ORIGINAL ARTICLE

Factors affecting functional outcome after lower extremity amputation

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Abstract

Background: More than 100,000 major lower extremity amputations -- amputations at the metatarsal, below-knee or above-knee level -- are performed yearly in the United States. Despite improvements in long-term outcome, operative mortality following such amputations has remained stable at 9% to 10% over the last 20 years. Several predictors for functional outcome of amputee patients are mentioned in the literature.

Objectives: The current study was planned to assess the impact of comorbidities on functional status after lower extremity amputations.

Materials and Methods: It was a prospective comparative study held at the Department of Orthopaedics and Traumatology, Punjab Medical College, Faisalabad, and affiliated hospitals. The study included 104 patients regardless of age and gender. Patients were allocated into trans-metatarsal (TM) group, below-knee (BK) amputation group and above-knee (AK) amputation group. Comorbidities before amputation included diabetes mellitus (70.7%), coronary heart disease (57.1%), chronic kidney disease (53.6%), and/or congestive heart failure (52.1%).

Results: Mortality within 30 days of hospital discharge was 9%, and hospital readmission was 27.7%. Stroke, end-stage renal disease (ESRD) and poor baseline cognitive function were associated with the poorest functional outcome after amputation. Patients undergoing BK or AK amputation failed to return to their functional baseline within 6 months.

Conclusion: Higher amputation level, history of stroke, ESRD, poor baseline cognitive scores, and female gender are factors associated with inferior functional status after amputation.

Keywords: Lower extremity amputation, Co-morbidities, Minimum data set, Recovery of function. (JPMA 65: S-220 (Suppl. 3); 2015)

Introduction

More than 100,000 major lower extremity amputations (LEAs) — amputations at the metatarsal, below-knee or above-knee level — are performed yearly in the United States.1 Despite improvements in long-term outcome, operative mortality following LEA has remained stable at 9% to 10% over the last 20 years.[1] Several predictors for functional outcome of amputee patients are mentioned in the literature. In general, the functional capabilities of patients with a higher amputation level and a higher age are worse than that of younger patients with a lower amputation level.[2,3] It is also generally accepted that the physical condition and the presence of comorbidity predict the functional outcome after amputation.[2] Cardiopulmonary diseases in particular cause a lack of extra energy necessary for walking with a prosthesis[4,5] Other diseases affecting the locomotor system diminish the functional prospective of amputees. Although amputation is a common procedure performed in patients, little data exists regarding the effects of amputation on functional status. Activities of Daily Living (ADL) are a person's basic personal care activities such as eating, dressing and mobility, and these are associated with patients' quality of life. ADL impairments are associated with hospital admission, death and poorer physical health.[5] Data describing ADL is readily available on the Minimum Data Set (MDS).[6,7] In addition to ADL, the MDS includes information on cognition, communication, behaviour, diagnoses, nutrition, activity, medication and other treatments. For analysis, seven activities' scores were summed to form a scale from 0-28, with 0 indicating complete independence in all seven activities, and 28 indicating complete dependence.[8-10] MDS assessments are used to develop detailed care plans for patients.

The current study was planned to determine the impact of comorbidities on ADL before and after amputations that included above-knee (AK), below-knee (BK), and trans-metatarsal (TM) procedures, and to assess the association of comorbidities and cognitive status on the functional trajectories after intervention.

Patients and Methods

The prospective comparative study was conducted at the Orthopaedics Department, Allied Hospital and District Headquarter (DHQ) Hospital, Faisalabad, which are both

