



Factors negatively affecting falling in patients with neuromuscular diseases: a prospective study

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Research Report

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Purpose: The aims of this study were to compare the muscle strength, mobility level and quality of life in faller and non-faller patients with neuromuscular diseases and to determine the correlation of these parameters with falling frequency. **Material and methods:** Eighty patients (49: faller, 31: non-faller) with various neuromuscular diseases, who applied to a neurological rehabilitation outpatient clinic, were included to this prospective study. **Results:** There was a significant difference in the health related quality of life, particularly in the 'social isolation' and 'physical activity' parameters and in the isolated hip flexors, knee extensors and ankle dorsiflexors (right and left) muscle strength, without any significant difference between total lower extremity muscle strength results, of the subjects in the faller and non-faller groups ($p < 0.05$). Falling frequency was found to be correlated with fear of falling ($r = 0.437$), both right and left knee extensors muscle strength ($r = -0.388$ ($p < 0.05$) and $r = -0.419$ ($p < 0.05$), respectively). **Conclusion:** Although the hip flexors, knee extensors and ankle dorsiflexors muscle strength results were lower in the faller subjects, only the knee extensors muscle strength was found to be an important factor affecting falling frequency in patients with neuromuscular diseases.

Key words: Neuromuscular diseases, Falling, Risk factors.

Nöromusküler hastalarda düşmeyi olumsuz yönde etkileyen faktörler: prospektif çalışma

Amaç: Bu çalışma düşen ve düşmeyen nöromusküler hastalarda kas kuvveti, mobilite düzeyi ve yaşam kalitesinin karşılaştırılması ve bu parametrelerin düşme frekansı ile korelasyonunun belirlenmesi amacıyla planlandı. **Gereç ve yöntem:** Bu çalışmaya nörolojik rehabilitasyon kliniğine başvuran çeşitli nöromusküler hastalık tanısı ile izlenen 80 hasta (49: düşen, 31: düşmeyen) dahil edildi. **Sonuçlar:** Düşen ve düşmeyen hastalar arasında sağlıklı ilgili yaşam kalitesi, özellikle 'sosyal izolasyon' ve 'fiziksel aktivite' parametreleri ve total alt ekstremitte kas kuvvetleri arasında önemli farklılık olmaksızın, izole kalça fleksörleri, diz ekstansörleri ve ayak bileği dorsifleksörleri (sağ ve sol) kas kuvvetleri açısından anlamlı fark bulundu ($p < 0.05$). Hastaların düşme sıklığı ve düşme yeri ($r = 0.437$), sağ ve sol diz ekstansör kas kuvveti arasında anlamlı bir korelasyon saptandı (sırasıyla $r = -0.388$ ($p < 0.05$) ve $r = -0.419$ ($p < 0.05$)). **Tartışma:** Düşen hastaların kalça fleksör, diz ekstansör ve ayak bileği dorsifleksör kas kuvvetleri düşmeyen hastalara göre daha düşük bulunmasına rağmen, sadece diz ekstansör kas kuvveti düşmeyi olumsuz yönde etkileyen önemli bir faktör olarak bulundu.

Anahtar kelimeler: Nöromusküler hastalıklar, Düşme, Risk faktörleri.

Falls result from a complex interaction of intrinsic (patient-related) and extrinsic (environment-related) risk factors.^{1,2} The intrinsic risk factors mainly include age, disease duration, previous falls, fear of falling, psychoactive/antihypertensive medicines, polypharmacy, muscle weakness, decreased mobility level,³⁻⁷ while the extrinsic risk factors comprise of various indoor and outdoor environmental hazards.⁸

Falls are among the primary causes of morbidity in the elderly population. Approximately 30% of the community-living people fall at least once a year,^{9,10} leading to serious injuries such as bone fractures, distortions and dislocations, and head injuries,^{11,12} as well as fear of falling and reducing activities due to fear of falling.¹³ Similarly, falling is the most common complication in patients with various neurological disorders such as Stroke and Parkinson's disease. Approximately 37% of the patients experience at least one fall and 18% two or more falls after a stroke.¹⁴ Fall related injuries, mainly hip fractures due to the presence of hemi- osteoporosis, occur in 13-29% of the patients with stroke.^{14,15} The fall rate was shown to be approximately 46%, in a 3-month follow up, of patients with Parkinson's disease in a meta-analysis study.¹⁶ In a study of Wielinski et al considering the fractures occurred in Parkinson's diseased patients, it was found that 27.8% of all fractures were belong to the hip and pelvis followed by the trunk with a rate of 21.4%.¹⁷

