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Gait characteristics in patients with major depression performing cognitive and motor tasks while walking

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ABSTRACT

Depressed patients demonstrate alterations in motor and cognitive functioning that can affect their adjustments to the variations in everyday life environment. The objective was to explore gait parameters and variability of patients with major depressive disorder in dual task walking situations. Eight patients and 20 healthy controls performed motor, mental and combined motor+mental tasks while walking. Calculated parameters were cycle time, stride length, swing time, double support time and their coefficients of variation (CV). Patients demonstrated greater gait variability (swing time CV) than controls during baseline walk ($t(26)=2.64$, $p<0.05$) and motor dual task ($t(26)=3.68$, $p<0.05$). Moreover, the transition from mental to combined task decreased stride length ($M=126.48\pm15.35$ and $M=121.19\pm13.55$, $p<0.001$) and increased double support time ($M=0.266\pm0.072$ and $M=0.287\pm0.076$, $p<0.01$) only in controls. Also, gait variability increased in controls during the combined task, while remaining the same or decreasing in patients. Tasks that required greater cognitive involvement affected gait variability in patients more than controls, but only up to a certain level, after which patients' stability appeared unaffected by the increase of cognitive demand. This could be explained by a tendency of patients to neglect complex cognitive tasks while walking in order to preserve stability and prevent possible falls.

1. Introduction

Depression has been ranked as one of the leading causes of disability worldwide according to World Health Organization, with the lifetime prevalence ranging between 11.1% and 14.6%. It was estimated that 80% of the costs of the disorder are due to production loss, causing considerable burden to the society, companies, affected individuals and their families (Bromet et al., 2011; Murray and Lopez, 1996; Smit et al., 2006). In addition to affective phenomenology, motor retardation and cognitive dysfunction are likely to be significant factors of disability in individuals with major depressive disorder (MDD) (Everson-Rose et al., 2005; Yanagita et al., 2006; Naismith et al., 2007). Depressed patients demonstrate alterations in motor and cognitive functioning that can affect their adjustments to the variations in everyday life environment. Motor retardation is a prominent clinical feature of major depression (Lemke et al., 2000). In particular, individuals with depressive symptoms have slower gait, slumped posture and they are less steady when walking (Hausdorff et al., 2004; Michalak et al., 2009). Cognitive functions are also compromised in MDD, with impairments in the domains of cognitive flexibility and complex attention (Gualtieri et al., 2006). Depressed individuals demonstrate increased elaboration of negative material (negative views of the self, the world and the future) and deficits in cognitive control when negative material is processed (Gotlib and Joormann, 2010). The relationship between MDD and cognitive impairment is complex, most likely associated with abnormalities in noradrenergic and dopaminergic neuromodulation (Sara, 2009).

It is long known that gait is not just an automated motor activity, but that it requires influential cognitive involvement (Ble et al., 2005; Al-Yahya et al., 2011). Furthermore, findings from brain imaging studies revealed activation of areas related to higher cortical control during actual gait (Harada et al., 2009; Miyai et al., 2001). Therefore, gait analysis may be highly suitable for the exploration of psychomotor retardation in depression. Assessment of gait might help in differential diagnosis of psychiatric and neurological disorders (e.g. non-organic vs. organic depression), as well as for predicting and monitoring response to therapy. Previous studies have mainly focused on aspects of motor retardation such as speech, eye movement, posture, facial

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expression, gross movements of hands and torso in depression (Buyukdura et al., 2011; Hoffstaedter et al., 2012). Only a few studies examined gait characteristics in depressive patients, but they either did not assess the association between gait and cognition or they explored this association in the population of elderly patients (Wright et al., 2011; Hausdorff et al., 2004).

The association between gait and cognitive functions can be explored using the dual task paradigm (Ble et al., 2005; Yogev-Seligmann et al., 2008; Al-Yahya et al., 2011). The dual task is performed by adding a motor or cognitive task while a person is walking, and it has been frequently used to assess the divided attention and executive functions. The simultaneous execution of an additional task (e.g. backward counting while walking) alters the execution of one or both tasks. This was observed in healthy young or elderly individuals, and is even more obvious in patients with neurological diseases (Huang and Mercer, 2001; Montero-Odasso et al., 2012; Yogev-Seligmann et al., 2008; Szturm et al., 2013). Previous studies have demonstrated that gait alterations during dual task performance, most notably the increase in gait variability, were associated with increased fall risk in patients with cognitive decline (Hausdorff et al., 2003; Bruce-Keller et al., 2012; Muir et al., 2012; Lamoth et al., 2011), although results minimizing this association have recently emerged (Smulders et al., 2012).

