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Preoperative motor strength and time to surgery are the most important predictors of improvement in foot drop due to degenerative lumbar disease

Mohamed Macki [a,b,1], Sbaa Syeda [b,1], Panagiotis Kerezoudis [c], Ziya L. Gokaslan [d], Ali Bydon [a], Mohamad Bydon [c,*]

[a] Department of Neurosurgery, Henry Ford Hospital, Detroit, MI, USA
[b] Department of Neurosurgery, Johns Hopkins University School of Medicine, Baltimore, MD, USA
[c] Department of Neurosurgery, Mayo Clinic, Rochester, MN, USA
[d] Department of Neurosurgery, Brown University Warren Alpert Medical School, Providence, RI, USA

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ABSTRACT

Objective: Palsy of dorsiflexion, or foot drop, may be due to degenerative lumbar disease and amenable to posterior spinal decompression. The objective of this study is to measure prognostic factors of and time to foot drop improvement after posterior lumbar decompression.
Methods: We retrospectively reviewed 71 patients undergoing first-time, posterior lumbar decompression for foot drop due to degenerative spinal disease. Patient sex, age, comorbidities (Charlson Comorbidity Index), preoperative anterior tibialis strength (manual muscle testing, MMT), and duration of foot drop were ascertained from clinical notes. Prognostic factors affecting foot drop improvement were calculated with a discrete time proportional hazards model, in which follow-up times and outcome measures were binned into six time intervals: 1 week, 6 weeks, 3 months, 6 months, 1 year, and ≥1 year.
Results: Of the 71 patients, the mean age was 54.6 ± 16.0 years, and 66.2% (n = 47) were males. The mean Charlson Comorbidity Index was 2.42. During a mean follow-up of 30.4 months, dorsiflexion function improved postoperatively in 73.2% (n = 52) of patients. The median time to surgery from onset of foot drop was within 6 weeks, and the median preoperative MMT strength of patients with foot drop improvement was 3. Following a discrete-time proportional hazards model, duration of anterior tibialis palsy (HR = 0.67, P = 0.004) and preoperative muscle strength (HR = 1.10, P = 0.010) were significant predictors of foot drop improvement. Following an adjusted Kaplan–Meier analysis, the median time to foot drop improvement was within 6 weeks of surgical intervention.
Conclusions: Preoperative muscle strength and palsy duration were statistically significant predictors of foot drop improvement. Furthermore, the median time to improvement was 6 weeks.

1. Introduction

Weakness of the tibialis anterior muscle, colloquially known as foot drop, is a debilitating condition that is secondary to both central and peripheral neurological deficits. Although currently foot drop is most often due to injury of the peroneal nerve at the fibular neck, degenerative spinal disease causing compression of the L4 and/or L5 nerve root(s) is emerging as a leading cause of dorsiflexion palsy [1]. Foot drop in the context of lumbar degenerative diseases remains a controversial topic, as studies analyzing the effect of surgical intervention have little consensus on predictive factors and their effect on time to improvement [2]. These factors include, but are not limited to, age, sex, preoperative manual muscle strength and duration of foot drop. In order to further our understanding of these variables and their impact on foot drop prognosis, we report a single-institution retrospective analysis of 71 cases of foot drop due to degenerative spinal disease, managed with posterior spinal decompression. The primary objective of this study was to identify time to and prognostic factors of foot drop improvement.

2. Methods

We retrospectively reviewed medical records of all neurosurgical patients undergoing first-time, posterior lumbar decompression for lower extremity weakness on dorsiflexion (foot drop) due to degenerative spinal disease from 1990 to 2012 at a single institution. All spinal operations must have included a decompression of the L4 and/or L5 nerve root(s), which innervate the anterior compartment of the leg.

* Corresponding author at: Department of Neurosurgery, Mayo Clinic, 200 First Street SW, Rochester, MN, USA.
E-mail address: Bydon.mohamad@mayo.edu (M. Bydon).
[1] These authors contributed equally to this manuscript.

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Patients with laminoplasty and/or fusion were excluded. Similarly, patients with weakness on dorsiflexion due to peripheral nerve injury (peroneal nerve injury) were excluded. All patients with inappropriate follow up were called via telephone call, and patients were asked to return to clinic for a follow up visit. Of those patients who were unable to return for a clinic visit, MMT was ascertained over the telephone. The majority of patients reported either no change in dorsiflexion or complete resolution. However, patients with ambiguous motor function were excluded from the study.

A total of 71 patients met our selection criteria. Comorbidities, including coronary artery disease, diabetes mellitus, osteoporosis, obesity, ever smoker, chronic obstructive pulmonary disease (COPD), hypertension, and depression were ascertained from the medical records. The impact of comorbidity on the surgical management for foot drop was assessed with the Charlson Comorbidity Index.

Palsy of the anterior compartment muscles of the leg, in particular tibialis anterior, results in difficulty of dorsiflexion at the ankle. Consistent with the literature, foot drop was defined as a decrease in dorsiflexion using a manual muscle testing (MMT) [3]. A decrease in MMT grade reflects a change, for example, from 4 + to 4 −. The primary objective of this study was to identify time to and prognostic factors of foot drop improvement. The primary outcome measure, foot drop improvement, was defined as an improvement of dorsiflexion function greater than baseline (preoperative) function per the MMT.