Falls have not been examined extensively in patients with neuromuscular disorders (NMD). Only Pieterse et al have investigated the falls in patients with various groups of NMD.¹⁸ This previous study concluded that falling is more often in patients with NMD when comparing to healthy people. The falls were accompanied by decrease in activities and fear of falling in this group of patients who had fallen. Similarly, the findings of another study including specifically the patients with myotonic dystrophy type 1 found that the patients were more likely to fall and stumble than the healthy control group. Furthermore, it was found that the faller patients have a lower mobility score, slower gait speed and higher depression

scores than the non-faller patients.¹⁹

In the light of the previous studies, it can be said that there are numerous patient and environment related factors negatively affecting falling in patients with NMD. Falls may lead to various physical (i.e. laceration, sprain, dislocation, fractures, concussion) and psychological (i.e. fear of falling, activity restriction, reduced quality of life, depression) destructions as such in other neurological diseases. According to the World Health Organization's (WHO) International Classification of Functioning, Disability and Health (ICF) the participation, which is involvement in a life situation, will be affected due to these physical (body structure) and psychological (body functions) destructions caused by falling.

The factors negatively affecting falling in patients with NMD should be determined in order to assure the safe mobility of the patients by preventing the falls with an appropriate treatment program. Therefore, prevention of falls will most probably help the patients to keep their activity and participation in higher level. The aims of this study were to compare the muscle strength, mobility level and quality of life in faller and non-faller patients with neuromuscular diseases and to determine the correlation of these parameters with falling frequency.

MATERIALS AND METHODS

Participants:

Eighty patients (37 female and 43 male) with various NMD, who applied to neurological rehabilitation outpatient clinic, were included to this prospective study. All patients had signed a written consent at the beginning of this study. Ambulatory patients over the age of 18, diagnosed by a neurologist were included while patients having neurological symptoms and other kind of balance compromising factors were excluded. None of the patients had used walking aids.

The age, gender, disease duration and medication history of the faller and non-faller patients were examined. The patients were classified as fallers if they fall at least two times in

the last 6 months, parallel to the definitions of the previous studies^{4, 20}. Falling was defined as 'An unexpected loss of balance resulting in coming to rest on the floor, the ground or an object below knee level'.²¹

Measurements:

A brief assessor-completed questionnaire of patient report of falls was recorded. The questionnaire were involved questions about; number of falls in the last 6 months (once, twice, three times or more), fear of falling (exist or not exist), reasons of falling (loosing balance, carelessness, stumbling, slipping and giving way of the knee), place of falling (indoor or outdoor) and injurious falling (sprain, laceration, hematoma, fracture, head injury and others).^{8,11,12,22}

The lower extremity muscle strength of the patients was measured with manual muscle strength testing, which was done according to the 0-5 grading system. The total muscle strength were obtained by the summation of eight left and right lower extremity muscle groups (hip flexors, extensors, abductors and adductors, knee flexors and extensors, ankle flexors and extensors). These results were gathered on the right and left side separately and summed to find the total lower extremity muscle strength. Additionally, the muscle strength of the hip flexors, knee extensors and dorsiflexors of left and right lower extremity were recorded individually. The total trunk (abdominals and trunk extensors) and neck (flexors and extensors) muscle strength were also obtained by the summation of these muscle groups summed.²³

The mobility level of the patients was evaluated with the Rivermead Mobility Index (RMI).²⁴ The RMI is a 15-item scale; 14 self-reported performances (range from turning over the bed to running) and one (standing unsupported) through direct observation of the subjects. Each answer is scored as '1' for 'yes' and '0' for 'no', giving a total maximum score of 15. Higher scores indicate better mobility level. The RMI was shown to be a reliable and valid measurement in patients with neurological diseases.²⁵ The Turkish version of the RMI was used in this study.²⁶

The health related quality of life (HRQOL) was assessed by the Nottingham Health Profile (NHP).²⁷ The instrument used to evaluate perceived distress of the applicants. The NHP consists of 38 yes/no items and 6 domains; Physical mobility (8 items), pain (8 items), social isolation (5 items), emotional reactions (9 items), energy (3 items), sleep (5 items). The scores range from 0 to 600, the maximum score '600' indicates greater health problem. The reliable and valid Turkish translation of the NHP was used in this current study.²⁸

Statistical analysis:

Statistical analysis was performed by using SPSS 13.0 Software. The Spearman's rho test was used to measure the strength of association between falling frequency and other parameters. The comparison between two groups was acquired by using Mann-Whitney U test. The level of significance was accepted as $p < 0.05$.

