Functional outcome after peroneal nerve injury

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The objective of this study was to describe muscle strength, ankle–foot orthosis (AFO) use, walking ability, participation and quality of life in patients with peroneal nerve injury. A historic cohort study (*n*=27) was performed with a median follow-up time of 61 months (inter quartile range 37–91). Muscle strength was assessed using the Medical Research Council scale. Perceived walking ability was assessed with the Walking Questionnaire. AFO use and problems in participation were assessed with a structured interview. The RAND-36 Health Survey was used to evaluate health-related quality of life. Muscle strength improved significantly during follow-up but 62% (16 of 26 patients, one missing value) of the patients still had paresis to some degree of ankle dorsiflexors. AFO use decreased significantly but 11% (*n*=3) still used an AFO at follow-up. Two-thirds (*n*=18) of the study population experienced some limitations in walking and climbing stairs. Decreased maximum walking distance was reported by 59 % (*n*=16). About half of the patients (*n*=13) reported some restrictions in leisure activities and 47% (*n*=9) of the patients with a paid job (*n*=19) experienced some restrictions in work. Scores on the domains physical functioning, mental health, vitality, bodily pain and general health perception of the RAND-36 were significantly lower compared with a Dutch reference group. Limitations in walking ability and participation are frequently present 5 years after peroneal nerve injury. Health-related quality of life was lower than in a reference group. *International Journal of Rehabilitation Research* 30:333–337 © 2007 Wolters Kluwer Health | Lippincott Williams & Wilkins.

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Introduction

Peroneal nerve injury is the most frequently encountered mononeuropathy in the lower extremity (Dawson *et al.*, 1999). It usually presents with flatfoot or drop foot resulting from weakness of the ankle dorsiflexors. Other signs are weakness of the foot evertors, and loss of sensibility of the lateral part of the lower leg and the dorsum of the foot and pain. The large majority of peroneal nerve injuries are caused by compression against the fibular head or by knee trauma (Berry and Richardson, 1976; Katirji and Wilbourn, 1988).

Deficits and prognosis depend on the extent and type of the nerve injury. Peripheral nerve injuries are classified into neurapraxia, axonotmesis and neurotmesis, according to the actual damage of the nerve and perineurial tissues (Sunderland, 1978). In neurapraxia, the neural and perineurial tissues are intact but the conductive function of the nerve is (temporary) lost or impaired. In axonotmesis, the perineurial tissues are intact but the axon is transected. In neurotmesis, the nerve and perineurial tissues are completely transected. In general, recovery in neurapraxia is better than in axonotmesis or neurotmesis. In neurapraxia and axonotmesis signs of regeneration are monitored before considering surgical treatment (Kim and Kline, 1996; Mont *et al.*, 1996; Fabre *et al.*, 1998; Thoma *et al.*, 2001). In neurotmesis, microsurgical reconstruction is indicated.

Paresis of ankle dorsiflexors produces gait abnormalities (Lehmann *et al.*, 1986). An ankle–foot orthosis (AFO) is usually prescribed when a flatfoot or drop foot exists. When conservative treatment with an AFO fails and recovery of the nerve injury is not expected, a tibialis posterior tendon transposition can be performed to restore functional dorsiflexion of the ankle (Hove and Nilsen, 1998; Breukink *et al.*, 2000; Yeap *et al.*, 2001).

Most studies on outcome after peroneal nerve injury focus on impairments. Only one study was found describing walking disability and quality of life after peroneal nerve injury (Aprile *et al.*, 2005). No studies exist describing restrictions in participation (WHO, 2001). The aim of this historic cohort study was to describe disability in walking and participation and assess health-related quality of life in patients after peroneal nerve injury.

Methods

Patients

All patients with one-sided peroneal nerve injury who visited the Center for Rehabilitation of the University

Medical Center Groningen between January 1997 and November 2004 were selected as potential candidates for this research. Patients with sciatic nerve injury that involved solely the peroneal division, confirmed with electromyography, were also included. Time between onset of nerve injury and follow-up had to be at least 1 year. Exclusion criteria were: age below 18 years at onset, additional peripheral neuropathy of the legs, central neurological disorder, severe visual handicap, psychiatric disease or mental retardation, lack of understanding the Dutch language, being nonambulatory or using a walking aid before the nerve injury.

