Available online at www.sciencedirect.com

SCIENCE DIRECT®

Schizophrenia Research 79 (2005) 271–280

SCHIZOPHRENIA RESEARCH

www.elsevier.com/locate/schres

# Performance of diadochokinetic movements in schizophrenic patients

Albert Putzhammer*, Maria Perfahl, Liane Pfeiff, Bernd Ibach, Monika Johann, Ute Zitzelsberger, Goeran Hajak

*Movement Disorders Unit, Department of Psychiatry, University of Regensburg, Regensburg, Germany*

Received 9 December 2004; received in revised form 17 May 2005; accepted 25 May 2005
Available online 28 June 2005

**Abstract**

Motor deficits are common and disabling symptoms in schizophrenic patients, which have enormous impact on the long-term outcome of the disease by affecting work performance and daily functioning. They are attributed to the disorder itself, as well as to treatment with dopamine-blocking antipsychotics.

This study assessed the kinematic parameters of motor performance of a diadochokinetic hand movement in 20 drug-naïve, 20 conventionally treated (haloperidol or fluphenazine), and 20 atypically treated (olanzapine) patients, as well as in 20 healthy controls using a three-dimensional ultrasonic movement analysis system. It also tested differences in motor enhancement as induced by an attentional strategy and in dexterity advantages of motor performance for the dominant hand between the four study groups.

Amplitude and peak velocity of diadochokinetic hand movements were significantly reduced in all patient groups compared to the controls, while frequency of the repetitive movement remained unaffected. The reduction was most pronounced in the conventionally treated patients. In addition, movement automation was impaired, primarily under conventional antipsychotic treatment. The study also revealed weaker effects of an attentional enhancing strategy on the movement amplitude in atypically and conventionally treated patients compared to both controls and drug-naïve patients. Alterations of dexterity could not be detected either in the drug-naïve or in the treated patients.

The results indicate that patients with schizophrenia suffer from a specific primary motor deficit in diadochokinesia with reduction of amplitude and peak velocity. This deficit is significantly worsened by conventional antipsychotic treatment. Antipsychotic treatment additionally reduces the enhancing effect of an attentional strategy on motor performance.


*Keywords:* Schizophrenia; Motor performance; Diadochokinesia; Antipsychotic treatment; Olanzapine; Extrapyramidal side effects; Neurological soft signs

* Corresponding author. Department of Psychiatry and Psychotherapy, University of Regensburg, Regensburg, Germany. Tel.: +49 941 941 2053; fax: +49 941 941 2091.
*E-mail address:* albert.putzhammer@medbo.de (A. Putzhammer).

0920-9964/$ - see front matter © 2005 Elsevier B.V. All rights reserved.
doi:10.1016/j.schres.2005.05.020

## 1. Introduction

Motor disturbances are common and disabling symptoms in schizophrenia, with the degree of impairment related to the degree of psychosis and to the antipsychotic treatment (King, 1976; Carnahan et al., 1997). These deficits are attributed both to the disorder itself and to treatment with dopamine-receptor blocking neuroleptics. Subtle disturbances of psychomotor performance, known as neurological soft signs (NSS), have frequently been reported even in drug-naïve schizophrenics, as well as in their unaffected first-degree relatives (Yazici et al., 2002). In a review of 17 studies on NSS, Boks et al. stated that impaired motor coordination seems to be the most specific motor defect to schizophrenia (Boks et al., 2000). A common test for NSS and disturbed motor coordination is the performance of diadochokinetic movements, which is usually tested by asking the patient to alternate between pronation and supination of the hand. Deshmukh et al. described a high incidence of dysdiadochokinesia in schizophrenic patients (Deshmukh et al., 2002). Most of the studies on NSS and dysdiadochokinesia in schizophrenia used clinical ratings to determine the severity of motor deficits. Until now, only few studies employed kinematic measurements in order to analyze key parameters of dysdiadochokinesia in schizophrenic patients. Using ultrasonic analysis on 25 schizophrenic patients, who performed alternating movements on a handle, Jahn et al. found major alterations in the variation coefficients of several motor parameters (Jahn et al., 1995). More recently, Tigges et al. described significant impairments in the regularity of repetitive hand movements with a decrease in frequency, peak velocity, peak acceleration and the degree of automation in a schizophrenic study group when drawing circles with a predefined amplitude on a digitized tablet (Tigges et al., 2000).

The present study assesses key parameters of a diadochokinetic hand movement without the constraints of a handle or of a preset amplitude by use of a three-dimensional ultrasonic movement analysis system. In order to differentiate between intrinsic effects of the illness and motor disturbances caused by atypical or conventional neuroleptic treatment, we compared drug-naïve schizophrenic patients, patients treated with olanzapine, and patients treated with haloperidol or fluphenazine, as well as healthy controls. Specifically, we instructed the probands to alternate between pronation and supination as quickly as possible and analyzed frequency, amplitude, and peak velocity of the movement, as well as the number of changes of velocity per stroke, which represents the degree of automation and regularity of a repetitive movement.

Since the basal ganglia network is specifically involved in the planning of movement amplitude and related covariates, basal ganglia dysfunction due to primary processes of schizophrenia or the antidopaminergic effects of antipsychotic medication might lead to deficits in the generation of an adequate amplitude and peak velocity (Jueptner and Weiller, 1998; Desmurget et al., 2001). Moreover, regularity of diadochokinetic hand movements depends on the ability to coordinate motor sequences involving multiple agonistic and antagonistic muscle groups. This can also be impaired by basal ganglia dysfunction or by dysfunction of the cerebellar network, which is involved in monitoring and optimizing movements using sensory feedback (Jueptner and Weiller, 1998; Desmurget et al., 2001).

Primary motor deficits in schizophrenic patients are attributed to the neuro-integrative dysfunction of central nervous circuits due to functional or structural brain abnormalities (DeLisi et al., 1997; Andreasen et al., 1999). In this context, the phenomenon of lateralized brain dysfunction in schizophrenia has been discussed on the basis of numerous results of clinical, neuropsychological, psychophysiological, and electrophysiological studies (Buchsbaum, 1990). Therefore, we further evaluated in the present study whether differences between motor performance of the dominant and the non-dominant hand are reduced in schizophrenic patients compared to healthy controls, as has been derived from the assumption that schizophrenic patients suffer from left-hemispheric dysfunction.

Some studies suggest similarities between motor disturbances in schizophrenic patients and those in patients suffering from Parkinson's disease (PD), based on the results of neurophysiological investigations and of imaging studies (Muller et al., 2003; Putzhammer et al., 2004). In PD, the provision of external cues or the use of attentional strategies can improve motor performance (Morris et al., 1996; Oliveira et al., 1997). In this context, it has been shown that movement performance in PD patients can be normalized by directing the patient's attention toward the task by instructing them to consciously attend to