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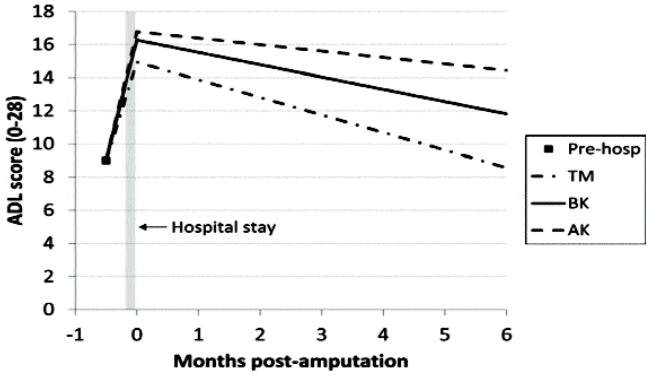
affiliated with Punjab Medical College. From January 25, 2011, to January 24, 2014, the study included patients regardless of gender and age. We excluded admissions during which a stroke occurred and admissions with a stroke in the preceding six months because stroke has a substantial and lasting effect on ADLs. Those selected were divided into TM, BK and AK groups according to their needs for amputation. We examined physical function of patients before and after hospitalisation. We used hierarchical modelling to determine the association between amputation level and post-hospital trajectories of ADL function. We used MDS ADL-Long form score to represent ADL function (Table-1). The score is a sum of seven variables representing self-care activities on the MDS (bed mobility; self-transfer; locomotion on unit; dressing; eating; toileting; and personal hygiene). These activities are scored from 0 to 4, where 0 indicates independence in performing the activity and 4 indicates total dependence on others. We also calculated the Cognitive Performance Scale (CPS) from each patient's first MDS assessment. The CPS is a 0-6 scale, with 0 representing intact cognition and 6 representing severe cognitive impairment.[9] We calculated the Charlson Comorbidity Index (Table-2) based on both prior and hospital diagnoses to represent each patient's overall comorbid burden. The Charlson Index assigns from 1 to 6 points to 16 comorbid conditions such as heart disease, dementia and cancer, based on the mortality risk associated with each. The sum ranges from 0, for a person with no comorbidities, to 33 for an individual with the severest form of all included conditions.

Data was analysed using the SPSS 21 and $p<0.05$ was considered statistically significant.

Results

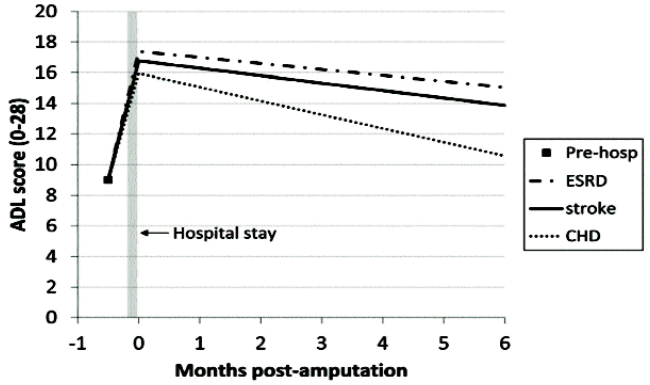
Of the 104 patients, 30(29%) were in TM group, 40(38.4%) in BK group and 34(32.6%) in AK group. All parameters were analysed and compared among the groups (Table-3).

Post-hospital ADL trajectories were noted for factors affecting the degree of ADL changeFor each additional point on the ADL score prior to hospitalisation, post-hospital scores were 0.45 points higher ($p<0.001$). Higher CPS scores were similarly associated with higher post-hospital ADL impairment ($p<0.001$). Post-hospital ADL scores were better for men than women, while greater age and hospital length of stay were associated with higher post-hospital ADL impairment. Stroke, end-stage renal disease (ESRD) and diabetes were associated with worse post-hospital ADL scores, while patients with coronary heart disease (CHD) did somewhat better following hospitalisation. Relative to TM procedures, BK and AK procedures were associated with worse ADL scores (1.33 and 1.83 points, respectively). We retained the acute myocardial infarction variable despite its non-significance (P=0.95) because its interaction with time was very close to being statistically significant (-=0.055) (Table-4).



ADL: Activities of Daily Living. CPS: Cognitive Performance Score.

Figure-1: Post-amputation ADL trajectories for patients with the following; 61 Years old male, pre-hospital ADL function = 9, CPS=2, Hospital Length of stay =8 days, and no co morbidities.



ADL: Activities of Daily Living. CPS: Cognitive Performance Score. BK: Below-Knee

Figure-2: Post-amputation ADL trajectories for patients with the following; 61 Years old male, pre hospital ADL function = 9, CPS=2, Hospital Length of stay =8 days, and a BK procedure.

Compared to TM procedures, BK slowed ADL recovery by 0.32 points per month, while AK slowed ADL recovery by 0.67 points per month.

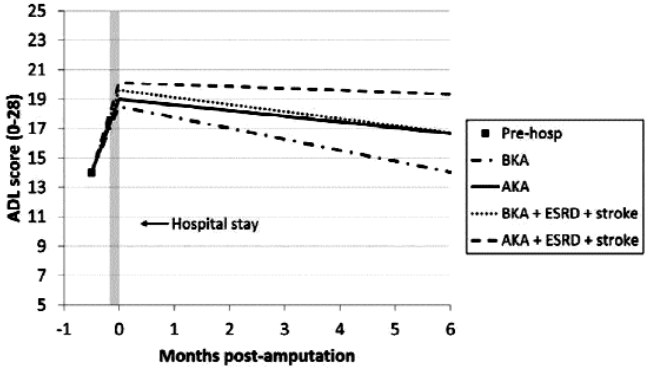
From a moderately impaired pre-hospital ADL score of 9, all patients showed worsened ADL scores following hospitalisation, with the AK group having the greatest change. On average, the ADL trajectories for all patients

Table-1: Description of scoring for Activities of Daily Living (ADL) self-performance items.

