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VARIATION OF RETRUDED AND MUSCULAR POSITION OF MANDIBLE UNDER DIFFERENT RECORDING CONDITIONS

by

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INTRODUCTION

The question as to the most suitable position of the mandible as a reference and recording position in examination of the occlusion and in association with occlusal rehabilitation has received much interest in the odontological literature. The discussion of the question has, however, been complicated by terminological diffuseness and incomplete reports of investigations.

The following definitions (*Krogh-Poulsen & Carlsen*, 1968) will be used in this paper.

Intercuspal position: the position of the mandible with maximal occlusal contact. *Synonym:* habitual occlusal position.

Muscular (occlusal) position: the position of the mandible when the occlusal surfaces have just made contact after the mandible has been raised from postural position with the use of minimal muscular activity. *Synonyms:* centric (occlusal) position, relaxed (contact) position.

Retruded (occlusal) position: (contact) position of the mandible after maximal retrusion. *Synonyms:* ligamentous position, centric relation.

Since the publication of *Posselt's* (1952) important work which showed the good reproducibility of the retruded position, several investigators have

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studied the precision of recording of this position and of the intercuspal position (*Ingervall*, 1964, 1968; *Kabcenell*, 1964; *Ingervall et al.*, 1971). A high precision was found in these investigations, but also a tendency to slight variation under certain circumstances. This prompted this further study of the retruded position.

The muscular position (*Brill et al.*, 1959; *Krogh-Poulsen & Olsson;* 1968) or centric (occlusal) position, on the other hand, does not appear to have been studied so extensively regarding its clinical reproducibility (*Agerberg*, 1971) but it has been examined electromyographically (*Ramfjord*, 1961; *Møller*, 1966; *Ahlgren*, 1969) and »gnathosonically» (*Watt*, 1968, 1970).

Many dentists report that they use the muscular position in analysis of the occlusion and this position is often recommended in handbooks on prosthetics. It was therefore considered of interest to study the reproducibility of the muscular position. In an edentulous patient it is difficult to find a really satisfactory recording method because of, among other things, the resilience of the oral mucosa and lack of fixed reference points (*Glantz*, 1966). The present authors therefore chose to work with dentulous subjects, and used a recording method eliminating the importance of the periodontal receptors so that the conditions resembled those prevailing in an edentulous mouth.

The purpose of the investigation was to compare:

1. the precision with which the retruded position could be reproduced on different occasions and by different examiners;
2. recordings of the retruded position made by different examiners;
3. recordings of the retruded position after terminal hinge movement and by tracing of the Gothic arch;
4. recordings of the retruded position with the subject in different postures;
5. recordings of the retruded position made with the examiner on the right and on the left side, respectively, of the subject;
6. the precision of recording of the muscular position with the precision of recording of the retruded position; and
7. recordings of the muscular position with the subject in different postures and with the head in different positions.

MATERIAL AND METHODS

The material consisted of 10 male dental students, aged 21 to 26 years (mean 23.5 years). These men, who all had a full complement of natural teeth, were

not selected according to any particular type of occlusion. The overjet varied between 0.0 mm and 5.5 mm (mean 2.8 mm); the range of overbite was 0.0—8.5 mm (mean 3.5 mm). The functional state of the masticatory system was evaluated by examination of the pattern and range of movement of the mandible, analysis of tooth contacts on occlusion and articulation as well as by palpation of the temporomandibular joints and the masticatory muscles (*Krogh-Poulsen & Olsson*, 1968; *Carlsson et al.*, 1970). No signs of any functional disturbances were found in any of the men.

Recording of mandibular position

The position of the mandible in retruded and muscular position was recorded graphically. The recording was made intraorally with the aid of acrylic splints fastened to the upper and lower teeth. The splints were retained to the teeth by the fact that the acrylic substance covered about 1 mm inferior to the most prominent part of the teeth. The upper splint was equipped with a holder for exchangeable waxed glass slides, while the lower splint had a pointed tracing screw (Fig. 1). The registrations were made with the smallest degree of opening between the jaws necessary for movement of the lower jaw not to be prevented by contact between the splints. The vertical opening measured between the incisors varied between 0.7 mm and 5.4 mm (mean 3.6 mm). The adjusted height of the bite was not changed during the experimental period.

