# Classification of Patients by the Function of Dentition, Postural, and Autonomic Nervous Systems

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Cluster analysis of the results of studies of the functional status of the dentition postural and autonomic nervous systems in 251 patients (129 men and 122 women) aged 20-60 years was carried out. European stabilometry variant was used. The patients could be distributed into two groups by the results of cluster analysis. By functional parameters, groups 1 and 2 could be defined as patients with decompensated and compensated functional status, respectively. The characteristics of the functional status of patients in the two groups are presented.

**Key Words:** *stabilometry; cluster analysis; functional status; classification of patients by functional status*

Great interest of modern scientists to the functional status of dentition has led to accumulation of a vast scope of relevant data. Unfortunately, the results are often purely descriptive and are not based on physiology and pathophysiology data [9,10]. On the other hand, it is acknowledged that dentition in general is essential for the postural balance [4,5].

The majority of reports present data on the functional status of the patients depending on the dental disease, concomitant diseases, occupation, anatomical structure, harmful habits, *etc*. On the other hand, no data on the "normal" functioning of the dentition postural and autonomic nervous system and on the mutual effects of these systems on each other are available. This problem is important theoretically and practically for physiology, dentistry, neurology, and manual therapy. According to P. K. Anokhin'a theory of functional systems [1], the systems retain their function for a long time in the presence of changes in anatomical structure. In practical dentistry, great attention is paid to restoration of the masticatory function, speaking, and esthetic appearance [8,12]. In addition, from phylogenetic viewpoint, one of the most ancient functions of dentition is its involvement in the maintenance of the postural balance [11,13,14].

No data on classification of patients with consideration for the function of dentition, postural, and autonomic nervous systems are available. Classification of patients by these signs will enable evaluation of the clinical and functional status of all patients and form the base for the diagnosis and treatment of patients with functional disorders depending on their individual functional status.

We attempted development of a classification of patients based on the functional status of the dentition postural and autonomic nervous systems evaluated by cluster analysis.

## MATERIALS AND METHODS

A comprehensive study was carried out in 251 patients: 129 (51.39%) men and 122 (48.61%) women aged 20-60 years. Patients with complete anodontia, acute somatic diseases, exacerbations of chronic diseases, myocardial infarction, mental disorders, alcohol and drug dependence were excluded from the study.

Stabilometric studies were carried out in accordance with the basic requirements of NORMES 1985 [7] on a Stabilometer MBN biological feedback computer stabiloanalyzer using the European variant (EV)

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of stabilometry. The relationship between dental occlusion and the postural balance was studied using the following tests: eyes open—lower jaw relaxed and eyes open—teeth clenched.

Clusterization of input data matrix was carried out using Ward method and Euclidean distance was used for distance measurement. The clusterization results are presented in Fig. 1.

## RESULTS

We used cluster analysis for classification of patients and distributing them into groups and rule out the subjective factor when forming the groups. The method consisted in mathematical grouping of the patients so that the patients in a group were maximally similar by the studied parameters (in our case by the functional status of the dentition, postural and autonomic nervous systems) and the differences between the studied parameters in patients of different groups were the maximum [2].

According to the findings of cluster analysis, the patients were distributed into two groups, the distance between the groups being 7189.456. Group 1 (decompensated functional status) consisted of three subgroups (clusters) with linkage distances of 12914.2, 7952.95, and 3603.7. Group 2 (compensated functional status) consisted of two subgroups with linkage distances of 4212.75 and 7290.65. The dendrogram showed that patients in each group formed subgroups (Fig. 1). Further distribution of patients into subgroups and interpretation of the clinical significance of this classification seemed to be an important and interesting scientific problem.

The first results of clusterization indicated that the resultant two groups of patients were highly differentiated from each other by the functional status of the dentition, postural, and autonomic nervous systems, which was confirmed by the distance between the two groups.

Group 1 consisted of 67 patients: 27 (40.30%) men and 40 (59.70%) women. Group 2 consisted of 184 patients: 98 (53.26%) men and 86 (46.74%) women. The groups did not differ much by gender, this indicating similar probability of functional disorders in men and women.

Comparison of the results of examinations of patients in both groups showed significant age-specific differences: group 1 patients were almost 2-fold older ($p$=0.001, Wald-Wolfowitz Runs test, Kolmogorov-Smirnov test, and Mann-Whitney $U$ test). Hence, age-specific changes were significant for the functional status of the dentition postural and autonomic nervous systems. On the other hand, there were patients aged over 40 years in the group with compensated functional status and, vice versa, patients aged under 40 years in the group with decompensated functional status. Therefore, age-associated changes were just one of the factors continually modulating the functional status of all systems. We regarded this effect as the basal, while other factors worked in parallel with it – once or regularly. Therefore, the age-specific characteristics of the patients and their impact for the dentition and postural status were an important theoretical problem with a great practical significance. The detected regularities necessitated special attention to the diagnosis of the functional status in patients aged over 40 years.

