

Falls in a Young Active Amputee Population: A Frequent Cause of Rehospitalization?

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ABSTRACT Falls occur in up to 50% of amputees within a single year of their operation and up to 40% of these falls result in injury. However, there is a lack of data evaluating falls in a young, active amputee population despite an estimated 58% of persons living with an amputation being under the age of 65. The authors evaluated an amputee population ($n = 393$) with a mean age of 25.53 years. Overall incidence, prevalence, fall characteristics, and risk factors were calculated for falls resulting in rehospitalization. An incidence of 1.92 per 1,000 person years with a prevalence of 2.04% was found with 87.5% occurring within the first 6 months following definitive amputation. Of the patients rehospitalized, 75% required at least 1 surgical procedure. Infectious complications had the most significant morbidity requiring a mean of 5 operative procedures. Those that delayed evaluation (mean = 13 days) vs. those that presented 0 to 1 day from a fall were significantly more at risk of an infectious complication ($p = 0.03$). This study is the first to report such a relationship, and emphasizes the need for at-risk patients to seek early medical attention as this may minimize the risk of infection and obviate the need for surgical intervention.

INTRODUCTION

The loss of a limb often requires lengthy rehabilitation in order for a patient to return to a high level of function after receiving a prosthesis.^{1,2} In addition, there can be a significant psychological impact on the patient who has lost their limb.³ For these reasons, it is important that postinjury morbidity is minimized in order to maximize the physical and emotional recovery of the new amputee.^{4,5}

Elderly patients, with vascular disease and diabetes, account for the majority of the amputee population currently studied. This population has been shown to have an incidence of falls up to 20% during inpatient rehabilitation in the immediate postoperative period.⁶ Perhaps more worrisome, 50% of amputees report falling at least once in a single year with 40.4% of these resulting in injury and 19.3% requiring medical attention.^{7,8} A fall by an amputee may require rehospitalization and, in some cases surgical intervention, resulting in significant morbidity for these patients.

Unfortunately, there is a lack of data evaluating the morbidity of falls in a young, active amputee population. The primary age cohort in the current available literature has an average age that ranges from 59 to 69 years,^{6–10} with none describing falls in a large population of young adult amputees. This may be attributable to disproportionate sampling,

as according to Ziegler-Graham et al,¹¹ 58% of persons living with an amputation are under the age of 65 and 18% are aged 18 to 44. The combat operations during the last decade, resulting in 1,221 amputees,¹² provide a unique opportunity to evaluate a closely monitored group that has thus far been under-represented in the current literature on the question of fall morbidity.

The purpose of this study is to identify the incidence of fall-related hospital readmissions among a young active amputee population. Secondary study goals are to evaluate the injury patterns seen with falls resulting in readmission, and to identify possible risk factors for these falls in an effort to avoid this complication in the future.

MATERIALS AND METHODS

This study was conducted under a protocol reviewed and approved by the local Institutional Review Board. The inpatient electronic medical record database at a single military treatment facility (San Antonio Military Medical Center) was reviewed to identify all patients hospitalized from September 2001 to March 2012 secondary to a fall that had an existing amputation on presentation in order to identify hospitalization as the result of a fall in those sustaining a major extremity amputation. The electronic medical records of these patients were then reviewed to ensure only patients that were hospitalized as a result of a fall-related complication were included and that the initial injury sustained leading to the amputation was combat related, i.e., sustained while serving on active duty in Operation Enduring Freedom (OEF), Operation Iraqi Freedom (OIF), and Operation New Dawn (OND).

The electronic medical records of those included for final analysis were queried for demographics, circumstances, and risk factors identified in civilian literature as significant for falls or felt to be important by author consensus. These

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datapoints included: age, sex, level of amputation, date of initial injury, date of amputation, date of fall, circumstance of fall to include whether the fall occurred during a transfer and if a prosthesis was being worn, injury from fall, date of initial intervention, reason for admission, length of hospital stay, narcotic or benzodiazepine use at time of fall, alcohol or illicit drug use at time of fall, and a diagnosis of traumatic brain injury at time of fall.

The compiled data set was then compared with the local combat amputee treatment population data to determine the rate of these falls.¹² Statistical analysis utilizing Kruskal–Wallis and the Students’ *t*-test, as appropriate, were performed; significance was established as $p < 0.05$.

RESULTS

121 patients were identified in the initial electronic medical record search. After excluding those that were not fall-related complications in a combat-related amputee patient ($n = 113$), 8 patients were found to meet inclusion criteria during the period reviewed. Using a local treatment population of 393 amputees,¹² the prevalence of an amputee having a fall-related complication requiring rehospitalization was determined to be 2.04%, with an incidence of 1.92 per 1,000 person years.

The amputation levels sustained by these amputees were: transtibial (5), transfemoral (1), transhumeral and a contralateral elbow disarticulation (1), and a transhumeral amputation with an ipsilateral transfemoral amputation (1). Falls leading to rehospitalization occurred a mean of 144 days after amputation (range, 5–735 days). 7 of the 8 rehospitalized (87.50%) fell within the first 6 months following their definitive amputation. There were no repeat hospitalizations for a fall.

