RESEARCH ARTICLE

Physiotherapy, Based on the Bobath Concept, May Influence the Gait Pattern in Persons with Limb-Girdle Muscle Dystrophy: A Multiple Case Series Study

Kjellaug Øygard[1]*, Helge Hæstad[2] & Lone Jørgensen[3]

[1]Section of Physiotherapy, Department of Clinical Therapeutic Services, University Hospital of Northern Norway, Tromsø, Norway

[2]Section of Physiotherapy, Department of Clinical Therapeutic Services, University Hospital of Northern Norway, Tromsø, Norway, and National Neuromuscular Centre, Tromsø, Norway

[3]Section of Physiotherapy, Department of Clinical Therapeutic Services, University Hospital of Northern Norway, Tromsø, Norway, and Institute of Community Medicine, University of Tromsø, Tromsø, Norway

Abstract

Background and Purpose. There are few studies on possible effects of physiotherapy for adults with muscular dystrophy. The aim of this study was to examine if treatment based on the Bobath concept may influence specific gait parameters in some of these patients. **Methods.** A single-subject experimental design with A–B–A–A phases was used, and four patients, three with limb-girdle muscular dystrophy (LGMD) and one with fascioscapulohumeral muscular dystrophy (FSHD), were included. The patients had 1 hour of individually tailored physiotherapy at each working day for a period of 3 weeks. Step length, step width and gait velocity were measured during the A–B–A–A phases by use of an electronic walkway. Walking distance and endurance were measured by use of the '6 minute walk test'. **Results.** The three LGMD patients, who initially walked with a wide base of support, had a narrower, velocity-adjusted step width after treatment, accompanied with the same or even longer step length. These changes lasted throughout follow-up. Moreover, two of the patients were able to walk a longer distance within 6 minutes after the treatment period. The fourth patient (with FSHD) had a normal step width at baseline, which did not change during the study. **Conclusions.** The results indicate that physiotherapy treatment based on the Bobath concept may influence the gait pattern in patients with LGMD. However, in order to evaluate the effectiveness of physiotherapy to patients with muscular dystrophies, we call for larger studies and controlled trials. Copyright © 2010 John Wiley & Sons, Ltd.

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***Correspondence**

Kjellaug Øygard, Physiotherapist, Section of Physiotherapy, University Hospital of North Norway, N-9038 Tromsø, Norway.

Email: Kjellaug.Oygard@unn.no

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Introduction

Muscle dystrophy is a group of inherited disorders, all characterized by variable degrees and distribution of muscle wasting and weakness (Bakker et al., 1995; Emerly, 2002). Muscular dystrophies include limb-girdle muscular dystrophy (LGMD), where weakness affects mainly the proximal limb-girdle musculature, and fascioscapulohumeral muscular dystrophy (FSHD), where the facial and shoulder girdle, but later also the leg and pelvic muscles become involved (Emerly, 2002). In both LGMD and FSHD, the progression of weakness is usually slow and occurs over years. Several genes that cause the disorders have been identified, but so far the identification of these gene/protein abnormalities has not changed patient care. Thus, because no curative genetic or pharmaceutical treatments are available, care is directed at the symptomatic impairments (Pandya et al., 2008; Stübgen, 2008).

Physiotherapy may be important in order to maintain as much muscle function as possible, and help the patients to function at their highest level within the constraints imposed by the disorders. Previous studies have shown that exercise can improve muscle strength and endurance in persons with LGMD and FSHD (van der Kooi et al., 2004; Olsen et al., 2005; Dawes et al., 2006; Sveen et al., 2007). However, to the best of our knowledge, no study has examined whether specific physiotherapy approaches (such as the Bobath concept) may influence the gait pattern in these patients.

A neuromuscular disease often leads to compensatory movement strategies. Some of these strategies might limit underlying potential. Within the Bobath concept, one objective is to identify potentially limiting strategies and to guide the patient towards more efficient ways of moving and performing different task (Graham et al., 2009; http://www.ibita.org/). Aspects such as postural orientation, components of movement, alignment, coordination and functional sequences of movement are addressed (Graham et al., 2009), and facilitation (defined as specific sensory information to make motor performance easier) is often used in treatment. Empirically, gait function might be improved in persons with muscular dystrophies as a result of the treatment, but studies on this prospect are lacking.

The aim of this study was to examine if specific gait parameters in persons with LGMD or FSHD can be influenced by physiotherapy based on the Bobath concept.