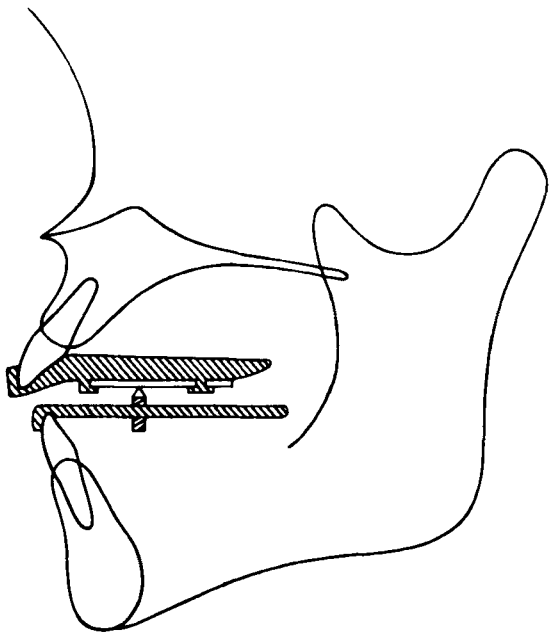

Fig. 1. Apparatus for intra-oral graphic recording.

The retruded position was recorded after terminal hinge movement as well as by tracing of the Gothic arch. During the hinge movement, the subject's mandible was guided by the examiner who pressed the mandible backwards with his right or left thumb, while gripping the chin with his index finger. When tracing the Gothic arch the subject closed his mouth in protruded mandibular position so that contact was made between the glass slide and the tip of the tracing screw. From this protruded position the mandible was pressed backwards to retruded position by the examiner and then to one side and the other. The retruded position was thus recorded without conscious active cooperation of the subject. The mandible was pushed backwards by strong pressure. Judging from previous investigations (*Ingervall et al.*, 1971), the pressure applied was about 2 kp.

During the recording of the muscular position the subject was instructed to relax as much as possible and to close the mouth, so that contact was obtained between the glass slide and the tracing screw without any help by the examiner.

The recordings were made with the subject's body and head in different positions. The retruded position was recorded with the subject lying with Camper's line vertical and with the subject sitting in a slightly reclined position with Camper's line horizontal.

The muscular position was recorded with the subject lying (with Camper's line vertical), sitting with Camper's line at an angle of 45° to the horizontal plane, and standing with the head in natural posture.

The retruded position was recorded with the examiner either on the right or the left side of the subject. When the examiner was on the left side the mandible of the subject was guided with the examiner's left hand.

Recordings were made on two occasions. On each occasion 8 recordings were made of the retruded position and 6 of the muscular position. The following recordings were performed:

Hinge movement, examiner A, subject sitting
» » » B, » »
Gothic arch » A, » »
» » » B, » »

Hinge movement, examiner A on right side, subject lying
» » » » » left » » »
Gothic arch » » » right » » »
» » » » » left » » »

Double recordings of muscular position with the subject
lying
sitting
standing

The recordings, which were made in random order, were repeated after 1—20 weeks.

After recording of the position of the mandible by contact between the tip of the tracing screw and the waxed glass slide, the latter was removed and etched with fluoride.

Measurements

The position of the contact of the tip of the tracing screw with the glass slide after the terminal hinge movement and after the habitual closing movement was determined by measurement in antero-posterior and in medio-lateral directions. The measurement were made *ad modum*

Posselt (1952) to the nearest tenth of a millimeter with a sliding caliper. The measuring error (see statistical methods) was determined by measurements of 30 glass slides on two occasions and was found to be 0.03 mm both in antero-posterior and in medio-lateral directions.