Fall-Related Complications

Complications as a result of the fall included 3 wound dehiscences without infection, 3 wound dehiscences with infections, 1 splenic laceration managed nonoperatively, and 1 knee and ankle joint sprain. All patients with the exception of the splenic laceration and joint sprain required an operative debridement and irrigation. The most morbid complication was infection. All 3 infected patients required multiple debridements before delayed primary closure with a mean of 5 (range 2–8) and tended to have longer hospital stays, mean 25.3 days for those infected vs. 3.8 days for those without an infection ($p = 0.10$). In addition, time from fall to presentation showed those that delayed coming to the hospital (mean 13 days, range 7–21 days) were more likely to have an infectious complication than those evaluated within 0 to 1 day from fall ($p = 0.03$).

Circumstances Surrounding Fall

Those amputees sustaining a fall requiring rehospitalization were approximately 5 years older (30.38) than the mean age of the local combat amputee population treated (25.53; $p < 0.0001$) with a range of 20–40 years. A trend showing a

preponderance of transtibial amputations, 5 of the 8, suggesting an increased risk was noted, but statistical significance was not established ($p = 0.13$). In addition, 1 female was identified of the 8 requiring hospitalization; this did not reach statistical significance ($p = 0.10$), but was notable as the total local population of combat amputees contains only 5 females. All 8 individuals were using narcotics at the time of the fall, and 2 were concurrently taking benzodiazepines. Fifty percent had a traumatic brain injury identified at time of injury. No bilateral lower extremity amputees were identified. Prosthesis wear and fall during transfer were unable to be fully evaluated as not all records noted these data points. However, 6 of the 7 (85.70%) with documented circumstances surrounding the fall occurred without a prosthesis in place and 3 of the 5 (60%) with documented mechanism of fall resulting in rehospitalization occurred during transfer from wheelchair or shower chair (p values were not calculated given the incomplete data) (Table I).

DISCUSSION

According to the current literature, as many as 50% of amputees will report falling at least once in a single year and 19.3% will seek medical attention.^{7,8} An amputee fall can cause injuries along a spectrum, with the worst requiring rehospitalization and in some cases, surgical intervention. This is especially important to note, as recent evidence suggests that even young, active amputees are at risk for bone mineral density loss during their recovery, which may further increase their risk of sustaining fall-related injuries, such as a femoral neck fracture.¹³ However, the majority of the available data is based almost exclusively on older amputee populations and current literature for fall-related complications is lacking for a young amputee population. The primary age cohort in current literature has an average age that ranges from 59 to 69 years,^{6–10} with no studies identified looking at a large population of young adult amputees despite an estimated 58% of all living amputees being <65 years and 18% being 18 to 44 years.¹¹

Many studies have evaluated rehospitalization or secondary hospitalization in amputee populations. Most notably,

TABLE I. Summary of Fall Circumstances Resulting in Hospitalization

Circumstances of Fall Resulting in Hospitalization	Falls Identified (%)
Narcotic Use	100%
Fall within First 6 Months after Amputation	87.5%
Not Wearing Prosthesis at Time of Fall	85.7%*
Traumatic Brain Injury	50%
Fall during Transfer (Wheelchair/Chair)	60%*
Fall from Standing	25%
Benzodiazepine Use	25%

TBI, traumatic brain injury. *Calculated using only those patients with documented mechanism of fall.

the Lower Extremity Assessment Project (LEAP) study group has shown 33.90% of those who underwent an amputation required a secondary hospitalization for a major complication.^{14,15} In addition, Masini et al¹⁶ identified 4% of rehospitalization codes for combat injured in the recent conflicts were due to complications or infection of the residual limb of amputees. Kulkarni et al¹⁷ who also evaluated falls leading to rehospitalization in a mixed population of lower extremity amputees found that 7% of falls resulted in bony injury requiring hospitalization. This study showed a slightly lower prevalence of 2.04% and an incidence of 1.92 per 1,000 person years of any fall-related complication resulting in rehospitalization. There may be several reasons that account for this difference. First, Kulkarni et al only evaluated falls in lower extremity amputees, whereas this study evaluated all amputees, to include those with upper extremity amputations. Second, this study evaluated a military population with good access to care, to include prosthetics and comprehensive rehabilitation programs. Third, this study only evaluated patients readmitted to a single regional military treatment facility. It is possible that patients may have been readmitted elsewhere as a result of a fall but any such data would be extremely difficult to locate.

