A New Gnathological Concept

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INTRODUCTION

Again and again appliances are invented to program full adjustable articulators. Most of the measuring instruments are using the terminal hinge axis, as near as possible to the condyles. This seems to be easier to interpret the trajectories of the condyles themselves. But the closer to the centers you measure, the shorter the registered lines will be and the greater the need for complementary elements to get full information. This fact can not be changed by optical or electronical and computerized magnification.

The temptation to simplify the procedures by interpreting the short but amplified recordings may be also as incorrect as the explications and deductions of the same short lines by QYSI with his mirrors. Among the 3-dimensional measuring procedures, there are still only few which are working without geometrical errors. We distinguish the intraoral from the extraoral systems.

Intraoral group
The wax-bite, TMJ and similar stereographic procedures.

Extraoral group
All pantographs constructed identically as STUART's conception with 6 planes of registration and the initial LEE system.

The MASTICATOR®-pantograph
By means of the intraoral procedures, the determination of a real physiological occlusion is difficult. Extraoral measurements taken graphically are all visually controllable during the recording. All recordings near the condylar centers on the hingeaxis need 6 planes for full information. In spite of that, all lines flow together so that we can not obtain clear centric relation points of intersection for occlusion. That's the reason why a supplementary check bite-transfer bow is needed to determine it precisely (Fig. 1).

Further, if something goes wrong on one plane, you have to verify
Fig. 1. Panthographic registration on 6 plates for the STUART System. Quelle: Dupas (1986)

Fig. 2. Panthographic registration on 3 plates for the MASTICATOR® System in scale 1:1.
CR = Centric relation
M = Stylus recording on meditrusion side
L = Stylus recording on laterotrusion side
P = Stylus protrusive recording
LL = Lateral movement to the left
LR = Lateral movement to the right

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Right sagittal plane

Medial horizontal plane

Left sagittal plane

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on all other 5 planes for corrections.

This was the reason to choose another way for the MASTICATOR® System: The registration-planes are placed as far away as possible from the condyles with the result, that any kind of movement has its distinctive line on every registration plane (Fig. 2).

In 1949 we published clearly the principles which have to be respected for correct 3-dimensional evaluation. They are still valid today. At this time we proved the fact that all usual registrations are in general no projections. That is why it is an illusion to use GYSI's not really existing inclined rotation axis.

It resulted clearly that any tracing interpreted on one plane only may lead to wrong conclusions.
Our first research has been realized on patients with natural teeth. The mandible movements were guided by the teeth intercuspa-
tion itself. I used for my first experimentations an axiographic pantograph too, tracing lines separately on 4 planes, similar to those still used by the STUART system. We described an electromagnetic procedure which allowed:
1. To “shoot” simultaneously the corresponding 4 points in any situation of the mandible.
2. As two stylus were orientated in a manner that they stayed always on one line it became possible, to transform by means of the descriptive geometry, the obtained tracings in parallel projections.

By this way, we were able to construct the exact movements of each condyle step by step in the space. But it took about 8 hours to construct for each patient his characteristic trajectories. The result obtained were very unexpected and showed an enormous variety. They confirmed the suppositions and practical observations of Prof. Krogh-Poulsen at that time.\(^9\)

During the following years, we lengthened the hinge-axis stylus approximately 20 cm on each side out of the patients face and combined it with a third stylus whose prolongation crossed exactly the hinge axis in a right angle. This device could be fixed on the mandible or full denture bases and allowed to reduce the 3-dimensional tracings to 3 planes.\(^10\)

We realised with this conception an exact separation of every lateral articulation movement but not from the protrusion path. As the 3 registration planes were fixed on the dental chair the resilience of the maxillary tissue was not included in the tracings. Therefore we obtained only unsatisfactory full denture work.

Later we changed the measuring places from the hinge-axis to 3 points in front of the patients nose and we added the central bearing point as a helpful guide (Figs. 3, 6).

Both bows of the pantograph could be fixed to the denture bases reposing on the gums or supported by the teeth themselves. This procedure enabled us to include the complete resilience during the recording.

The advantages of the new arrangement were enthusiastic:
1. Strong amplification of all principal movement tracings
2. Exact crossing on one centric point on all 3 planes
3. The unreliable plaster or centric wax-bite became unneeded\(^11\)
4. The evaluation of the tracings by the MASTICATOR® I-articulator (which is working precisely on excursions till 5 mm) allowed to finish full dentures in laboratory after remount
Fig. 3. After registration of all movements the pointers are oriented to the hinge axis in the non manipulated distal position. Position from which the patient started all movements.

Fig. 4. Mandibular movement to the left.

Fig. 5. Mandibular movement to the left: The working condyle does not move on the terminal hinge axis but away from it.

without any need for grinding corrections on the articulating teeth in mouth.

