Return to Duty and Disability After Combat-Related Hindfoot Injury

Andrew J. Sheean, MD, Chad A. Krueger, MD,* and Joseph R. Hsu, MD†*

Objectives: To characterize the return-to-duty (RTD) rates and disability outcomes for soldiers who sustained combat-related hindfoot injuries that were treated with either reconstruction or transtibial amputation (TTA).

Design: Retrospective cohort series.

Setting: Tertiary trauma center.

Patients/Participants: All patients treated for combat-related hindfoot injuries between May 2005 and July 2011.

Intervention: TTA or hindfoot reconstruction/ankle fusion.

Main Outcome Measurements: Age, RTD rate, combined disability, and associated disabling conditions.

Results: One hundred twenty-two patients underwent treatment for combat-related hindfoot injuries. Fifty-seven patients were treated with amputation, and 65 patients were treated with hindfoot reconstruction or ankle fusion. The overall RTD rate was 20%. Amputees had a RTD rate of 12%, which was lower than those who had a fusion or hindfoot repair [26% ($P < 0.06$)]. The disability ratings of amputees were significantly higher than those patients undergoing either ankle fusion or primary hindfoot repair [75% and 62%, respectively ($P < 0.006$)].

Discussion: While RTD rates were higher for hindfoot reconstruction or ankle fusion compared with TTA, psychiatric conditions were more common among these patients. Although there were clear differences between both groups, the relationship between true functional outcomes and disability ratings remains unclear and both treatment groups seem to do poorly in terms of returning to active duty.

Key Words: hindfoot injury, disability, outcomes

Level of Evidence: Therapeutic Level III. See Instructions for Authors for a complete description of levels of evidence.

(*J Orthop Trauma* 2014;28:e258–e262)

Eighty-two percent of casualties of military operations in Iraq and Afghanistan have sustained extremity injuries, and majority of injuries are related to explosions.[1] Of these injuries, 53% were penetrating soft tissue wounds and 26% were fractures.[2] The difficulties of treating combat-related foot and ankle injuries stem from the frequent involvement of high-energy mechanisms, which increase the likelihood of comminuted fractures and soft tissue coverage issues (Fig. 1).[3,4]

Return to work is frequently used as an outcome measure after traumatic injury, and civilian trauma patients with severe lower extremity injuries have a well-described rate of returning to work (49%–53%).[5] The equivalent metric for active duty service members is return to duty (RTD) after injury. RTD rates for various combat-related injury patterns have been described. Stinner et al[6] demonstrated that RTD rates among amputees to be 16.5%. Similarly, Cross et al[7] have described RTD rates for those patients sustaining combat-related Gustilo and Anderson type III tibia fractures, showing RTD rates of patients with salvaged extremities and amputations to be 20.5% and 12.5%, respectively. It is speculated that total disability costs for the current conflicts will approach $2 billion underscoring the importance of a more

FIGURE 1. Clinical photograph of a severely injured hindfoot that was treated successfully with primary reconstruction.

Accepted for publication March 21, 2014.

From the *Department of Orthopaedic Surgery, San Antonio Military Medical Center, Fort Sam Houston, San Antonio, TX; and †Department of Orthopaedic Surgery, Carolinas Medical Center Orthopaedic Surgery, Charlotte, NC.

The authors report no conflict of interest.

This study commenced after being approved by the United States Army Institute of Surgical Research Institutional Review Board. The opinions or assertions contained herein are the private views of the authors and are not to be construed as official or reflecting the views of the Department of the Army, Department of Defense, or the US government. This work was prepared as part of their official duties and, as such, there is no copyright to be transferred.

Reprints: Andrew J. Sheean, MD, Orthopaedic Surgery, San Antonio Military Medical Center, 3851 Roger Brooke Drive, Fort Sam Houston, San Antonio, Texas 78234 (e-mail: andrew.j.sheean.mil@mail.mil).

