Chapter 12
Thoracic and Lumbar Spine Injuries

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Introduction

Military service members represent a highly active population that is regularly engaged in rigorous physical training as well as occupational activities that place significant stress on the spinal column. As such, spine conditions present a significant burden within this population and are among the leading causes of disability in both volunteer and conscript armies [1, 2]. In 2012, "back problems" were the most common condition resulting in a medical encounter, resulting in 917,738 visits of 214,210 service members [3].

This was well demonstrated in a recent study by Mydlarz et al., who performed a comprehensive surveillance of military service members presenting with degenerative disc disorders (which included lower back pain, sciatica, cervicalgia, spondylolisthesis, etc.…). During the study period of 2006–2010, the authors identified an incidence of 951.4 per 1000 person-years. Additionally, this was the primary diagnosis for 1,660,702 medical encounters, 68,247 lost duty days, and 11.1 % of medical discharges in the US Army [4].

Among spinal conditions, the lumbar spine represents the most common site of injury/disability among military personnel. Lumbar spine injuries were responsible for 145,324 episodes of care over a 1-year period in non-deployed military personnel [5]. Additionally, Knox et al. demonstrated an incidence rate of lower back pain requiring medical attention of 40.5 per 1000 person-years among the US military service members [6]. Childs et al. demonstrated that 15.8 % of soldiers incurred health-care costs related to low back pain over a 2-year period with a median cost of $432 per soldier [7]. Back pain is also the cited reason behind 11 % of lost duty days in the British Army [8].

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Both the high incidence as well as the challenges of diagnosis were highlighted by Carragee et al. These authors performed a prospective study in which Special Operations reserve soldiers without prior history of back pain were followed and queried about low back pain in addition to their normal annual medical questionnaire. In this study, less than 3 % of soldiers reported back pain in their annual medical questionnaire despite 84 % reporting mild and 64 % moderate low back pain during the study period during the interviews.

Thoracic spine pain and injuries are much less common and much less commonly studied than similar conditions in the lumbar spine. Prevalence rates vary significantly between studies with differences in criteria for inclusion as well as population studied. Rates of thoracic pain in the military ranged from as low as 4.3 % among Naval officers [9] to as high as 32 % in fighter pilots [10].

Causes of Injury

Military service members are engaged in a variety of activities that place them at risk for back injuries. Military training is frequently cited as a cause of back pain or back injury in numerous studies. This, however, represents a broad category involving many different specific activities. Such activities include marching, drill, weapons training, field exercises, as well as fitness training. Gruhn et al. reported military training to be the cause of 37 % of back injuries seen at an Army physical therapy clinic [11]. Similarly, Strowbridge reported 30 % of back injuries resulting in a health-care visit to be caused by military training.

Carragee reported a 1/3 rate of back pain with an intensity rated over 4/10 during drill weekends in Special Operations reservists after training that involved road marches compared to 20 % in training without. Additionally, during such weekends, 25 % of soldiers reported an Oswestry Disability Index (ODI) over 10 after these training periods. The intensity of training does appear to correlate with injury risk as Carragee et al. reported a 10 % increased risk of injury and 3–4x risk of disability during periods of heavy training [12]. Also, frequent night training has been implicated in increased rates of back injury. Hou et al. demonstrated that night training more than twice per week resulted in nearly double the incidence of back pain in Chinese conscripts [13].

Within the broad category of military training, combat training and marching are frequently cited causes for low back pain. Fitness training which includes running 5 km more than three times per week was shown to increase the incidence of back pain by 80 % [13]. Grenade throwing training with greater than 200 throws per day resulted in a 1.7-fold increase in back pain rates [13].

In addition to military training activities, occupational activities attributed to the development of back pain or injury in over 50 % of cases [8]. There is a wide diversity of occupations within the military service with wide differences in risk exposure. Specifics regarding different occupations will be discussed in the next section. There are also certain activities that are associated with back pain and injury across multiple occupations. One such high-risk occupational activity is manual handling and lifting. Lifting/handling activities are among the most common causes of injury and lost workdays with the back representing the most common site of injury [14]. Gruhn et al. reported manual handling to be the cause of 16 % of back injuries presenting to a physical therapy clinic [11].

