular eminences; in this position, the mandible is restricted to a purely rotary movement; from this unstrained, physiologic, maxillomandibular relationship, the patient can make vertical, lateral or protrusive movements; it is a clinically useful, repeatable reference position" [2].

The characteristics of centric relation differ for each individual. The operators must softly, without using any force, direct the mandible posteriorly to the maximum intercuspation. Consequently, the components of TMJ (condyles, discs, ligaments, muscles, and physiological limits) will establish the centric relation. The tripod concept is the basis for deprogramming the lateral pterygoid, which is the muscle-releasing tool. When there is a gap between teeth, and fewer teeth are in contact, the lateral pterygoid is released temporally and the muscle memory is erased; hence, the masticatory muscles can help the condyle return to its natural position [3,4].

Recently, intraoral contactless 3D scanners are used to record CR. A virtual articulator and software program are being used to import the analog occlusal record. To construct an occlusal device, the jaw relation records and the virtual occlusal record of the maximal intercuspal position are utilized [5-7].

In fact, there are numerous benefits of digital recording, in terms of accuracy and efficiency. For example, there is no intermediary medium present during the recording process. Moreover, the dental laboratory technician does not need to place the actual stone casts; instead, the digital casts are uploaded into the software in the CR position. This guarantees a precise and effective installation in the virtual articulator. Additionally, the intraoral scanner software compares the digital casts of the arches to the inter-arch scan, which was acquired from the side view of the arches, to perform the direct digital occlusal recording. However, the expense of

Vol 13, No 1 (2025) DOI 10.5195/d3000/2025.930

purchasing the intraoral scanner and the learning curve that goes along with it are drawbacks of direct digital recording [8].

In addition, there are common different techniques that can be usually used to record CR. They include graphic techniques, such as gothic arch tracing (intraoral and extraoral); physiologic ones, including tongue retrusion along the posterior part of the palate and swallowing methods; guiding techniques, such as guidance of chin and bilateral manipulation; and anterior device techniques, involving composite resin stops, an anterior deprogrammer, and a leaf gauge [9-12].

In fact, the anterior device is considered a useful tool since it stabilizes the mandible and does not block the side view of the intraoral scanner. Besides, because the mandible is more stable when supported by an anterior device, in comparison to a lateral device, the anterior device technique seems to be simpler and less error-prone than similar techniques. Additionally, the anterior device technique is very efficient regarding positioning the condyles in CR by allowing the patient to contract the elevator muscles and relax the lateral pterygoid muscles. Conventionally, bimanual manipulating wax rims on base plates, wax wafers, or polyvinyl siloxane pastes can be used to record CR [12-14].

Previous studies reported that the presence of the two condyles in the articular eminences (the tripod) help in the stabilization of the mandible; therefore, some researchers prefer to use conventional method with an anterior device, where the mandibles is more stable, and put polyvinyl siloxane while positioning the mandible in CR [4,8].

Many researchers have described a technique that permits a straightforward and precise CR recorded at the chosen OVD and transferred to a virtual articulator . Moreover, a direct intraoral digital scanner is used to record CR. Conventional methods were used to stabilize mandible and determine CR at the required OVD. The position pertaining to the left and right posterior regions of the arches was recorded using an intraoral scanner._An anterior composite resin stop for fixed prostheses and an occlusal device are constructed using a leaf gauge [8].

Many researchers tried to guide jaw closure and avoid errors in assessing occlusal contacts by using two methods, the leaf gauge (1 to 6 mm thick) and the anterior acrylic resin jig, to record centric relation closures. These two methods were adopted to avoid adaptive mandibular closure patterns [15].

Furthermore, a study was conducted on five healthy adults without symptoms of TMD. The researchers trained the patient to bite with maximum and half-maximum bite force using an anterior jig. Then, they recorded the condylar displacement during clenching with electromyographic activity of muscles of mastication. They found that there was significant decrease in anterior temporalis activity ($p<0.05$), when compared to the maximum intercuspal clench and maximum clench on a leaf gauge temporalis muscle activity. Additionally, they concluded that there was no identification for constant change in condylar position [16].

Researchers also studied the use of different planned methods for jaw transfer records to accomplish a superior positioning of the condyles, such as leaf gauge, Roth's power centric relation registration, or anterior jig. These methods depend on the anterior stop to disclose posterior teeth and disregard the tooth contact interfering. They placed several sheets between the anterior teeth (10 sheets 0.1mm thick) to ensure that the posterior teeth are not in contact. They supposed that this procedure allows the jaw and condyles to adopt a reproducible position for recording the transfer records for prosthodontic [17-20].

Moreover, a study considered the centric relation records for 40 patients before and after the usage of an anterior flat plane deprogramming appliance (Jig). The Panadent condylar path indicator was used to record overjet dimensions, incisal overbite, and three-dimensional instrument condylar. They found that, the Lucia jig deprogramming appliance offers more movement of centric relation record from MI. They concluded that the appliance is more useful in cases where there is a problem in centric relation bite registration. 21 According to other reports, there was minimal antero-posterior component, and the most superior condylar position was obtained by heavy biting on an anterior rigid stop, when compared to other techniques [22].

The bimanual manipulation technique is a commonly described technique of recording CRCP, where the dentist supports the mandible through the retruded movement till the patient feels the initial tooth contact (CRCP). This procedure is repeated while using an articulating paper. Many operators suppose this method is subject to worker error; and it is problematic when the mandible is in CRCP [14,23–25]. Clinicians also used discarded panoramic radiography film to create a simple, low-cost leaf gauge deprogrammer. To prevent posterior occlusal contacts, a deprogrammer is positioned in the anterior region to accomplish muscle deprogramming. Then, the condyles were set in the centric relation position because of the lateral pterygoids relaxing. Long introduced leaf gauge deprogrammers, which are useful for muscle deprogramming [26-28].