Method

Design

We used a single-subject experimental design (SSED), where each patient serves as her or his own control, similar to time-series design (Morley, 1989; Payton, 1992; Domholdt, 2000). The patients were exposed to a treatment phase (B-phase) and to non-treatment phases (A-phases). Their performance was measured several times during each phase (Morley, 1989; Wasson, 2008).

The patients were followed closely during 12 weeks, and tested in each phase as follows:

- A-phase (baseline): weeks 1–3; two test series per week
- B-phase (treatment): weeks 4–6; one test series per week
- A-phase (follow-up 1): weeks 7–9; two test series per week
- A-phase (follow-up 2): 3 weeks, ranging from weeks 11–13 to weeks 17–19; two test series per week (the time of the follow-up phase differed somewhat because of public holidays)

One therapist did all the assessments. The assessments were undertaken at the same time of the day and in the same sequence each time. Another therapist, a clinical specialist in neurological physiotherapy and a Bobath basic course instructor treated the patients during phase B.

Patients and intervention

Patients with muscle dystrophy affecting the proximal muscles, who were 18 years or older and living in Troms, Norway were eligible for the study. Other inclusion criteria were capability to walk without personal support for 6 minutes, and ability to walk at least 10 m without walking aids. The exclusion criteria were other diseases that may affect balance and gait (e.g. stroke).

The patients were recruited from the Department of Neurology, University Hospital of Northern Norway by a medical doctor who sent a letter of invitation to all persons registered with muscular dystrophy diagnoses ($n = 19$). The leader of the local branch of The Muscular Dystrophy Organization sent a similar letter to their members with muscular dystrophy (n = 60, of whom some were also registered in the hospital). The information letter informed about the aim of the study; the criteria for exclusion; and that transportation to the hospital on the days of examination, as well as accommodation during the treatment phase, would be provided. Nine persons wanted to participate. Among these, five did not fulfill the inclusion criteria; three lived in another community, one was under 18 years old, one had finished rehabilitation at our hospital less than 1 month ago. This left us with four individuals (three with LGMD and one with FSHD). They were all included in the study. The regional ethical committee approved the study, and the patients gave written informed consent.

All patients received 60 minute physiotherapy treatment on each of 15 consecutive working days. The treatment was based on the Bobath concept as defined by the International Bobath Instructors Training Association and described by Gjelsvik (2008). Treatment focused on functional tasks and motor learning, and was individually tailored to each patient. Tasks were chosen based on the patient's goals. Specific movement control was trained both as preparation for and as part of task performances. A general aim was to enable and challenge the patient to recruit neuromuscular activity in patterns where movements within and in between body segments where optimally co-ordinated according to the tasks for the individual patient.

Patient A, a 35-year-old woman with LGMD (type 2i), was able to walk unaided inside her house. For longer distances, she used an electrical wheelchair. In order to stand up from the wheelchair, she had to elevate the seat to the level of her hips in the standing position. In standing, she could only flex her knees to about 5 degrees before she collapsed. In all activities where her balance was challenged, the neck was held stiffly and the arms were held in a fixed position against the thorax. She walked with a very wide step width and hyper-extended knees. During walking, the patient had difficulty in bringing her weight diagonally forwards over the standing leg. In order to weight transfer, the thorax and the shoulder girdle were moved extremely laterally with only minimal lateral movement of the pelvis.

The patient's goal was to improve her balance and arm function. She hoped that this could also influence her ability to walk.

An important aim of the treatment was to improve the coordination within the trunk and between the trunk, the neck and the arms during different tasks in sitting. Treatment was also focused on postural alignment during walking. This was manually facilitated by the therapist. Afterwards, the patient tried to integrate the new movement experiences in independent walking.

Patient B, a 43-year-old woman with FSHD, walked with a narrow base of support and hyper-extension of the right knee. In order to reduce the degree of hyperextension, she used a knee orthosis. In the stance phase on the right leg, the hip fell rapidly into a mechanically locked position in adduction, combined with anterior pelvic tilt and increased lumbar lordosis. There was no observable abductor or extensor activity of the hip muscles. She was only able to elevate her right arm to 90 degrees and had no visible stabilization of the scapula towards the thorax. The neck and thorax were held in a fixed position in relation to each other.

The patient worked in an office. Her goals for the treatment were to be able to sit with less effort and to prevent pain in her right knee.

The main focus in treatment was to improve the stability of the scapula and the coordination between the eyes, neck and thorax in relation to different arm activities. In standing, treatment focused on knee and hip control.

