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Computerized Ultrasonographic Craniocorpography and Abnormal Psychomotor Activity in Psychiatric Patients

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Abstract: A new version of craniocorpography (CCG), called *computerized ultrasonographic CCG* (Comp-USCCG), has been clinically applied for objective recording, documentation, and quantitative evaluation of abnormal psychomotor activity in psychiatric patients. Implications of this completely new approach to psychopathology are discussed. An original representation of Comp-USCCG data (introducing the time dimension as a new CCG parameter) is used to illustrate better the atypical abnormal stepping Comp-USCCG movement patterns in psychotic patients, some of which have not been described in neurootological patients to date. These atypical abnormal stepping Comp-USCCG movement patterns are prolonged longitudinal or shortened or backward longitudinal displacement; dysrhythmic longitudinal or lateral sway; and longitudinal or lateral directional changes. Reflecting the abnormal psychomotor activity, Comp-USCCG also provides for possible indirect evaluation of the underlying subjective psychotic experience. The contribution of the approach could be defined as an application of a known neurootological method into a new field of medicine (psychiatry) with a new purpose (to record and measure abnormal psychomotor activity). Our conclusion is that Comp-USCCG could become the first objective and quantitative method available for use in the field of clinical psychiatry.

Key Words: computerized ultrasonographic craniocorpography; craniocorpography stepping test; movement patterns; psychomotor activity

Craniocorpography (CCG) was developed by Claussen in 1968 as a functional imaging method for objectively recording, representing, and measuring the human equilibrium function [1–3]. The original photooptical procedure basically consists of charting patients' head and body axes as they perform the classic Unterberger stepping and Romberg standing tests. The method is relatively simple to perform and is reliable, reproducible, noninvasive, and time-saving, and it immediately provides a hard document (a Polaroid picture called a *craniocorpogram*).

Before 1993, CCG had not been applied in clinical psychiatric practice, although many psychiatric patients complained of vertigo and dizziness sensations [4]. In 1993, our international interdisciplinary team began an intensive research activity on the borderline between neurootology and psychiatry, including clinical application of photooptical CCG in psychiatric patients [5–13].

During the first investigations in psychotic patients, it was revealed that the majority of these patients produced abnormal stepping CCG pictures [9,11,12]. This was true whether or not vertigo symptoms were present.

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Some *atypical* abnormal stepping CCG movement patterns were found to coexist with the usual abnormal stepping CCG movement patterns classically described by Claussen in neurootological patients (broad lateral sway as an indicator of central dysfunction, or large angular deviation or large body axis spin [or both] as indicators of peripheral lesion) [5].

By comparing the CCG pictures of each individual psychiatric patient with clinical observations during the test performance, we realized that the atypical abnormal stepping CCG movement patterns are prolonged longitudinal displacement (irritated gait); shortened or backward longitudinal displacement (inhibited gait); dysrhythmic longitudinal sway (longitudinal dysregularity); dysrhythmic lateral sway (lateral dysregularity); longitudinal directional changes (transient propulsions or retropulsions or both); and lateral directional changes (transient lateropulsions). However, achieving a precise measurement of these atypical abnormal stepping CCG movement patterns was very difficult (and sometimes impossible) on the photooptical craniocorpogram.

COMPUTERIZED ULTRASONOGRAPHIC CRANIOCORPOGRAPHY

For a few years, we have been using the new version of CCG called *computerized ultrasonographic CCG* (Comp-USCCG). This new version allows the very precise measurement of all abnormal CCG movement patterns. Among others, its great advantage consists in a computer data bank that simultaneously may detect and reconstruct the single traces of both the shoulder markers and the head markers and may interrelate the movements among the head and shoulder recordings [5,14].

For Comp-USCCG, we are using the evaluation of run-time differences of ultrasonographic impulses among the senders in the regular CCG marker positions on head and shoulders and several receivers, all connected to the processing computer. Thus, a very precise temporal and spatial localization of the ultrasonographic senders is possible by digital computer calculations and numerical and graphic synoptic evaluations. This technical precision allows measurement of the acoustic impulse run-time on a scale of a very small fraction of a second (50 msec), and a relative determination of the location of the source can be achieved at a sensitivity of 0.1 mm.