Design

Patients with peroneal or sciatic nerve injury were identified by computer using the International Classification of Impairments Diseases and Handicap registration codes (Ekker, 1980). Data about sex, age, comorbidity influencing walking ability, affected nerve, side, date of onset, aetiology, type of nerve injury, AFO use and surgical treatment were retrieved from the medical records. Eligible patients were asked by mail to participate. Nonresponders received a reminder after 4 weeks. The local medical ethics committee was consulted for this research project but it appeared that an approval was not obligatory. Patients signed an informed consent and visited the hospital once. Follow-up data were collected by means of a structured interview, physical examination and two questionnaires. The principal investigator (I.B.) examined all patients.

Measurements

Muscle strength of ankle dorsiflexors and evertors was assessed using the Medical Research Council scale (Medical Research Council, 1976). These data were compared with data at first referral to our outpatient clinic of the Center for Rehabilitation (UMCG, Groningen, The Netherlands).

Present AFO use was assessed as well as reasons to stop AFO use.

Walking ability was assessed with the Walking Questionnaire, part A, version 1.2 (Roorda *et al.*, 2004, 2005). This questionnaire is validated, and assesses the perceived limitations in walking inside the house and outside (35 items) and climbing stairs (15 items) in patients with lower-extremity disorders who live at home. The items refer to what persons actually do, not what they think that they can do. The instrument operationalizes different aspects of walking such as velocity, adaptations, difficulty, uncertainty, use of aids and maximal walking distance. Three scores are calculated: walking inside the house, walking outside and climbing stairs. Scores range between 0 (not possible) and 100 (no limitations). Additionally, three questions were asked about the ability to walk in darkness, on uneven underground and on slippery or wet underground. Restrictions in work, leisure activities, car driving and biking related to the nerve injury were assessed in a structured interview.

Health-related quality of life (HRQoL) was evaluated with the RAND 36-item Health Survey, a questionnaire very similar to the SF-36 (Hays *et al.*, 1993). The RAND-36 measures nine distinct dimensions of current HRQoL, that is physical functioning, social functioning, role limitations owing to physical problems, role limitations owing to emotional problems, mental health, vitality, bodily pain, general health perception and health changes. Scores for each scale range from 0 to 100, with higher scores indicating higher level of functioning or well being. The RAND-36 is widely tested and validated in the Dutch general population. Scores of a Dutch reference group from the Northern part of the Netherlands were used for comparison (Van der Zee and Sanderman, 1993).

Statistical analysis

Data analysis was performed in SPSS version 12.0 for Windows (htpp://www.spss.com). Data are presented as means and standard deviation (SD) or as median and interquartile range (IQR). The Wilcoxon signed-ranks test was used to analyse changes in muscle strength and to compare the three scores of the Walking Questionnaire, walking inside the house, i.e. walking outside and climbing stairs. The McNemar test was used to analyse changes in AFO use. An independent samples *t*-test was performed to analyse the effect of the presence of comorbidity on scores of the Walking Questionnaire. A confidence interval analysis was used to compare scores of our patients on the RAND-36 with those of a Dutch reference group.

Results

Study population

In total, 128 potential candidates were identified. Fifty six patients were not eligible: 15 had died, 41 were excluded because of age (9), additional neurologic disorder of the legs (20), severe visual handicap (1), psychiatric disease or mental retardation (3), lack of understanding the Dutch language (3), having a significant pre-existing walking disorder (5). The remaining 72 patients were invited to participate. Twenty-seven patients (38%) actually participated in this study, 32% ($n = 23$) refused and the other 30% ($n = 22$) did not respond. Comparison between nonparticipants and participants revealed no significant differences on age, sex and type of nerve injury. Data on demographics and clinical characteristics of the study population are presented in Table 1. The common peroneal nerve was involved in 82% ($n = 22$) of the cases. About half of the nerve injuries were caused by trauma. Forty-one percent ($n = 11$) of the patients reported comorbidity affecting their walking ability. In cases of a drop foot or paresis of the dorsiflexors

Table 1 Demographic and clinical characteristics of the study population ($n=27$)

Variables	
Age in years	
Mean (SD)	45 (14)
Follow-up in months	
Median (IQR)	61 (37–91)
	% (*n*)
Sex	
Male	82 (22)
Nerve involved	
Common peroneal nerve	82 (22)
Sciatic nerve	7 (2)
Superficial peroneal nerve	7 (2)
Deep peroneal nerve	4 (1)
Affected side	
Right	52 (14)
Etiology[a]	
Trauma	48 (13)
Pressure	19 (5)
Tumour[b]	19 (5)
Postsurgery/iatrogenic	15 (4)
Lesion type[a]	
Neuropraxia	19 (5)
Axonotmesis	41 (11)
Neurotmesis	22 (6)
Tumour[b]	19 (5)
Surgical treatment[c]	48 (13)
Tibialis posterior tendon transposition	26 (7)
Extirpation tumour	22 (6)
Neurolysis	4 (1)
Primary neuroraphy	15 (4)
Nerve graft	4 (1)
AFO use at referral	82 (22)
Comorbidity affecting walking ability	41 (11)
Arthropathy (hip/knee/ankle)	22 (6)
Muscle damage lower leg	11 (3)
Low back pain	7 (2)

