Pattern of occlusal contacts in lateral positions: Canine protection and group function validity in classifying guidance patterns

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Statement of problem. The concept of canine protection and group function lack consistency in the definitions and examining methods, and a valid system for evaluating and classifying occlusal contact patterns has not been established.
Purpose. This study assessed the use of canine protection and group function in classifying occlusal guidance in the natural dentition.
Material and methods. Occlusal contacts of 86 young adults were examined with shim stock in regulated lateral positions, 0.5, 1, 2, and 3 mm from the maximum intercuspation. The patterns of occlusal contacts varying with the lateral position were described.
Results. Focusing on the working-side contact only, most contact patterns belonged to group function, and a few to canine protection. Focusing on both the working and nonworking side contacts, nearly half the contact patterns were those other than canine protection and group function and were classified into balanced occlusion.
Conclusion. The validity of the classification system using canine protection and group function is questionable. A new classification system of occlusal guidance is desirable. (J Prosthet Dent 1998;80:67-74.)

CLINICAL IMPLICATIONS

This study demonstrated a great variety of occlusal contact patterns according to the lateral position and evaluated the validity of canine protection and group function as categories for the classification of the occlusal guidance patterns. Aspects of the classification system that need to be improved are discussed.

Anterior guidance is essential to a harmonious functional relationship in the masticatory system.[1] Anterior guidance can be categorized into three occlusal schemes: canine protection, group function, and balanced occlusion. Canine protection and group function have been described as forms of therapeutic occlusion in the natural dentition, based on the theoretical background and clinical failure of balanced occlusion.[1-4] Canine protection has been defined as contact only between the maxillary and mandibular canines on the working-side.[5-8] Group function was defined as contacts between the working side opposing teeth in a segment or group.[9-11]

Canine protection and group function have recently been used as categories for classification of the patterns of occlusal contacts in lateral excursions in natural dentition. Several studies have noted the prevalence of these two types of occlusal guidance[12-15] and the relationship between the occlusal contact pattern and mandibular function.[13,16-24] The relationship between the occlusal contact pattern and mandibular function includes the effect of occlusal contact on mandibular movement,[16,17] on masticatory muscle activity,[16,18] on the forces in the temporomandibular joint,[19,20] and on the signs and symptoms of temporomandibular disorders (TMD).[13,21-24] However, there are conflicting findings among these studies, due in part to the variations in the definitions and systems used to describe and classify the occlusal contact pattern. The definitions of canine protection and group function should be reconsidered, and the systems used for classifying the patterns of occlusal contact should be reexamined.

In *The Glossary of Prosthodontic Terms*,[25] canine protection is defined as "a form of mutually protected articulation in which the vertical and horizontal overlap of the canine teeth disengage the posterior teeth in the excursive movements of the mandible." Group function is defined as "multiple contact relations between the maxillary and mandibular teeth in lateral movements on the working side." However, the occlusal contact pattern varies according to the mandibular position examined.[14,15,26,27] There is no description regarding the mandibular posi-

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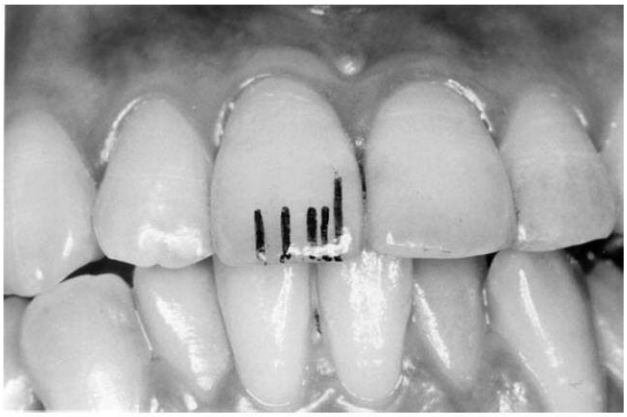

Fig. 1. Five lines marked on maxillary incisor, maximum intercuspation, and 0.5, 1, 2, and 3 mm right positions. This figure shows 1 mm eccentric position to right indicating mandibular midline corresponding to 1 mm line.

tion when examining occlusal contacts, which may account for the inconsistencies among the findings of the previously mentioned studies. In addition, the patterns of canine protection or group function with the presence of nonworking contacts have been categorized differently in different studies.[14,15,19] A precise and reproducible system for evaluating occlusal contacts is needed for the investigation of the effect of occlusal contacts on mandibular function.[24] Such a system would not be limited to the research field; a system for classifying guidance patterns is also required in clinical situations.