2.1. Statistical analysis

Summary statistics are reported for 71 patients who underwent posterior lumbar decompression for foot drop. Mean values ± standard deviation and percentages were used to describe baseline characteristics [Table 1]. Because dorsiflexion function was evaluated at discrete follow-up clinic visits, we considered the data on the underlying continuous time to foot drop improvement to be interval-censored data. Therefore, we utilized a discrete-time approach, in which follow-up times and outcome measures were binned into six time intervals: 1 week (time 1), 6 weeks (time 2), 3 months (time 3), 6 months (time 4), 1 year (time 5), and ≥1 year (time 6). Patients in whom foot drop did not resolve were censored at the last follow-up period. The hazards of dorsiflexion improvement were calculated with a complementary log–log function in a discrete-time proportional hazards model [4]. The constant term was set equal to six discrete baseline hazards corresponding to time 1–time 6.

Time to surgery from foot drop onset was also binned into 6 discrete-time bins: 1 day (time 0), 1 week (time 1), 6 weeks (time 2), 6 months (time 3), 1 year (time 4), and ≥1 year (time 5). Time to surgery for foot drop was analyzed with seven discrete-time bins coded as continuous integers (time 0–time 6). Statistical significance was set at $P \leq 0.05$. Statistical analysis was performed with STATA (version 12.0, College Station, TX, USA) and Microsoft Excel.

Table 1
Peri-Operative characteristics in 71 cases of foot drop.

	Foot drop n = 71 (%)
Mean age (years)	54.6 ± 16.0
Sex (male)	47 (66.2)
Mean follow-up (months)	30.4 ± 38.2
Co-morbidities	
Mean Charlson Comorbidity Index	2.42
Coronary artery disease	3 (4.2)
Chronic obstructive pulmonary disease	3 (4.2)
Ever smoker	9 (12.7)
Diabetes mellitus	7 (9.9)
Hypertension	16 (22.5)
Obesity	4 (5.6)
Osteoporosis	1 (1.4)
Intraoperative parameters	
Mean number of spinal levels decompressed	3.1 ± 1.2
Number of discectomy cases	47 (66.2)
Median blood loss (interquartile range)	145.0 ± 106.7
Incidental durotomy	5 (7.0)
Postoperative characteristics	
Mean length of hospital stay (days)	4.34 ± 9.61
Discharge to rehab	7 (9.9)
Postoperative cerebrospinal fluid leak	1 (1.4)
Deep vein thrombosis	0 (0.0)
Pulmonary embolus	1 (1.4)
Hematoma	0 (0.0)
Surgery for hematoma	0 (0.0)
Wound infection	1 (1.4)
Wound dehiscence	1 (1.4)
Surgery infection/dehiscence	0 (0.0)
Stroke	0 (0.0)
Death	0 (0.0)

3. Results

In our institutional series, a total of 71 patients underwent posterior lumbar decompression for foot drop due to degenerative spinal disease between 1990 and 2012. The mean age of the study population was 54.6 ± 16.0 years, and 66.2% (n = 47) were males. The mean Charlson Comorbidity Index was 2.42. Following a discrete-time analysis, time to surgery was 1 day in 4 patients (5.6%), 1 week in 10 patients (14.1%), 6 weeks in 24 patients (33.8%), 6 months in 16 patients (22.5%), 1 year in 3 patients (4.2%), and >1 year in 13 patients (18.3%). Time could not be ascertained in 1 patient. Of the 71, indications for surgery include degenerative disc disease/disc herniation (n = 45), lumbar stenosis (n = 22), foraminal stenosis (n = 6), and spondylolisthesis (n = 4). While all patients underwent laminar decompression, 66.2% (n = 47) required an additional discectomy. The mean length of hospital stay was 4.34 days, and the mean follow-up time was 30.4 months. During the follow-up period, the rate of foot drop improvement postoperatively was 73.2% (n = 52).

Following an adjusted Kaplan–Meier analysis, the median time to surgery from onset of foot drop was within 6 weeks [Fig. 1]. In the discrete-time proportional hazards model, for every increase in time interval to surgery, the hazards of foot drop improvement statistically significantly decreased by 33% (HR = 0.67, P = 0.004) [Table 2]. In other words, patients were less likely to experience foot drop improvement with increasing time to surgery.

The median preoperative MMT strength of patients with foot drop improvement was 3. In the discrete-time proportional hazards model,

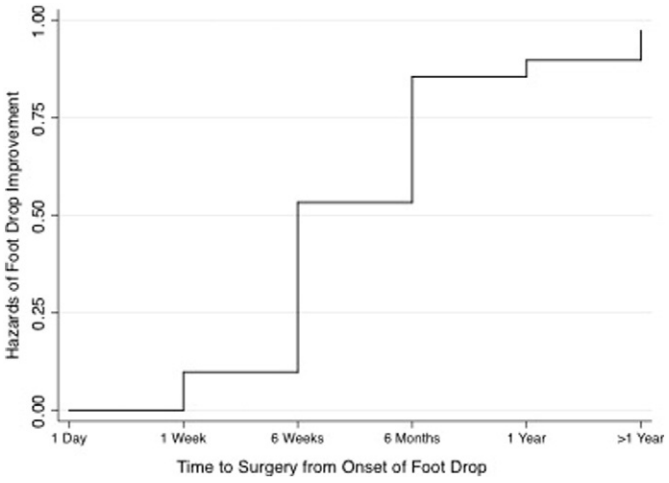

Fig. 1. Kaplan–Meier Curve for time to surgery adjusting for (1) sex, (2) age centered about the mean, (3) Charlson Comorbidity Index, (4) bilateral foot drop, and (5) preoperative manual muscle testing. The median time to surgery was approximately 6 weeks.