Score	Description
0	Independent - no help or oversight - OR - help/oversight provided only 1 or 2 times during last 7 days
1	Supervision - Oversight, encouragement or cueing provided 3 or more times during last 7 days - OR - Supervision (3 or more times) plus physical assistance provided only 1 or 2 times during last 7 days
2	Limited assistance - Resident highly involved in activity; received physical help in guided maneuvering of limbs or other non-weight bearing assistance 3 or more times - OR - More help provided only 1 or 2 times during last 7 days
3	Extensive assistance - While resident performed part of activity, over last 7-day period, help of following type(s) provided 3 or more times: - Weight-bearing support - Full staff performance during part (but not all) of last 7 days
4	Total dependence - Full staff performance of activity during entire 7 days

From Minimum Data Set (MDS) - Version 2.0, Centers for Medicare and Medicaid Services, September 2000.

subsequently improve, with only the TM group returning to baseline in six months. The ADL trajectory showed greater improvement for the BK group compared to the AK group, but neither group returned to their pre-hospital ADL level (Figure-1).



ADL: Activities of Daily Living. CPS: Cognitive Performance Score. AKA: Above-Knee Amputation.

Figure-3: Post-amputation ADL trajectories for patients with the following Characteristics: 61 Years old male, pre hospital ADL function = 14, CPS=2, Hospital Length of stay =8 days and AKA procedure with no co morbidities.

ADL trajectories for a group of patients who had BK procedure were cmopared changing the comorbidities

Table-2: Charlson Comorbidity Index.

Score	Condition
1	Myocardial infarction (history, not ECG changes only)
	Congestive heart failure
	Peripheral vascular disease (includes aortic aneurysm ≥6 cm)
	Cerebrovascular disease: CVA with mild or no residua or TIA
	Dementia
	Chronic pulmonary disease
	Connective tissue disease
	Peptic ulcer disease
	Mild liver disease (without portal hypertension, includes chronic hepatitis)
	Diabetes without end-organ damage (excludes diet-controlled alone)
2	Hemiplegia
	Moderate or severe renal disease
	Diabetes with end-organ damage (retinopathy, neuropathy, nephropathy, or brittle diabetes)
	Tumor without metastases (exclude if >5 y from diagnosis)
	Leukemia (acute or chronic)
	Lymphoma
3	Moderate or severe liver disease
6	Metastatic solid tumor
	AIDS (not just HIV positive)

NOTE: For each decade >40 years of age, a score of 1 is added to be above score.
ECG: Electrocardiogram; CVA: Cerebrovascular accident; TIA: Transient ischemic attack; AIDS: Acquired immunodeficiency syndrome; HIV: Human immunodeficiency virus.

while holding other variables constant. Patients with a history of stroke or ESRD improved more slowly after hospitalisation than patients who did not have a history of stroke or ESRD. Patients with CHD improved somewhat faster (Figure-2).

ADL trajectories for a hypothetical group of patients showing the effect of varying amputation level and comorbid diagnoses while holding other characteristics constant Showed that patients with a history of ESRD and stroke undergoing BK amputation had similar functional trajectories as patients undergoing an AK procedure who did not have those comorbidities (Figure-3).

Discussion

We evaluated the functional status of patients after amputation, using ADL scores to depict functional trajectories. Elderly patients undergoing BK and AK amputations failed to return to their functional baseline within six months. BK amputation had a better functional trajectory compared to AK amputation suggesting that limb preservation is of benefit. ESRD, stroke and poor cognitive performance scores were associated with poor functional outcomes after an amputation and may be considered as indications for performing an AKA based on the equivalently poor trajectories for BKAs. Previous studies have evaluated post-hospital ADL trajectories in patients, including those with hip fracture, CHF, stroke, pneumonia, and sepsis, and have demonstrated that except for in-patients with hip fracture, those with acute hospitalisations for several other diagnoses do not return to baseline function within six months of hospital discharge.[11]

Other authors have evaluated functional outcome of patients who underwent amputation.