After recording of the Gothic arch the antero-posterior position of the tip of the acute angle was determined with the above method (measuring error 0.02 mm). The medio-lateral position of the tip of the angle, like the size of the angle, was not measured directly on the glass slide but on a photographic enlargement of it. The glass slide was enlarged 10-fold on photographic paper, after which the medio-lateral position of the tip of the acute angle was measured with a precision of 0.1 mm. The size of the acute angle was measured to the nearest half degree with a protractor graded in half degrees. The error of the enlargement and measuring was determined by measurement of 30 pairs of enlargements and was found to be 0.13 mm for measurement of the medio-lateral position and 0.94 degrees for determination of the angle.

Statistical methods

Examination for systematic differences between repeated recordings was performed by calculating the mean difference and the mean error of the mean difference, $M_D \pm {}^{e}M_D$. With the t-test it was checked whether the mean difference differed significantly from 0. The measuring error and the accidental error, s(i), of duplicate determinations (error of method) were calculated according to the formula $s(i) = \sqrt{\frac{\Sigma (x_1-x_2)^2}{2n}}$. Differences between accidental errors were tested with the F-test and differences between means with the t-test.

RESULTS

Precision of recording of mandibular positions

Retruded position. The precision of recordings of the retruded position with the subject sitting was judged from double determinations by two examiners on two occasions.

Only in one case was a significant systematic difference found between the recordings made on the two occasions. The mean difference in that case was, however, extremely small (0.04 mm). The accidental errors are given in Table I. The errors were very small and mainly of the same magnitude for both examiners. The errors were somewhat larger for recordings in the medio-lateral direction than for those in the antero-posterior direction. A statistically significant difference was, however, found only for recordings made by hinge movement performed by examiner A ($P<0.001$). The errors were also somewhat larger for recordings made by tracing of the Gothic arch than by terminal hinge movement. A statistically significant difference was found for recordings in the antero-posterior direction performed by examiner A ($P<0.001$).

Recording of the retruded position with the subject lying was performed by examiner A. No significant systematic difference was found between

Table I

Accidental errors, s(i) ,on recording on two occasions, of the retruded position by the terminal hinge movement and by tracing of the Gothic arch. Linear measurements in millimeters

Recording	Examiner A		Examiner B	
	Hinge movement	Gothic arch	Hinge movement	Gothic arch
Antero-posterior	.04	.14	.09	.10
Medio-lateral	.15	.22	.10	.16
Angle of the Gothic arch		4.81°		2.70°

repeated determinations. The accidental errors are given in Table II. The errors were just as small as those obtained when the recordings were made with the subject sitting. The precision appears to be the same whether the examiner is standing on the right or the left side of the subject, except for the error of the recording of the size of the angle of the Gothic arch, which was smaller when the examiner was standing on the left side ($0.01 < P < 0.05$).

Like recording with the subject sitting, the errors were numerically larger when the recordings were made by tracing of the Gothic arch than when made by the terminal hinge movement. No statistically significant differences were, however, found. Neither was any difference found between the precision of recording in antero-posterior and medio-lateral directions.

Muscular position. No significant systematic differences were found between double recordings, made on two occasions, of the muscular position. The accidental errors are given in Table III.

Table II

Accidental errors, s(i), on recording of the retruded position on two occasions, with subject lying. Linear measurements in millimeters

Recording	Examiner on right side of subject		Examiner on left side of subject	
	Hinge movement	Gothic arch	Hinge movement	Gothic arch
Antero-posterior	.11	.18	.07	.13
Medio-lateral	.09	.12	.08	.13
Angle of the Gothic arch		3.82°		1.63°

Table III

Accidental errors, s(i), on double recordings, on two occasions, of contact position of mandible after habitual closure (muscular position). Measurements in millimeters

Recording	Posture of subject		
	Lying	Sitting	Standing
Antero-posterior	.50	.56	.60
Medio-lateral	.29	.18	.25

The errors were much larger than those of the recordings of the retruded position. Especially the error in antero-posterior direction was larger for the muscular position than for the retruded position. The errors did not vary with the posture of the subject, but were larger for recordings in antero-posterior direction than in medio-lateral direction. With the subject sitting the difference between the precision in antero-posterior and in medio-lateral direction was significant ($0.001<P<0.01$) and in the standing position, probably significant ($0.01<P<0.05$).

