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Functional recovery and rehabilitation of postural impairment and gait ataxia in patients with acute cerebellar stroke

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ABSTRACT

Studies about recovery from cerebellar stroke are rare. The present study assessed motor deficits in the acute phase after isolated cerebellar stroke focusing on postural impairment and gait ataxia and outlines the role of lesion site on motor outcome, the course of recovery and the effect of treadmill training. 23 patients with acute and isolated cerebellar infarction participated. Deficits were quantified by ataxia scores and dynamic posturography in the acute phase and in a follow up after 2 weeks and 3 months. MRI data were obtained to correlate lesion site with motor performance. Half of the patients that gave informed consent and walked independently underwent a 2-week treadmill training with increasing velocity. In the acute phase patients showed a mild to severe ataxia with a worse performance in patients with infarction of the superior in comparison to the posterior inferior cerebellar artery. However, after 3 months differences between vascular territories were no longer significant. MRI data showed that patients with larger infarct volumes had a significantly more severe ataxia. In patients with ataxia of stance, gait and lower limbs lesions were more common in cerebellar lobules IV to VI. After 3 months a mild ataxia in lower limbs and gait, especially in gait speed persisted. Because postural impairment had fully recovered, remaining gait ataxia was likely related to incoordination of lower limbs. Treadmill training did not show significant effects. Future studies are needed to investigate whether intensive coordinative training is of benefit in patients with cerebellar stroke.

1. Introduction

Only 2–3% of ischaemic strokes are isolated infarctions of the cerebellum [1,2]. In contrast to brainstem or neocortical infarction, symptoms of cerebellar infarction are often non-specific and moderate, like nausea, dizziness or headache. As a challenge in diagnosis the characteristic limb ataxia only occurs in 40% [1,3,4]. Previous studies described a functional compartmentalization of the human cerebellum, indicating that various areas within the cerebellum have different functions corresponding to their afferent and efferent connections [1,3,5]. Therefore, infarctions of different areas in the cerebellum lead to distinct symptoms. The superior cerebellar artery (SCA) supplies the superior cerebellum from hemispheral and vermal lobule I to parts of lobule VII and most of cerebellar nuclei. Infarction of the SCA causes pronounced limb ataxia combined with gait ataxia when a cerebellar hemisphere is affected and dysarthria when paravermal regions are affected. The posterior inferior cerebellar artery (PICA) supplies the more inferior parts of the cerebellum and parts of the dentate nucleus. Infarction of the PICA leads to gait and postural instability, nystagmus and vertigo [1,5]. In general, patients with infarction of the SCA seem to have a poorer outcome in motor functions than patients with infarction of the PICA [2,6,7].

The present study focused on functional recovery of postural impairment, gait and limb ataxia after acute cerebellar stroke. Recent lesion studies using voxel based lesion symptom mapping showed a significant correlation of lower limb ataxia with lesions of vermal and hemispheral lobules III to IV and of ataxia of posture and gait with lesions of vermal lobules II to IV [8]. The territory of the SCA includes all these regions. Therefore, it is one hypothesis of the present study, that the impairment of posture and gait may be

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pronounced in patients with SCA infarction. According to a previous study in patients with cerebellar tumours, a poorer outcome in patients with an involvement of cerebellar nuclei was expected, too [9]. A further expectation was a good recovery from symptoms according to a prior study focusing on ataxia of the upper limbs in the same patient group as in the present study [10]. Standardized ataxia scores and dynamic posturography were used to quantify the impairments. In order to correlate the motor deficits with the lesion site voxel based lesion symptom mapping was applied. There are several studies which investigate the rehabilitation of patients suffering from neocortical infarction [11–13]. In contrast, rehabilitation programmes for patients after cerebellar stroke are rare. So far the effects of special rehabilitation programmes like balance training, coordination training or treadmill training are only examined in patients with chronic cerebellar degeneration [14–17]. Therefore, in another part of the present study, according to a well-established approach in patients with hemiparetic stroke [12], an effect of treadmill training with increasing velocity on ataxia of gait and posture should be examined.