In the last 15 years it became necessary that an occlusal analysis should not only be realised for edentulous patients but also before a full mouth rehabilitation to prevent or to try to correct TMJ
disorders. The pantograph device became finer, the recording more and more improved and the possibilities of the articulator enlarged. The pantograph II consists of 2 parts: The registration planes are fixed on a U-bow that it remains in equilibrium on the mandible without need of any supplementary fixation.\(^\text{12}\)

The maxillar bow contends 2 horizontal and a vertical stylus. The horizontal writers are guided in a tube by a central spring which is moving with them and neutralized between the vertical planes when working. The vertical stylus writes by his proper weight. The choice of the registration placed as far away as possible from the condyle centers allows this pantograph to record directly longer lines than all other pantographs (Fig. 2).

The inversion of the measuring principle, the stylus fixed on the maxilla and the registration planes on the mandible, allows us to read the traced paths seen in front of the patient or the articulator in the right way, (i.e. a left movement of the mandible is seen on the left side of the central recording plane (Figs. 4, 5)).

The argument that the hight of the central bearing point might disturb the mandibular movements were contradicted research of BURKI\(^\text{13}\).

The lines cross on every plane in one point thus forming the centric relation points. They are realised by placing the 2 sagittal planes so distant that there result a clear separation of all border movements at the same time in addition with a good magnification. We obtain by this procedure 3 distinctive lines on any of the 3 planes: 3 different lines for the protrusion, 3 others for the left lateral movement of the mandible right lateral and the 3 others to the right lateral movement.

We can record on all planes a fourth line for the opening hinge-axis movement. All the four lines on any of the 3 planes finish with a wide angle in the C.R. point (Figs. 2, 6).

It is very important to know that we wish to receive with this system the 3-dimensional measuring of the free condyle trajectories. These are conducted by the neuro-muscular impulses of the patient himself including the disc guidance without any intercuspidal obstacle. Therefore we don’t touch or guide the patient’s mandible in any manner but let him make the movements he is able to do himself. By this technic, we obtain neither mean values nor artificial geometrical orbits. We get the physiological guided movement of the mandible in relation to the maxilla in the 3 dimensions.

This principle allows us to include in the recording the influence of the resilience of the gums for full denture prosthetics. Special
Fig. 6. Mandibular movement to the right.

Fig. 7. The mandibular border movements are fully reproducible on the MASTICATOR® II.

Fig. 8. Mandibular movement to the right. The position of the balancing condyle is downward and inward. The MASTICATOR® is a non arcon articulator. The centers of the spheres correspond to the center of the TMJ. The projected coordinates are measured on the surveyor table (Fig. 18).

Fig. 9. Comparing the tracings written near the hinge axis position and in front-lateral position. There we find distinctive paths for each movement (O, M, P, L1). Near the hinge axis position the paths are more or less confluent. For a TMJ diagnosis with a clicking/popping disk the posterior tracing however is helpful und easier to interpret.

Trays permit to set them directly on the teeth with plaster ready for registration. These trays are retentive and so formed that plaster breaks just on the equator-line upon removal (Paraocclusal trays exist also).
Fig. 10. The models centered and/or corrected in position by the adjustable mounting plate (compensation for plaster expansion).

It is not only possible to control if the models had been correctly elaborated but we can also replace the pantograph several times in mouth and/or on the articulator to confirm the registrations (Fig. 7).

For that we protect the registred lines by a transparent foil. Further this repantography procedure can be used as a simple examination to test any articulator or condylar-box if they are right or wrong in view of their utility, as well as to answer if an electronic system is reliable or demonstrate, if and where it failes (Fig. 8).\textsuperscript{14,15} (The modification of a classic STUART pantograph closer to the hinge-axis will mask existing errors!

For a differential diagnosis of a clicking joint the 3 plane pantograph was combined with 2 accessory pneumatic stylus in the prolongation of the terminal hinge axis for patients with TMJ disorders. We can determine if there is a difference between protrusion and retrusion forming a hystersis line (Fig. 9).

The quantitative and qualitative interpretation can then exactly be supervised on the amplified and separated 3 lines on all 3 anterior planes: Any type of clicking or popping\textsuperscript{16} will appear there distinctly 3 times and can be situated in the space by simultaneous pointing out of any desired position.

A adjustable mounting plate allows, to correct mistakes of the setting expansion during the mounting of the models without new plastering. It is also possible with that appliance to correct not only a vertical pathological condyle position, but also any deviation in space, this under controle of the pantograph (Fig. 10).
The simple MASTICATOR® pantograph II enables to realise in one consultation:

1. An error free 3-dimensional recording which can be observed step by step and controled again on the articulator.

2. To determine the hinge axis, the centric relation and the centric occlusion in the same manner by visual monitoring as to control the spatial relationship of the mandible to the maxilla of the mounted models.