The purpose of this study was to elucidate the pattern of occlusal contact in various mandibular lateral positions and to evaluate the validity of canine protection and group function as categories in the classification of occlusal guidance patterns in the natural dentition.

MATERIAL AND METHODS

Eighty-six subjects (62 men, 24 women) between the ages of 20 to 29 years (average = 24.2 years) were selected from a group of 170 undergraduate students in the fourth, fifth, and sixth years of the Faculty of Dentistry. The criteria for inclusion in the study were as follows: All subjects had to (1) be in their twenties; (2) have normal occlusal alignment with an Angle Class I relationship; (3) have full dentition except for third molars; (4) have no history of orthodontic therapy; and (5) have no restorations involving a cusp. Informed consent was obtained from each subject before the commencement of the investigation.

Recording of occlusal contacts

The interocclusal contacts were recorded with shim stock (10 to 15 μm thick) (occlusal registration strips, Artus Corp., Englewood, N.J.) in four lateral positions on both sides; 0.5, 1, 2, and 3 mm from the maximum intercuspation.

Each subject was required to sit upright in a dental chair with the Frankfurt horizontal plane almost horizontal. The subject's head was not fixed. To regulate each lateral position, marks were made on the maxillary central incisors with a water-resistant pencil to the right of the mandibular midline (Fig. 1). The shim stock was placed on the occlusal surface of the right side, most posterior mandibular molar, and the subject was requested to close his/her mandible to the maximum intercuspation. While a constant pulling force is maintained on the shim stock, the subject was requested to perform a habitual gliding movement to the right with the teeth in light contact. When the subject's mandible was moved 0.5 mm right from the intercuspal position, the presence or absence of an occlusal contact was examined. The teeth holding the shim stock were considered to have occlusal contact. To prevent the movement with mandibular opening and without any occlusal contact and lateral protrusive excursion, the movement was observed, and occasionally the subject was instructed to correct the movement. The movement was performed by the subject without any help from the examiner. When the subject could not perform the movement voluntarily, he or she was asked to practice with the use of a hand mirror.

The examination was continued from the right side, most posterior molar to the one on the left side. For the examination of the molars, the shim stock was placed on both mesial and distal sites of the occlusal surface. The same procedure was performed in the 1, 2, 3 mm right and 0.5, 1, 2, 3 mm left positions. All recordings were performed by the same examiner and were repeated. In the case of differing results, the existence of occlusal contact was reexamined and verified. All recordings were made in the afternoon to avoid possible diurnal variations.[28]

Classification of occlusal contact patterns

One occlusal contact pattern was determined in the total range of lateral positions and classified into three groups (canine protection, group function, or balanced occlusion) focusing on the contact pattern on the working side only, and on the working and nonworking sides. If any contact patterns other than canine protection, group function, and balanced occlusion were observed, they were categorized into the unclassifiable pattern.

Classification system 1: Contact pattern on working side only

Canine protection was defined as the contact of only working side maxillary and mandibular canines in the total range of lateral positions from 0.5 to 3 mm. Group function was defined as the contacts of two or more working side teeth in at least one lateral position, and/or as single tooth contacts on the working side in different lateral positions, for instance, the contact of only first molars in the 0.5 mm position followed by the contact of only canines in the 1, 2, and 3 mm positions. The unclassifiable pattern