2. Subjects and methods

2.1. Subjects

A total of 23 patients with acute, isolated cerebellar stroke (6 females and 17 males, mean age 58.6 ± 13.5 yrs) and 13 healthy age-matched controls (4 females and 9 males, mean age 59.3 ± 10.5 yrs) were enrolled in this study. In detail, ten patients presented with a stroke in the territory of the superior cerebellar artery (SCA) and 13 patients had a stroke of the posterior inferior cerebellar artery (PICA). On initial presentation, eleven of 23 patients showed cerebellar lesions that included the cerebellar nuclei. Only patients with an isolated cerebellar stroke were included in the study, verified by an initial MRI scan. Mean duration from diagnosis of stroke until enrolment in the study was 12.4 ± 11.7 (range 1–41) days. Most of the patients and control subjects of the present study have already been examined in a recent study of recovery of upper limb ataxia [10]. In a multicentre-study patients were recruited from the university hospital in Essen and five other neurological hospitals in the surroundings. Fig. 1 gives a detailed explanation of the relationship of patients of the acute stage, of the follow-up investigation and treadmill training. A detailed description of the patients' characteristics is given in Table 1. All subjects gave their written informed consent prior to their inclusion in the study. The study was approved by the local ethics committee and has therefore been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments.

Table 1
Patient characteristics, type, and side of stroke and clinical ataxia score.

Patient	Age (yr)	Gender	Stroke	Side	International Cooperative Ataxia Rating Scale, total score		
					Session 1	Session 2	Session 3
01	77	M	SCA	Right	18	2	2
02	59	M	SCA	Left	8	–	–
03	81	M	SCA	Left	37	–	–
04	71	M	SCA	Right	22	11	3
05	55	M	SCA	Left	6	2	1
06	43	M	PICA	Right	6	4	4
07	44	M	PICA	Left	2	0	0
08	49	M	PICA	Right	3	0	0
09	55	M	SCA	Right	42	23	16
10	48	F	SCA	Right	5	2	0
11	46	F	PICA	Left	16	7	2
12	83	F	SCA	Left	46	–	–
13	60	M	PICA	Left	14	9	8
14	61	M	SCA	Right	62	43	25
15	75	F	PICA	Right	11	6	0
16	59	M	PICA	Right	9	9	5
17	82	F	SCA	Left	20	20	18
18	47	M	PICA	Left	5	4	0
19	61	M	PICA	Right	13	12	4
20	48	F	PICA	Right	6	–	–
21	42	F	PICA	Right	9	–	–
22	58	F	PICA	Left	6	–	–
23	44	F	PICA	Left	6	–	–

F indicates female; M, male; PICA, posterior inferior cerebellar artery; SCA, superior cerebellar artery.

2.2. International Cooperative Ataxia Rating Scale (ICARS)

Cerebellar symptoms were quantified using the International Cooperative Ataxia Rating Scale (ICARS) of the World Federation of Neurology [18]. ICARS ranges from 0 (no ataxia) to 100 (strongest ataxia) and comprises four main clinical core symptoms: "posture and gait disturbances", "kinetic functions", "speech disorders" and "oculomotor disorders". As it has been reported previously the scores were subdivided into "gait" (max. score 12), "posture" (max. score 18) and "lower limb" (max. score 16) to describe more in detail the relevant ataxia for the applied methods [9]. Additionally, the "gait" score was subdivided into the parameters "walking capacities" and "gait speed".

2.3. Dynamic posturography

Postural stability was examined by dynamic posturography using the Sensory Organization Test (SOT) of the EquiTest® system (NeuroCom Inc., Portland, OR) and might be regarded as an advanced version of the Romberg Test. The application of SOT for

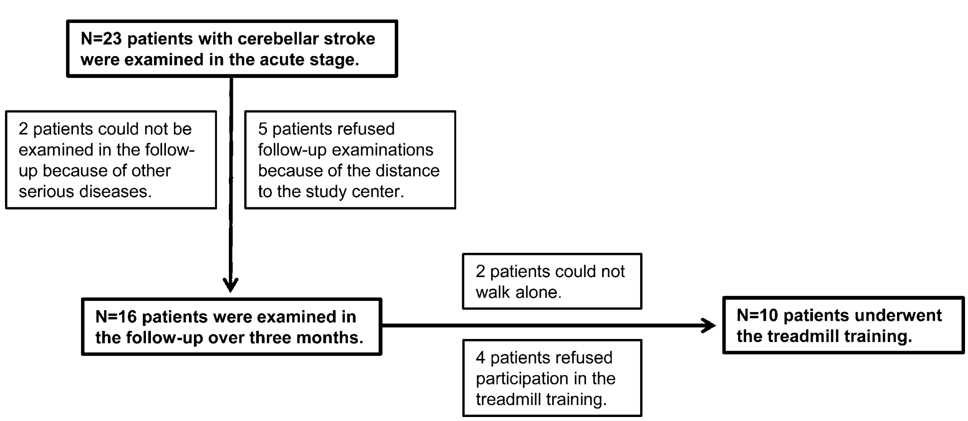

Fig. 1. Flow chart with an explanation of the relationship of patients of the acute stage, of the follow-up investigations and treadmill training and reasons for the loss of patients.