The Department of Prosthetic Dentistry, Skubiszewski Medical University of Lublin

MAGDALENA BAKALCZUK, ANDRZEJ BOŻYK, MICHAŁ IWANEK,
JANUSZ BOROWICZ, JANUSZ SYKUT, JANUSZ KLEINROK

Diagnostic abilities of three-dimensional electronic axiography on the basis of ARCUSdigma device

ARCUSdigma is an electronic facebow enabling graphic presentation and chart analysis of patient's lower jaw movement on monitor display and printouts of special printer. It consists of arc supplied in nasal bracket, ultrasound sensors – Fig. 1, computer with touch control screen, foot pedal and printer – Fig. 2. To make recording we use host software, which explains the order of actions in a very legible way. The most time-consuming and controversial action is sensor fixing by usage of composite materials on the labial surface of front lower jaw teeth.

Fig. 1. Electronic facebow   Fig. 2. Computer with touch control screen

ARCUSdigma can be used for two main applications: setting articulators type Protar according to individual movement of patient's lower jaw; diagnostics of temporo-mandibular joints, analysis and evaluation of pathologic function (6, 8, 11). This device gives the opportunity of evaluation of individual kinematic axes of lower jaw in opening and protrusion.

Perception ability of feeling occlusion disorders by the patient is very big, patients with teeth can feel disorders from 0.02 mm (12). Approximation in evaluation of kinematic axis which is about 5 mm gives occlusion mistakes range from 0.2 to 0.4 mm on molars, that's why this system has very big diagnostic value (2, 3). Also the graph of kinematic axis allows to comparatively evaluate opening and protrusion.

After fixing location of jaws accord with relation to skull and kinematic axis we can begin recording of individual lower jaw movements. ARCUSdigma gives the opportunity of visual evaluation and

analysis of opening, closing, laterotrusion and protrusion in peroneal, horizontal and frontal planes. Recording can be made either for dental leading and free lower jaw movements. Diagnostic value of these measurements allows us to evaluate possibilities of making a given movement, existing occlusional obstacles. We can check if the patient is capable of making maximal movements and compare analogous movements in two joints in three dimensions – Fig. 3. This device makes possible also an electronic analysis of lower jaw location in static occlusion (EPA test), thanks to which we get essential hints about stability of occlusion or pathologic 3-D dislocation of temporo-mandibular joints, caused by maximal intercuspidation – Fig. 4 (1). After making the recording of lower jaw movements, computer calculates parameters of angles and movements, which are necessary to adjust the articulator – Fig. 5. On the basis of protrusional movement we can get inclination angle of joint's way to the Camper's plane. Right and left mediotrusion movement allows to evaluate movement individual parameters of balancing side (Bennet's angle), immediate side shift (ISS) and deviation from free Bennet's movement in front-back dimension on the working side, angle values Shift Angle from – 20 to 20 (7).
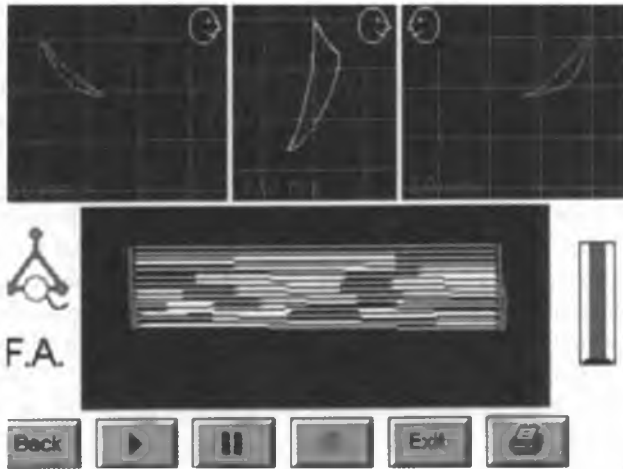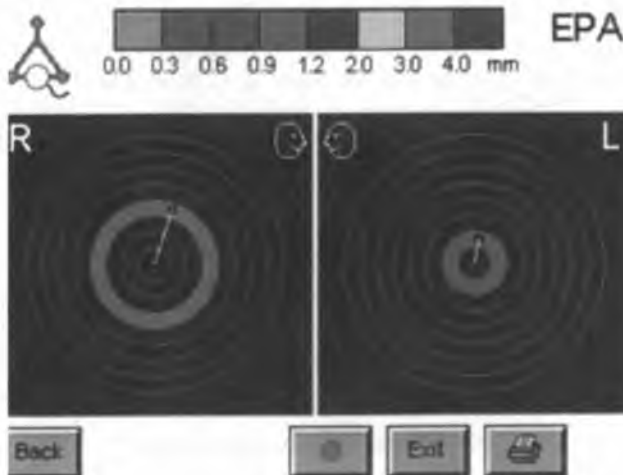

Fig. 3. 3-D opening

Fig. 4. Electronic position analysis, EPA test

PROTAR Articulator Settings

Bite Fork Position 2

Right Joint		Left Joint	
HCN/HCI	44.7 (CE)	HCN/HCI	49.1 (CE)
Bennett	12.2	Bennett	08.9
Iss	00.0	Iss	00.0
Shift Angle	00.0	Shift Angle	00.0