For clinical proposes, we mainly apply this method together with the well-established polar reference net of CCG [5,14]. The head and shoulder movements then appear as the radar images of four moving objects, progressing in an interrelated direction, in one or several polar planes. For the standard standing and stepping tests, the protocol of the investigation and test results are printed on a color printer, graphically separating all four traces of markers. The computer program automatically measures the standard CCG parameters according to Claussen [5]. For the stepping test, these parameters are longitudinal displacement, lateral sway, angular deviation, and body axis spin. Additionally, Comp-USCCG automatically measures and displays the number

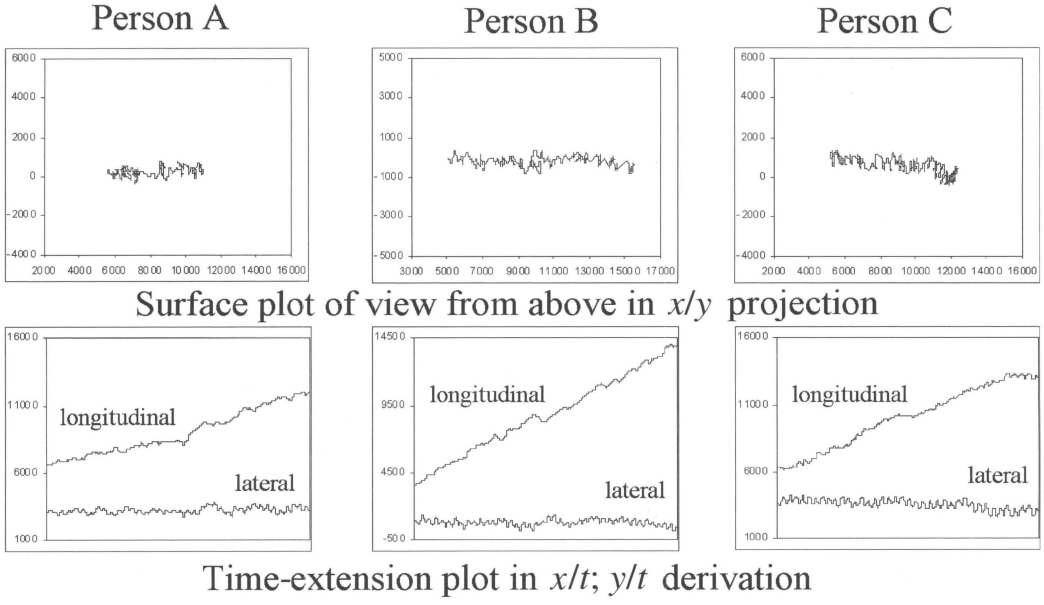

Figure 1. Characteristic computerized ultrasonographic craniocorpography movement patterns of healthy persons.

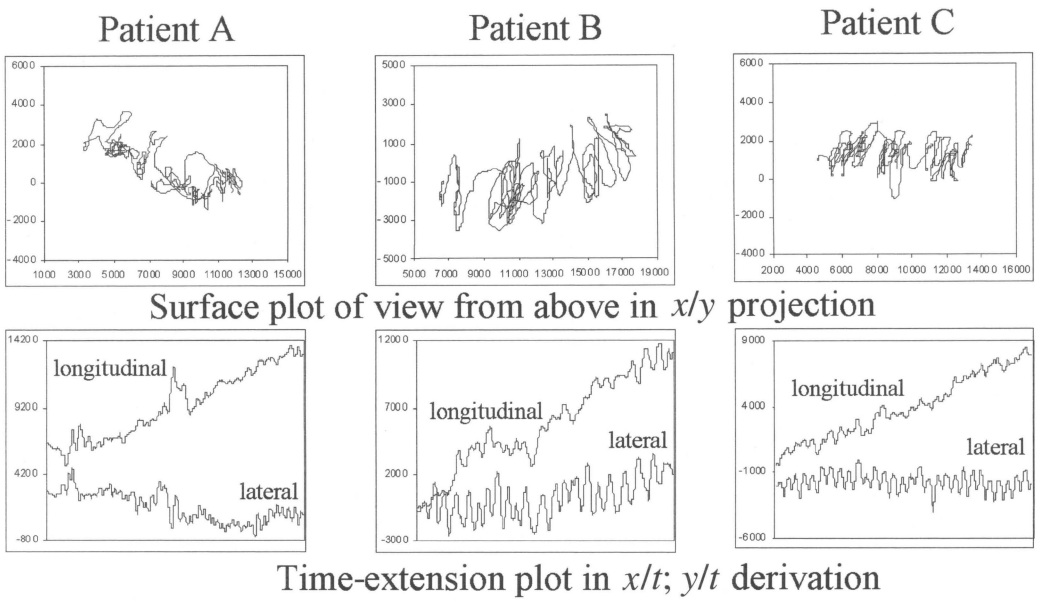

Figure 2. Characteristic computerized ultrasonographic craniocorpography movement patterns of psychotic persons.

of steps and the movements of the head as compared with the shoulder movements, assessed by the head torsion and head nod angles. Together with the numerical data, the graphic CCG movement patterns are important for discriminating between normal and abnormal CCG pictures. By assessing the CCG picture as a whole (i.e., by gestalt comparison), the difference between healthy subjects and psychotic patients usually is seen as qualitative—that is, the subjects' and patients' movement patterns could be differentiated at first glance on the craniocorpogram.

