The Transfer of The Information Received by Static Mandibular-Position-Analysis into The Latero-Lateral Cephalometric Tracing

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INTRODUCTION

During the past number of years we have regarded a continuous increase of so-called "dysfunction" of the stomatognathic system. Thus the stomatognathic system has become more and more the object of intensive analytic, diagnostic and therapeutic care. One possible succession of a complex function analysis is shown in Fig. 1.

The entity of the reported single analyses represents the basis of the considerations, while combination and exchange of single results during the analytic flow intensify the diagnostic image, which thus becomes a real "Function-analytic-complex-diagnosis".

Described in this article is one of several methods combining the following analytic steps (Fig. 1):

A. The static position analysis
B. The transfer of the static position analysis to cephalometrics (Fig. 2).

The term "Cephalometric Radiography" was introduced as a new X-ray method by Holly Broadbent in 1931.

In 1938 Konrad Thielemann described a measuring instrument, which he called "Kinometer" instrument, by which it was "possible to measure the condyle movement caused by tooth guidance" (Fig. 3).

The basic considerations of the two different analytic systems have been developed to their actual maturity by different authors: Gausch, Guichet, Mack, Posselt, Slavicek, concerning mandibular-position-analysis and Bjoerk, Bolton, Downs, Jarabak, Ricketts, Sassouni, Subtelny, Slavicek, Tweed concerning cephalometrics (the alphabetic list of the authors does not pretend to be complete).
Upper Model with Split-Cast + Lower Arch in 5 Sections
Cinematic Axix Location + Interocelusal Relation Record
Model Transfer + Split-Controle
Arch- and Teeth-Analysis
Mandibular · Position · Analysis
Diagnostic-Explorative and Programming Axiography
Latero · Lateral Transcranial X-ray
Bilateral TMJ X-ray
Diagnostic Selective Grinding + Wax-up
Diagnostic Orthodontic- / Surgery-Set-up
Complexdiagnosis
Pre- / Transitory- / Final-Treatmentplanning
Detailed Forsight of Revaluationsteps

Fig. 1 Listing of an extensive type of instrumental functional analysis.

Fig. 2. Thielemann's Kinometer.

Fig. 3. Cephalometric Radiograph.
Based on hinge axis referring mounted casts, we can say that the rotation-axis of the instrument (i.e. of the articulator) is corresponding to the patient's rotating TMJ-axis, and that the three dimensional relation of the gypsum models to the space of the articulator is equal to the position of the arches to axis-orbital plane. Due to construction of articulators currently in use, which foresee a tripoguided rotation of both condylar-elements (Fig. 4), maximum intercuspsation is obtainable only in case of coincidence of maximum intercuspsation and terminal rotation, or if deflective tooth contacts cause a forward-downward axisdisplacement. Such a limitation does not exist in the MPI-instrument (Fig. 5) developed by Mack. One reason why this instrument in combination with the articulator becomes a precise and useful measuring device, is that the three-dimensional static axisdisplacement gets comprehensible in quality and quantity, information which is useful in the pretreatment of dysfunctional systems.

The latero-lateral long distance X-ray is the basis of several different analyses which, used frequently in orthodontics, today influences more and more gnathological considerations. One of these cephalometric analyses is apt to point out the individual vertical dimension based on the type of cranium.

In case we want to make a VTO (visualized treatment objective) based on this information, we need exact determination of the rotation center. Therefore the combination of the two measuring systems (MPI/Ceph.) is suggested.
EXPLANATION OF BOTH MEASURING SYSTEMS AND THEIR COMBINATION

a) Analysis of the static mandibular position
In Gnathology it is used to transfer casts to an articulator. If this mounting shall come up to geometry, it is mandatory to use a facebow and interocclusal relation-record. On this premise the three-dimensional relationship of the patient’s arches and of the mounted casts to the axisorbital plane is the same for both. Since upper part of the SAM-articulator and MPI are equal (Fig. 6), a direct mode transfer from one instrument to the other is possible. If mounting of models is done by the above mentioned criterion, the rotation axis of the instrument and the patient’s one can be considered geometrically the same.

If we put the lower model, which still remains in the lower part of the articulator into maximum intercuspation with the upper model (Fig. 7) which we transferred to the MPI, we can determine if centric interferences are present — an often three-dimensional discrepancies between the articulatoraxis and the MPI (displaced) axis, which is measurable in quality and quantity and will be expressed as: delta x++, delta z++, delta y++ (Fig. 8).

On these values is based the diagnosis of “compression” and “distraction” separately for each of the two joints. X, Z, Y denote the axis, +, – the direction of deviation (Fig. 9).

b) The cephalometric analysis of vertical dimension
The cephalometric X-ray done by a craniostat in maximum intercuspation allows the identification of several antropological landmarks. Beyond this, points can be settled geometrically. The lines between these points include angles, the measurement of which allows diagnosis of cranial type. In cephalometric analysis, three different types are distinguishable: mesiofacial type, brachifacial type and dolicho-facial type. The diagnosis of the individual type of cranium will be based on the measurement of the following
Fig. 8. Possible condylar displacements due to tooth interference.

Fig. 9. The X, Y, Z axis in relation to the mandible.

Fig. 10. Cephalometric measurement of the FA, FW, MEW, CW angle.

Four angles (Fig. 10):
FA / FW / MEW / CW.