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
01 NOV 2014	**N/A**	**-**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
Return to Duty and Disability After Combat Related Hind Foot Injury	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
Sheean A. J., Krueger C. A., Hsu J. R.,	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)	8. PERFORMING ORGANIZATION REPORT NUMBER
US Army Institute of Surgical Research, JBSA Fort Sam Houston, Texas	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release, distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
unclassified	**unclassified**	**unclassified**	**UU**	**5**	

complete understanding of disability among military members.[8] Recent work has characterized the extent of soldiers' incapacity by analyzing disability ratings at the time of medical retirement, demonstrating that 76% of casualties of Operation Iraqi Freedom and Operation Enduring Freedom were diagnosed with an orthopaedic condition that constituted their primary disability.[9] The purpose of this study is to characterize RTD rates and disability outcomes for service members that sustained combat-related hindfoot injuries that were treated with reconstruction to those treated with transtibial amputation (TTA).

PATIENTS AND METHODS

This study was conducted under a protocol reviewed and approved by the Institutional Review Board. All service members treated for combat-related hindfoot injuries between May 2005 and July 2011 at our institution were identified and categorized based on definitive treatment type. Two cohorts were defined based on treatment; those treated with TTA and those treated with either primary hindfoot repair or reconstruction. All patients not treated with TTA underwent either triple arthrodesis, subtalar arthrodesis, ankle fusion, or operative fixation of calcaneus and/or talus fractures. Each patient either returned to duty directly after their treatment or was referred to a Physical Evaluation Board (PEB) for disposition and determination of disability. Patient records were reviewed to characterize patient demographics, injuries, and outcomes. Such information included patient age, rank, gender, injury mechanism, military occupational specialty, presence of complications, and associated injuries. The PEB was then queried for the final disposition and disability of each patient. The PEB determines if a service member should be permanently retired, separated with severance pay, placed on the temporary disability retirement list, or is fit for duty. A service member may also return to active duty with a disposition of continuation on active duty (COAD), which allows an individual to return to active duty after a PEB appeal process and a change in job status. Although a service member may rarely be transferred from the temporary disability retirement list to either COAD or fit for duty status, for the purposes of this project, the first 3 dispositions were considered to indicate that a service member is unable to RTD and is therefore medically retired or separated (MRS).

Each service member who is not fit for duty, as determined by the PEB, has a list of "unfitting conditions," indicating those diagnoses that are determined to contribute to the individual's persistent disability. "Unfitting conditions" are coded using the Veterans Affairs System of Rating Disabilities and are assigned a percent disability 0 to 100 with ratings greater than 75% designated service members "fully disabled."[10] Because it is not uncommon for service members to carry multiple diagnoses, we calculated each service member's disability related directly to their orthopaedic injuries and their overall disability rating using this system in the event that they were not able to RTD.[11–13] The frequency of unfitting conditions and the average percent disability were calculated. The cohort impact for each unfitting condition was determined using methods described by Cross et al,[9] multiplying the average percent disability for each disabling condition by the frequency with which each condition occurred.

The RTD rate was calculated by combining service members who returned to duty with recovery, those judged to be fit for duty at the PEB, and those who returned to duty on COAD. Additionally, comparisons were made between groups regarding demographics, injury characteristics, and disability ratings between service members who were MRS and those who RTD. Each group was compared using two-tailed Fisher exact test for categorical data or student t tests for continuous data (GraphPad Software, La Jolla, CA). Statistical significance was set at $P \leq 0.05$.

RESULTS

One hundred twenty-two patients underwent treatment for combat-related hindfoot injuries between May 2005 and July 2011 at our institution (Fig. 2). The average age for each group was between 25 and 26 years, and all groups had a mean rank at the time of injury of E-5 (Table 1). All injured personnel were male. The majority of service members (89%) were injured by improvised explosive devices. Fifty-seven patients were treated with amputation, and 65 patients were treated with either hindfoot fusion (24 patients) or primary hindfoot repair (41 patients) (Fig. 1). Isolated calcaneus injuries were more likely to be treated with hindfoot reconstruction ($P < 0.0002$), whereas combined talus and calcaneus injuries were more likely to be treated with amputation ($P < 0.0001$).