Although military service members are engaged in many occupational activities that place them at risk for back injury, a large proportion of individuals sustain injury during off-duty activities. Strowbridge et al. reported only 57 % of injuries to be related to military training or work activities in a series of British soldiers with the remainder caused by off-duty activities, sporting activities, and road traffic accidents resulting in the remainder [8]. Gruhn et al. reported sporting activities to be responsible for 16 % of lumbar spine injuries presenting to an Army physical therapy clinic [11].

Occupational Risk Factors

Despite being relatively common across the armed services, different occupations are subjected to dramatically different work environments and physical demands. Because of this, individuals of different occupations are subjected to significantly different risk of back injury and back pain. While occupational risk has been evaluated in multiple studies, there has been little consensus on high-risk occupations between these studies. Comparisons among the literature is challenging due to differences in definition of injury/disease, differing classifications of occupations, and difficulty in controlling for actual work environments or activities performed even among those with apparently similar occupations.

a. Infantry

The infantry represents another highly demanding occupation with significant stresses on the lower back as a result of both combat and training-related activities. Infantrymen have been shown in prior studies to have among the highest rates of musculoskeletal injury among the military. As such, it would be expected that this group would have high rates of injury and spinal disorders. However, in a military-wide study, Ernat et al. reported infantrymen to have 31 % lower rates of lower back pain compared to matched controls. This difference was even more profound among infantrymen in the Marine Corps with a 41 % decreased rate compared to matched non-infantry Marines. Similar findings have been demonstrated in other studies looking at different populations. Hou et al. reported on the low back pain rates among Chinese basic trainees and found those in the infantry to have the lowest rates of low back pain. The difference was significant with a 26 % overall incidence, however the rate among the infantry was only 11 % [13]. MacGregor et al. also demonstrated a significantly lower rate of low back pain in the infantry compared to other occupational groups in a post-deployment sample of the US Marines [15].

b. Artillery

Another occupation with significant burden of lumbar injury is artillerymen. Occupational requirements as an artillerymen include digging fighting positions and repetitive bending and lifting of artillery shells with weights often exceeding 70 lbs. Reynolds et al. evaluated the incidence of lower back injuries in artillerymen over a 1-year period. In this period, they reported an incidence of 30 %, which resulted in an average 4.5 limited duty days per soldier [16].

c. Aviators

Military aviators are a group with high demands placed on the spinal column. These individuals are involved in a physically demanding in poor ergonomic environments. As such, they have high rates of spinal pain and injury, particularly among helicopter pilots. Operation of rotary aircraft is particularly strenuous on the spinal column due primarily to the poor posture and awkward position required in to operate these aircraft. This includes a forward flexed posture, which induces increased thoracic kyphosis and lumbar hypolordosis. The pilots must then maintain compensatory cervical hyperextension to maintain visualization of the controls and the external environment. In addition, operating aircraft controls often requires frequent trunk rotation and lateral bending and maintenance of pelvic retroversion with notable differences between specific aircrafts [17] (Fig. 12.1).

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In addition to ergonomic factors, these individuals are subjected to long periods of exposure to whole body vibration (WBV). WBV has been implicated as a potential contributing factor in the development of back pain in multiple studies [18–20], in particular when combined with awkward posture [21]. Vibratory frequency of rotary aircraft resembles the spinal resonant frequency [22, 23], which theoretically increases its potential harm. Despite this exposure, the role of WBV in the pathogenesis of back pain in this population is unclear as it is difficult to isolate WBV exposure from the exposure of flight or other aircraft-related factors.