Patient C, an 18-year-old man with LGMD (no specific subgroup), walked with very wide step width and the pelvis posteriorly tilted. In walking, the centre of gravity was well behind the normal line, and in the stance phase the hips fell rapidly into a mechanically locked position in adduction. The mobility of the ankles, foot joints and toes was reduced, and he was mainly weight bearing on the lateral borders of the feet. In all activities where his balance was challenged, he stiffened his trunk and held the arms in a fixed position against the thorax.

Patient C wanted to improve his balance during walking in order to walk with less effort between his home and his friends.

Treatment was particularly focused on trunk control during walking. Moreover, the feet were mobilized in order to prepare for more flexibility during weight bearing. Segmental movement control of the neck, thorax and lumbar area was trained in sitting as preparation for facilitated, as well as independent, walking.

Patient D, a 55-year-old man with LGMD (type 2i), walked unaided, but in order to stand up from sitting he had to push off with his arms. He reported that stair climbing and walking uphill were very difficult, but that he had no problems walking on a flat and even surface. However, he was very worried that his feet should catch unforeseen objects, resulting in a fall. He walked with a very wide step width and with the centre of gravity well behind the normal line. The pelvis was anteriorly tilted, and in the stance phase the lumbar lordosis increased.

Treatment was particularly focused on the ability to create a strong stance phase as a pre-requisite for a more automatic swing phase. The therapist facilitated both single steps and continuous walking, and had particular focus on coordination between the eyes, neck and thorax. Diagonally weight transfer over the standing leg was emphasized.

Procedure

GAITRite

Gait parameters were measured using a pressure sensitive 5 m long electronic walkway (GAITRite, CIR Systems Inc., Clifton, NJ, USA). The subjects walked without shoes and did not use walking aids. To ensure that acceleration and deceleration were not a part of the tested walk, the patient started to walk 1 m before the beginning of the walkway, and continued walking 1 m after the end of the walkway. Before data registration, the patients performed one walk on the walkway in order to become accustomed with the test. In the test session, each patient performed six walks: two walks at slow speed, two walks at preferred comfortable speed and two walks at fastest possible speed at which the person felt safe. Step length and step width were registered for each speed. Gait velocity was registered for slow, maximal and preferred speed. Step length was calculated as the distance (cm) between two successive heel centre contacts of opposite feet. Step width (cm) was calculated as the right angle distance from a footmark to a straight line connecting the previous and the next contra-lateral footfalls.

When data are obtained from repeated trials representing different walking speeds, individual curve estimates can be calculated for each variable over the speed range demonstrated by that subject. From each curve, a point estimate at a normalized speed can be chosen for comparison. We reported step width and step length at a normalized speed of $0.5\ m{\cdot}s^{-1}$ for all the participants. In this way, comparisons between test occasions could be done without the confounding effect of walking speed (Moe-Nilssen, 1998). Results from the GAITRite have shown strong test–retest reliability and concurrent validity for healthy adults (Bilney et al., 2003).

Six-minute walk test

The primary measure is the distance walked within 6 minutes (Enright, 2008). The patient turns after a distance of 20 m. Immediately after the test, perceived exertion was scored using the Borg rating of perceived exertion scale (RPE) (Borg, 1982, 1998). The RPE is a 15-point graded scale, ranging from 6 (no exertion) to 20 (maximal exertion).

Tandem stance test

The ability to maintain balance in parallel, semi-tandem and tandem stances during 10 seconds is tested. The maximal score for each of the tree positions is 10 points, which gives a maximal total score of 30 (Berg et al., 1989; Jonsson et al., 2005).

The patient's global impression of change (PGIC) and the therapist's clinical global impression of change (CGIC)

The patient's and the therapist's impressions of change after treatment were rated according to the PGIC and the CGIC, respectively. After the treatment phase, the patient and therapist were asked to describe their impression of change as follows: very much improved, much improved, improved, minimally improved, no change, minimally worse, worse, much worse, very much worse (Farrar et al., 2001).

Semi-structured interview

After the treatment phase, the patients were interviewed. The interview included questions about treatment effects regarding balance, gait and general movement.

Data analysis

Analyses of the data were visually illustrated by graphs. Statistically significant changes were defined according to the 2 SD band method; if at least two consecutive data points after the baseline phase fall outside the 2 SD range, this indicates that there has been a significant change in performance (Gottman and Leiblum, 1974; Ottenbacher, 1986, 1992; Nourbakhsh and Ottenbacher, 1994).

