Chapter 6
Disability Associated with Musculoskeletal Injuries

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Introduction

Musculoskeletal-related injuries and disabling conditions represent the fastest-growing subset of military disability claims over the last 30 years. From 1981 to 2005, the number of disabling conditions related to the musculoskeletal system increased from 70/100,000 persons to 950/100,000 persons for those exiting the military [1]. While there are many factors, such as an increase in combat missions or an increasing recognition of disabling conditions, that may account for this increase, recent analysis has shown that the almost 12-fold increase in musculoskeletal disability claims is coming largely from young, enlisted servicemen and servicewomen with lower levels of education [1]. These disabling conditions require a disproportionately large amount of resources to care for [2–4], and it is imperative to have a basic understanding of these ailments to develop and implement effective injury prevention strategies and to optimize the care provided to these patients [5]. This chapter discusses the burden of disability associated with some of the more common musculoskeletal injuries and conditions seen within the military.

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Upper Extremity

Shoulder Instability and Superior Labrum Anterior and Posterior Tears

In an evaluation of 275 consecutive Navy patients for shoulder complaints, Provencher et al. [6] found that those patients who underwent surgery to correct their pathology (instability, rotator cuff, or labral tear) had outcome scores that were lower than those of patients who were treated nonoperatively. This suggests that patients with shoulder injuries sustained on active duty that require surgical treatment may continue to have persistent pain and decreased function after repair. Obviously, those patients who were treated nonoperatively likely had less serious shoulder conditions than those who underwent operative treatment, but the finding remains important when counseling patients on their expected prognosis. Furthermore, their study found that the outcome scores were similar across the different shoulder conditions (superior labrum anterior and posterior tears, rotator cuff tears, and shoulder instability) evaluated [6]. These findings suggest that it may simply be the fact that the shoulder is injured that determines the outcome as much as it is the type of injury or method of fixation.

A similar study looked at 179 active duty Navy patients who were prospectively evaluated for type 2 superior labrum anterior and posterior (SLAP) tears and followed for close to 4 years. This study showed an improvement in the mean Single Assessment Numeric Evaluation (SANE) score from 50 to 85 and the mean American Shoulder and Elbow Surgeons Standardized Shoulder Assessment (ASES) score from 65 to 88 after repair. Considering that any score above 90 is considered a "normal" shoulder, these results indicate that type 2 SLAP tears can be reliably fixed, and most patients can return to their baseline activities [7].

When specifically looking at shoulder instability, the age at which the patient first dislocates his shoulder seems to matter more than anything else [8]. Older patients who undergo surgical treatment for their instability with a Bankart procedure are less likely to have recurrent instability than a younger person. In fact, one study found that there is a 7% decrease in dislocation rate for each year older a patient is when they undergo the Bankart repair [8]. In an analysis of 3854 military personnel who underwent a Bankart repair, 5% underwent revision surgery for instability, and 8.8% were medically discharged with complaints of shoulder instability at 2–7 years of follow-up [9]. When extrapolating literature looking at the return to sports from the civilian literature, around 90% of athletes can expect to return to their previous level of activity around 6 months following surgery with an average increase of 20 points on their ASES [8, 10, 11]. However, it should be noted that a history of multiple dislocations and trying to return to the previous level of activity without taking enough time off for rehabilitation or surgery decreases the likelihood of a patient making a full recovery [11, 12]. In terms of chronic disability after surgical repair, there appears to be a relatively low

level of osteoarthritis (OA) that develops after either arthroscopic or open Bankart repairs; however, this may be dependent on the degree of glenoid and/or humeral head bone loss [13]. In more severe cases of instability where bone loss is present and a Laterjet procedure is indicated, the outcomes also appear to be promising. In an analysis of 68 Latarjet procedures in young adults, the mean Rowe score increased almost 38 points during the 20-year study period [14]. Patients who are undergoing a Laterjet procedure for instability, however, are at a higher risk of developing OA compared to those patients who are able to be treated with a Bankart procedure alone [15].