Twenty-four (20%) soldiers, 17 treated with primary repair or ankle fusion and 7 treated with amputation, were able to RTD. Of those 24 soldiers, 14 were able to RTD with recovery, all of which were treated with either primary hindfoot repair or ankle fusion. All amputees underwent PEB, and 7 of these soldiers were able to RTD. Four service members, 3 amputees and 1 patient treated with primary hindfoot repair, were RTD designated to COAD. Thus, 20 soldiers (16%) were able to return to an active duty role within the military. Overall, amputees had a RTD rate of 12%, which was lower than the RTD rate for those injured service members who underwent ankle fusion or hindfoot repair (26%, $P < 0.06$). Fifteen patients (23%) of those who underwent limb salvage were fitted with a custom energy-storing ankle foot orthosis, the Intrepid Dynamic Exoskeletal Orthosis (IDEO). This novel orthotic, when used in concert with a specialized rehabilitation program, has been shown to significantly outperform other available orthoses.[14] Of the 14 service members who were able to RTD, 5 (36%) were fitted with the IDEO.

Sixty-five percent of unfitting conditions in this cohort were related to the subjects' hindfoot injuries. The most common disabling condition among those soldiers treated with either primary hindfoot repair or ankle fusion was related to loss of joint motion (Table 2). Among amputees, lower extremity amputation was the most common disabling condition and also had the highest impact score (Table 3). Overall, PTSD was present in 27% of individuals in this study and had the highest and second highest impact scores in the

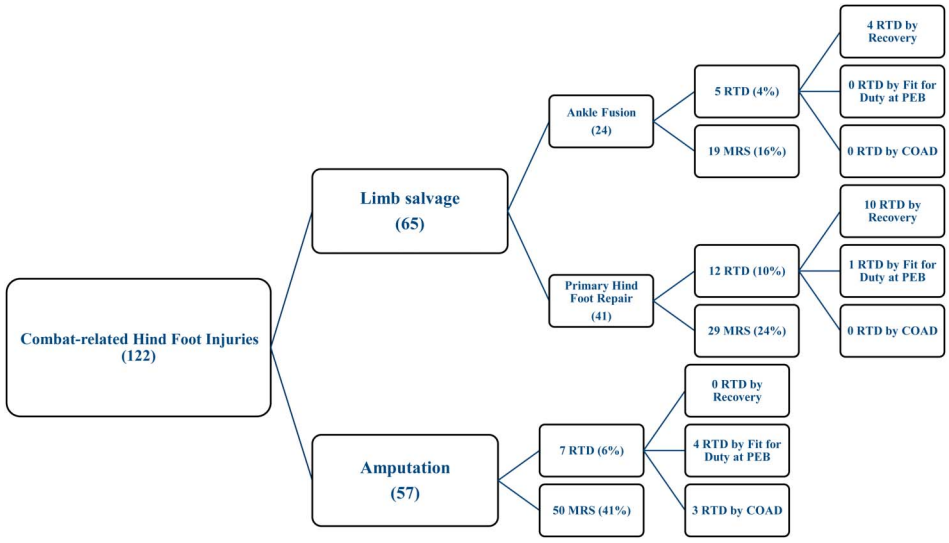

FIGURE 2. One hundred twenty-two patients met inclusion criteria.

nonamputee and amputee groups, respectively. The average combined disability ratings of amputees (75%) were significantly higher than those patients undergoing either ankle fusion or primary hindfoot repair (62%, $P < 0.006$). Traumatic brain injury was present in 7% of MRS soldiers. Seventy-two percent of patients treated with either ankle fusion or primary hindfoot repair had associated psychiatric disabling conditions compared with 28% of patients treated with amputation ($P < 0.002$).

