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CORRELATION OF MMSE, SKT AND CLOCK TEST SCORES IN PATIENTS WITH MILD AND MODERATE DEMENTIA

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ABSTRACT

The objective of our study was to assess the correlation of routine neuropsychological test results in elderly patients referred to a gerontopsychiatric ward. MMSEs, Clocktests (CT) and SKTs were performed in 94 patients (Age: Median = 74 ys, Range = 54–89 ys; 64 f, 30 m; MMSE < 25:45 and MMSE > 25:37) with mild to moderate dementia and evaluated retrospectively. Linear and multiple regression was used.

The scores of all 3 tests used were reciprocally correlated ($p < 0.05$). Multiple regression analysis showed a maximum correlation of 0.87 and marked standardized β values, if SKT was chosen as dependent variable. In conclusion, results of SKT, CT or MMSE in patients with dementia showed marked pairwise or multiple correlations and therefore it is not necessary to include more than two reliable tests in clinical psychogeriatric studies.

Key Words: dementia, psychodiagnostic tests, correlation

INTRODUCTION

Elderly patients referred to gerontopsychiatric wards or those included in clinical psychogeriatric studies are subjected to a battery of cognitive tests in order to detect and classify dementia. Test batteries, particularly if they are regularly repeated during clinical trials, may induce stress in elderly patients and demand a maximum of concentration and co-operation. The question arises whether its ethical justified to produce redundancy in clinical practice and psychopharmacological research? The following work presents available retrospective informations about three tests in psychogeriatric diagnostics, which are routinely used on admission to the gerontopsychiatric university department, and assesses the relation between the tests using a multiple regression model or response surface analysis. The possible implications of redundancy of exhausting test batteries with regard to clinical studies in elderly patients are discussed.

Syndrom-Kurztest

The SKT (Syndrom-Kurztest) has been introduced by Erzigkeit (1) and is meanwhile a routine diagnostic tool in the psychogeriatric assessment which can be done in about 20 minutes. It is composed of 9 subtests including naming of objects, short- or long-term memory, to put numbers

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in a row and calculation capabilities. It is scored from zero to 27, 27 being the weakest score. Normal scores range from zero to four and a score of 5 to 9 indicate a mild organic syndrome. Kim et al. (2) found test-retest reliability of 0.9 with regard to the total SKT score. However, Bergener et al. (3) discussed substantial lack of test quality and standardization which would restrict the general use of the SKT in clinical practice.

Mini-Mental-State-Examination

The Mini-Mental-State-Examination (MMSE) was inaugurated by Folstein et al. (4). The test can be completed in approximately 15 minutes and is suited as a routine test on admission to psychogeriatric wards. The maximum score which can be obtained is 30 and scores lower than 25 to 23 indicate the presence of dementia or related syndromes. Test-retest reliability with a time interval of 24 hours is 0.89 and the inter-rater reliability comes up to 0.82 (5). The external validity of the MMSE has been extensively investigated by comparison with EEG, CCT scans or PET scans. Scores lower than 19 in the MMSE indicate a marked reduction of prognosis in patients with dementia as approximately 50 % of those patients die within two years (6).

Clock Test

A very practical tool for the diagnosis of organic syndromes, which can be done and documented without specific test manuals within 5 minutes, is the Clock Test [CT] (7). The patient is asked to draw a clock (e.g. 11.10 Hour) in a circle. The results can be classified in categories from 1 to 6, where 1 denotes a perfect clock and 6 corresponds to a plot which has no relation to the task (8). Test-retest correlation using these categories was 0.89 and inter-rater correlation achieved 0.81. Specifity and sensitivity appears to be slightly lower compared to the MMSE (9).

Correlations between tests in literature

Spearman's rank correlation analysis between SKT and MMSE yielded a significant correlation coefficient of –0.66 based on the test results of 49 patients with dementia (10). Lehfeld et al. (11) calculated a Spearman rank correlation coefficient between these two tests of –0.84 in a multicenter trial with 180 patients. SKT/MMSE data could be fitted to simple linear regression models, the corresponding slopes being in an order of –0.8 [score/score]. Gürtler et al. (12) simultaneously investigated 40 patients using a battery of 5 tests which included SKT, MMSE and CT. CT scores were ranked according to Ploenes et al. (13). Nonparametric correlation analysis according to Spearman showed respective significant correlations between the test scores: MMSE/SKT: 0.71, MMSE/CT: 0.58 and SKT/CT: 0.57.