Recently, we began using rectangular coordinates for fitting together spatial-to-spatial observations (as on the standard craniocorpogram) and spatial-to-time observations (introducing the time dimension as a new CCG parameter). Such an approach allows us to measure not only the typical but also the atypical abnormal stepping Comp-USCCG movement patterns. Characteristic Comp-USCCG movement patterns of healthy persons (Fig. 1) can be compared with characteristic Comp-USCCG movement patterns of psychotic patients (Fig. 2).

To permit better understanding of the figures, we have selected only one (the frontal) marker. The top charts show the usual horizontal projections (i.e., *x/y* derivation in surface plots), and the bottom charts show the longitudinal and lateral deviations as a function of time (i.e., *x/t* and *y/t derivations* in time-extension plots). We must explain that the longitudinal deviations (of the *x*-curve) are seen as deviations upward in cases of marker deviation forward and as deviations downward in cases of marker deviation backward. The lateral deviations (of the *y*-curve) are seen as deviations upward in cases of marker deviation to the left and as deviations downward in cases of marker deviation to the right. By means of these charts, we can easily measure different parameters (including the atypical patterns mentioned), which we shall discuss in future articles.

COMP-USCCG AND ABNORMAL PSYCHOMOTOR ACTIVITY

As early as after the first discovery of the atypical abnormal CCG movement patterns in psychiatric patients, the question of the possible cause for this finding was posed. Theoretical analysis caused us to assume that, in the absence of data for vestibular and neurological pathology, the most logical explanation for the abnormal Comp-USCCG movement patterns remains the presence of abnormal psychomotor activity in the investigated patients (with impact on the performance of the stepping test and, consequently, on the craniocorpogram).

The term *psychomotor activity* encompasses all movements (facial expressions, gestures, gait, posture, overall behavior) reflecting, in one way or another, the mental state of both healthy and diseased persons at a given moment [12,15]. Psychomotor activity is an objective expression of subjective mental processes.

Clinically, a significant number of psychiatric patients have abnormal psychomotor activity [12,15,16]. It could be stated that abnormal psychomotor activity represents the objective side of mental pathology. It

reflects almost all psychopathological states [12,15,16]. Despite of its objective character, however, abnormal psychomotor activity is still recorded and analyzed subjectively, by means of observation and description.

The hypothesis that abnormal Comp-USCCG findings in psychotic patients are due to these individuals' abnormal psychomotor activity was also confirmed by the direct observation of patients' motor behavior during performance of the stepping test. We noticed that a great number of psychotic patients, while stepping in place with eyes closed, have strange and unusual behavior clearly distinguishing them from healthy controls and from nonpsychotic psychiatric and neurological patients. In addition to noticing inadequate facial expression (grimacing), we observed certain specific movements of the head, trunk, and limbs (contorsions, twisting, jigging, nodding, bowing, twitches, staggering, rocking, dancing, wringing, wriggling, stretching, straining, marked heel tapping, etc.) in various combinations that could explain the abnormal Comp-USCCG pictures. From a clinical point of view, the observed abnormal movements could be specified as mannerisms, stereotypes, catatonic excitement, automatisms, impulsive and obsessive-compulsive acts, motor hyperactivity, ataxia, convulsions, and the like, depending on the specific features of the respective motor phenomena.

In the final analysis, the unexpected CCG finding proved to be fairly logical and explicable. Abnormal psychomotor activity (as an objective phenomenon) is recorded objectively by the abnormal craniocorpograms, and its severity could be quantitatively measured by Comp-USCCG.

The contribution could be defined as an application of a known neurootological method into a new field of medicine (psychiatry) with a new purpose (to record and measure abnormal psychomotor activity). Such an application allows for the possible objective recording and quantitative measurement of underlying mental pathology, objectively manifested by abnormal psychomotor activity.