Rotator Cuff

There are not any military-specific studies that examine outcomes after rotator cuff injuries. However, Provencher et al. showed that rotator cuff repairs faired no better or worse than SLAP tears or cases of shoulder instability in terms of functional outcome scores after surgery [6].

A review of 78 workers' compensation patients who underwent arthroscopic rotator cuff repair of full-thickness rotator cuff repairs showed that almost 90 % of the patients were able to return to their preoperative level of work at an average of 7.6 months [16]. These findings suggest that active duty personnel who have not returned to full duty at a year may be unlikely to do so with further recovery. Recovery may also depend on the physical demands of each patient's job as patients who do lighter-duty work returned to work at a higher rate than those who did heavy work [16]. Vocation aside, the vast majority of patients who undergo a repair for a rotator cuff injury have a good outcome at 1 and 2 years after their injury [17, 18]. There has been little to no work assessing return to duty after elbow or wrist injury.

Upper Extremity Amputations

Upper extremity amputations have dramatic affects on patient disability [19, 20]. Despite advances in prosthetic and rehabilitation options [21], a recent study comparing upper extremity amputees from the Vietnam war with upper extremity amputees from the Operation Iraqi Freedom/Operation Enduring Freedom (OIF/OEF) conflicts suggests that there is little change in patient satisfaction between groups [22]. In addition, research suggests that, as a whole, upper extremity amputees have significantly higher disability ratings and are significantly less likely to be found fit for duty compared to lower extremity amputees [23].

One reason that prosthetic advances may not be having a greater impact on patient satisfaction is that many upper extremity amputees tend to avoid using their prostheses. Recent data suggest that 30–50 % of all upper extremity amputees, regardless of prostheses type, report minimal daily usage of their prosthetic limb [22].

Additionally, only 50 % of OIF/OEF upper extremity amputees who have a myoelectric device use it daily, whereas 68 % of OIF/OEF upper extremity amputees use their mechanical device daily [22]. Less frequent prosthetic usage may be part of the reason why patients who have a more distal upper extremity amputation report increased life satisfaction than patients with proximal amputations [22] as they may be less reliant on the prosthesis for function.

For upper extremity amputations taking place at least 90 days after the date of injury, it is important to note that performing a late upper extremity amputation may not completely eliminate some of the associated problems with the salvaged limb. One study of these patients showed that half of the patients who underwent late upper extremity amputation in part because of the heterotopic ossification and neurogenic pain in their limb had recurrence of those issues postoperatively [24].

Upper Extremity Limb Salvage

There is very little research assessing outcomes or associated disabilities with upper extremity limb salvage. There is strong historic dogma that even a minimally functional upper extremity is better than no upper extremity at all [19, 20, 24]. While there may be some truth to this line of thinking [25], complications, such as heterotopic ossification, neuroma formation, and infection, are common in this patient cohort [24, 26].

Spine

Disorders of the spine are quite common within the military, especially in the combat environment [5, 27, 28]. Yet, the long-term outcome and disability of the military personnel who sustain these injuries remains unknown. Previous civilian studies have found that polytrauma patients who sustain thoracolumbar fractures associated with neurologic injury tend to have poor recoveries in terms of physical function [29]. While it can be assumed that the 17 % of active duty personnel who sustained a spinal cord injury from combat [28] have a similarly poor outcome and continued disability from their injury, this has not been longitudinally reported.

Noncombat-related spinal injuries within the military are also common causes of disability. One cross-sectional survey of military office workers in the Belgium military found that 51 % of the military force experience regular neck pain throughout the year, and 63 % of those patients reporting this pain state that it interferes with their life [30].

When examining lumbar degenerative disk disease within the military, one study found that older, female, enlisted patients were more likely to suffer from degenerative disk disease than younger patients [27]. While there are no published data on the disability from degenerative disk disease within the US military, rates are

likely high, giving the incidence and prevalence of low back pain in this population. Studies have also shown that chronic pain or function at baseline predicts a worse outcome for those patients who are required to miss work or seek treatment at an emergency department for back pain [31, 32].