DISCUSSION

The prevalence of orthopaedic injuries among those participating in recent military conflicts is well described.[1,2,6] Patients in this series treated with either ankle fusion or primary hindfoot repair returned to duty at a greater rate (26%) than those treated with amputation (12%). These RTD rates are comparable to those determined by Cross et al (20.5%) for salvaged limbs after severe tibia fractures and the 16.5% found by Stinner et al for amputated limbs.[1,4] Although multiple analyses of combat-related injuries and resultant disability have shown RTD rates correlated with older age and higher rank,[6] this cohort did not demonstrate similar relationships.[5] This finding was surprising and may be secondary to the relatively small number of patients in each cohort.

For soldiers who are unable to RTD, orthopaedic injuries accounted for the majority (73%) of their permanent disability and hindfoot injuries specifically accounted for 65% of all disabling conditions. Disability among those retired was substantial with all MRS subjects receiving an average disability rating of 70, markedly greater than that (50%) found by Cross et al for service members sustaining type III tibia fractures.[5] Amputees received higher disability ratings than those of the primary repair or ankle fusion groups, which is consistent with findings demonstrated by Cross et al for patients with type III open fractures treated with either amputation or limb salvage. This difference may represent a consequence of more severe injuries that those patients treated with amputation are more severely injured than those whose limbs are salvaged. Furthermore, although these findings are drastically different than those described in the LEAP study,[5] our patient population and outcome measures used are far different than those evaluated in the LEAP study. We would caution against making such a comparison. Furthermore, the availability of robust rehabilitation services available within the military and the desire to return to active duty may play a role in any differences found between military and civilian patient outcomes after severe trauma.

The prevalence of psychiatric conditions in veterans of Operation Iraqi Freedom/Operation Enduring Freedom is well described, and the burden of psychiatric conditions is noteworthy among the soldiers in this cohort.[15] PTSD was the highest impacting disabling condition for soldiers treated with either hindfoot repair or fusion and the second highest impacting disabling condition among amputees. Furthermore, there was a significant difference in the incidence of associated psychiatric conditions between groups, with patients treated with either primary repair or fusion to be 2.6 times more likely to have an associated disabling psychiatric diagnosis. This finding is consistent with the findings of Doukas et al,[16] which showed that amputees tend to have a lower incidence of disabling psychiatric conditions compared with those treated with limb salvage. This recurring trend among different cohorts may simultaneously demonstrate the success of efforts to rehabilitate amputees and an apparent shortcoming of the resources available to those treated with limb salvage.

The decision to amputate or reconstruct the severely injured lower extremity continues to confound orthopaedic

TABLE 1. Demographics

	Entire Cohort	MRS	RTD	Hindfoot Repair	Amputees	*P*
Age, y	26	25	26	26	26	0.159
Median rank	E-5	E-5	E-5	E-5	E-5	0.566

TABLE 2. Ranking of Unfitting Conditions by Impact for Primary Repair or Ankle Fusion

Rank Number	Unfitting Condition	Frequency	Average Percent Disability	Impact
1	PTSD	22	42	924
2	Foot injury	25	26	660
3	Loss of joint motion	29	22	641
4	Lower extremity amputation	10	47	560
5	Arthritis	20	17	331
6	TBI	10	33	330
7	Nerve: loss of function	11	28	310
8	Hand condition	7	29	203
9	Anxiety disorder	4	35	140
10	Spine condition	6	20	120
11	Burn scar of head, face, and neck	3	40	120
12	Sleep apnea	1	50	50
13	Forearm condition	1	40	40
14	Genitourinary condition	1	20	20
15	Nerve: pain	1	10	10