METHODS

Mini-Mental-State Examination (MMSE), Clocktest (CT) and Syndrom-Kurz-Test (SKT) [for simplification MMSE, CT, SKT denote "test score" in equations], performed in an explorative, retrospective (naturalistic) study without predefined endpoints in 94 patients (Age: Median = 74 ys, Range = 54–89 ys, 64 women, 30 men) who were referred to the gerontopsychiatric ward with mild to moderate dementia of degenerative or vascular origin [ICD 10 diagnostic groups: F00 (Alzheimer's disease N = 41), F01 (vascular dementia N = 20) and F06.7 (slight cognitive disorder N = 21), other N = 12]. All patients referred to the gerontopsychiatric ward have been tested routinely by means of these three tests for several years. The tests can be completed within one hour and do not overcharge patients. Internal consistency (Cronbach's alpha > 0.75

[MMSE, SKT]) was suitable. Clock Test results were classified into 6 categories (8). According to Jaccard et al. (14) ordinal variables with at least 5 categories can be used as ratio scaled data without substantially influencing type I or type II error which is the rationale for application of linear and nonlinear regression methods of retrospective data. Normal distribution was given (Kolmogorov-Smirnov one sample test) except for CT data due low number of categories. However, corresponding normal probability plot did well fit to a line. The number of N = 94 was considered to be sufficient to show the objective of the study in an explorative naturalistic study design (15).

Linear regression models including 95% confidence intervals (CI) were calculated. Significance of correlation was assessed using a two-sided t-test statistic (16). Multiple least square regression analysis was used to analyse the relationship between one dependent variable (Y) and independent variables (Xi, „predictors“) according to Zar (16). The general basic model applied can be written as follows: Y = a + B1*X1 + B2*X2 + …Bi*Xi. B values, standardized B values (β) (with regard to an increase, if the independent variable increases 1 SD) and multiple correlation coefficients and multiple coefficients of determination ($Rmult^2$: measure of variance explained by the model) were calculated. P-values for multiple regression based on F-tests were given (17). In general, p-values smaller than 0.05 were considered as significant. All statistical calculations were done with Statistica^R (Version 5.0, Statsoft, Tulsa, USA) and Table Curve 3D^R (SPSS Inc., Chicago, USA.).

RESULTS

The scores of all 3 tests were reciprocally correlated yielding the linear regression characteristics summarised in table 1. All linear models were significant, correlation coefficients being in an order between 0.61 and 0.77. Figures 1 a–c show the corresponding scattergrams with regression lines and 95% confidence limits of the pairwise analysis. In order to compare mild and moderate dementia syndromes, the values for patients with an MMSE score above 25 and less than 25 are given in table 2. Obviously, the correlation between tests is especially marked in mild to moderate dementia compared to patients with mild cognitive impairment..

Multiple regression results were significant ($p < 0.01$) irrespective of the dependent variable chosen. The results of multiple regression analysis are summarised in table 2. Marked multiple correlation coefficients were found having an order of 0.8. Approximately 60% of the total variance of a dependent variable is explained by the model applied ($Rmult^2$). Generally, the β values of the clock test in the models were lower compared the respective β values of the SKT or MMSE. The highest multiple correlation coefficient was found, if SKT scores were chosen as dependent variable.

Table 1: Results of pairwise linear regression analysis including 95% Confidence Intervals.

	r	b1 (slope)	bo (intercept)	p-value
SKT/MMSE	–0.77	–1.12 (0.09)	37.17 (2.17)	< 0.05
SKT/CT	0.69	3.5 (0.39)	–1.06 (1.37)	< 0.05
MMSE/CT	–0.61	–2.25 (0.31)	31.16 (1.1)	< 0.05