CONCLUSION

Clinical application of Comp-USCCG in psychiatric patients showed that in the absence of neurological and vestibular signs (as in most psychiatric cases), the method could be considered as a behavioral tool for objective recording, documentation, and analysis (through the Comp-USCCG movement patterns) of abnormal psychomotor activity and, consequently, of underlying psychopathology. Thus, Comp-USCCG could in fact become the first objective and quantitative method in the field of clinical psychiatry to bring this medical discipline closer to the other fields of clinical medicine and to clinical neurology in particular.

REFERENCES

1. Claussen C-F. Die Cranio-Corpo-Graphie (CCG), eine einfache photooptische Registriermethode für vestibulospinale Reaktionen. *Zeitschr Laryngol Rhinol* 49:634–639, 1970.
2. Claussen C-F. Cranio-corpo-graphy (CCG), a simple objective and quantitative whole-body as well as intracorporal posturography. *Agressologie* 24(2):97–98, 1983.
3. Claussen C-F. Cranio-Corpo-Graphy: An Objective and Quantitative Representation of Movement Patterns During the Stepping and Standing Test. In A Cesarani, D Alpini (eds), *Diagnosi e Trattamento dei Disturbi dell'Equilibrio*. Milano: Mediamix Edizioni Scientifiche, 1990:79–84.
4. Haralanov S, Shkodrova D. Psychiatric Aspects of Vertigo: Clinical and Therapeutical Problems. In C-F Claussen, MV Kirtane, D Schneider (eds), *Vertigo, Nausea, Tinnitus and Hypoacusia Due to Central Dysequilibrium*. Hamburg: Medicin und Pharmacie, 1994:557–561.
5. Claussen C-F. Cranio-Corpo-Craphy (CCG)—30 Years of Equilibriometric Measurements of Spatial and Temporal Head, Neck and Trunk Movements. In C-F Claussen, CT Haid, B Hofferberth (eds), *Equilibrium Research, Clinical Equilibriometry and Modern Treatment*. Amsterdam: Elsevier, 2000:245–259.
6. Claussen C-F, Haralanov S. Cranio-corpo-graphy for objective monitoring of alcohol withdrawal syndrome. *Neurootol Newslett* 6(1):61–62, 2002.
7. Haralanov S. Wanted and unwanted effects of neuroleptic treatment: Objective control by cranio-corpo-graphy [abstract]. In *Abstracts of the International Conference on the Therapy of Mental and Neurological Disorders*. Bulgaria: Kyustendil, 1995:33.
8. Haralanov S, Claussen C-F, Schneider D, et al. Craniocorpo-graphy: Possibilities and perspectives in the field of clinical equilibriometry. *Neurol Balkanica* 1:30–34, 1997.
9. Haralanov S, Claussen C-F, Shkodrova D, et al. Cranio-Corpo-Graphy in Schizophrenic Patients. In C-F Claussen, E Sakata, A Itoh (eds), *Vertigo, Nausea, Tinnitus and Hearing Loss in Central and Periphreal Vestibular Diseases*. Amsterdam: Elsevier, 1995:325–328.
10. Haralanov S, Shkodrova D. Objective control on the neuroleptic medication in schizophrenic patients by craniocorpo-graphy [abstract]. In *Abstracts of the International Conference on the Therapeutic Standards of Psychiatric Diseases*. Bulgaria: Varna, 1996:10–11.
11. Haralanov S, Shkodrova D, Claussen C-F. Cranio-corpographic findings in schizophrenic patients. *Neurootol Newslett* 6(1):27–31, 2002.
12. Haralanov S, Shkodrova D, Claussen C-F, Haralanova E. Objective recording and quantitative analysis of abnormal psychomotor activity by means of cranio-corpo-graphy (CCG). *Psychiatr News (Sofia)* 8:1–8, 2000.

13. Haralanov S, Shkodrova D, Haralanova E, Claussen C-F. Objective and quantitative monitoring of antipsychotic treatment by means of cranio-corpo-graphy (CCG). *Psychiatr News (Sofia)* 9:1–5, 2001.
14. Claussen C-F, Claussen E, Heindl E. Recent Developments in the Computer Evaluation of Cranio-Corpo-Graphy. In C-F Claussen, E Sakata, A Itoh (eds), *Vertigo, Nausea, Tinnitus and Hearing Loss in Central and Periphreal Vestibular Diseases*. Amsterdam: Elsevier, 1995:287–292.
15. Teplitskaya EI. *Psychomotor Activity in Mental Disorders* [in Russian]. Kiev: Zdorovya, 1982.
16. King HE. *Psychomotor Aspects of Mental Disease*. Cambridge: Harvard University Press, 1954.