Position of mandible

Retruded position. No systematic difference was obtained in the position of the mandible on comparison between the recordings of the retruded position made by different examiners or between recordings made by the hinge movement or by tracing of the Gothic arch. The size of the angle of the Gothic arch did not vary from one examiner to another, either. In the comparisons as in those described later, means of several corresponding recordings were used. The position of the mandible in recordings of the retruded position with the examiner on the right side and the left side, respectively, did not differ in antero-posterior direction with side. Neither was any difference found between determination of the position of the mandible in medio-lateral direction by tracing of the Gothic arch. On registration by the hinge movement, however, a difference was found in medio-lateral direction (mean difference 0.24 mm, $P<0.001$) implying a shift of the mandible by about 0.1 mm laterally away from the operator. The size of the angle of the Gothic arch did not vary with the position of the examiner.

Recordings of the retruded position with the subject sitting and lying did not differ from one another in antero-posterior direction when the recordings were made by tracing of the Gothic arch. On recording by the hinge movement

the mandible was, on the average, 0.06 mm ($0.01<P<0.05$) more posterior when the subject was sitting.

In medio-lateral direction differences in the position of the mandible were found between the sitting and lying position both when the recordings were made by tracing of the Gothic arch and by terminal hinge movement. In both methods the mandible was placed further to the left when the subject was lying. The difference was larger (diff. 0.17 mm, $P<0.001$) for recordings made by the hinge movement than by tracing of the Gothic arch (diff. 0.10 mm, $0.01<P<0.05$). The size of the angle of the Gothic arch did not vary with the position of the subject.

The retruded position recorded by the hinge movement and by tracing of the Gothic arch could be compared in antero-posterior direction. No such comparison could be made for the determination in the medio-lateral direction because different measuring methods were used. The mandible was placed, on the average, 0.08 mm more posteriorly when the recordings were made by tracing of the Gothic arch than when made by the hinge movement ($0.01<P<0.05$). when the recordings were performed by examiner A with the subject sitting. No significant difference was found for corresponding recordings by examiner B. With the subject lying (examiner A) the mandible was, on the average, placed more posteriorly when recordings were made by the Gothic arch than when they were made by the hinge movement (when recorded on the right side diff. 0.11 mm, $0.001<P<0.01$ and on the left side diff. 0.10 mm, $0.01<P<0.05$).

Muscular position. The position of the mandible in antero-posterior direction in the muscular position varied with the posture of the subject. The most anterior position (see Fig. 2) was noted when the subject was standing and the most posterior position when he was lying (mean difference 0.56 mm, $0.001<P<0.01$). A difference was also found between the sitting and the standing position (diff. 0.39 mm, $0.001<P<0.01$).

The mean antero-posterior distance between the retruded and the muscular position with the subject sitting and with the increased vertical dimension used was 1.65 mm.

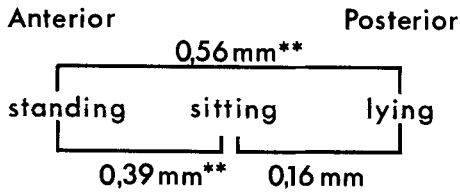

Fig. 2. Differences in antero-posterior position of mandible in muscular position with variation of posture of the subject.

DISCUSSION

The recording method used is very precise as is reflected in the very small size of the measuring errors and of the accidental errors of recordings of the retruded position of the mandible. This method therefore lends itself well for studying the effect of various recording factors.

The retruded position can evidently be reproduced with good precision without being appreciably affected by differences in examiners, position of the examiner on the right or left side of the subject, whether the subject is sitting or lying, intervals between recordings and the use of the Gothic arch or terminal hinge movement.