Lower Extremity

Cartilage Injuries

There has only been one study examining the outcomes and disabilities associated with cartilage preservation and restoration knee surgery within the military. In a review of 38 consecutive osteochondral autografts at a single institution, 42% were unable to return to duty in any form because of continued disability related to their operative knee. Of the 29% of patients returned to full duty, only two stated that they were symptom free and could continue unrestricted activity [33]. Although there are many possible confounders that could affect these results, this study shows that cartilage defects within the knee prevent nearly all military personnel from returning to their pre-injury level of function.

These military-specific findings are in stark contrast to published reports for college and professional athletes. Those studies have found that 65–79% of athletes reached their pre-injury level of sports within a year of surgical treatment of the cartilage lesion, and close to 90% were able to return in a limited capacity [34, 35]. Age greater than 25 and preoperative symptoms lasting longer than 12 months negatively affected an athlete's ability to return to sports [34]. It is unclear why these results have not been replicated within the military.

Anterior Cruciate Ligament Injury

There is no literature that examines the short- or long-term disabilities encountered by active duty personnel who sustain anterior cruciate ligament (ACL) injuries, and the civilian literature looking at such outcomes vary widely [36]. However, it may be possible to extrapolate earlier studies examining an athlete's ability to return to play to a service member's ability to return to duty. Although between 60 and 80% of high school and college athletes return to their previous level of competition following ACL reconstruction [37, 38], only 40% of athletes thought they returned to their previous level of performance after ACL reconstruction [38]. As many as 85% of patients who sustain an ACL injury go on to experience eventual posttraumatic osteoarthritis (PTOA) of the injured knee, and one study suggested that the ACL rupture was equivalent to adding 30 years of degenerative wear to the native knee [39]. While these estimates may be high, they indicate that even if service members are able to return to duty after an ACL injury, it is likely that their injured knee will cause them some type of late disability.

Meniscus

Interestingly enough, it appears that the status of the menisci at the time of ACL injury is the main determinant of developing PTOA [39]. Service members injure their menisci at a rate that is almost ten times as high as civilian population [40, 41]. Yet, there are no studies specifically looking at the outcomes or persistent disability these injuries cause service members. While the civilian literature details outcomes that are often good or excellent, it is difficult to translate these results to an active duty population secondary to the unique physical demands of military personnel. Meniscus transplantation is an intriguing treatment option for young, active military personnel who have severe meniscal injuries, but the long-term outcome of this procedure is not established [40].

Lower Extremity Amputations

Lower extremity amputation is the fifth most common unfitting condition for service members who were injured in battle and the injury that has the greatest disability impact when accounting for the percent of disability for each injury and the frequency with which each disability appeared [5]. These facts speak to the short- and long-term debility associated with these injuries for service members.

According to the military-specific Military Extremity Trauma Amputation/Limb Salvage (METALS) study, amputees have improved patient-reported outcome scores compared to limb salvage patients who sustained similar injuries [42]. However, these patients sustained their injury and amputation prior to the development of more focused limb salvage rehabilitation and the Intrepid Dynamic Exoskeletal Orthosis (IDEO). The METALS conclusions suggest that focused rehabilitation may be the largest determinant of outcomes, in the limb-loss cohort, leading to their improved outcome [43].

One study found no difference in SF-36 scores or Prosthesis Evaluation Questionnaire subsections between transtibial amputees undergoing modified-Ertl and modified-Burgess transtibial amputations. However, those amputees who underwent a modified Ertl amputation were significantly more likely to require a revision amputation [44]. For those service members who undergo a hip disarticulation or transpelvic amputation, they are likely to require lifelong assistance and will do better in mental outcome scores than physical outcome scores [45].

When evaluating the ability of amputees to return to duty and be deployed, amputees have been found to have a return-to-duty rate of 12.5% after type III tibial fracture [46]. This rate is lower than the 20.5% rate of return to duty for those limb salvage patients sustaining the same injury and the 51% of those service members undergoing limb salvage for a lower extremity injury who participated in the return-to-run (RTR) pathway using an IDEO [47]. Only 5% of all combat-related amputees deploy after their amputation. However, members of the Special Forces deploy at a 48% rate after amputation. This increased rate likely stems from them

having a greater psychosocial support and increased incentive compared to the general military population [48].