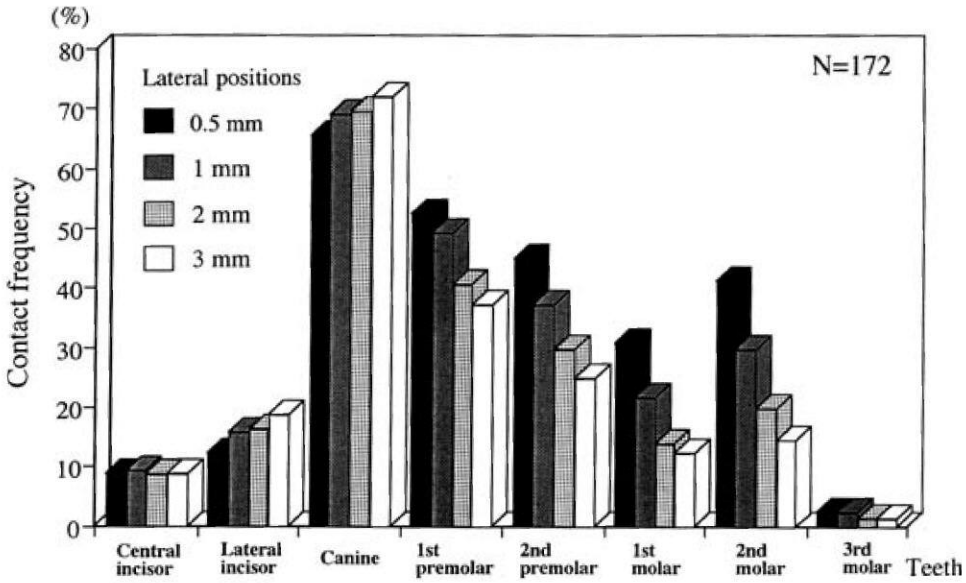

Fig. 2. Distribution of occlusal contacts on working side.

was identified when a contact pattern other than those previously described was observed, namely, contact of only first premolars throughout the lateral positions.

Classification system 2: Contact pattern on working and nonworking sides

Canine protection and group function were defined in the same way as previously described with an additional criterion for both types of occlusal contact: No nonworking side contacts were observed. Balanced occlusion was defined as the contacts of both working and nonworking side teeth in at least one lateral position. Namely, it was identified when canine protection or group function was observed with the nonworking side teeth in contact in at least one lateral position. An unclassifiable pattern was identified when a contact pattern other than canine protection, group function, or balanced occlusion was observed, namely, contact of only working side first premolars throughout the lateral positions or contacts of only nonworking side teeth throughout the lateral positions, the so-called balancing side interference.[26]

RESULTS

Figures 2 and 3 illustrate the frequency of contact on each tooth according to the lateral position. The percentages of excursions in contacts were calculated from the data of both right and left sides.

The working side occlusal contact was predominantly on the canine in all lateral positions (Fig. 2). Frequency of contact decreased gradually from the canine to the first molar as the tooth type became located posteriorly. However, the contact on the second molar was as prevalent as that on the premolars. The change of contact frequency according to the lateral position varied with tooth type. The frequency increased from the 0.5 mm to the 3 mm position on the canine, and in contrast, the frequency decreased from the 0.5 mm to the 3 mm on premolars and molars.

The nonworking side contact was prevalent mainly on the first and second molars. Further, the contact on the second molar predominated, especially in the 0.5 mm position. The prevalence of nonworking side contacts decreased with increasing deviation of the mandible from the 0.5 mm to the 3 mm position. This finding was the same as the contact pattern in the working side premolars and molars.

Each contact pattern in the total range of lateral excursion was classified by both classification systems 1 and 2, and the results are summarized in Tables I and II. According to classification system 1, most contact patterns (86.0%) were classified into group function (Table I). Canine protection was found in few patterns (10.5%). Bilateral canine protection was found in 2.3% of the subjects. Contact patterns other than canine protection and group function were found in 3.5% of the contact patterns.

According to classification system 2, canine protection and group function were found in 9.3% and 45.3% of the contact patterns, respectively (Table II). About half of the contact patterns (41.8%) were classified into balanced occlusion. Contact patterns other than canine protection, group function, and balanced occlusion were found in 3.5% of the contact patterns.