3. To avoid the hardly controllable and often unprecise centric wax bites.

4. To analyse if TMJ disorders are caused by misalignments of the jaws or combined with temporomandibular joint troubles. It can also be used to study other 3-dimensional problems:

A. Procedure to test articulators
1. Choose the desired occlusion on the pantograph and adjust exactly the recording stylus of the upper part on the recorded three points of the lower part of the pantograph. In this position fix the upper tray with the stylus to the lower tray with its part of the pantograph by means of a small portion of plaster between the metal borders of both trays on the right and the left side, but not in front.

2. Fix the models on the trays and set them in this position on the articulator on the hinge-axis with the axis pointers belonging to the mandible (Fig. 11). By this manner both models are oriented automatically on the same axis without any centric waxbite transfers.

3. Separate the trays with a turning instrument in the middle (i.e. screwdriver or waxknife). Take the plaster blocks between the trays away and program the articulator.

4. Control all movements if anyone of the three stylus is following simultaneously its recorded line. If not, the articulator is only useful for centric control (Fig. 12).

5. Take the trays together with the pantograph away.

6. In max intercuspation-occlusion can be seen directly if the condyles are displaced to distract or compress the TMJ (Fig. 13).

B. Procedure to analyse TMJ-Positions

1. Set only the lower model by means of the lower part of the pantograph on the hinge-axis in relation to the occlusal plane. (Fig. 14).

2. Remove the pantograph.

3. Mount the upper model in the habitual intercuspation together with the adjustable mounting plate.

4. After the models mounting replace the complete pantograph on the models. Observe all stylus positions for this habitual
Fig. 15. The deviation in habitual occlusion can be checked on any of the 3 front planes. With the adjustable mounting plate centric relation, position from which the border movements were obtained, can be set. The 2 different occlusion positions can be compared without resetting the models.

Fig. 16. After placing the models in habitual intercuspidation the pantograph is placed for diagnosis. Deviations can be seen on all planes. If the working condyle is situated behind under the terminal hinge axis a joint distraction is present.

Intercuspidation to understand where the deviation is situated in space (Pro-, Latero-, Mediotrusion, generally combined), on every of the 3 recorded lines or inside of the border movements. We can mark the habitual occlusion points with a coloured foil on the 3 planes (Fig. 15).

Combine the pantograph with the hinge axis recording device. Take the hinge axis-pointers out of the lower part before replacing the upper pantograph with the recorded sagittal tracings on the flags. The ejected stylus indicates now exactly on the flags where the hinge axis is deviated. If you mark also these points you can measure and calculate how much and where it is different from the non manipulated registered centric relation (Fig. 16).

To calculate the condyle positions take in consideration:

a) the deviation of the points on each side
b) the distance between the two points and its displacement on the hinge axis itself with its new angle
c) the distance of the artificial condyles of the articulator

5. Adjust the upper model with the 3 stylus on their recorded non manipulated centric relation points by means of the adjustable mounting plate and program the articulator according to A3, 4.

C. Comparison of the different kinds of occlusion

The MASTICATOR® II-articulator is a full adjustable instrument specially constructed with a double hinge-axis to com-
Fig. 17. The MASTICATOR® opened with two hinge axis: one fixed in centric occlusion the other in the non manipulated centric relation.

Fig. 18. The surveyor table with the measuring instrument. The back of the registration paper is oriented parallel to the terminal hinge axis level. The figures indicate the distance of the incisal line (44) from this level, the point the labial middle of the root beginning (35). The difference (44-35=9) fix the visible tooth length. This device allows to evaluate the spatial orientation of any tooth and condyle center position.

...plete the possibilities of the adjustable mounting plate. The trajectories of the condyle centers can now be programmed even for curved lines and that completely over 12.8 mm. Multiple different occlusions recorded with the same pantograph can be compared.

To solve this problem start with the non-manipulated centric relation program on the articulator like written in chapter B 5, Fig. 15, 2nd paragraph. The most other occlusions (except the manipulated most retruded position) are situated inside of the border movements the condyle centers a little anteriorly and inferiorly to the initial recorded centric relation. Every situation can be detected and marked by 3 simultaneous points during the recording or like B 4. What will be the most physiologic intercuspal position? I think to answer to this question it would be helpful to combine the pantograph with a myographic recording to control the reactions of the neuro-muscular system in the chosen occlusion17,18. If it is situated on the protrusive recordings, the situation can be fixed by adjustable screws (Fig. 17).
With Bennett-angles more than 5°, it will then result an immediate sideshift for the Bennett movement. Liberated again for the border-movements we can also reproduce the retrusive part of the protrusion. By this procedure it is possible to compare the chosen occlusion with the chosen centric relation in the same articulator without new plaster setting, but under control of the pantograph and the surveyable (Fig. 18).

Before grinding or reconstructing teeth, it is recommended to study the consequences for each tooth on the models. By means of the repeatable controls — whenever you wish — this system avoids errors in the finished dental work.

REFERENCES


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