Each skeletal type corresponds to an individual vertical dimension, which we express still in degrees measured in the lower third of the cranium. This measurement may disclose a discrepancy between the existing vertical dimension and what should exist according to individual norm. Now it is possible by VTO, based on individual vertical dimension and using the non deviated axisposition, to figure out the dental-, intermaxillary- and skeletal effect caused by the desired position of the mandible.
c) The combination of MPI and Cephalometrics
Usually the cephalometric X-ray is made before starting treatment and is in maximum intercuspation. It is possible to register the rotating axis and to visualize the bilateral correlated skinpoints radio-graphically before hand; yet doing so makes sense in RP cases only. If DRP (deranged reference position) exists however, we can expect a considerable axisdisplacement when the condyles gain centric relation at the end of pretreatment. Dynamic axismeasurement by Axiography will provide for the required information. Since the axisorbital-plane is reference parameter in MPI-analysis as well as in cephalometrics, both measuring systems are compatible. If we want to transfer the rotating center into cephalometrics, we can make use of the values we acquired by MPI-analysis. Thus we get the point, in which the mandible may rotated until it reaches the angle of the individual vertical dimension.
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*d) The Use of the MPI*

The upper and the lower models are mounted, at the end of the pretreatment, on the articulator using facebow and interocclusal registration. The upper model is transferred to the MPI. Both models are placed into maximum intercuspation.

The measuring cubes, with interposed black tape, touching the condylar elements, will mark the displaced axioposition onto stuck-on labels (Fig. 11). The medially pushed cubes perforating the labels, release the instrument's mounting axis which corresponds to the rotating axis of the patient.

We express the displacement in \( \delta x^{+}\), \( \delta z^{-}\), and \( \delta y^{+}\). The information which is important for cephalometrics is delivered however, by \( x^{-}\) and \( z^{-}\) axis only. Based on the fact that all points of an X-ray tracing are related to medial + sagittal plane, it becomes evident that even the bilateral MPI-diagnosis must be correlated to this plane (Fig. 12). Therefore we add right to left \( \delta z \) and right to left \( \delta x \) and divide this number by two.

The result is the to-dimensional axisdisplacement of the instrument, related medial-sagittal plane called "\( \delta x / z \) average" (Fig. 13). Now we invert (+) and (-) in order to reach centric relation, leaving maximum intercuspation which is existing in the X-ray. We recall the fact that axisdisplacement in the MPI measuring system is related to the instrument's (and patient's) rotating axis, while in cephalometrics done in maximum intercuspation, we deal with the just-displaced axis. In other words: in the MPI we are searching for the displaced axispoints, in cephalometrics we search for the non displaced one. Beyond this, we must consider the cephalometric's blow-up effect which is about 8 to 10% if the film is located in 152.5 cm distance to the X-ray emitting source. This is the reason, why 10% must be added to delta average values.

Here are the mathematic steps according to Fig. 14:

1. \( \delta x \) right = +1.5 / \( \delta x \) left = +1.7
   \( \delta z \) right = -1.3 / \( \delta z \) left = -1.8
2. \( \delta x \) average = +1.6 / \( \delta z \) average = -1.5
3. Change of (+) and (-) / addition of 10%:
   \( \delta x \) average = -1.7 / \( \delta z \) average = +1.6

The informations elaborated in that manner now ready to be used in cephalometrics.

**e) The use of Cephalometrics**

The X-ray done by usual principles will be traced as follows (Fig. 15, 16, 17):

1. Points
   1.1 Nasion
   1.3 a.n. Spine
   1.5 corpus/ramus mand.
   1.2 Orbitale
   1.4 + - incision and apex
   1.6 Basion
Fig. 15. Cephalometric radiograph in latero-lateral projection.

Fig. 16. Isolated tracing of cephalometric radiograph shown in Fig. 15.

Fig. 17. Measurement of the FA, FW, MEW, CW angles on the cephalometric radiograph.

Fig. 18. Measurement of the different angles on the tracing of the cephalometric radiograph.

Fig. 19. Addition of the ideal angles to the made measurement on the tracing starting from the axisorbital plane.

Fig. 20. Axisorbital Plane plus Z-Axis and the centric relation point.
The determination of the type of cranial of the patient makes it possible to elaborate the ideal individual vertical dimension: the relation of skeletal dimension may be considered as "normal" only if all components show corresponding proportions. The relation between the cranial type and the vertical dimension does not differ from this principle. Slavicek introduced a helpful method in order to work out what should be the degrees of the vertical dimension, due to individual norm: by confronting the deviations of the above mentioned four angles to mesio facial type, we can elaborate the difference of what exists and what should be (Fig. 18).

In order to figure out the effects of this ideal vertical dimension, we introduce now the axisorbital plane into the tracing (Fig. 19). This axisorbital plane represents the x-axis. In the (deviated) rotation center we now erect the z-axis (Fig. 20). By these two in
CR-point intersecting lines, together with the delta x / z average information, the CR'-point — which represents the center of the non displaced rotating axis — can easily be found and marked on the tracing.

A separate tracing of the mandible which includes CR-point and corpusaxis, is now made. We will introduce further the ideal vertical dimension as a line starting from the Xi-point (Fig. 21).

We superimpose the second tracing upon the first one in such a way that CR-point (tracing 2) touches CR'-point (tracing 1) (Fig. 22). Thus the information received by MPI-analysis is transferred into
cephalometrics which means that we rely upon the exact center for all VTO rotations (Fig. 23, 24, 25).

It should be noted that a transfer from CR to CR' makes sense only if delta average values are at least 1.0 to 1.5 mm. Otherwise there is no geometrical need to do so.

Conversely the MPI information can even be used to figure out and introduce to the cephalometric tracing the displacement of “in centric relation rotating axis” which was marked on the patient’s skin before the X-ray was done. These axispoints are NOT identical to the displaced axispoints of the mandible when the X-ray is made in maximum intercuspation.

**SUMMARY**

A technic showing the combined use of articulator oriented studymodels with a cephalometric radiographic analysis, allows the precise determination not only of the ideal vertical dimension but also of the ideal jaw positions.

**REFERENCES**


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