RESULTS

Of the eighty patients 58 were diagnosed as myopathy (72.5%), 15 as neuropathy (18.75%), and 7 as motor neuron disease (8.75%). The sample comprised of 37 women and 43 men, aged between 18-57 (mean age: 30.03 ± 11.89 years). Forty nine of the subjects reported their selves as faller (at least two times in the last 6 months) and thirty-one as non-faller. The physical characteristics of the subjects were given in Table 1. Of the forty-nine faller subjects thirty-six (73%) reported fear of falling. Forty-six (94%) of the faller subjects reported that they fall in outdoor environment. 12.5% of the patients reported their falls due to loosing balance, 2.5% due to carelessness, 21,3 due to stumbling and 25% due to giving way of the knee.

There was no significant difference for age, height, weight, Body Mass Index (BMI) and, disease duration in the fallers and non-fallers group (Table 2). There was a significant difference in the total upper extremity manual muscle strength test results, whereas the no significant difference was found in the lower extremity manual muscle strength test results between faller

and non-faller groups ($p < 0.05$). There was a difference in right and left hip flexors, knee extensors and ankle dorsiflexors muscle strength in two groups. The difference of the total neck and trunk muscle was not statistically significant. Also, the mobility level measured by RMI (Rivermead Mobility Index) was not different in both groups. The HRQOL of the patients in the fallers and non-fallers group measured with NHP was found to be different, and considering the NHP parameters the 'physical activity' and 'social isolation' parameters was statistically different.

Falling frequency was found to be correlated with fear of falling ($r = 0.437$) ($p < 0.05$), on the other hand no statistically significant correlation was found between falling frequency and falling environment (Table 3). A significant correlation was obtained between falling frequency and both right and left knee extensors muscle strength ($r = -0.388$ ($p < 0.05$) and $r = -0.419$ ($p < 0.05$), respectively). Neither the total lower extremity muscle strength nor the individual muscle strength of the hip flexors and ankle dorsiflexors was found to be correlated with falling frequency. Additionally, the mobility level and HRQOL was not found to be correlated with falling frequency.

DISCUSSION

The results of this study revealed that the hip flexors, knee extensors and ankle flexors muscle strength were lower in the fallers group comparing to the non-fallers group. These findings were also compatible with the HRQOL of the patients. Therefore, the total NHP score and, 'physical activity' and 'social isolation' parameters of the NHP were lower in the non-fallers group, indicating a better health status comparing to the fallers group.

Although the place of falling (indoor or outdoor) was not correlated with falling frequency, fear of falling of the faller patients was found to be correlated with falling frequency. Amongst the three muscle groups (hip flexors, knee extensors and ankle flexors) only the knee extensors muscle strength was found to be correlated with falling frequency.

The study of Pieterse et al showed that the most frequent risk factor for falling was lower extremity muscular weakness, which was reported in 94% of the patients with various NMD.¹⁸ In this study the total eight lower extremity muscle group (hip flexors, extensors, abductors and adductors, knee flexors and extensors, ankle flexors and extensors) strength were found to be relatively higher in the fallers group comparing to the non-fallers group. However, particularly the strength of the three muscle groups (hip flexors, knee extensors and ankle flexors) were lower in the fallers group. Therefore, these three muscle groups can be more determinative of faller and non-faller NMD patient groups.

In the study of Daubney and Culham,²⁹ the ankle flexors were found to be the best predictor of falling in the elderly, which was also compatible with the findings of the other studies.³⁰⁻³² This was explained by the importance of the ankle dorsiflexors, together with hip and knee flexors, for lifting the leg to allow an adequate clearance of the foot over the ground during the swing phase. On the other hand, the muscle strength of knee extensors was shown to be the main determinant of functionality and balance in NMD previously.^{33,34} In this current study, the knee extensors muscle strength was found to be as an important factor affecting falling due to the giving way of the knee, which was the most frequently seen cause of falling in our study group. Understanding the mechanism of falls may be helpful for protective, supportive and treatment strategies of patients with NMD.

The previous study of Pieterse et al indicated that falling was accompanied by fear of falling (57%) and reduced activities (48%) in this group of patients.¹⁸ In this study, considering the faller patients 94% have reported that they fall in an outdoor environment and 73% have defined fear of falling. The augmentation of falling frequency may stimulate fear of falling, especially in outdoor activities, therefore patients may reduce their physical activities and this may lead to isolation of these patients from their social environment. The isolation of these patients from outdoor events may lead to a more decreased physical activity

Table 1. Characteristics of the subjects in the fallers and non-fallers groups.

	Fallers (N=49)	Non-fallers (N=31)	
	X±SD	X±SD	p
Age (years)	31.16±12.43	28.25±19.92	0.446*
Body weight (kg)	63.0±11.8	65.0±13.7	0.756*
Height (cm)	166.82±10.3	170.29±10.4	0.173*
Body mass index (kg/m ²)	23.0±3.7	23.1±3.1	0.910*
Disease duration (month)	46.1±70.1	42.3±57.1	0.921*
Falling frequency	2.7±1.3	-	
	n (%)	n (%)	
Gender (Male/Female)	24/25 (49/51)	19/12 (61/39)	
Use of psychoactive medicine	1 (2%)	- (0%)	
Use of antihypertensive medicine	2 (4%)	- (0%)	

* p>0.05.