IQR, inter quartile range; AFO, ankle–foot orthosis; SD, standard deviation.
[a]Total of percentages exceeds 100% because of rounding off.
[b]Two gangliomas, two schwannomas, one neuroma.
[c]Some patients received more than one surgical treatment.

an AFO was prescribed as a rehabilitation therapy to correct the impairment and to insure the patients to be able to be more active.

Muscle strength

Muscle strength improved significantly between referral and follow-up (Table 2). At follow-up 62% ($n = 16$) of our population still had some paresis. In one conservatively treated patient assessment of strength of ankle dorsiflexors and foot evertors was not possible because of triple arthrodesis of the ankle joint. All patients with neurapraxia regained normal muscle strength of ankle dorsiflexors. Of the 14 conservatively treated patients 92% ($n = 12$) had a MRC score ≥ 3 of the ankle dorsiflexors and of the 13 surgically treated patients 77% ($n = 10$). This difference was not significant.

AFO use

At referral 82% ($n = 22$) of the patients used an AFO, at follow-up 11% ($n = 3$). This decrease was significant ($P < 0.001$). A tibialis posterior tendon transposition was performed in 26% ($n = 7$) of the patients. All seven stopped using an AFO. Other reasons to stop AFO use were improvement of active dorsiflexion owing to natural recovery ($n = 9$), discomfort ($n = 2$) and use of orthopaedic shoes ($n = 1$).

Table 2 Muscle strength at referral and at follow-up ($n=26$[a])

Muscles	Strength	At referral [% (*n*)]	Follow-up [% (*n*)]	*P* value[b]
Ankle dorsiflexors[c]	MRC 0–2	77 (20)	15 (4)	0.001
	MRC 3–4	12 (3)	46 (12)	
	MRC 5	12 (3)	38 (10)	
Foot evertors	MRC 0–2	62 (16)	27 (7)	0.004
	MRC 3–4	19 (5)	31 (8)	
	MRC 5	19 (5)	42 (11)	

MRC, Medical Research Council scale.
[a]Measurement of muscle strength was not possible in one patient because of triple arthrodesis of the ankle.
[b]Comparison of strength at referral and follow-up using Wilcoxon signed-ranks test.
[c]Total of percentages is not 100% because of rounding off.

Walking ability

Scores on walking inside (median: 94, IQR: 63–100) were significantly ($P < 0.001$) higher than scores on walking outside (median: 79, IQR: 42–100) and were significantly ($P = 0.007$) higher than scores on climbing stairs (median: 73, IQR: 53–100). In total 63% ($n = 17$) of our patients experienced some limitations in walking inside and 67% ($n = 18$) experienced some limitations during walking outside and climbing stairs. Decreased maximum walking distance owing to the nerve injury was reported by 59% ($n = 16$). Eleven percent ($n = 3$) reported a very limited maximal walking distance of less than 500 m. Scores of patients with comorbidity were statistical significant lower than the scores of patients without comorbidity (walking inside the house $P = 0.013$, walking outside $P = 0.004$, climbing stairs $P = 0.004$). Seventy percent ($n = 19$) experienced difficulties in walking on uneven underground, 59% ($n = 16$) had difficulties walking on a slippery underground and 30% ($n = 8$) had difficulties walking in the darkness.

Participation

Forty-seven percent ($n = 9$) of the 19 patients with a paid job experienced some restrictions in work. Work adaptations were reported by two patients. No jobs were lost because of the nerve injury. Forty-eight percent of the patients ($n = 13$) reported restrictions in leisure activities, mostly experienced during sports activities. All 25 patients with a driving license were still able to drive a car but 32% ($n = 8$) experienced some problems such as limited endurance in stepping on the gas pedal and problems in operating the clutch pedal. These problems were usually solved by adaptations of the car like cruise control or automatic transmission. Problems in biking were reported by 19% ($n = 5$) of our population involving stepping off the bike on the affected side and slipping from the pedal of the affected foot.