surgeons. Although multiple scoring systems that incorporate a variety of clinical parameters have been proposed to inform this decision, no method has been consistently validated as a reliable means for accurately predicting the likelihood of amputation or the functional recovery. Characterizations of experiences of those treating combat casualties may be useful in providing general guidance in the management of extremities injured by high-energy mechanisms.[17–21] Ramasamy et al[22] showed that injuries involving the foot and ankle vasculature and open fractures predicted amputation. In this series, fracture of both the calcaneus and talus was a significant predictor of amputation when compared with those soldiers without concomitant calcaneus and talus fractures. This finding is not particularly remarkable because those injuries that fracture both the calcaneus and the talus have likely imparted a great amount of soft tissue damage to the remaining limb, increasing the difficulty of reconstruction and salvage.

The weaknesses of this study are typical of retrospective analyses because the strength of the data is contingent on the quality of the medical record and completeness of PEB documentation. This study is also limited by a relatively small sample size, making it difficult to determine statistical significance between various characteristics of the two groups. Moreover, this analysis does not control for injury severity, and it is entirely possible that the cohorts compared were not similarly injured. If this were the case then it is not surprising that those with more severe injuries compelling amputation would be more likely to also RTD at lower rates.

The generalizability of these results beyond the military setting remains uncertain, and caution must be taken in using military RTD rates as surrogates for functional outcomes because the physical requirements for active military duty are undoubtedly more demanding than those of civilian vocations. It is important to note the incorporation of specialized orthoses such as the IDEO into the multidisciplinary rehabilitation regimens of patients in this study. Although the implications of this technology on functional outcomes are beyond the scope of this manuscript, it is possible that IDEO usage may further complicate efforts to extrapolate our findings to civilian cohorts. Additionally, other objective metrics such as education level and marital status that have been described in characterizing civilian return to work rates, were neither available nor incorporated into this study, and

TABLE 3. Ranking of Unfitting Conditions by Impact for Amputees

Rank No.	Unfitting Condition	Frequency	Average Percent Disability	Impact
1	Lower extremity amputation	55	52	2855
2	PTSD	11	42	460
3	TBI	12	35	420
4	Loss of joint motion	15	18	270
5	Nerve: loss of function	9	29	260
6	Foot injury	8	23	184
7	Arthritis	6	17	100
8	Hand condition	3	23	70
9	Spine condition	3	13	40
10	Anxiety disorder	2	20	40
11	Genitourinary condition	1	30	30

outcomes beyond the PEB decision for service members remain less clear.[23] This limitation underscores the importance of ongoing efforts to devise a means by which to more fully understand the process of facilitating veterans' reintegration into society after separation from the military.[24,25]

Overall, this study shows that service members with combat-related hindfoot injuries treated with primary reconstruction seem to RTD at higher rates than those treated with amputation. Perhaps a more striking feature is the incidence of psychiatric disability among those treated with limb salvage. Although there were clear differences between both groups, the relationship between true functional outcomes and disability ratings remains unclear. More research is needed to further elucidate these relationships.