DISCUSSION

In many studies of occlusal contact patterns, the occlusal contacts have been recorded in an edge-to-edge

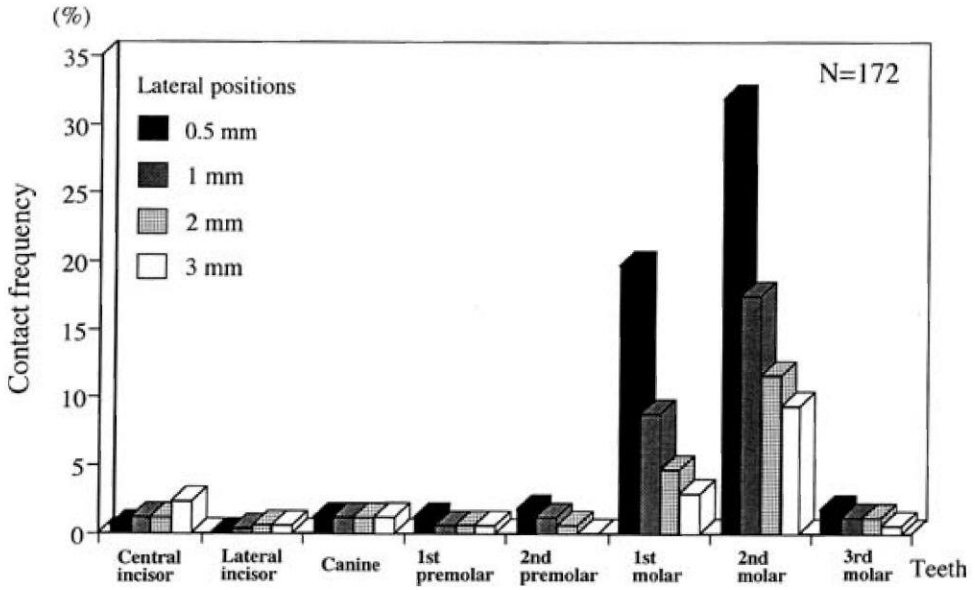

Fig. 3. Distribution of occlusal contacts on nonworking side.

Table I. Result of classification system 1 (n= 172)

	Number of contact patterns
Canine protection	18
Group function	148
Unclassifiable pattern	6

Table II. Result of classification system 2 (n = 172)

	Number of contact patterns
Canine protection	16
Group function	78
Balanced occlusion	72
Unclassifiable pattern	6

position of the canines approximately 3 mm lateral from the maximum intercuspation,[27,29,30] or in an unregulated position. Because this position is rarely used during mastication except in incising food and in parafunction such as bruxism,[26,31] recent studies have investigated the pattern of occlusal contact in regulated positions in the range of 1 to 3 mm from the maximum intercuspation.[14,15] However, it is highly possible that the occlusal contact during mastication occurs only within the 1 mm lateral position, depending on the person.[31-33] Kinematical analyses by Ogawa et al.[34-37] suggested that occlusal gliding contact during mastication would occur in the 0.5 mm position and that the occlusal contact pattern in this position must be evaluated when investigating the role of occlusal contact on masticatory function. Therefore, in this study, occlusal contacts were examined in lateral positions from 0.5 to 3 mm, namely, the functional region to parafunctional region in the masticatory system.

Understanding the usefulness of the available examination methods for diagnosis requires a working knowledge of the reliability of clinical measurement.[38] A comparative study has shown that shim stock has better reliability than articulating film for examining occlusal contacts, and that shim stock provides acceptable reliability in the clinical measurement of occlusal contacts.[39] To obtain the reliability of contact recording, the current study standardized the factors that affect the results of occlusal contact, such as head posture,[40,41] diurnal effects,[28] and interexaminer variation. It was expected that the subjects would be fatigued by repeating the occlusal contact recording in several positions, which might result in the variation of data even from one subject. In this study, all recordings were repeated in each subject and, in the case of differing results, the existence of occlusal contact was reexamined and verified. The prevalence of disagreement between first and second recordings was less than 10%. The effect of fatigue on the contact recording seemed insignificant, and the current method that uses shim stock seemed to have acceptable reliability for examining occlusal contacts during lateral excursion.