Risk factors associated with falls of any severity have been discussed in previous literature, and were based on primarily elderly patient cohorts. The site of amputation to include transtibial, transfemoral, bilateral, and right sided amputation have all been found to show statistically significant increased risk for fall.^{6,8,18} An age greater than or equal to 71 years, cognitive impairment, requiring ≥ 2 as needed (prn) medications, benzodiazepine use, opiate use, and having 4 or more comorbidities have also been noted to be significant risk factors.^{6,18} As an etiologic risk, an amputation because of a dysvascular cause has been identified.¹⁸ In addition, literature has shown between 29.40% and 71% of injurious falls associated with wheelchair transfers.^{6,9,19} Furthermore, it has been found that those amputees that sustain a fall have a 1 in 3 chance of falling again.¹⁹ Conflicting data have shown time from amputation as possibly protective, with 4 years or greater noted in 1 study but also being specifically noted as having no protective effect in another.^{8,17} Our cohort is on average significantly younger than currently studied amputee populations with an age range of 20 to 40, and is the first

large young amputee population to be studied to our knowledge. In addition, so as to evaluate a specific complication and focus on the most significant morbidity associated with a fall, inclusion criteria only accounted for the falls that resulted in rehospitalization, not all falls as examined in the majority of currently published literature. However, many of the risk factors noted in the previously published literature for falls in amputees are consistent with our findings (Table II). The majority of falls in our population occurred during wheelchair/chair transfer, specifically 60% of the patients that had their fall circumstance documented. In addition, 50% of the falls were identified in individuals with a documented traumatic brain injury at the time of the fall; which correlates with previous literature that has shown an increased risk for falls with cognitive impairment.⁶ Our study showed a statistically significant risk with increased age relative to the local amputee population, showing the mean age of those requiring hospitalization of 30.38 as compared with the overall local amputee population mean age of 25.53 ($p < 0.0001$). This is in line with Pauley et al's⁶ data in which their older-aged grouping was most at risk. All patients were taking narcotic pain medication at the time of the fall, which has been demonstrated as a statistically significant risk factor as well.

In regard to amputation level, bilateral, transtibial, and transfemoral have all been implicated as significant risk factors without consistency across the literature.^{6,8,18} Interestingly, out of a total local population of 80 bilateral lower extremity amputees, none were identified as having sustained a fall necessitating rehospitalization. In addition, no more than one hospitalization for a fall was noted within our patient cohort with any level of amputation. As Dyer et al¹⁹ has shown a 1 in 3 chance of refall in an older cohort, it is possible younger amputees do not have this same risk. Time from amputation in the older population studies have shown < 4 years from time of amputation associated with an increased risk⁸; our study, in a younger population, showed that amputees may be at an increased risk of sustaining a fall resulting in rehospitalization within the first 6 months of an amputation. This may be a function of our target endpoint being rehospitalization, as the LEAP study group¹⁴ showed half of their residual limb complications because of infection occurred within the first 3 months and had no cases of wound dehiscence or complication after 6 months. The

TABLE II. Comparison of Fall Risk Factors With Current Literature

	Current Study	Previous Literature
Fall during Transfer (Wheelchair/Chair)	60%*	30–70%
Increased Age	30 years	70yo
Narcotic Use	100%	Statistically significant increased risk
Cognitive Impairment	50%	Statistically Significant Increased Risk
Transtibial Level	62.5%	Statistically Significant Increased Risk
Time from Amputation	87.5% < 6 Months	< 4 years

*Calculated using only those patients with documented mechanism of fall.

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authors did note a statistically significant increase in infectious complications in those that delayed their presentation a mean of 13 days vs. 0 to 1 day in the noninfected group after sustaining a fall ($p = 0.03$). Our study is the first to suggest this relationship, and is intuitive in that those who seek medical attention sooner can be treated appropriately earlier, and perhaps leads to the difference in infectious complications. It would be beneficial to recommend to amputee patients to seek immediate medical evaluation after a fall if there is any question of possible residual limb injury.

There are several limitations present in this study. This study is retrospective in nature and maintains the associated weaknesses, limitations, and potential biases inherent to the study design. In addition, only 8 patients were identified as meeting inclusion criteria, making meaningful statistical analysis difficult and introducing fragility to our data. Although this resulted in an overall low prevalence in the population studied, it is likely an underestimate, as mentioned earlier, as some patients were likely to have fallen and been admitted elsewhere with a fall-related complication. Finally, this study consisted of a military population, and although they are likely similar to their age-matched amputees within the civilian population, they have inherent differences in access to care, rehabilitation, and social support systems.

CONCLUSION

Not all falls result in significant injury, and even fewer necessitate readmission as identified in our study. A prevalence of 2.04% or an incidence of 1.92 per 1000 person years is not a large number, but if consistent throughout, the population would represent a significant number of injuries and secondary hospitalizations. This is particularly important, as 75% of those rehospitalized within our cohort required at least one reoperation. In addition, the current study demonstrated an increased risk of infectious complication with a delayed presentation after a fall. These data emphasize the need for at-risk patients to seek early appropriate medical attention as early medical intervention may minimize the risk of infection and obviate the need for surgical intervention. This data can be used to educate at-risk patients and encourage the execution of fall-education programs, especially during the first 6 months following amputation to minimize potential complications for young active amputees.

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