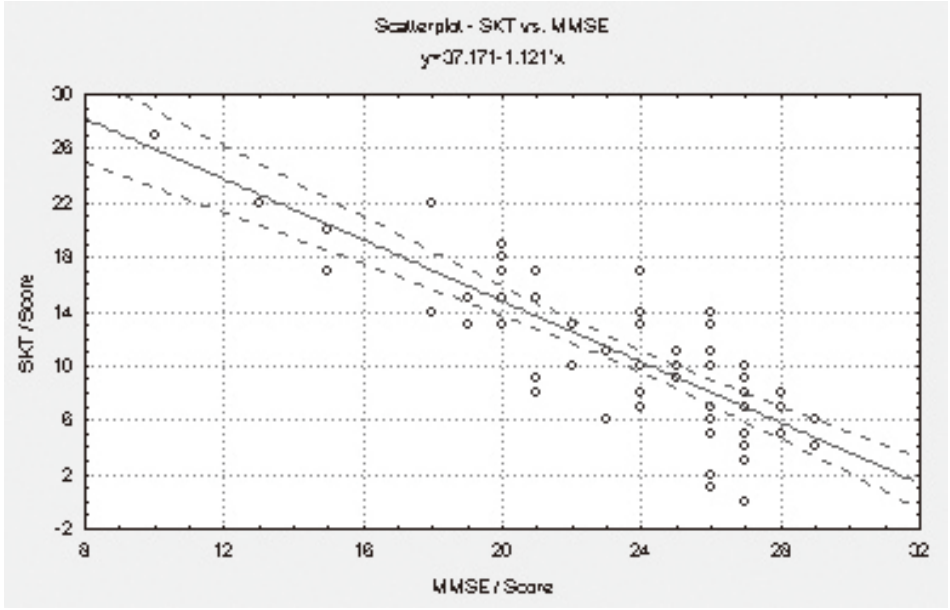

Figure 1a: SKT versus MMSE scores: Scattergram with regression line and 95% confidence limits (see text).

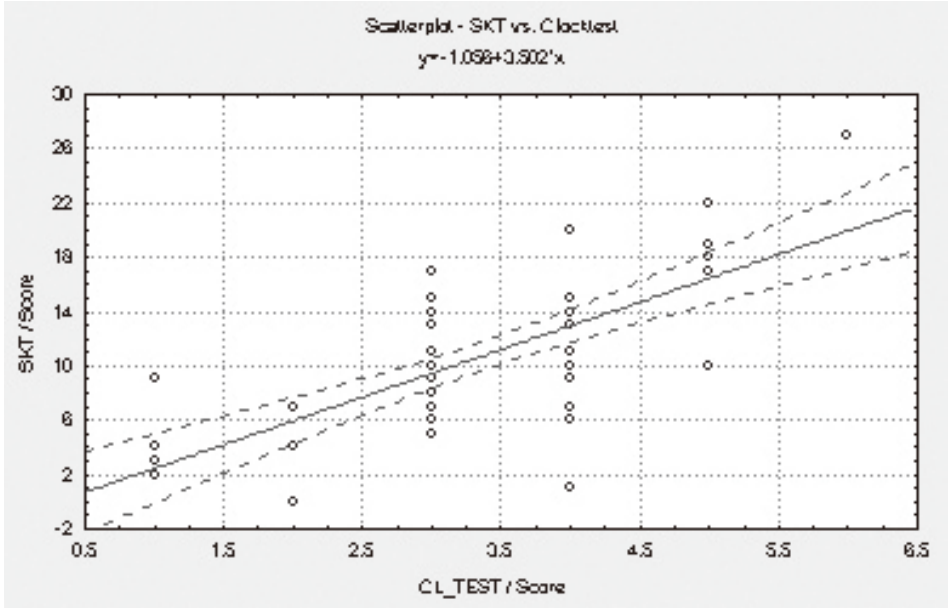

Figure 1b: SKT versus CT scores: Scattergram with regression line and 95% confidence limits (see text).

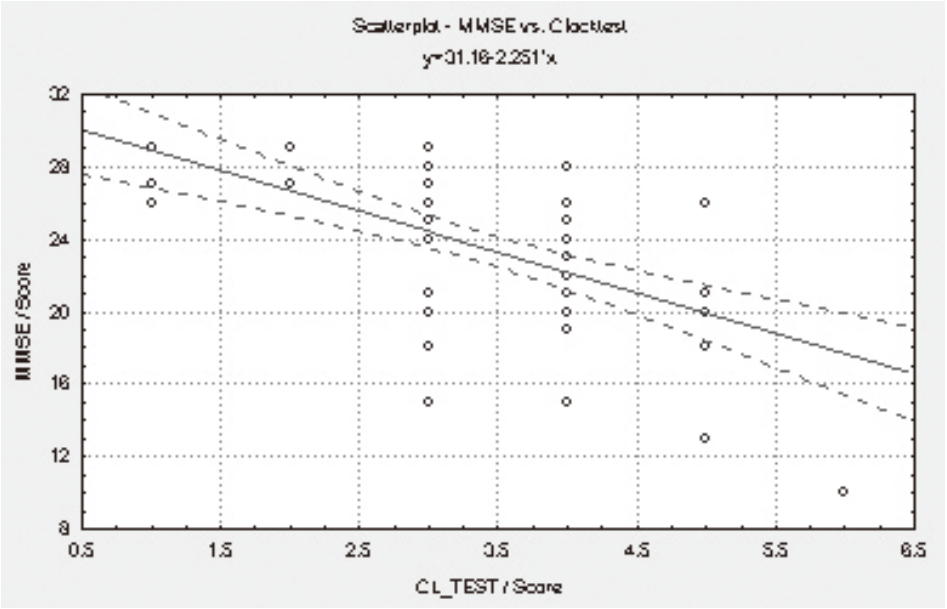

Figure 1c: MMSE versus CT scores: Scattergram with regression line and 95 % confidence limits (see text).