Suckow et al. evaluated 436 patients who subsequently received an above-knee (AK), below-knee (BK), or minor amputation after lower extremity bypass. They reported that patients most likely to remain ambulatory were those living at home preoperatively. They documented the presence of several comorbidities associated with patients less likely to achieve a good functional outcome, including coronary disease, dialysis and congestive heart failure.[12,13] This analysis found that prehospital diagnoses of ESRD, stroke and diabetes were significantly associated with inferior functional trajectories after amputation. The finding is consistent with that of our study.

Nehler et al. evaluated the functional history of patients undergoing major amputation in an academic vascular surgery practice and concluded that the ability to predict ambulation after BKA in the vascular population is poor.[14,15] Frykberg et al. described that major lower extremity amputation in the patients 80 years of age and above was associated with a considerable mortality and deterioration of functional and residential status.[16] They reported that postoperative functional status remained unchanged in 40% and worsened in 55% patients. We have demonstrated that functional status did not return to baseline by six months following amputation. Other authors have stated that when preservation of function is the chief concern, amputation should be performed at the lowest possible level.[16,17]

Suckow et al. reported that the proportion of surviving patients with a good functional outcome varied by the presence and extent of amputation (proportion surviving with good functional outcome = 88% no amputation, 81% minor amputation, 55% BK amputation, and 45% AK amputation; p=0.001).[17] This study demonstrated similar findings for patients in that there was significant benefit to limb preservation. This study has also demonstrated the importance of baseline function and cognitive status as a predictor of functional outcomes in patients undergoing lower extremity amputations.

In our study, poor baseline ADL function and poor baseline cognitive performance scores (CPS) were significantly associated with poor functional trajectories after amputation. This finding is consistent with that of other studies showing that significant predictors of poor functional outcome were impaired ambulatory ability at the time of presentation and the presence of dementia.[18] One theory for this is that hospitalised older adults are often discharged with ADL function that is worse than their pre-hospital function, and hospitalisation-associated disability can occur despite successful treatment of the admission-triggering illness.[19] Also, others have suggested that post-amputation rehabilitation is physically and cognitively demanding and those neuropsychological and clinical variables predict a large 6-month outcome variance. Cognitive difficulties may be considered mediators of poor outcome.[20] This analysis demonstrates that baseline cognitive scores and ADL scores were associated with poor functional trajectories after amputation and may be considered in the patients requiring amputation as a tool to evaluate future functional trajectories.

Other factors which were found to be associated with poor functional trajectories after amputation included age and gender. We have evaluated the functions occurring before and after hospital admission for medical illness and reported that oldest patients are at high risk of poor functional outcomes as they are less likely to regain ADL functions and more likely to develop new functional deficits during their hospitalisation. This is consistent with

the results of Covinsky et al.[21]

We also discovered that women had worse ADL function after amputation compared to men. Armstrong et al. evaluated a New York State database for 14,555 non-traumatic amputations and concluded that when controlling for age, prevalence of vascular disease was not significantly different by gender in diabetic and non-diabetic groups at all amputation levels.[22] That having been stated, little evaluation has been performed on gender disparity and function after amputation.

With regard to comorbidities, ESRD, diabetes, and stroke were significantly associated with inferior function after amputation, whereas acute myocardial infarction (AMI) was not associated with poor functional trajectories. Previous studies utilising ADL data have demonstrated that among patients with ESRD, the initiation of dialysis was associated with a substantial and sustained decline in functional status. Also, lower-extremity disease was found to be twice as high among individuals with diabetes.[23] This analysis has demonstrated that ESRD, previous stroke and diabetes mellitus are associated with poorer functional outcomes than in patients without these diagnoses. Hypothetical models created and presented in this analysis demonstrate that a BK amputation may not be the procedure of choice when these comorbidities are combined based on their poor functional trajectory.[24]

Conclusion

The importance of considering pre-morbid conditions, cognitive status and baseline ADL function prior to amputation in patients undergoing lower extremity amputations is critical. Functional status after amputation is multifactorial beyond procedure type and worse functional trajectories after intervention are associated with female gender, poor baseline cognitive performance, poor baseline ADL scores, history of ESRD and stroke.