Lund et al. (1970) studied the postural activity in the masticatory muscles electromyographically in subjects in the upright, inclined and supine position. They found the activity in the muscles examined to be lowest when the subject was lying and therefore felt »that the supine position is suitable for recording the most retruded position of the mandible». Judging from the observations made in the present investigation, however, there appears to be no certain clinical differences in the retrusion of the mandible on passive recording of the position whether the subject is sitting or lying. It is probable that the method used by us for placing the mandible in the retruded position, *i.e.* relatively strong backward pressure against the chin, and recording without any intentional active cooperation by the subject eliminates the variation in muscular activity found by *Lund et al.* with the posture. On the other hand, the position of the mandible will be much more posterior when the subject is lying than when he is standing if the subject himself, *i.e.* actively, is allowed to close the mouth into a relaxed position which clinically verifies the electromyographic findings.

Recording of the retruded position by tracing of the Gothic arch appears to be less precise than recording by terminal hinge movement, but the differences are only occasionally statistically significant. Recording by tracing of the Gothic arch tends to give smaller and fewer systematic errors than recording by the hinge movement, but this may be due to the lower precision of the former method. The antero-posterior coordinate for the retruded position can apparently be determined with somewhat higher precision than the medio-lateral coordinate irrespective of the recording method used, but the differences were significant in only one of eight comparisons.

An interesting result was obtained on comparison of the recording in medio-lateral direction of the retruded position with the examiner standing on different sides of the subject. The small but significant shift in position of the mandible in the opposite direction (from the examiner) shows that

the examiner should preferably stand in front of the subject when recording the retruded position.

The small systematic differences found on comparison of recordings in the antero-posterior direction of the retruded position recorded by tracing of the Gothic arch and by the terminal hinge movement, respectively, may be of methodologic nature. Owing to technical measuring difficulties it may be hard to decide the actual position of the tip of the angle of the Gothic arch or the selected measuring point may not be equivalent to the clearly defined registration point obtained when recording by the hinge movement.

The results of recordings under different conditions show that the retruded mandibular position with its good reproducibility is suitable as a recording and reference position. The results thereby verify those obtained by earlier investigations with the same, similar or other methods (*Posselt*, 1952; *Ingervall*, 1968; *Agerberg*, 1971; *Ingervall et al.*, 1971).

The picture is quite different on recording of the habitual relaxed path of closing movement which, according to definition, results in the so-called muscular position. The precision is much lower than that of recording of the retruded position, especially in the antero-posterior direction. The muscular position is influenced markedly by the posture of the subject and the position of his head (with an average difference in antero-posterior direction of 0.6 mm between the standing and lying position). The lack of precision of recordings of the muscular position is also apparent from the largest antero-posterior difference between two repeated recordings which was 1.95 mm, against 0.55 mm for the corresponding value for the retruded position.

In healthy dentulous subjects the intercuspal position can be reproduced with the same degree of precision as the retruded position (*Ingervall*, 1968; *Agerberg*, 1971). This can probably be ascribed to guiding impulses from periodontal proprioceptors and cuspal locking. In the present investigation (as in edentulous subjects) the effect of these impulses was eliminated so that other receptors, of which those in the temporo-mandibular joints and mandibular musculature are probably the most important, are responsible for the precision of the closing movement.

Analysis of recordings of mandibular positions in edentulous subjects have shown a much lower degree of precision (*Walker*, 1962; *Glantz*, 1966), which can probably be explained by the difficulty in fixing the recording apparatus to the alveolar processes in edentulous patients. But in most such studies using the graphic method the »retruded position»/centric relation has been recorded actively, *i.e.* the subject has been allowed to perform lateral movements of the mandible by himself and not with the aid of the examiner. In wax index (checkbite) methods (*Yurkstas & Kapur*, 1964;

Glantz, 1966) no backward pressure has been used or physiological methods, such as swallowing or placing of the tongue up against the soft palate have been tried (*Walker* 1962). However, one should evidently use a relatively strong backward pressure against the mandible and make the recording with the subject passive, *i.e.* without cooperation of the subject in order to be sure to obtain a reproducible retruded position of the mandible (*Carlsson & Helkimo*, 1971; *Ingervall et al.*, 1971).

