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 prosthesis4,5 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.6 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
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. We calculated the Charlson Comorbidity Index (Table-2) based on both prior and hospital diagnoses to represent each patient’s overall comorbidity 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 change for 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).

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

**Table-2:** Charlson Comorbidity Index.

<table>
<thead>
<tr>
<th>Score</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Myocardial infarction (history, not ECG changes only)</td>
</tr>
<tr>
<td></td>
<td>Congestive heart failure</td>
</tr>
<tr>
<td></td>
<td>Peripheral vascular disease (includes aortic aneurysm ≥6 cm)</td>
</tr>
<tr>
<td></td>
<td>Cerebrovascular disease: CVA with mild or no residua or TIA</td>
</tr>
<tr>
<td></td>
<td>Dementia</td>
</tr>
<tr>
<td></td>
<td>Chronic pulmonary disease</td>
</tr>
<tr>
<td></td>
<td>Connective tissue disease</td>
</tr>
<tr>
<td></td>
<td>Peptic ulcer disease</td>
</tr>
<tr>
<td></td>
<td>Mild liver disease (without portal hypertension, includes chronic hepatitis)</td>
</tr>
<tr>
<td></td>
<td>Diabetes without end-organ damage (excludes diet-controlled alone)</td>
</tr>
<tr>
<td>2</td>
<td>Hemiplegia</td>
</tr>
<tr>
<td>3</td>
<td>Moderate or severe renal disease</td>
</tr>
<tr>
<td></td>
<td>Diabetes with end-organ damage (retinopathy, neuropathy, nephropathy, or brittle diabetes)</td>
</tr>
<tr>
<td></td>
<td>Tumor without metastases (exclude if &gt;5 y from diagnosis)</td>
</tr>
<tr>
<td></td>
<td>Leukemia (acute or chronic)</td>
</tr>
<tr>
<td></td>
<td>Lymphoma</td>
</tr>
<tr>
<td>4</td>
<td>Moderate or severe liver disease</td>
</tr>
<tr>
<td>5</td>
<td>Metastatic solid tumor</td>
</tr>
<tr>
<td>6</td>
<td>AIDS (not just HIV positive)</td>
</tr>
</tbody>
</table>

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.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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**

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.