On the other hand, there is a pattern of muscle activity called engram; it causes the mandible to deflect, leading to an error when recording the position of the centric relation. To remove this, tools called deprogrammers are used. The condyles should be engrammed, positioned, and secured in the centric relation position [29]. Therefore, to help dentists achieve precise bite registration in Centric Relation (CR) and occlusal analysis, Huffman created the Leaf Gauge in 1970. It offers a quick and easy way to register for bites in CR. It is a set of 56 strips made of flexible plastic leaves, each measuring 0 to 1 mm. Its design has not considerably changed, which reflects how useful and successful it is in clinical settings. In clinical practice today, it is still a commonly used tool [30].

A leaf gauge consists of multiple smooth, flexible plastic sheets arranged together on top of each other; the thickness of each leaf is around 0.1 mm. It is used to detect centric relation. It is placed along the midline of the anterior teeth to separate the posterior teeth retruding the mandible and to offer a suitable record of the precise vertical opening between the incisors. According to the case, the vertical opening will be controlled through increasing or decreasing the number of sheets. When the patient is applying pressure on the leaf, the biting force tends to move the condyles against their eminence. The position of the mandible does not exceed physiologic limits. The Leaf gauge is placed in the patient's mouth during retruding for occlusal equilibrium. Moreover, it is utilized to do fast deprogramming, to identify the first point of CR contact, and to record CR position. However, it is contraindicated in cases of a deep overbite with strong elevator muscles, where the flexible gauge can exert a

Vol 13, No 1 (2025) DOI 10.5195/d3000/2025.930

force on the condyle [15,31,32]. Kwiecien also lists several uses for a leaf gauge; they include obtaining bite records for centric relations, loading the TMJ, deprogramming the lateral pterygoid, and identifying the first point of contact in centric relation [4].

Additionally, there are steps for leaf gauge application. First, several leaves (about 5 to 8) are placed anteriorly in the maxillary central incisors along the midline, parallel to the palatal plane. Then, the patient is asked to close the mouth till the lower incisors contact the underneath of the leaf gauge, with no contact in the posterior region. Moreover, more leaves can be added to get posterior separation. Next, the patient is instructed to move the lower jaw forward/back and hold down onto the mylar strips, without any posterior molar contact. The number of leaves used is controlled based on the patient's response. After that the patient is requested to grasp the gauge in place for 2 to 5 minutes. Subsequentially, A-Silicone bite registration paste is used [33]. Prior to that the patient moves his jaw forward and backward and squeeze lightly (half-hard bite); the leaf gauge is placed between his upper and lower centrals while he is in a supine position. This bite only activates the temporal muscle, not the masseter, to prevent the mandible from protruding [4]. The opening must remain within the arc of closure (rotation) while enough leaf gauges are used to maintain the back teeth apart and create a smooth path. Furthermore, a distinct vertical component can be created by too few leaves, especially if the patient has a deep overbite. On the other hand, the condyle is forced down the eminence, beyond rotation, by too many leaves, which would feel heavy and possibly too open (translation). Two sets of leaves can be used to measure the amount that needs to be increased in vertical dimension (VD) [34].

The operator can record the quantity and direction of the slide using a leaf gauge, whether vertical, horizontal, or lateral. To measure the slides, the leaf gauge is moved laterally. In the anterior/posterior position, the facial of the same lower incisor is to the incisal edge of the same upper incisor. For the vertical position, the incisal edge of the same upper incisor is adjacent to the free gingival margin of the same lower incisor. All three positions should be measured using the same reference point for first tooth contact and MIP [35].

Obviously, many advantages were recorded by authors for using a leaf gauge. First, there is no need for management by the dentist because the patient can seat the condyles into centric relation using his own musculature. Moreover, the biting is concentrated on the leaf gauge rather than on the wax or articulating paper. This results in relaxing the jaw muscle and sometimes relieving pain due to continuous strong incisor contact on the leaf gauge for 1 to 5 minutes, allowing the jaw to retrude, which is a more relaxed position, and eliminating the periodontal ligament proprioception. Furthermore, a leaf gauge can be used with an articulating paper to predict which teeth will touch in a centric relation. If a deflective contact is present, it will be easier to determine whether the mandible is deviating from its typical path of closure. Besides, accurate occlusal analysis and bite registration are provided by a leaf gauge. In addition, a leaf gauge is simple for both patients and dentists to use. It can be also autoclave sterilized, and it can be used for a range of dental procedures. However, it is challenging to use on patients who have deep bites, anterior cross bites, or anterior mobile teeth. Additionally, if the condyle is overly rigid, it may shift posterior to CR, or some patients may attempt to bite off a sandwich by protruding their mandible anterior to CR by biting on the leaf gauge slightly forward [12,25,36-41].

In addition, numerous studies have tried to recognize the effects of a leaf gauge on the activity of (EMG) jaw muscle electromyographic. Hickman et al. 1993 found that a leaf gauge showed the lowest activity of anterior temporalis and masseter, when compared with three methods of jaw relation (manually guided centric relation position, maximum intercuspation, and neuromuscular guided position). Moreover, other studies have documented the condylar displacement during a leaf gauge biting. They reported that the leaf gauge led to superior condyle displacement with slight anteroposterior displacement [42,43]. Previous researchers also stated that the masseter muscles were lesser involved than the temporalis muscles, when a leaf gauge was used for interocclusal recording [20].

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