REFERENCES

1. Owens BD, Kragh JF, Wenke JC, et al. Combat wound in operation Iraqi freedom and operation enduring freedom. *J Trauma.* 2010;68:1476–1479.
2. Owens BD, Kraugh JF, Macaitis J, et al. Characterization of extremity wounds in operation Iraqi freedom and operation enduring freedom. *J Orthop Trauma.* 2007;21:254–257.
3. Ursone RL. Unique complications of foot and ankle injuries secondary to warfare. *Foot Ankle Clin.* 2010;15:201–208.
4. Lantry JM, Perumal V, Roberts CS. Can patterns of segmental injuries of the foot and ankle predict amputation and disability? *J Surg Orthop Adv*. 2009;18:134–138.
5. Bosse MJ, MacKenzie EJ, Kellam JF, et al. An analysis of outcomes of reconstruction of amputation of leg-threatening injuries. *N Engl J Med.* 2002;347:1924–1931.
6. Stinner DJ, Burns TC, Kirk KL, et al. Return to duty rates of amputee soldiers in the current conflicts in Afghanistan and Iraq. *J Trauma.* 2010; 68:1476–1479.
7. Cross JD, Stinner DJ, Burns TC, et al. Return to duty after type III open tibia fracture. *J Orthop Trauma*. 2012;26:43–47.
8. Masini BD, Waterman SM, Wenke JC, et al. Resource utilization and disability outcome assessment of combat casualties from operation Iraqi freedom and operation enduring freedom. *J Orthop Trauma.* 2009;23: 261–266.
9. Cross JD, Ficke JR, Hsu JR, et al. Battlefield orthopaedic injuries cause the majority of long-term disabilities. *J Am Acad Orthop Surg.* 2011;19 (suppl 1):S1–S7.
10. Veterans Benefits Administration. *References: 38 CFR–Book C, Schedule for rating disabilities*. Available at: www.warms.vba.va.gov/bookc.html. Accessed February 1, 2013.
11. US Army Personnel Separations: physical evaluation for retention, retirement, or separation. Army Regulations 2006. Available at: www.army.mil/usapa/epubs/pdf/r635_40.pdf. Accessed February 1, 2013.
12. US Army Medical Services: standards of medical fitness. Army Regulations 2007. Available at: www.army.mil/usapa/epubs/pdf/r40_501.pdf. Accessed February 1, 2013.
13. US Army Medical Services: patient administration. Army Regulations 2008. Available at: www.army.mil/usapa/epubs/pdf/r40_400. Accessed February, 2013.
14. Patzkowski JC, Blanck RV, Owens JG, et al. Comparative effect of orthosis design on functional performance. *J Bone Joint Surg Am.* 2012;94:507–515.
15. Lapierre CB, Schwegler AF, Labauve BJ. Posttraumatic stress and depression symptoms in soldiers returning from combat operations in Iraq and Afghanistan. *J Trauma Stress.* 2007;20:933–943.
16. Doukas WC, Hayda RA, Frisch M, et al. The military extremity trauma amputation/limb salvage (METALS) study. *JBJS Am.* 2013;95:138–145.
17. McNamara MG, Heckman JD, Corley FG. Severe open factures of the lower extremity: a retrospective evaluation of the mangled extremity score (MESS). *J Orthop Trauma.* 1994;8:81–87.
18. Helfet DL, Howey T, Sanders R, et al. Limb salvage versus amputation. Preliminary results of the mangled extremity score. *Clin Orthop Relat Res.* 1990;256:80–86.
19. Howe HR Jr, Poole GV Jr, Hansen KJ, et al. Salvage of lower extremities following combined orthopedic and vascular trama. A predictive salvage index. *Am Surg.* 1987;53:205–208.
20. Bosse MJ, MacKenzie EJ, Kellam JF, et al. A prospective evaluation of the clinical utility of the lower extremity injury severity scores. *J Bone Joint Surg Am.* 2001;83:3–14.
21. Ly TV, Travison TG, Castilo RC, et al. Ability of lower extremity injury severity scores to predict functional outcome after limb salvage. *J Bone Joint Surg Am.* 208;90:1738–1743.
22. Ramasamy A, Hill AM, Masouros S, et al. Outcomes of IED foot and ankle blast injuries. *J Bone Joint Surg Am.* 2013;95:e25.
23. MacKenzie EJ, Morris JA Jr, Jurkovich GJ, et al. Return to work following injury: the role of economic, social, and job-related factors. *Am J Public Health.* 1998;88:1630–1637.
24. Resnik L, Reiber G. Long-term disabilities associated with combat casualties: measuring disability and reintegration in combat veterans. *J Am Acad Orthop Surg.* 2012;20(suppl 1):S31–S34.
25. Castillo RC, MacKenzie EJ, Bosse MJ. Measurement of functional outcomes in the major extremity trauma research consortium (METRC). *J Am Acad Orthop Surg.* 2012;20(suppl 1):S59–S63.