Table 2: Results of pairwise linear regression analysis of subgroups with mild cognitive impairment and moderate or severe dementia (*p < 0.05)

	MMSE < 25 N = 45	MMSE > 25 N = 37
SKT/MMSE	–0.67 *	–0.26
SKT/CT	0.63 *	0.51 *
MMSE/CT	–0.49 *	–0.31

Table 2: Summary of multiple regression analysis based on different models. In addition to regression coefficients B, standardized B values (β) were calculated including corresponding standard errors. Multiple correlation coefficients (Rmult) and multiple coefficients of determination ($Rmult^2$) are given.

Multiple Regress.	Dependent variable SKT		Dependent variable CT		Dependent variable MMSE	
N=94	Multiple R = 0.870 ($Rmult^2$ = 0.672)		Multiple R = 0.704 ($Rmult^2$ = 0.496)		Multiple R = 0.779 ($Rmult^2$ = 0.607)	
	b	B	b	B	b	B
SKT			0.54 (0.12)	0.10 (0.02)	–0.67 (0.09)	–0.48 (0.07)
CT	0.35 (0.08)	1.82 (0.39)	–0.20 (0.12)	–0.05 (0.03)	–0.15 (0.09)	–0.58 (0.34)
MMSE	–0.56 (0.08)	–0.76 (0.10)				

DISCUSSION

The objective of the present work was to assess the relation between SKT, clock test and MMSE in routine sample of 94 patients referred to a gerontopsychiatric ward. Pairwise correlations were in an order of 0.61 to 0.77 and insignificantly exceeded the correlation values of Gürtler et al. (12). In general, pairwise correlations are less marked in patients with only mild cognitive impairment, which may reflect the problem to detect early stages of dementia. In the present investigation, too, the clock test showed slightly lower correlations compared to MMSE and SKT. The slopes found in our population (SKT versus MMSE) were approximately 0.3 [score/score] steeper compared to the regression results of Lehfeld et al. (11). Especially the SKT and MMSE have been successfully used in clinical pharmacological studies to assess the cognitive function of patients (18, 19, 20). The clock drawing test has more importance as a routine tool to predict cognitive frailty of patients in practice (21). Although all three test are suited to separate between normal and demented individuals, the extent of dementia, particularly in advanced stages, may be more exactly quantified by means of the MMSE, as the MMSE lacks an early floor effect.

The main approach was to assess multiple regression models which integrated all three tests. The highest multiple correlation coefficient (0.87) was found, if the SKT was chosen as the dependent variable. The multivariate approach confirmed a close relationship between the test scores of the SKT, CT and MMSE scores. This close multivariate correlation between the three tests can be interpreted as a measure of internal consistency (estimate of "reliability") of the test battery. Using canonical correlation techniques and split-half techniques Koch et al. (22) have shown that internal consistency of a test battery is not identical with the consistency of the individual tests applied. On the one hand, test batteries show better reliability which, on the other hand, can obviously not be substantially improved by including more than three tests.

The marked association of the three tests has not been expected a priori, as the tests differ with regard to priority of capabilities. The Clock Test is predominantly based on the visuo-constructive faculty of the patient, the SKT emphasizes alertness and the MMSE does include items assessing language abilities. Obviously, in most of patients included in our study dementia was characterized by multiple symptoms or syndromes ("constructs") such as memory or visuo-constructive deficits, which were detected by the test items. It is therefore not surprising that the clock test did yield slightly lower β values than the SKT or MMSE. In addition, we hypothesise that the correlation between the tests would be weaker, if only patients with mild dementia are included due the increased probability of monosymptomatic psychopathology in the beginning of the disease.

With regard of the objective of the study we conclude that three different tests are suited to assess and classify dementia with adequate reliability and that two tests already explain roughly two thirds of the total variability. Obviously, additional tests do not add substantial information on the patients cognition both in diagnostics or neurospychopharmacological research. The question arises, whether it is warranted to repeatedly explore demented patients in clinical psychopharmacological trials with strenuous test batteries, occasionally lasting more than one hour per day. The presented results showed that two to three tests lasting less than one hour per session should lead to a critical re-appraisal of this practice.

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