Results

Table 1 shows the results of the gait and balance tests at baseline, during treatment and at follow-up.

Table 1. Test data of patients A–D at baseline, treatment and follow-up 1 and 2

	Baseline	Treatment	Follow-up 1	Follow-up 2
Step width (cm), at 0.5 $m \cdot s^{-1}$, mean (SD)				
Patient A	24.4 (0.6)	21.7 (2.8)	20.7 (0.6)	20.4 (3.2)
Patient B	7.1 (1.3)	6.6 (0.5)	6.9 (0.8)	8.2 (0.6)
Patient C	18.0 (0.8)	15.0 (2.4)	14.4 (0.9)	15.4 (0.5)
Patient D	13.7 (0.4)	11.6 (0.7)	11.3 (0.5)	11.8 (0.5)
Step length (cm), at 0.5 $m \cdot s^{-1}$, mean (SD)				
Patient A	46.2 (0.5)	46.3 (0.5)	46.5 (0.3)	46.2 (0.3)
Patient B	47.0 (0.9)	47.1 (0.4)	47.3 (1.2)	46.6 (0.9)
Patient C	44.7 (1.2)	42.1 (0.4)	42.6 (0.6)	44.3 (0.7)
Patient D	39.8 (0.5)	42.9 (1.1)	41.3 (0.4)	42.3 (1.0)
Maximal gait velocity ($m \cdot s^{-1}$), mean (SD)				
Patient A	0.8 (0.0)	0.8 (0.0)	0.8 (0.0)	0.8 (0.0)
Patient B	1.2 (0.1)	1.3 (0.1)	1.5 (0.0)	1.5 (0.1)
Patient C	1.1 (0.0)	1.1 (0.0)	1.1 (0.0)	1.1 (0.0)
Patient D	1.6 (0.1)	1.6 (0.1)	1.7 (0.0)	1.6 (0.0)
Preferred gait velocity ($m \cdot s^{-1}$), mean (SD)				
Patient A	0.7 (0.0)	0.7 (0.0)	0.7 (0.0)	0.7 (0.1)
Patient B	0.8 (0.1)	0.8 (0.1)	0.8 (0.1)	0.7 (0.1)
Patient C	0.9 (0.1)	0.9 (0.1)	0.8 (0.0)	0.9 (0.1)
Patient D	1.1 (0.2)	1.0 (0.1)	0.9 (0.1)	0.9 (0.1)
Six-minute walk test (m), mean (SD)				
Patient A	243 (4)	255 (2)	262 (4)	250 (9)
Patient B	418 (18)	441 (9)	439 (5)	430 (4)
Patient C	347 (6)	335 (11)	349 (3)	345 (10)
Patient D	473 (5)	476 (6)	490 (6)	493 (5)
Rating of perceived exertion after 6 minute walk test, median (range)				
Patient A	17 (16–19)	14 (13–14)	14 (13–17)	15 (13–16)
Patient B	14 (14–15)	14.5 (14–15)	15 (15–15)	15.5 (15–16)
Patient C	14 (13–15)	14 (13–15)	15.5 (14–16)	15 (14–16)
Patient D	13 (12–14)	13 (13–14)	14 (13–15)	14.5 (14–15)