Anterior Guidance	
Right	60.0
Middle	63.6
Left	57.0

Exit   Reset   🖨

Fig. 5. Parameters to adjust the articulator

These values affect the height of cuspids, future prosthetics works (9). Main information which is needed for making the reconstruction of anterior teeth is angle of incisors inclination and graph of anterior guidance. ARCUSdigma gives us information about all these parameters in numerical data (Anterior Guidance) based on which we can set Protar articulator – Fig. 6. Recording and analysis of graphs of movements we can make before, during and after treatment. Thanks to this we can evaluate if our treatment is successful or not. 3D electronic axiography is very helpful in diagnostics of TMJ discus disorders and its reposition (1, 6). An analysis of axiography graphs of movements on computer's screen enables accurate indicating of the point of dislocation and designing splint, the use of which can eliminate this symptom (10). The repeated analysis after early treatment will be helpful in the evaluation of its efficacy and in designing prosthetic restoration. Unfortunately changes of TMJ movements not in all cases can be diagnosed by ARCUSdigma, so that graphs of movement can be connected with clinical symptoms (5).
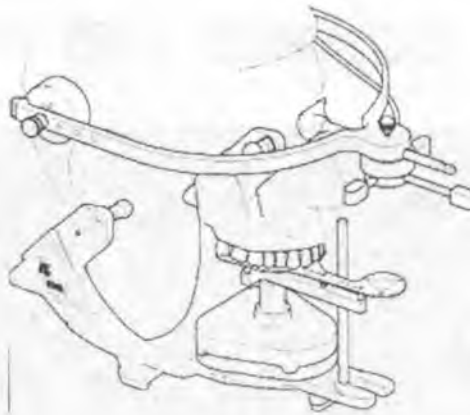

Fig. 6. Protar articulator and facebow

ARCUSdigma can be very useful as the diagnostic technique which can support screening techniques (4), but still most important for the doctor will be physical examination and subjective patient's feeling.

REFERENCES

1. B e r n h a r d t O. et al.: Craniomandibular disorders – comparative investigations with clinical examination and electronic axiography. Anat. Anz., Jan. 181 (1), 51, 1999.
2. G o r d o n S. et al.: Location of terminal hing axis and its effect on the second molar cusp position. J. Prosth. Dent., 52, 99, 1984.
3. H o f m a n n M. et al.: Geometrisch-mathematische Analise von Ubertragungsfehlern in den Articulator und deren praktische Auswirkungen. Teil II. Dtsch Zahnarztl Z., 33, 529, 1978.
4. L o c h m i l l e r W. et al.: Zur Wertigkeit der elektronischen Axiographie in der klinischen Funktionsdiagnostik. Fortschr-Kieferorthoph., Oct. 52 (5), 268, 1991.
5. L o t z m a n n K. U.: Paraokklusale Axiographie mit den SAS-System nach Meyer/Dal Ri im Rahmen einer funktionanalytischen Studie. Med. Diss, Gottingen 1987.
6. L u c e r a t h W.: Vergleich der mechanischen und der dreidimensionalen elektronischen Axiographie. Dtsch Zahnarztl Z., Nov. 98, 976, 1989.
7. O l t h o f f L. W. et al.: Computer modeling of occlusal surfaces of posterior teeth with the Cicero CAD/CAM system. J. Prosth. Dent., Aug. 84(2), 154, 2000.
8. R a m m e l s b e r g P.: Zur Diffferentialdiagnose reziproker Knackphanomene mit Hilfe der elektronischen Axiographie (SAS) Dtsch. Zahnarztl Z., July 45 (7 Spec No), S 61, 1990.
9. S a m e t N. et al.: A clinical and cost benefit evaluation of five facebows. Quintessence Int., Jul.-Aug. 33(7), 511, 2002.
10. S h o d a d a i S. P. et al.: Is there a benefit of using an arbitrary facebow for the fabrication of stabilization appliance? J. Prosth., Nov.-Dec. 14(6), 517, 2001.
11. S l a w i c e k G.: Einsatz der elektronichen Axiographie in Diagnostik und Terapie. Biomed Tech. Berl., 35 Suppl. 2, 219, 1990.
12. U t z K. H.: Untersuchugen uber die interoklusale taktile Feinsensibilitat naturlicher Zahne mit Hilfe von Aluminium-Oxid-Teilchen. Dtsch Zahnarztl. Z., 41, 313, 1989.

SUMMARY

The ARCUSdigma is an electronic facebow enabling presentation and graphic analysis of mandibular movements on the computer screen. A kinematic hinge axis of the mandible can be determined using this device. The paper presents the diagnostic potential of the ARCUSdigma in relation to programming an articulator according to individual parameters of mandibular movements of the patient and its application in the diagnosis of temporo-mandibular joints.

Możliwości diagnostyczne trójwymiarowej aksjografii elektronicznej
na podstawie urządzenia ARCUSdigma

ARCUSdigma jest elektronicznym urządzeniem dającym możliwość graficznego przedstawienia i analizy ruchów żuchwy pacjenta na ekranie monitora. Urządzenie pozwala na wyznaczenie kinematycznej osi zawiasowej. Artykuł prezentuje możliwości diagnostyczne urządzenia ARCUSdigma w nastawianiu artykulatora według indywidualnych parametrów ruchomości żuchwy pacjenta i ich wykorzystanie w diagnostyce stawu skroniowo-żuchwowego.