Table 3 **Health-related quality of life: scores on domains of the RAND-36**

Domains	Study population		Reference population		Mean difference	95% CI
	Mean	SD	Mean	SD		
Physical function	70.6	24.8	81.9	23.2	11.3	2.4 to 20.2[a]
Social function	86.6	18.0	86.9	20.5	0.3	−7.5 to 8.1
Role limitations owing to physical problems	75.9	36.3	79.4	35.5	3.5	−10.1 to 17.1
Role limitations owing to emotional problems	88.9	37.0	84.1	32.3	−4.8	−17.2 to 7.6
Mental health	63.1	12.2	76.8	18.4	13.7	6.7 to 20.7[a]
Vitality	56.3	14.3	67.4	19.9	11.1	3.5 to 18.7[a]
Bodily pain	54.9	18.3	79.5	25.6	24.6	14.9 to 34.3[a]
Health perception	55.4	15.5	72.7	22.7	17.3	8.7 to 25.9[a]
Health change	56.5	20.3	52.4	19.4	−4.1	−11.5 to 3.3

95% CI, 95% confidence interval.
[a]Confidence interval includes the neutral value of no difference (0): the difference between the groups is significant ($P \leq 0.05$).

Quality of life

Significantly lower scores on the domains physical functioning, mental health, vitality, bodily pain and general health perception of the RAND-36 were present in our patients compared with a Dutch reference group (Table 3).

Discussion

Muscle strength significantly improved during follow-up but a substantial part of the patients still had paresis to some degree of ankle dorsiflexors. AFO use decreased significantly, 11% still used an AFO at follow-up. About 50% of the patients with a paid job experienced some restrictions in work and 50% of the study population reported restrictions in leisure activities. HRQoL was significant less on five domains of the RAND-36 compared with a reference group.

Improvement in muscle strength was also reported previously in patients with peroneal nerve injury (Vastamaki, 1986; Aprile *et al.*, 2000; Thoma *et al.*, 2001). Percentages of surgically treated patients with MRC scores of ankle dorsiflexors ≥ 3 differs between studies ranging from 61 to 100% (Wilkinson and Birch, 1995; Kim and Kline, 1996; Mont *et al.*, 1996; Fabre *et al.*, 1998). The percentages of conservatively treated patients with MRC score of ankle dorsiflexors ≥ 3 were lower (45–67%) compared with the percentage we found (Kim and Kline, 1996; Mont *et al.*, 1996). In these two studies patients with traumatic nerve injuries and tumours were included, whereas our population also included patients with compression injuries that usually show a better outcome.

In our patients AFO use decreased significantly, from 82 to 11% over time. After tendon transposition ($n = 7$) all patients stopped using their AFO. Similar results were reported by others (Hove and Nilsen, 1998; Breukink *et al.*, 2000; Yeap *et al.*, 2001). After a nerve decompression none of the patients needed to use an AFO but the number of drop outs in that study was not described (Mont *et al.*, 1996).

Two-thirds of our patients perceived some limitations in walking and climbing stairs. A similar proportion was found by Aprile *et al.* (2005). In that study, however, 20% needed assistance or supervision during walking. We found less severe limitations in walking. All our patients could walk independently. The study mentioned was performed in the early phase, 30–70 days after nerve injury. Recovery of muscle strength and walking ability of those patients might be expected. Other explanations for this difference in walking ability could be adaptation of our patients to their impairments or treatment of the drop foot in our patients.

In this study HRQoL was significantly lower in our patients on the domains physical functioning, mental health, vitality, bodily pain and general health perception compared with a reference group. Our patients did not, however, experience more role limitations owing to physical or emotional problems. Aprile *et al.* (2005) assessed HRQoL in the early phase after peroneal nerve injury finding lower scores on both physical functioning and role limitations owing to physical problems. In the early phase after nerve injury, daily life might be more disturbed than after 5 years, when patients adapt to their impairments in a way that it does not interfere with their role functioning. The scores on the 'mental status' were significantly lower than in the reference group, despite our exclusion criteria of psychiatric disease or mental retardation. This can be a result of the fact that most of our patients had a peroneal nerve injury due to a trauma (48%) or tumour (19%), so this statistical significance can be related to the primary reason this nerve injury.

A weakness of this study was the limited number of patients. Comparison of participants and nonparticipants, however, showed no significant differences, on age, sex and type of nerve injury, between the groups. A considerable number of our patients had comorbidity affecting walking ability, which influenced the results on the Walking Questionnaire.

A prospective study with a larger group is needed to further investigate disability in patients with peroneal nerve injury enabling analysis of subgroups of patients, but also to study what kind of measurements should be taken to promote participation and to support quality of life. On the basis of the results of this study, it is concluded that muscle strength improves significantly and AFO use decreases significantly in our patients 5 years after peroneal nerve injury. Limitations in walking ability and participation are, however, frequently found and health-related quality of life is lower compared with the Dutch reference group.