Table 2. The comparison of the mobility level, health related quality of life and muscle strength of the individuals in the fallers and non-fallers groups.

	Fallers (N=49)	Non-fallers (N=31)	
	X±SD	X±SD	p
Rivermead Mobility Index (0-15)	12.6±2.8	13.4±1.5	0.489*
Nottingham Health Profile			
Energy Level (0-100)	50.7±34.9	36.7±30.7	0.081*
Pain(0-100)	21.1±29.6	13.2±21.5	0.082*
Emotional Reactions (0-100)	29.7±27.7	19.2±22.5	0.060*
Social Isolation (0-100)	17.3±22.0	8.3±14.5	0.025**
Sleep (0-100)	18.2±22.1	17.7±22.5	0.920*
Physical Activity (0-100)	43.0±23.4	23.6±15.2	0.000**
Total (0-600)	180.6±115.8	118.4±90.5	0.019**
Muscle strength (0-5)			
Total Upper Extremity	150.1±11.8	141.6±15.8	0.015**
Total Lower Extremity	61.4±9.8	58.0±12.7	0.273*
Right Hip Flexors	3.5±1.0	4.1±1.1	0.014**
Left Hip Flexors	3.6±1.1	4.1±1.0	0.035**
Right Knee Extensors	3.6±1.5	4.6±0.7	0.004**
Left Knee Extensors	3.6±1.0	4.0±1.1	0.046**
Right Ankle Flexors	3.5±1.1	4.1±1.0	0.034**
Left Ankle Flexors	3.6±1.5	4.5±0.8	0.011**
Trunk	7.7±1.8	7.8±1.7	0.917*
Neck	8.8±1.7	8.9±1.6	0.902*

* p>0.05, ** p<0.05.

Table 3. The correlation of falling frequency with mobility level, health related quality of life and muscle strength in the fallers group (N=49).

	Falling frequency	
	r	p
Age	0.064	0.662*
Disease duration	0.059	0.687*
Rivermead Mobility Index	-0.245	0.090*
Nottingham Health Profile		
Energy Level	0.159	0.275*
Pain	0.147	0.315*
Emotional Reactions	0.222	0.125*
Social Isolation	0.198	0.172*
Sleep	0.234	0.106*
Physical Activity	0.204	0.161*
Total	0.212	0.143*
Muscle strength		
Total Upper Extremity	-0.014	0.932*
Total Lower Extremity	-0.082	0.575*
Right Hip Flexors	-0.078	0.593*
Left Hip Flexors	-0.064	0.664*
Right Knee Extensors	-0.388	0.006**
Left Knee Extensors	-0.419	0.003**
Right Ankle Flexors	-0.020	0.893*
Left Ankle Flexors	0.020	0.893*
Trunk	-0.118	0.418*
Neck	0.020	0.889*

* p>0.05, ** p<0.05. Spearman's Rho Correlation Analysis.

level, which may also affect the psychological state of the patients. Therefore, falling is not only a physical demolition but also a psychological destruction and the treatment strategies for patients with NMD should include both physical and psychological aspects.

One of the limitations of this study was using a self-reported scale in the assessment of number of falling, fear of falling, reasons of falling, place of falling and injurious falling of the patients. The incidence of falls by using the memory recalls may not be reliable due to the underestimation or exaggeration of the patients. Therefore, further studies may prefer to use a diary of falling rather

than using falls recall in order to obtain more reliable information about falling. Another limitation of the current study was the study population, which was mainly comprised of patients with myopathy. Hence the results of this study are tentative for other groups of NMD. Further studies are required for identifying the risk factors of falling in other types of NMD.

In conclusion, although the total lower extremity muscle strength results of the faller subjects was relatively higher comparing to the non-faller subjects, the isolated muscle strength results of the hip flexors, knee extensors and ankle dorsiflexors are lower in the faller subjects. However, only the knee extensors muscle strength was found to be as an important factor affecting falling frequency in patients with NMD. Hence, the patients with reduced knee extensors muscle strength are more prone to fall, especially in outdoor activities. The HRQOL of the faller subjects, particularly 'physical activity' and 'social isolation' parameters, are lower comparing to non-faller subjects. The faller NMD patients have reduced physical activity level, hence, this may lead to isolation from the social environment and more decreased activity level. Therefore, the treatment program of patients with NMD should include both physical and psychological approaches.

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