One type of occlusal contact pattern was determined from the data in the total range from the 0.5 mm to the 3 mm position, namely, canine protection, group function, or balanced occlusion. Though there is no clear description regarding the nonworking side contact in the definition of canine protection and group function,[25] there may be a possible consensus that canine protection and group function are designated when no nonworking side contacts are present. However, the patterns of canine protection and group function with nonworking side contacts are categorized differently by different studies[14,15,19] and are designated as being either

canine protection or group function limited on the working side or balanced occlusion. The criteria for categorization have depended on the dentist or researcher.

As mentioned in at the beginning of this article, *The Glossary of Prosthodontic Terms*[25] defines canine protection as "a form of mutually protected articulation in which the vertical and horizontal overlap of the canine teeth disengage the posterior teeth in the excursive movements of the mandible," and group function is defined as "multiple contact relations between the maxillary and mandibular teeth in lateral movements on the working side." The interpretation of canine protection and group function as classification categories is relatively easy. In summary, canine protection is a single tooth contact pattern on the working side canine throughout lateral excursion. Group function is a contact pattern on two or more working side teeth throughout lateral excursion. This interpretation is the reason why the pattern of single tooth contacts on two or more working side teeth in different lateral positions was categorized into group function in the current study. The only problem with these definitions is the absence of a description for the situation of nonworking side contacts.

The interpretation of balanced occlusion is difficult. *The Glossary of Prosthodontic Terms*[25] defines balanced occlusion as "the bilateral, simultaneous, anterior, and posterior occlusal contact of teeth in centric and eccentric positions." The question thus arises as to which category is appropriate when the occlusal contact exists on the working side canine in the total range of positions from 0.5 to 3 mm and on the nonworking side second molar only in the 0.5 mm position, and when the contact exists on the working first and second molars in the total range of positions and on the nonworking side first molar only in the 3 mm position. In these contact patterns, there are bilateral, simultaneous occlusal contacts in one lateral position. However, these contact patterns are not consistent throughout the total range of lateral excursion; in addition, not all anterior and posterior teeth are necessarily in contact. In light of the given definition, balanced occlusion appears to imply an ideal therapeutic occlusion as a goal of complete denture construction and is not a usable description for an existing contact pattern.[2] It seems that dentists often consider balanced occlusion as bilateral and simultaneous contacts on posterior teeth throughout lateral excursion to maintain the stability of the denture supported by resilient tissue. It does not seem appropriate to categorize the above-mentioned two patterns as balanced occlusion, unless its definition were to be modified so that it could be applied to the natural dentition. However, the purpose of this study was to elucidate the great variation of occlusal contact patterns in the natural dentition. Balanced occlusion was included as a classification category when representing such occlusal contact patterns in classification system 2.

Regardless of the status of the nonworking side contacts, according to classification system 1, most contact patterns were classified as group function and only a few as canine protection. Subjects with bilateral canine protection were rarely observed. Scaife and Holt[29] reported the prevalence of 57% for bilateral canine protection and 16% for unilateral canine protection in male subjects with Angle Class I. They examined occlusal contact in an edge-to-edge position of canines and molars. In contrast, some studies that examined several positions outside the 1 mm position reported a low prevalence of canine protection.[14,15] The current results demonstrated an even lower prevalence of canine protection compared with those studies. The disparity among these findings seems to be due to the differences in registration material,[14,15,26,27] age,[26] type of occlusion (such as Angle classification),[15,40] and gender of the subjects. Though little information is available regarding the effect of gender on the prevalence of the occlusal contact pattern, the effect of the dentocranial structure on occlusal contact pattern has been suggested by Ingervall et al.[42] Further, kinesiologic and morphologic analyses by Ogawa et al.[43,44] have shown that the width and length of the mandible, and the anterior and condylar guiding system differ between the genders. It is possible that a gender difference exists in the prevalence of the occlusal contact pattern. In the current study, no gender difference was found in the frequency of canine protection and group function. However, 62 men and only 24 women were examined. Further studies should be conducted with more female subjects. The lateral positions examined should be emphasized as a factor responsible for the lower prevalence of canine protection in our results. In this study, lateral excursion was divided into four stages to reflect the total range of occlusal contact. On the working side, the prevalence of contact on canines was increased, and simultaneously, the prevalence of contact on premolars and molars decreased with increasing deviation of the mandible from the maximum intercuspation. It was suggested that recording occlusal contact close to the maximum intercuspation makes it possible to detect the contact on premolars and molars. Thus, as occlusal contact is recorded closer to the maximum intercuspation, the frequency of canine protection decreases. The recordings in the 0.5 mm positions may account for the low prevalence of canine protection observed in this study. The patterns that were impossible to classify in classification system 1 were contact patterns on only a working side incisor, a premolar, or a molar throughout the total lateral positions. There were no contact patterns with an absence of working side contacts, the so-called balancing side interference.