Lower Extremity Limb Salvage

Lower Extremity Assessment Project (LEAP) data concluded no differences between limb salvage and amputations. The METALS study found worse outcomes with limb salvage and also lower return to vigorous activity and significantly higher depression screening [49, 50]. However, in a prospective study of limb salvage patients who were able to use IDEO and RTR pathway, there was significant improvement in their measured physical abilities, pain, and self-assessment tests at the 4- and 8-week evaluation points. Just as importantly, 41 of the 50 patients who were initially considering amputation at the start of the study for their injured lower extremity favored limb salvage after 8 weeks of training and rehabilitation with IDEO and RTR [49].

Still, between 10 and 15% of those patients who attempt lower extremity limb salvage go on to seek a late amputation [51, 52]. Additionally, research has shown that those service members who sustain complications related to their salvaged tibia and hindfoot injuries are significantly less likely to return to duty than those who did not [53, 54]. Lastly, PTOA, the most common disabling condition for those service members who are injured in battle [5], is thought to be quite prevalent among the limb salvage population.

Osteoarthritis

Osteoarthritis (OA) is a chronic degenerative disease that impacts the articular cartilage, bone, and surrounding soft tissues in the affected joint. It is estimated that more than 27 million adults in the USA are affected by this debilitating condition [55]. Known risk factors for OA include female sex, obesity, history of joint injury, and engaging in occupations that require a significant amount of repetitive bending, squatting, kneeling, and lifting [6, 56–65]. While OA is typically thought to be a disease that affects individuals later in life, recent studies suggest that OA can affect individuals in their third and fourth decade of life, particularly in the presence of these known risk factors [59, 66]. OA has been a leading cause of disability and medical discharge in the US military for over a decade [67].

Military service members are regularly exposed to many of the known risk factors for OA described above. Military service members have been shown to be at increased risk to acute traumatic joint injury due to the physical training requirements and the nature of their work [41, 68–71]. Furthermore, the physical training and occupational demands placed upon military service members require a significant amount of repetitive bending, squatting, kneeling, and lifting. Finally, while most

military service members are not obese, many are required to endure heavy equipment loads during training and the performance of their occupational tasks. This may produce similar outcomes in terms of joint damage due to excessive loading that have been observed in obese individuals.

Emerging data suggest that the incidence of OA among active duty US military personnel is significantly higher when compared to the general population [72, 73]. Cameron et al. [73] conducted a retrospective cohort study using data from the Defense Medical Surveillance System to examine the incidence rate and burden of OA among military service members. The authors hypothesized that the rates of degenerative joint disease among active duty military personnel would be significantly higher when compared to the general population. The authors observed that the incidence rate for OA was significantly higher in every age group among military service members when compared to the general population, and that the disparity between military service members and the general population increased with increasing age. While the authors were unable to link the increased incidence rate of OA in this study to a history of prior joint injury or the other risk factors noted above, they speculated that the increased incidence rates observed in the military population were likely a function of the high rates of joint injury and the cumulative stress associated with the physical demands associated with years of military service.

In a separate study, Scher et al. [72] examined the incidence of hip OA among active duty military service members. The overall incidence rate for males was 35 cases per 100,000 person-years, with rates ranging from 32 cases per 100,000 person-years among males to 54 cases per 100,000 person-years among females. While they observed lower incidence rates for hip OA than previously reported in the literature, this is likely because the majority of published studies have focused on the incidence of OA in much older study populations. When the data presented by Scher et al. [72] are compared with sex- and age-stratified data from the general population [57], the incidence rates for OA are 4.76–6.30 times as high in males and 18.32 times as high in female military service members on active duty. The observed incidence rates for hip OA in this relatively young and healthy population are disconcerting, and combined with the overall rates for OA in comparison to the general population raise concerns about the burden of OA in load-bearing joints following years of military service.

