In our investigation, we used a mechanic and an electronic recording system. The mechanical extraoral recordings were done by use of a modified Stuart-pantograph and paraocclusal splints. Tracing of reproducible three-dimensional border-movements of the mandible with and without a central bearing point were possible by the help of supplementary recording plates. In the TMJ-region a frontal-vertical plate and in the anterior part of the mandible a frontal-vertical and a sagittal-vertical plate were used. By the help of the inductive displacement transducers, placed in paraocclusal
splits, it was possible to study the relationship between kinetics of single teeth during mastication and parafunctional activity. Parallel to this electromyographic recordings of both masseter muscles of each proband were done with special surface electrodes (Fig. 1).

RESULTS AND DISCUSSION

Extraoral recordings
On the anterior registration plates, differences were found between recordings with and without central bearing point, concerning the guidance path angle, which means the angle between the right and left lateral border movement (Figs. 2, 3). The lowest values of the guidance path angle were found in canine protected occlusion often associated with Angle-class I and Angle-class II/2. Patients with group function occlusion, as often appearing in Angle-class II/1, showed increasing values of the guidance path angle, while patients with balanced occlusion and TMJ-guidance, for example in cases of angle-class III, exhibited the highest values of the guidance path angle. There are correlations between the type of mandibular guidance and the Angle-classes (Table 1). The posterior registration plates also showed differences between recordings with and without central bearing point. In cases of canine protected occlusion, the posterior angle of ascension is greater than in all other patterns of mandibular guidance, inclusive registrations.
Table 1. Correlation of mandibular guidance and Angle-classes.

<table>
<thead>
<tr>
<th>Angle class</th>
<th>preferred type of guidance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angle class II/2</td>
<td>canine protected occlusion</td>
</tr>
<tr>
<td>Angle class I</td>
<td>canine protected group function</td>
</tr>
<tr>
<td>Angle class II/1</td>
<td>group function occlusion</td>
</tr>
<tr>
<td>Angle class III</td>
<td>balanced occlusion</td>
</tr>
</tbody>
</table>

Figs. 4a, b. Posterior registration plates in vertical-frontal and horizontal direction which show canine protected occlusion with real immediate side shift.

with central bearing point. The differences in the guidance path angle traces with and without tooth contact showed that canine protected occlusion limits the movement capacity of the TMJ. Contrary to this, the full movement capacity is utilized in cases of balanced occlusion.

New aspects were found concerning the question if immediate side shift is a physiological or a pathological condition, because investigations of SITTIQ\textsuperscript{22} showed that only few probands have an initial transverse shift of the mandible in registrations with tooth contact. In opposite to this finding some probands showed a real immediate side shift in registrations with central bearing point (Figs. 4a, 4b). Only two of the thirty probands investigated by SITTIQ\textsuperscript{22} had a real immediate side shift in registrations with and without tooth contact. Therefore, a real immediate side shift only exists if it is provable on the posterior horizontal plates and the posterior vertical-frontal plates. Otherwise it is an unreal immediate side shift. These are the following conclusions of our results: The anterior guidance limits the range of movement of the TMJ, what means that the anterior guidance has a protective function on the TMJ-tissues. The movement capacity of the TMJ is greater than the movement capacity of the anterior guiding elements, namely the canines. The central bearing point registration shows us tracings of the TMJ-guidance pathways.
Table 2. Qualitative gradation for the guidance in natural dentition.

<table>
<thead>
<tr>
<th>Anterior Tooth Guidance</th>
<th>TMJ-Guidance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canine Protected Occlusion</td>
<td>Canine and First Premolar Protected Occlusion</td>
</tr>
<tr>
<td>Canine and First Premolar Protected Occlusion</td>
<td>Occlusion with Multiple Function Only on the Working Side</td>
</tr>
<tr>
<td>Balanced Occlusion</td>
<td>Posterior Tooth Guidance</td>
</tr>
</tbody>
</table>

Fig. 5. Tooth movements during guidance: canine and first premolar or pure canine guidance.

Electronic recordings
These results prove that anterior teeth work as mandibular guiding elements because of their morphology and topography. The study of anterior guidance suggests a qualitative gradation from the pure canine protected occlusion to the most extreme group function and balanced occlusion in natural dentition (Table 2). When the first premolars are dominant in lateral mandibular guidance they show pathophysiologic movements in buccal-distal and distolingual direction (Fig. 5). When a pure canine guidance is found, the first premolars do not show the afore mentioned movements but remain in their basic position and the canines themselves show a physiologic amount of movement. Following local anesthesia of the upper canines, the amount of movement increased up to twice of the amount of movements without anesthesia. This points to the role of proprioceptors in the periodontal tissues of upper canines. Those receptors are apparently the regulatory factor in the cybernetics of mandibular kinesiology and therefore guarantee the TMJ-protection against loading influences during lateral movements of the mandible. The determining factor of anterior guidance is that the anterior teeth have a non-occlusion of about 30 micrometers in centric occlusion, because the anterior teeth will move during clenching in a lingual and distal respectively mesial direction.

Electromyography and tooth-kinetics
The results of simultaneous measurements of tooth kinetics and masticatory muscle activity show, that there are increased movements of the guiding teeth and also an increased muscle activity on the contralateral side in cases of balancing interferences. After
removal of those, anterior guidance works with decreased muscle activity and reduced tooth kinetics. In the stomatognathic system, the teeth have masticatory and receptor functions as confirmed by several authors.\textsuperscript{1,11,14,21}

The consequence of our findings is a qualitative gradation in the natural complete dentition (Table 2) and, moreover, that anterior guidance is the key to a successful occlusal treatment.\textsuperscript{4} By the help of special registration appliances, anterior guidance can be determined and afterwards transferred and simulated on the articulator (Figs. 6, 7).

**SUMMARY**

Twenty patients with complete dental arches were examined by extraoral recordings with and without central bearing point and by help of inductive displacement transducers. Parallel to this, muscle activity was recorded. The conclusions of the study are:

1. The anterior guidance limits the movement capacity of the TMJ and therefore has protective function on the TMJ-tissues.
2. The anterior guidance is of great importance for the maintenance of orthofunction in the stomatognathic system.
3. The individual anterior guidance recordings must be accurately transferred and reproduced on the articulator.
REFERENCES


Prof. Dr. G.K.Siebert
Dep. Stomatognathic Physiology,
Dental School, University Marburg,
Georg-Voigt-Str. 3,
D-3550 Marburg, W. Germany