Because most of the contact patterns in classification system 1 were classified as group function, and the guidance patterns other than canine protection and group function existed in 3.5%, the validity of the classification

using canine protection and group function is questionable. Clinically, when most guidance patterns are group function, it does not seem useful to classify and describe the guidance pattern of a person. From a research point of view, a classification system should categorize the whole sample into experimental groups and be sensitive enough to distinguish characteristics other than the factors by which the classification was made.[45,46] For instance, it would be informative if each classified group, canine protection or group function, showed characteristics in the pattern of masticatory movement, masticatory muscle activity, and masticatory efficiency. A classification system that reflects other functional characteristics would provide useful and valuable information to dentists and researchers. Because of uneven grouping, it is difficult to make a random sampling and equalize the groups with the current classification system of canine protection and group function. In addition, this system provides no information concerning the details of the group-function group and how the unclassifiable patterns should be dealt with.

In classification system 2, canine protection and group function were identified only when no nonworking side contact was present. About half of the contact patterns (45.3%) could not be classified into canine protection or group function, and most of them (41.8%) were classified into balanced occlusion. The reason for this was that most had nonworking side contacts in the 0.5 mm and/or 1 mm positions simultaneous with working side contacts. As previously mentioned, the definition and image of balanced occlusion does not seem to correspond to these patterns of occlusal contact, and it is difficult to categorize these types of guidance patterns. However, nearly half of the contact patterns were found to have the nonworking side contacts in positions close to the maximum intercuspation. If these patterns were not to be considered balanced occlusion, how should they be categorized? Even if these patterns were to be considered balanced occlusion, the concept of occlusal guidance in natural dentition needs to be reconsidered, and the definition of balanced occlusion needs to be modified. This study selected young adults in their twenties with Angle Class I occlusion. Because of abrasion, older subjects may show a lower prevalence of canine protection and a higher prevalence of group function and balanced occlusion.[14] In addition, variation in occlusion type, besides Angle Class I occlusion, would be responsible for an increase of unclassifiable contact patterns.[14,15,42] These findings and suggestions will not support the validity of canine protection and group function as categories in the classification of occlusal guidance patterns in the natural dentition.

Occlusal guidance is an acquired relationship between form, function, and tooth wear. Many studies[31-37,47] have investigated the role of occlusal guidance on masticatory function and have shown that the pattern of masticatory movement reflects the individual pattern of occlusal guidance. Dentists therefore try to make the occluding form of a restoration with a contact pattern in harmony with the person's occlusal guidance,[48,49] based on the principle that restorations should be in harmony with existing factors in the masticatory system so as not to disturb the relationship between individually acquired form and function.[50] An understanding of occlusal contact, including the examining methods and classification of the occlusal contact pattern therefore is required in such clinical situations. The findings in this study revealed a large group of contact patterns that were unclassifiable by the system categorizing guidance patterns that used only canine protection and group function. A new classification system of occlusal guidance should be established; otherwise, any theory regarding prosthetic treatment and/or occlusion will be ambiguous.