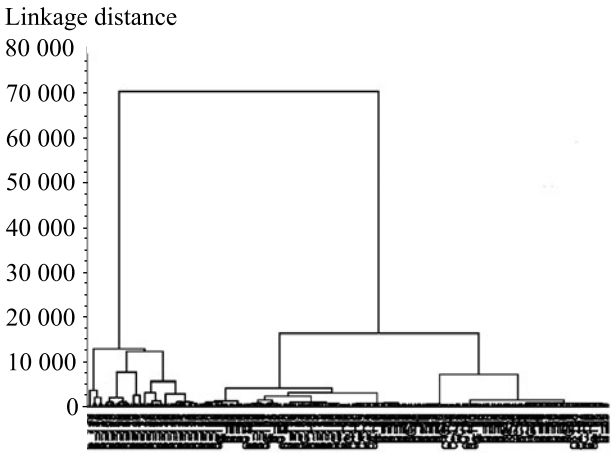


**Fig. 1.** Group 1 (linkage distance 12914.2): observations 110, 124, 120, 134, 111, 125, 121, 136, 116, 130, 118, 132, 114, 128, 115, 129, 138, 151, 173, 188, 190, 193, 203, 213, 214, 219, 220 (cluster 1, linkage distance 12914.2); 117, 131, 148, 170, 119, 154, 222, 176, 133, 158, 122, 137, 135, 162, 191, 201, 204, 216, 222, 232, 240 (cluster 2, linkage distance 7952.95); 112, 126, 113, 127, 123, 187, 189, 192, 199, 211, 212, 223, 233, 242 (cluster 3, linkage distance 3603.7). Group 2 (linkage distance 16653.04): observations 1, 70, 17, 60, 75, 20, 62, 72, 81, 31, 217, 21, 67, 35, 37, 90, 96, 102, 106, 186, 94, 107, 92, 104, 93, 2, 85, 10, 11, 32, 59, 69, 14, 13, 27, 194, 224, 66, 226, 230, 61, 78, 3, 234, 239, 247, 83, 25, 79, 6, 65, 8, 24, 9, 15, 68, 97, 34, 18, 248, 218, 216, 28, 84, 26, 76, 64, 100, 105, 101, 245, 249, 22, 77, 5, 82, 141, 73, 109, 7, 19, 16, 33, 249, 251, 12, 23, 36, 29, 63, 80, 71 (cluster 4, distance 4212.75); 4, 39, 42, 53, 52, 56, 38, 41, 50, 95, 43, 46, 48, 144, 195, 215, 233, 244, 250, 143, 54, 142, 139, 45, 140, 108, 30, 159, 180, 161, 88, 165, 160, 181, 145, 153, 175, 157, 179, 155, 177, 98, 164, 183, 149, 171, 150, 172, 185, 55, 57, 221, 74, 86, 87, 167, 147, 169, 163, 182, 166, 184, 225, 40, 47, 44, 99, 51, 58, 89, 91, 103, 146, 168, 152, 174, 156, 178 (cluster 5, linkage distance 7290.65).

Shifted habitual occlusion from the central position of the jaws was more often detected in group 1 patients than in group 2 ones ($p$=0.001, Wald-Wolfowitz Runs test, Kolmogorov-Smirnov test, and Mann-Whitney $U$ test). The clinical status of the dentition system indicated that the status of the teeth and dentition was essential for the functional status of the dentition and postural systems. These regularities confirmed the data on the relationship between the postural and dentition systems [3]. The clinical status of the dentition system modulated the masticatory muscle functional status,

the pathogenetic effects of the dentition system on the postural function realized through this influence.

Comparison of the results of stabilometry showed higher position of the pressure center in the sagittal and frontal planes in group 1 patients ($p$=0.001, Mann-Whitney U test; $p$<0.005 and $p$<0.001, Kolmogorov-Smirnov test). The velocity of pressure center translocation was also significantly higher in group 1 patients than in group 2 ($p$=0.001, Mann-Whitney $U$ test).

The postural balance frequency characteristics in patients of both groups consisted in the predominance of pressure center fluctuation frequencies in the frontal and sagittal planes ($p$=0.001, Wald-Wolfowitz Runs test; $p$<0.005, Kolmogorov-Smirnov test; $p$=0.03, Mann-Whitney $U$ test). In addition, the 60% Pw(F) index (60% power spectrum level in the frontal plane) was higher in group 2 than in group 1 ($p$=0.001, Wald-Wolfowitz Runs test). Moreover, higher 60%Pw(S) values (60% power spectrum in the sagittal plane) were also recorded in group 2 ($p$<0.05, Kolmogorov-Smirnov test; $p$=0.001, Mann-Whitney $U$ test).