The design of the present experiment was such that the habitual relaxed closing position used by us corresponded well to different definitions of the so-called muscular position (*Brill et al.*, 1959; *Krogh-Poulsen & Olsson*, 1968). This easily defined and theoretically ideal position of the mandible can clinically hardly be attained with certainty and is influenced by various factors which may be difficult to control (*Agerberg*, 1971), It may perhaps be possible to determine it electromyographically (*Ahlgren*, 1969). The use of this position in clinical work can therefore not be recommended in the examination of the occlusion of patients with natural teeth and denture wearers or, in the recording of the intermaxillary relation in edentulous patients and in patients with functional disorders of the masticatory system. The retruded position has clear advantages as a reference position, as is obvious from the results of this investigation.

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SUMMARY

The variation of recordings of the retruded position and the muscular position of the mandible was examined with the graphic method on 10 men, aged 21 to 26 ,with complete dentitions.

The investigation showed that the errors of recording of the retruded mandibular position are very small and do not vary from one examiner to another. The precision of recording of the retruded position was largely the same whether the recording was made by the terminal hinge movement or by tracing of the Gothic arch and was not affected by the posture of the subject (sitting or lying) or by the position of the examiner (on right or left side of the subject). The precision was largely the same for determination of the position of the mandible in antero-posterior and in medio-lateral direction.

The precision of the recording of the muscular position was much lower than that of the retruded position. This was especially the case regarding the

position of the mandible in antero-posterior direction. The precision of recording of the muscular position was not influenced by the posture of the subject but was lower in antero-posterior than in medio-lateral direction.

The position of the mandible in the retruded position did not vary from one examiner to another, but was influenced in medio-lateral direction somewhat by the position of the examiner relative to the subject (right or left side). The effect in medio-lateral direction was reflected in a shift of the mandible by, on the average, 0.1 mm in direction away from the examiner. The position of the mandible in the retruded position was not appreciably affected by the posture of the subject or by the recording method (by the hinge movement or with the Gothic arch).

The position of the mandible in the muscular position varied in antero-posterior direction with the posture of the subject. The most anterior position was noted when the subject was standing and the most posterior when he was lying (mean difference 0.6 mm). Such a difference was also found between the standing and sitting positions (mean difference 0.4 mm).

The results show that because of its good reproducibility the retruded position is suitable as a reference position in functional analysis of the occlusion while the muscular position cannot be recommended as a reference position.

RÉSUMÉ

VARIATIONS DE LA POSITION DE LA MANDIBULE EN RÉTROPULSION ET EN POSITION MUSCULAIRE DANS DIFFÉRENTES CONDITIONS D'EXAMEN.

Les variations observées lors de l'enregistrement de la position de la mandibule en rétropulsion et en position musculaire ont été étudiées par méthode graphique chez 10 hommes âgés de 21 à 26 ans et ayant une denture naturelle complète.

Cette étude a montré que les erreurs d'enregistrement de la position de la mandibule en rétropulsion sont peu importantes et ne varient pas d'un observateur à l'autre. La précision de l'enregistrement de la position en rétropulsion restait sensiblement la même, que l'enregistrement ait été fait en utilisant le mouvement d'ouverture pure ou par tracé de l'arc gothique; elle n'était modifiée ni par la position du sujet (assis ou couché), ni par la position de l'observateur (à droite ou à gauche du sujet). La précision obtenue était sensiblement la même pour la détermination de la position de la mandibule dans le sens antéro-postérieur et dans le sens transversal.

La précision de l'enregistrement de la position musculaire était beaucoup moins élevée que pour la position en rétropulsion. C'était tout particulière-

ment le cas en ce qui concernait la position de la mandibule dans le sens antéro-postérieur. La précision de l'enregistrement de la position musculaire n'était pas modifiée par la position du sujet, mais elle était moins élevée dans le sens antéro-postérieur que dans le sens transversal.

La position de la mandibule en rétropulsion ne variait pas d'un observateur à l'autre, mais elle dépendait quelque peu, dans le sens transversal, de la position de l'observateur par rapport au sujet (à droite ou à gauche). L'effet dans le sens transversal s'exprimait par un déplacement de la mandibule de 0,1 mm en moyenne, dans la direction opposée à l'observateur. La position de la mandibule en rétropulsion n'était modifiée de façon notable ni par la position du sujet ni par la méthode d'enregistrement (par le mouvement d'ouverture pure, ou par l'arc gothique).