Patient A

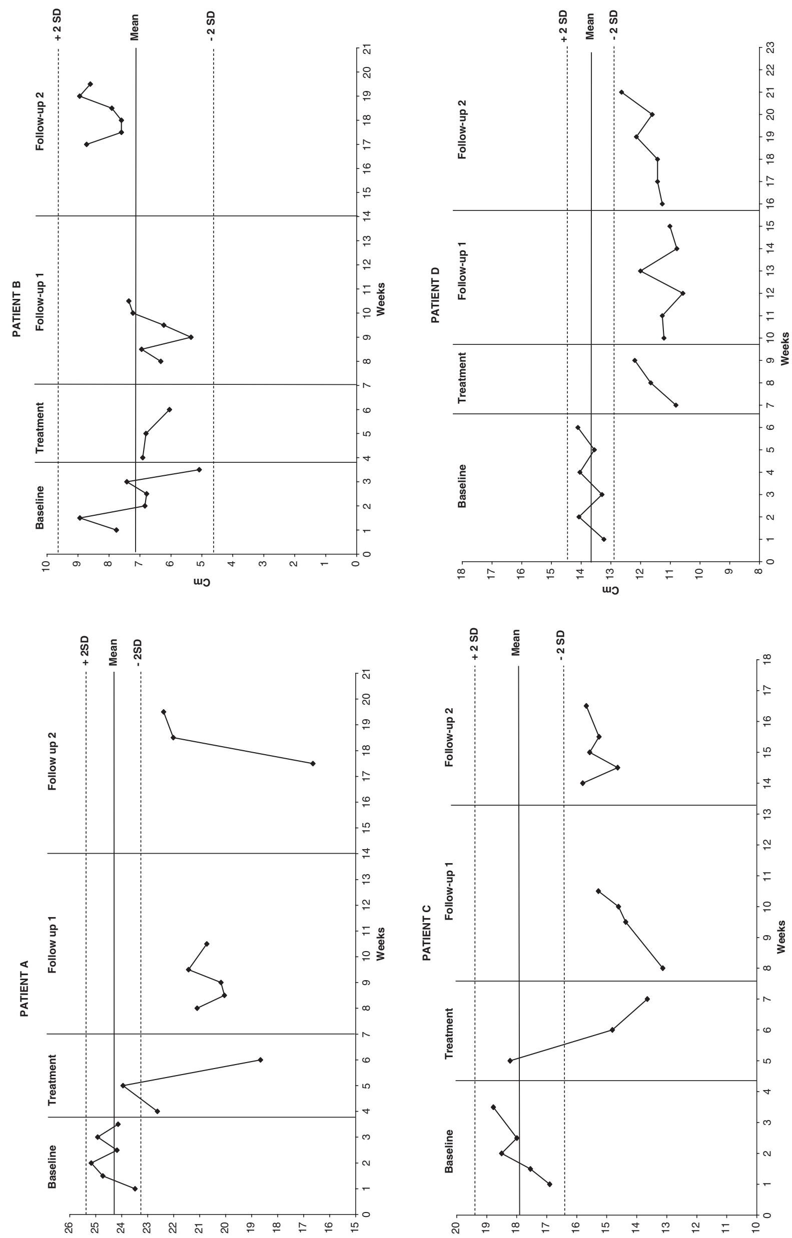
The step width decreased significantly from baseline to follow-up 2 (Table 1; Figure 1). Step length was kept at approximately 46 cm at a normalized speed of 0.5 $m \cdot s^{-1}$ during the whole study (Figure 2). The maximal and preferred walking velocity did not change (Table 1), but the distance walked within 6 minutes improved significantly during treatment and follow-up 1. The tendency at follow-up 2 was similar, but not significant (Figure 3). The patient felt less exerted after the test, both during the treatment period and at follow-up 1 and 2 (Table 1). The PGIC score was rated as 'very much improved', and the CGIC as 'improved' (Figure 4).

In the semi-structured interview, patient A reported that she moved with less effort. She experienced increased mobility, better balance and less pain, and could breathe more freely. While walking, she felt like 'floating down the corridor' and that the joy of moving had returned. Earlier, she felt that she walked like a drunken person, but this was not the case after treatment. Moreover, it was easier to stand up from a chair, and she was less afraid of falling.