References

1. Gillen P, Spore D, Mor V, Freiberger W. Functional and residential status transitions among nursing home residents. J Gerontol A Biol Sci Med Sci 1996; 51: M29-36.
2. Mehr DR, Binder EF, Kruse RL, Zweig SC, Madsen R, Popejoy L, et al. Predicting mortality in nursing home residents with lower respiratory tract infection: the Missouri LRI Study. JAMA 2001; 286: 2427-36.
3. Manton KG. A longitudinal study of functional change and mortality in the United States. J Gerontol 1988; 43: S153-61.
4. Rantz MJ, Popejoy L, Zwygart-Stauffacher M, Wipke-Tevis D, Grando VT. Minimum Data Set and Resident Assessment Instrument. Can using standardized assessment improve clinical practice and outcomes of care? J Gerontol Nurs 1999; 25: 35-43.
5. Morris JN, Fries BE, Morris SA. Scaling ADLs within the MDS. J Gerontol A Biol Sci Med Sci 1999; 54: M546-53.
6. Hawes C, Morris JN, Phillips CD, Mor V, Fries BE, Nonemaker S. Reliability estimates for the Minimum Data Set for nursing home resident assessment and care screening (MDS). Gerontologist 1995; 35: 172-8.
7. Carpenter GI, Hastie CL, Morris JN, Fries BE, Ankri J. Measuring change in activities of daily living in nursing home residents with moderate to severe cognitive impairment. BMC Geriatr 2006; 6: 7.
8. McConnell ES, Pieper CF, Sloane RJ, Branch LG. Effects of cognitive performance on change in physical function in long-stay nursing home residents. J Gerontol A Biol Sci Med Sci 2002; 57: M778-84.
9. Morris JN, Fries BE, Mehr DR, Hawes C, Phillips C, Mor V, et al. MDS cognitive performance scale. J Gerontol 1994; 49: M174-82.
10. Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. J Chronic Dis 1987; 40: 373-83.
11. Kruse RL, Petroski GF, Mehr DR, Banaszak-Holl J, Intrator O. Activity of daily living trajectories surrounding acute hospitalization of long-stay nursing home residents. J Am Geriatr Soc 2013; 61: 1909-18.
12. Singer JD, Willett JB. Applied Longitudinal Data Analysis Modeling Change and Event Occurrence. First ed. New York, NY: Oxford University Press; 2003; pp 644.
13. Henderson R, Diggle P, Dobson A. Joint modelling of longitudinal measurements and event time data. Biostatistics 2000; 1: 465-80.
14. Suckow BD, Goodney PP, Cambria RA, Bertges DJ, Eldrup-Jorgensen J, Indes JE, et al. Predicting functional status following amputation after lower extremity bypass. Ann Vasc Surg 2012; 26: 67-78.
15. Nehler MR, Coll JR, Hiatt WR, Regensteiner JG, Schnickel GT, Klenke WA, et al. Functional outcome in a contemporary series of major lower extremity amputations. J Vasc Surg 2003; 38: 7-14.
16. Frykberg RG, Arora S, Pomposelli FB Jr, LoGerfo F. Functional outcome in the elderly following lower extremity amputation. J Foot Ankle Surg 1998; 37: 181-5.
17. Waters RL, Perry J, Antonelli D, Hislop H. Energy cost of walking of amputees: the influence of level of amputation. J Bone Joint Surg Am 1976; 58: 42-6.
18. Taylor SM, Kalbaugh CA, Blackhurst DW, Cass AL, Trent EA, Langan EM 3rd, et al. Determinants of functional outcome after revascularization for critical limb ischemia: an analysis of 1000 consecutive vascular interventions. J Vasc Surg 2006; 44: 747-56.
19. Covinsky KE, Pierluissi E, Johnston CB. Hospitalization-associated disability: "She was probably able to ambulate, but I'm not sure". JAMA 2011; 306: 1782-93.
20. O'Neill BF, Evans JJ. Memory and executive function predict mobility rehabilitation outcome after lower-limb amputation. Disabil Rehabil 2009; 31: 1083-91.
21. Covinsky KE, Palmer RM, Fortinsky RH, Counsell SR, Stewart AL, Kresevic D, et al. Loss of independence in activities of daily living in older adults hospitalized with medical illnesses: increased vulnerability with age. J Am Geriatr Soc 2003; 51: 451-8.
22. Armstrong DG, Lavery LA, van Houtum WH, Harkless LB. The impact of gender on amputation. J Foot Ankle Surg 1997; 36: 66-9.
23. Helm P, Engel T, Holm A, Kristiansen VB, Rosendahl S. Function after lower limb amputation. Acta Orthop Scand 1986; 57: 154-7.
24. Gregg EW, Sorlie P, Paulose-Ram R, Gu Q, Eberhardt MS, Wolz M, et al. Prevalence of lower extremity disease in the US adult population >=40 years of age with and without diabetes: 1999-2000 national health and nutrition examination survey. Diabetes Care 2004; 27: 1591-7.