In addition to the higher incidence rates for any OA diagnosis and hip OA observed in military populations, PTOA has been noted as the primary source of disability in military service members injured in battle [74]. Rivera et al. [74] noted that fractures and arthrotomies resulting from explosive devices caused 75% of the PTOA conditions observed following battle wounds. High rates of PTOA were particularly noted following injury to the weight-bearing joints in the lower extremity including the knee (100%) and ankle (91%). High rates of PTOA were also observed in the elbow (96%) in the upper extremity. The most alarming finding reported by Rivera and colleagues was that the average time from injury through PTOA diagnosis, classification as a disabling condition, and documentation in the medical record was 19 (±10) months. While PTOA has

been observed to advance at increased rates (e.g., within 10 years of injury) in the general population [59], the rate of progression to PTOA following combat-related injuries appears to be 5–10 times faster in military service members.

Concomitant Mental Health Conditions

More than 50 % of both amputees and limb salvage patients alike will be diagnosed with a mental health condition within their first year of treatment [75]. These conditions appear likely to persist, too, as more than 75 % of Veterans screened in one survey endorsed increased irritability, sleep disturbance, forgetfulness, and anxiety many years after their tour of duty [76]. Such mental health conditions can have a profound effect on both short- and long-term disability as patients with psychological distress are known to have inferior outcome scores when compared to similar cohorts without the psychological distress [77].

Traumatic Brain Injury

One of the more recent disabilities to be noted from the OIF/OEF/Operation New Dawn conflicts is that of traumatic brain injury (TBI). It has been estimated that 10–25 % of service members returning from deployment have at least mild TBI, a rate that seems consistent among multiple injury patterns [75, 78, 79]. While the majority of these cases appear to resolve within the first year of treatment, persistent TBI symptoms have been found in 1–5 % of service members [78]. TBI can affect disability and long-term outcomes in many ways. First, it can impede a service member's ability to participate in rehabilitation. Second, studies have found that individuals with TBI are predisposed to chronic neurobehavioral and pain disorders that can greatly decrease a person's quality of life [75, 79].

Posttraumatic Stress Disorder

Posttraumatic stress disorder (PTSD) is the third most common disabling condition affecting service members who sustain battlefield injuries [5]. Yet, this condition does not just affect those who were recently deployed [78]. Veterans with PTSD are likely to have lower levels of life satisfaction and a more difficult time with personal and professional relationships than those without the condition [80]. Similar to TBI, patients who have PTSD are also at increased risk of developing pain-related disabilities, and PTSD can significantly complicate rehabilitation and recovery from concomitant musculoskeletal injuries [78, 81]. Lastly, one study found that limb salvage patients had a significantly higher rate of PTSD than amputees (32 % vs. 18 %, respectively) [75]. While the cause for this discrepancy is not known, it is important to note when counseling limb salvage patients and formulating their treatment plan.

General Return to Duty

It has been found that those injuries that are able to be treated at lower levels of care without escalation to higher levels of care have up to a 90 % chance of returning to duty, whereas those patients who need to be escalated to higher levels of care have return-to-duty rates as low as 0–3 % [82]. An injured service member's job description also matters greatly when determining their ability to return to duty. In an analysis of amputees it was found that being a member of the Special Forces significantly increased the likelihood of an amputee being found fit for duty than any other military occupational specialty [83]. In terms of returning to duty with a more elective procedure, 86 % of active duty personnel who underwent total knee or hip arthroplasty returned to active duty, and 70 % were able to deploy to the combat zone and complete their tour [84].

Research examining the factors that are related to successful return to duty following musculoskeletal injuries and conditions is lacking. Currently, return-to-duty criteria are based on expert opinion and clinical judgment rather than solid scientific evidence. This may be why recurrence rates following injury in athletes and military service members are so high. There is a critical need to identify the factors at the time of injury, and at the time of return to duty, that are associated with successful return to duty and reduce the risk of reinjury. These factors can be used to develop and implement evidence-based criteria for return to duty that contribute to secondary prevention efforts in high-risk military populations.

Summary

The cumulative effect of an all-volunteer military force and 14 years of continuous conflict have led to significantly elevated disability determinations and loss of the fighting strength and have had a considerable impact on force readiness. While recruiting and combat strength have maintained numbers, the burden of musculoskeletal injury and disability medical costs remain substantial.

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