Patient B

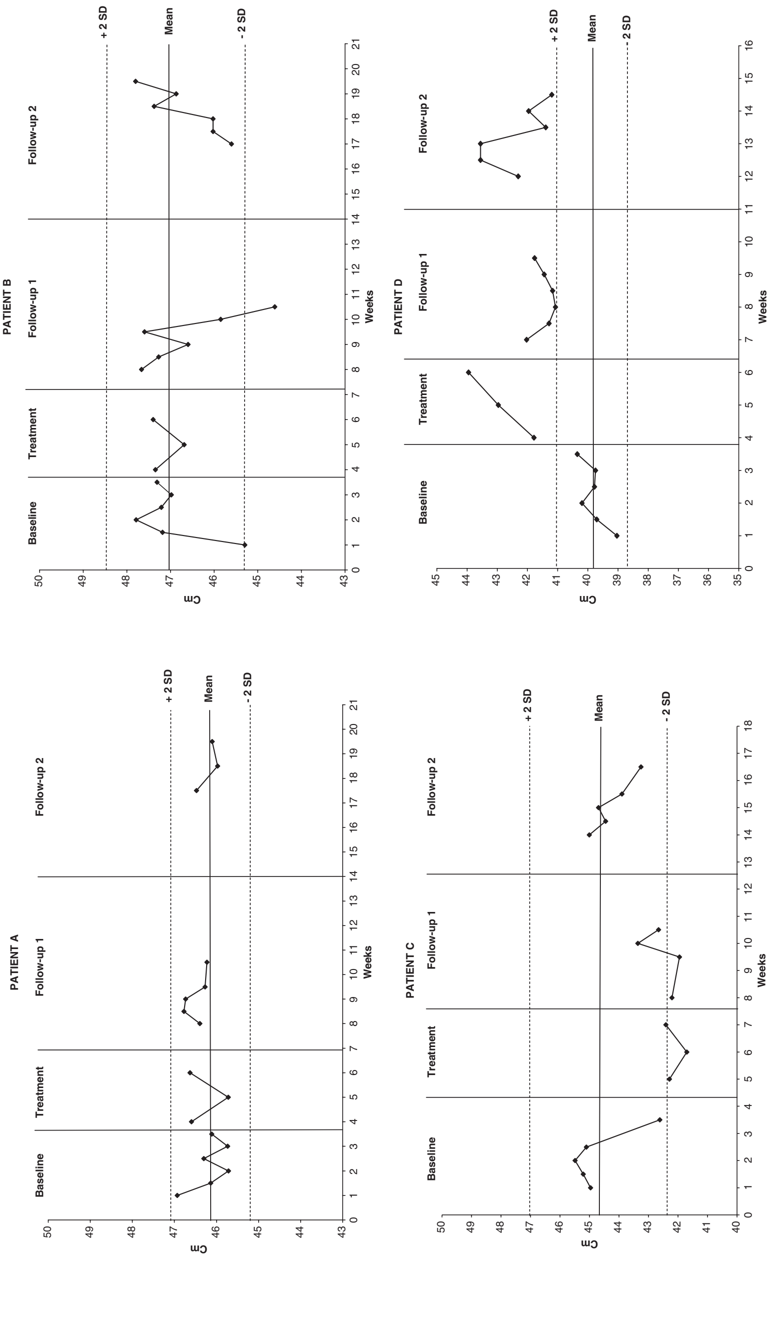
No major changes were found. The step width remained at about 6–8 cm throughout the study, and the step length did not change (Table 1; Figures 1 and 2). Because of knee pain, she was unable to perform the 6 minute walk test the last four times at follow-up 2 (Figure 3). The PGIC score was rated as 'minimally improved', and CGIC as 'no change' (Figure 4).

In the interview, patient B reported that her ability to walk without hyper-extension in the right knee had



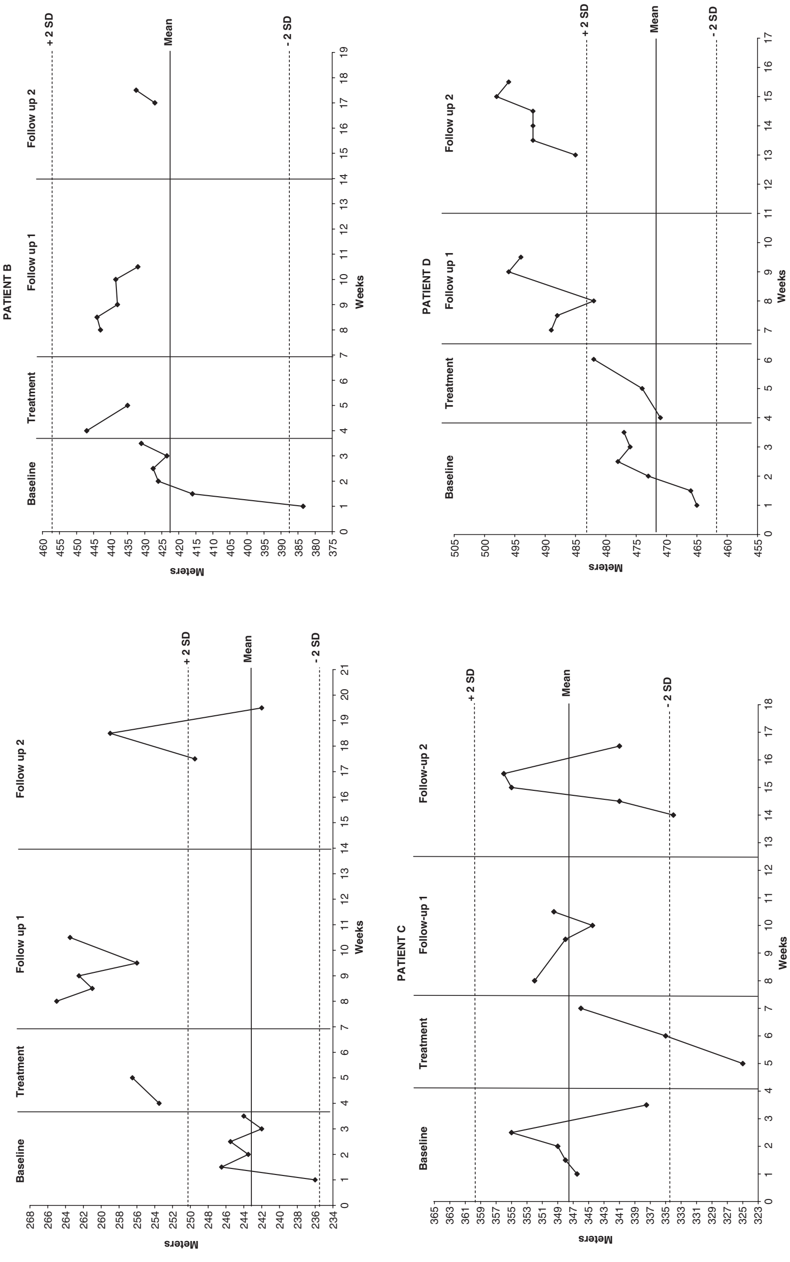
* Note that the scale on the axis differs between patients