La position de la mandibule en position musculaire variait dans le sens antéro-postérieur avec la position du sujet. La position la plus antérieure s'observait quand le sujet était debout, et la position la plus postérieure quand il était couché (différence moyenne 0,6 mm). Une telle différence était aussi observée entre les positions du sujet debout et assis (différence moyenne 0,4 mm).

Il ressort de cette étude que la position de la mandibule en rétropulsion, en raison de son degré élevé de reproductibilité, constitue une référence adéquate dans les analyses fonctionnelles de l'articulé; tandis que la position musculaire ne peut être recommandée comme référence.

ZUSAMMENFASSUNG

VARIATIONEN DES UNTERKIEFERS IN RETRUDIERTER UND MUSKELLAGE BEI VERSCHIEDENARTIGEN REGISTRIERUNGSVERHÄLTNISSEN

Variationen beim Registrieren des Unterkiefers in retrudierter und muskelbedingter Schlussbisslage sind bei 10 vollbezahnten männlichen Probanden im Alter von 21—26 Jahren untersucht worden. Es wurde eine graphische Registrierungsmetode angewendet.

Die Untersuchung ergab, dass Fehler beim Registrieren der *retrudierten* Unterkieferlage sehr klein sind und bei verschiedenen Behandlern in gleicher Grössenordnung auftreten. Die Präzision bei der Registrierung der retrudierten Lage verblieb in der Hauptsache gleich — ohne Rücksicht darauf, ob das Verfahren mit terminaler Scharnierbewegung oder durch Aufzeichnung des gotischen Bogens durchgeführt worden war. Die Ergebnisse wurden durch die Körperhaltung der Probanden (sitzend oder liegend) oder durch die Position des Behandlers (Stellung rechts oder links vom den Probanden)

nicht beeinflusst. Die Registrierungspräzision bei der Bestimmung dieser Unterkieferlage in antero-posteriorer sowie medio-lateraler Position war die Gleiche.

Die bei der Registrierung der *Muskellage* erzielte Präzision war bedeutend geringer als es bei der Positionsbestimmung der retrudierten Lage der Fall war. Vor allem galt das bei der antero-posterioren Positionsbestimmung des Unterkiefers. Die Präzision der Registrierung der Muskellage wurde weiterhin von der Körperhaltung des Probanden nicht beeinflusst. Sie war antero-posterior geringer als medio-lateral.

Wenn verschiedene Behandler Unterkieferregistrierungen in *retrudierter* Lage durchführten, so wurden im Allgemeinen gleiche Ergebnisse erzielt, die jedoch bei entweder links oder rechts vom Probanden stehenden Behandler ein wenig voneinander abwichen. Es wurde eine Verschiebung des Unterkiefers von 0,1 mm medio-lateral in Richtung vom Behandler weg konstatiert. Die Position des Unterkiefers in retrudierter Lage wurde von Körperhaltung und Registrierungsmethodik (Scharnierbewegung oder gotischer Bogen) nicht wesentlich beeinflusst.

Die Position des Unterkiefers in *muskulär bedingter* Schlussbisslage variierte antero-posterior, der Körperhaltung des Probanden entsprechend. Die am weitesten nach anterior verschobenen Lage wurde bei stehenden Probanden, die am weitesten nach posterior verschobene Lage bei liegenden Versuchspersonen (mittlerer Unterschied 0.6 mm) beobachtet. Die registrierte antero-posteriore Differenz bei stehenden und sitzenden Patienten ergab eine Mitteldifferenz von 0.4 mm.

Die Resultate dieser Studie deuten darauf hin, dass die retrudierte Lage des Unterkiefers auf Grund ihrer guten Reproduzierbarkeit sich zur Referenzlage bei Gebissuntersuchungen eignet, während im Gegensatz dazu die »Muskellage» nicht als Referenzlage empfohlen werden kann.

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