The results of this study regarding contact frequency demonstrated that even a slight difference in the examining position resulted in a great difference in the contact patterns. This suggests that a lack of consistency in the examining position may produce various evaluations of the contact pattern, even from one person. In an EMG analysis related to occlusal guidance pattern, Belser and Hannam[16] indicated that canine protection that was artificially and temporarily developed from group function significantly reduced muscle activity during lateral clenching but did not significantly alter muscle activity during mastication. The difference in muscle response may be due in part to the difference of occlusal contact pattern in each situation. Occlusal contact during lateral clenching would occur in about an edge-to-edge position,[26,31] and that during mastication occurs close to the maximum intercuspation.[31-37] An edge-to-edge position corresponded to the 3 mm position, and the position close to the maximum intercuspation corresponded to the 0.5 mm position in our study. Even under the condition of experimentally established canine protection, it is possible that the contact pattern was different between lateral clenching and mastication. The current results demonstrated that the 0.5 mm position showed a marked prevalence of working and nonworking side posterior tooth contact resulting in a significantly lower prevalence of canine protection. The artificial change of occlusal contact was not examined in a total range of lateral excursion in the study by Belser and Hannam.[16] A more critical examination of occlusal contact may have obtained different results and might have determined the underlying reason of these findings.

In contrast to the research supporting the relationship between occlusal contact and mandibular function, there are several studies that do not support a significant role of occlusal contact on mandibular function. For instance, an occlusal splint did not stop the habit of nocturnal bruxism.[51,52] This finding did not support the

effect of the temporary change of occlusion and/or the proprioception in the periodontal membranes[53] on oral motor function and is opposed to the above-mentioned EMG analysis. There are also disagreements regarding the role of occlusal contact on TMD symptoms.[15,22-24] In a review of canine protection and group function, Thornton[3] stated that there is no scientific evidence that supports one contact pattern over the other. Many investigations have been performed regarding the role of occlusal contact on functional characteristics in the masticatory system. Nevertheless, a precise and reproducible method for determining the occlusal contact and classifying the occlusal contact patterns has not been established, as concluded by McNamara et al.[24] in their review on occlusion and TMD. The establishment of a new examination method and classification system for occlusal contact pattern could resolve these disagreements and clarify the impact of the occlusal contact patterns that contribute to the success of restorative dentistry and in the prevention and treatment of TMD.

CONCLUSIONS

Canine protection and group function have been used when describing occlusal contact patterns during lateral excursion and are simple and useful concepts to outline the occlusal guidance pattern. They are widely accepted as types of therapeutic occlusion in natural dentition. However, much confusion and inconsistency has accompanied the interpretation of these terms. On the basis of the results of this study, it does not seem appropriate to describe and classify the patterns of occlusal contact using only these terms in clinical and research fields. The following problems need to be resolved: (1) a clear description regarding nonworking side contact, including a clear and modified definition of balanced occlusion; (2) consistency of the lateral position when occlusal contact is examined; and (3) how to deal with contact patterns, such as single tooth contact on other than canines in a total range of lateral excursion.

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Noteworthy Abstracts of the Current Literature

Denture treatment for the stroke patient
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Purpose. While strokes can occur at any age, they are more common in the elderly above 65 years of age. Strokes are caused by cerebral thrombosis and contributing factors are uncontrolled hypertension, smoking, physical inactivity, obesity, diabetes mellitus, and heart disease. This article reviews the difficulties that face stroke patients who require denture treatment. This article provides the dentist with an overview of recommendations that will facilitate a successful outcome.
Discussion and Recommendations. The article reviews the common effects of stroke: dysphagia (inability to swallow); dysarthria (slurred and sloppy speech); aphasia (reduction in understanding and use of language), and agnosia (confusion). The author stresses the need of tolerance, patience, reassurance, compassion, and understanding when treating the stroke patient. The palatal training appliance may be useful for treating speech problems and aids in swallowing. After a stroke, many denture wearers cannot wear dentures that were previously stable. This is due to loss of concentration on denture control, difficulty in swallowing, loss of oral sensation, weight loss, xerostomia, oral apraxis (reduced muscular movements), and anesthesia of the affected oral mucosa, which reduces the ability to position their dentures and how they close their mouth. It is critical that the dentist, patient, and caregiver review the benefits of continued denture wearing versus their discontinued use. The author reviews the assessment of existing dentures, the modification of the existing dentures, the use of the "sulcus eliminator" (a modification of the mandibular buccal polished surface on the affected side to eliminate the overspill of food), and using new dentures. There is a review of facial asymmetry, use of RPDs, stroke and oral hygiene practices and root caries. All stroke patients are different and must be assessed as to their individual needs and when treated care must be given with the highest possible standard for success. 13 References. — *RP RENNER*