Figure 1 Step width (cm) at baseline, treatment and follow-up 1 and 2



* Note that the scale on the axis differs between patients

Figure 2 Step length (cm) at baseline, treatment, follow-up 1 and 2



* Note that the scale on the axis differs between patients

Figure 3 Six minutes walk test. Walking distance (m) at baseline, treatment and at follow-up 1 and 2

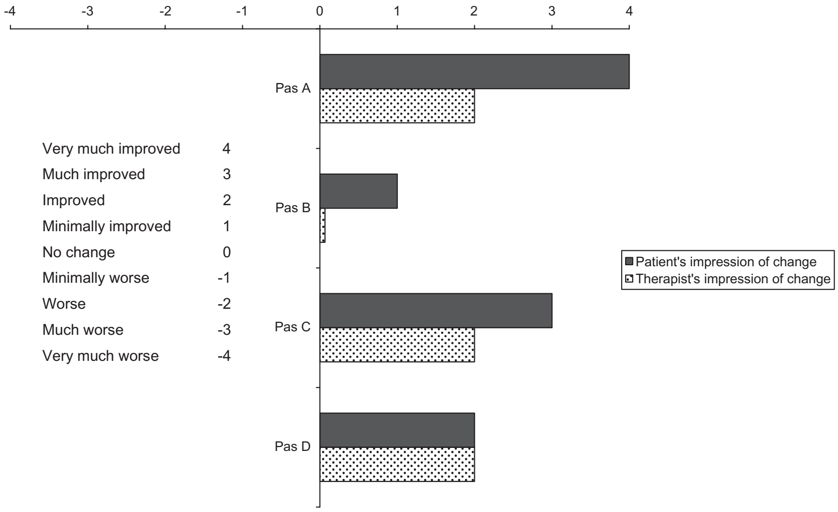


Figure 4 The patient's impression of change and the therapist's global impression of change after treatment

improved slightly. Moreover, she had reduced stiffness of the neck and felt less dizzy.

Patient C

The step width changed significantly from baseline to follow-up 1 and 2 (Table 1; Figure 1). The step length was slightly reduced during treatment, but unchanged at follow-up 2 (Figure 2). The maximal and preferred walking velocity did not change (Table 1). Neither did the distance walked during 6 minutes (Table 1). There was high variability in walking distance during the whole study period (Figure 3).

The PGIC score was rated as 'much improved', while the CGIC as 'improved' (Figure 4).

In the interview, patient C reported that he walked better on flat ground, but felt that his walking speed was somewhat reduced.

Patient D

The step width decreased and step length increased significantly during treatment and at both follow-up phases (Table 1; Figures 1 and 2). The maximal and preferred walking velocity did not change (Table 1). The walking distance within 6 minutes had increased significantly at the two follow-up phases (Table 1; Figure 3). The PGIC, as well as the CGIC, was rated as 'improved' (Figure 4).

In the interview, patient D reported that he could walk more fluently and longer. He felt safer when walking on a flat surface, and his ability to climb stairs had improved.

All four patients achieved full score in the tandem test throughout the study (results not shown).