The aim of this study was to compare gait characteristics and gait variability in patients with MDD and healthy control subjects. We wanted to examine how different types of dual tasks influenced gait and to explore the changes in gait patterns that would appear as additional motor and cognitive tasks were added to participants' base walk pattern.

We hypothesized that gait of depressive patients would differ from control subjects, having greater gait variability during dual and multiple task situations. We expected that those differences in gait characteristics would be most pronounced during the most demanding task situation.

2. Method

2.1. Patients and controls

Upon admission to the Clinic for Psychiatry, Clinical Center of Serbia, patients with depression were consecutively screened for the present study on the basis of the following criteria:

- Diagnosis of current unipolar major depression with or without melancholic features, according to Mini International Neuropsychiatric Interview (MINI) for DSM IV diagnosis (Sheehan et al., 1998). The diagnosis was confirmed by consensus of two psychiatrists during separate clinical interviews.
- No history of another condition that could interfere with motor activity (any neurological disorders, orthopedic diseases, general medical conditions).
- No depression due to organic brain disorder.
- No cognitive decline (Mini-Mental State Examination (MMSE) >25) (Folstein et al., 1975).

The exclusion criteria were lifetime diagnosis of dementia, schizophrenia, schizoaffective disorder, bipolar disorder, current diagnosis of PTSD, OCD or eating disorder, alcohol and harmful drug abuse during the past 12 months and alcohol/substance-related disorders during lifetime.

Eight patients fulfilled the aforementioned criteria during a 1-month observational period. They have been included in the following study procedures performed during a single visit. The same protocol was used for 20 control subjects recruited by local advertisements (spouses of patients or volunteers asked to participate in the study). Healthy control subjects were age-, education- and gender-matched to the patients.

Demographic and additional clinical data were obtained from a standard questionnaire given to all participants before entering the additional assessments. At the time of the examination, all patients were taking benzodiazepines (in dose range 2–4 mg equivalent to lorazepam (Sadock and Sadock, 2003)) and seven out of eight were on antidepressant medication (see Table 1).

The severity of present depressive symptoms in patients was rated using the Hamilton Rating Scale for Depression (HAMD – 17 items) (Hamilton, 1960), administered by a trained clinician. The HAMD scores were later correlated to the gait characteristics.

All study participants gave their informed consent to participate in the study. The research protocol was approved by the Medical Ethics Committee of Clinical Center of Serbia. The study was performed in accordance with the ethical standards of the Declaration of Helsinki and its later amendments.

2.2. Experimental protocol

The cognitive and motor demands of gait performance were explored using dual task methodology. Gait was measured with and without performing concurrent cognitive and motor tasks. The participants performed

(i) a basic, simple walking task,
(ii) a dual-motor task – comprised of walking with a glass cup fully filled with water with the aim not to spill the water, allowing the use of one or both hands,
(iii) a dual-mental task – serial "7" subtraction while walking (100–7=?, then −7=?, and so on…), and
(iv) a combined, concomitant motor+mental task while walking – performing serial subtractions while walking with the glass of water. Participants in both groups received no instruction on prioritizing given tasks while walking.

Participants performed six passes on the GAITRite electronic carpet, three times down the corridor and back to the starting point at preferred, comfortable usual walking speed (Fig. 1). Walking distance was approximately 50 m (6 passes × 8–9 m) for each given task (BASE walk, MOTOR task, MENTAL task and COMBINED

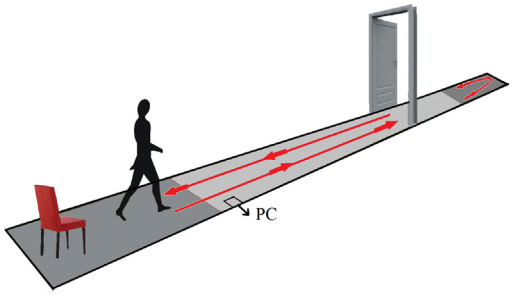

Fig. 1. Pathway during performance of the walking tasks. Lighter zone of the pathway presents the electronic carpet where footprints were being recorded.

Table 1
Patients' characteristics.

Age	Gender	Diagnosis (ICD-10)	Age at first diagnosis	No of episodes	HAM-D	Antidepressants	Dosage (mg)
38	M	F32.2	38	1	23	Paroxetine	20
37	F	F33.2	31	3	20	Escitalopram	15
56	F	F.33.2	36	7	24	Clomipramine	100
46	F	F33.2	39	2	28	Maprotiline	200
55	F	F33.2	52	3	26	Maprotiline	150
46	F	F33.2	19	3	19	Sertraline	50
						Mirtazapine	30
51	M	F33.2	25	11	16	Paroxetine	20
46	M	F33.2	36	4	29	–	–
46.87	Mean		**34.50**	**4.25**	**23.17**		
7.02	S.D.		**9.90**	**3.24**	**4.55**		