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References

Aprile I, Padua L, Padua R, D'Amico P, Meloni A, Caliandro P, *et al.* (2000). Peroneal mononeuropathy: predisposing factors, and clinical and neurophysiologic relationships. *Neurol Sci* **21**:367–371.

Aprile I, Caliandro P, La Torre G, Tonali P, Foschini M, Mondelli M, *et al.* (2005). Multicenter study of peroneal mononeuropathy: clinical, neurophysiologic and quality of life assessment. *J Peripher Nerv Syst* **10**:259–268.

Berry H, Richardson PM (1976). Common peroneal nerve palsy, a clinical and electrophysiological review. *J Neurol Neurosurg Psychiatry* **39**:1162–1171.

Breukink SO, Spronk CA, Dijkstra PU, Heybroek E, Marck KW (2000). Transposition of the tendon of M. tibialis posterior an effective treatment of dropfoot; retrospective study with follow-up in 12 patients [in Dutch]. *Ned Tijdschr Geneeskd* **144**:604–608.

Dawson DM, Hallet M, Millender LH (1999). Peroneal nerve entrapment. In: Dawson DM, Hallet M, Millender LH, editors. *Entrapment neuropathies*. Philadelphia: Lippincott-Raven; pp. 270–296.

Ekker W (1980). *Classification of Diseases 1980* [in Dutch]. Utrecht: Stichting Medische Registratie.

Fabre T, Piton C, Andre D, Lasseur E, Durandeau A (1998). Peroneal nerve entrapment. *J Bone Joint Surg* **80-A**:47–53.

Hays RD, Sherbourne CD, Mazel RH (1993). The RAND 36-item Health Survey 1.0. *Health Econ* **2**:217–227.

Hove LM, Nilsen PT (1998). Posterior tibial tendon transfer for drop-foot. *Acta Orthop Scand* **69**:608–610.

Katirji MB, Wilbourn AJ (1988). Common peroneal mononeuropathy: a clinical and electrophysiologic study of 116 lesions. *Neurology* **38**:1723–1728.

Kim DH, Kline DG (1996). Management and results of peroneal nerve lesions. *Neurosurgery* **39**:312–320.

Lehmann JF, Condon SM, De Lateur BJ, Price R (1986). Gait abnormalities in peroneal nerve paralysis and their corrections by orthoses: a biomechanical study. *Arch Phys Med Rehabi* **67**:380–386.

Medical Research Council (1976). *Aids to examination of the peripheral nervous system*. London: Her Majesty's Stationery Office.

Mont MA, Dellon AL, Chen F, Hungerford MW, Krackow KA, Hungerford DS (1996). The operative treatment of peroneal nerve palsy. *J Bone Joint Surg* **78-A**:863–869.

Roorda LD, Roebroeck ME, van Tilburg T, Lankhorst GJ, Bouter LM (2004). Measuring activity limitations in climbing stairs: development of a hierarchical scale for patients with lower extremity disorders living at home. *Arch Phys Med Rehabi* **85**:967–971.

Roorda LD, Roebroeck ME, van Tilburg T, Molenaar IW, Lankhorst GJ, Bouter LM, Measuring Mobility Study Group (2005). Measuring activity limitations in walking: development of a hierarchical scale for patients with lower-extremity disorders who live at home. *Arch Phys Med Rehabi* **86**:2277–2283.

Sunderland S (1978). *Nerves and nerve injuries*. Edinburgh: Churchill Livingstone.

Thoma A, Fawcett S, Ginty M, Veltri K (2001). Decompression of the common peroneal nerve: experience with 20 consecutive cases. *Plast Reconstr Surg* **107**:1183–1189.

Vastamaki M (1986). Decompression for peroneal nerve entrapment. *Acta Orthop Scan* **57**:551–554.

Wilkinson MCP, Birch R (1995). Repair of the common peroneal nerve. *J Bone Joint Surg* **77-B**:501–503.

WHO (2001). *ICF: International Classification of Functioning, Disability and Health*. Geneva: World Health Organization.

Yeap JS, Birch R, Singh D (2001). Long-term results of tibialis posterior tendon transfer for drop foot. *Int Orthop* **25**:114–118.

Van der Zee KJ, Sanderman R (1993). *User manual RAND-36*. Groningen: Northern Center for Health Care Research, University of Groningen; pp. 1–28.