Discussion

The present pilot study indicates that physiotherapy based on the Bobath concept might have an impact on some specific gait parameters in patients with LGMD. Thus, the three patients initially walking with a wide base of support had a narrower step width after treatment. These changes lasted throughout follow-up which might indicate a long-term treatment effect (Shumway-Cook and Woollacott, 2007). Moreover, two of these patients were able to walk a longer distance within 6 minutes immediately after the treatment period. However, the maximal and preferred walking velocity measured on the electronic walkway did not change significantly, and in the fourth patient (with FSHD) all the gait parameters were unchanged.

Poor balance can reveal different, and sometimes opposite gait patterns (Whittle, 1991). Examples are the wide base of support often seen in cerebellar ataxia and the scissoring gait seen in some patients with cerebral palsy and dystonia. Therefore, in some patients, the ability to walk with a narrower step width may be a sign of better balance, whereas in others a wider step width may be regarded as an improvement. Step width varies greatly between individuals, but is on average about 7 cm (Trew, 1997). Patients A, C and D had a mean step width ranging from 14 to 24 cm at baseline that decreased significantly after treatment. Because gait parameters such as step width and step length vary with speed (Andriacchi et al., 1977), these variables were adjusted for gait velocity. Patient B (with FSHD) had a normal step width (7 cm) at baseline that did not change during the study. One important aim of the treatment was to improve postural control and help the patient to gain more efficient movement patterns. We hypothesize that the velocity-adjusted narrower step width at follow-up in patients A, C and D, accompanied by the same (patients A and C) or even longer step length (patient D), is related to a better balance. However, it must be noted that this interpretation is not based on objective data. Because our patients belong to a deconditioned population with a mixture of primary muscle weakness and disuse atrophy, it is also possible that the changes were caused by increased muscle strength. Moreover, other factors (e.g. range of joint motion, fear of falling) may have contributed to the change in gait pattern. The primary aim of this study was to examine possible changes in gait parameters, and the underlying causes were not examined.

Patients A and D both walked longer in the 6 minute walk test at follow-up 1. However, they did not increase their preferred or maximum walking velocity measured at the electronic walkway. This appears to be a contradictory result. It might, however, be explained by the fact that the 6 minute walk test, in addition to speed, also requires endurance. Patients A and D may have improved their endurance partly because of a more efficient walking pattern. The treatment did not affect the walking distance in patients B and C.

We considered SSED to be an appropriate design for the study of individualized physiotherapy to patients with muscular dystrophies. First, because only a few persons were available as participants in the study, and, second, because of the large variability in functional status among persons with this disease. SSED can give a deep impression of changes in few individuals (Domholdt, 2000), and might give better advice in guiding treatment for individual patients than clinical trials (Mant, 1999). However, one limitation of the single-subject research design is the limited generalizability or external validity of the study results. Thus, although we found that individualized Bobath treatment seemed to influence the gait pattern in the three patients with LGMD, the result cannot be generalized to a broad population of these patients. Another limitation of the present study is that the data collector had not been blinded to the purpose of the study. Theoretically, this could have influenced the results, although the measurements we used (e.g. GAITRite data) were considered to be objective, and therefore hardly affected by the tester's opinion.

To optimize stability in the data, each test was performed six times during baseline and in each follow-up phase. Still, a learning effect at baseline might have influenced the SD and through this influenced the calculation of significant results. During the treatment phase, the patients were assessed three times. It may be discussed whether our study would have been strengthened if we had tested the patients six times also in the treatment period in order to get a more detailed picture of the effects. However, we were concerned that this, in addition to intensive treatment, would have been too strenuous for the patients. Furthermore, although a treatment period of 3 weeks seems rather short, the duration is similar to that at our hospital. This makes the results more directly valuable in the clinical setting.

A key feature of the Bobath approach is to guide the patient towards recruiting optimal movement patterns as basis for solving different tasks (Gjelsvik, 2008). The quality of movements is difficult to standardize, and several possible benefits, such as changes in postural alignment during gait and movements of the upper limbs, trunk and head, were not measured in our study. Registration of movements, for instance with an accelerometer, video recordings and EMG measurements would have given some information about actual changes in postural control. Moreover, one of the tests we used (the tandem test, thought to measure balance) had a clear ceiling effect and was not sensitive enough to register changes.

Implications for practice and research

The results of the present study indicate that physiotherapy treatment based on the Bobath concept may influence the gait pattern in patients with LGMD. However, in order to evaluate the effectiveness of physiotherapy to patients with muscular dystrophies, we call for larger studies and controlled trials.

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