The statokinesiogram area in group 2 patients was larger than in group 1 ($p$<0.005, Kolmogorov-Smirnov test; $p$=0.001, Mann-Whitney $U$ test). The two groups also differed by shift of the pressure center in the frontal plane ($p$=0.04, Wald-Wolfowitz Runs test).

These differences in the stabilometric characteristics indicated that the stabilometric values in group 1 were shifted from the standard values presented in NORMES 1985 [7]. On the other hand, the stabilometric parameters in group 2 corresponded to the normal stability values.

Hence, comparison of stabilometric parameters in the two groups indicated more adequate regulation of the postural balance in group 2 patients. The postural balance of group 1 patients was disordered; for example, they had higher frequency of the pressure center fluctuations in the frontal and sagittal planes. These regularities confirmed the hypothesis on the subcompensated and/or decompensated functional status of the dentition and postural systems and indicated their close relationship. The compensatory regulation under conditions of functional overloading of one of the systems was realized due to these relationships. It is noteworthy that intersystemic relationships were better coordinated in the patients with the compensated status of the postural and autonomic nervous systems, due to which the reserve potential of these patients was higher.

Qualitative analysis of stabilograms showed that patients of both groups had in fact similar characteristics; that is, the main differences consisted in difference of stabilometry values. Presumably, a more detailed analysis of stabilograms with consideration for patients' functional status will make it possible to outline a stabilometric picture characteristic of each functional class of patients.

The results of cluster analysis confirmed the data [3] on age-associated changes in the postural balance in patients aged over 40 years. The postural balance values in patients aged over 40 years did not correspond to the "normal" values (according to NORMES 1985) [6,7]. Moreover, age-specific changes in the functional status of the maxillodental and autonomic nervous systems revealed in these patients indicated that the functional states of all systems were liable to change with aging, these changes being most active after the age of 40 years. These age-associated regularities in changes of the functional status of the studied systems confirmed the hypothesis about their relationship, as age-specific changes in these systems were synchronous.

Comparison of the parameters of the autonomic nervous system stimulation showed that in general, the amplitude characteristics of heart work in group 2 patients did not surpass the values in group 1. Wave $P$ amplitude in group 1 patients was 14.3% higher than in group 2 ($p$=0.001, Wald-Wolfowitz Runs test; $p$<0.001, Kolmogorov-Smirnov test; $p$=0.001, Mann-Whitney $U$ test). The amplitude of wave $S$ in group 1 patients was 11.2% higher than in group 2 patients ($p$=0.001, Wald-Wolfowitz Runs test; $p$<0.005, Kolmogorov-Smirnov test; $p$=0.03, Mann-Whitney $U$ test). The amplitude of wave $T$ was 15.1% higher in group 1 *vs.* group 2 patients ($p$=0.005, Wald-Wolfowitz Runs test; $p$<0.005, Kolmogorov-Smirnov test; $p$=0.03, Mann-Whitney $U$ test).

The ECG interval characteristics in group 1 patients were lower than in group 2. The $QRS$ interval length was 0.1 sec in group 1 and 0.17 sec in group 2 ($p$=0.00001, Wald-Wolfowitz Runs test; $p$<0.005, Kolmogorov-Smirnov test; $p$=0.0071, Mann-Whitney $U$ test). The $ST$ interval was 0.15 sec in group 1 and 0.18 sec in group 2 patients ($p$=0.0036, Wald-Wolfowitz Runs test; $p$<0.005, Kolmogorov-Smirnov test; $p$=0.0075, Mann-Whitney $U$ test).

These characteristics of the functional status of the autonomic nervous system indicated shorter intervals of heart work in group 1 patients under conditions of decompensated functional status of the dentition, postural, and autonomic nervous systems. The detected regularities indicated that the cardiovascular system was involved in adaptation in disorders of functional status of the dentition system. The pathogenetic mechanism of decompensation consisted in shorter recovery processes (for example, myocardial repolarization) inside the system, this involving shortening and exhaustion of the compensatory mechanisms within each system participating in adaptation to the irritator.

Hence, the diagnosis of the functional status of the dentition, postural, and autonomic nervous systems

should include studies by the polygraphic and stabilometric methods. Comprehensive functional diagnosis shows the level of compensation of the functional systems. By the functional status of the dentition postural and autonomic nervous systems, the patients can be distributed into 2 groups: with compensated and decompensated functional status. The results of cluster analysis provided theoretical prerequisites for detailed development of this classification.

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