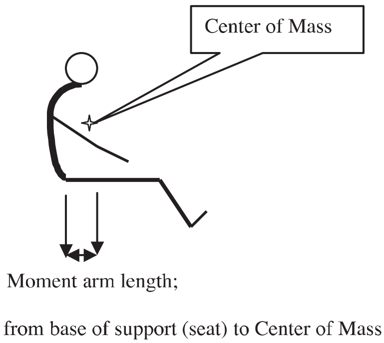

Fig. 12.1 Seated position of pilot during flight

Shanahan et al. performed a study utilizing a helicopter cockpit with and without vibration exposure. They found no difference in back pain rates or intensity after prolonged flying with or without vibration exposure in this simulation [24].

When considering the above factors, it is not surprising that this population experiences an extremely high rate of lower back pain with rates ranging from 50 to 92 % [23, 25, 26]. Back pain is also associated with significant disability and compromised mission readiness. Among pilots with back pain, approximately ½ reported interference with concentration [26] and compromised performance secondary to their pain [27]. Additionally, between 16 and 28 % of pilots admit to rushing flights because of back pain [23, 26].

The pain associated with this occupation is generally felt to be directly related to the operation of the aircraft itself. Back pain typically begins during flight and in the majority of cases resolves within hours after flight is completed. Pain is more common during operations that require flying that is more dependent on manual control including precision and instrument flying. This is often more frequent in pilots greater than 71 in., which results in a more hunched-forward posture during aircraft operation. Orsello et al. demonstrated a 9 % increase in incidence for every 1-in. increase in height [28].

While fixed-wing pilots also experience high rates of back pain and injury, they have been shown to have much lower rates compared to rotary-wing aircrew with a 50 % lower rate reported in the Norwegian military [27]. Fighter pilots have been shown to have high rates of thoracic spine pain, with rates among the highest in the military [29].

Fixed-wing pilots are also subjected to prolonged periods of sitting in a poor ergonomic environment. Military aircraft seats are typically angled in a forward-flexed position, which places the spine in a poor position during flight. In addition, these individuals are subjected to WBV and often experience high G-forces which may also play a significant role in spinal pain or injury. While the majority of research has focused on the cervical spine in these individuals, there are significant consequences on the thoracic and lumbar spine in this population.

An additional risk, which fixed-wing aircrew are uniquely exposed to is aircraft ejection. Ejection from an aircraft subjects the spine to incredibly high forces with injury rates up to 69 % [30] and vertebral fracture rates between 26.2 and 35.2 % [31]. The location of injury during ejection is characteristically the thoracolumbar junction [32] with fractures occurring primarily at T12 and L1. Such fractures typically arise from a combination of axial load and forward flexion, which occurs during the ejection process [33]. This typically results in a compression-type injury, however more severe spinal fractures can occur.

It should be noticed that while the majority of research focuses on the pilots of the aircraft, the entire aircrew are at risk of back pain and injury. Flight crew, in particular the flight engineers, also encounter frequent awkward positions, which have the potential to result in back pain or injury [23, 34]. In addition, Simon-Arndt et al. demonstrated the flight engineers to have rates of diagnosed back problems higher than the pilots of the same aircraft [35].

d. Drivers

Similar to aviators, drivers have also been implicated to be at increased risk of lower back disorders. Occupational driving has been implicated in development of low back pain in multiple studies in civilian populations with anywhere from 15 to 300 % increase in incidence compared to nondrivers [36–38]. Despite a high rate in such occupations, studies are limited by the diverse nature of different driving occupations including different vehicles and driving duration. Also, occupational drivers frequently perform tasks in addition to driving such heavy lifting or loading of vehicles, which would also place the back at increased risk of injury. Military vehicles, in particular, play a potential role with prolonged exposure. Such vehicles often have poor ergonomic design with significant WBV exposure [39]. Despite this, few studies have evaluated the role of occupational driving in the military.

Rozali et al. demonstrated a 73 % 12-month prevalence of low back pain among Malaysian armored vehicle drivers, with rates reaching nearly 82 % in drivers of tracked vehicles [39]. This study also demonstrated low back pain to be correlated with driving in a forward-flexed posture as well as WBV exposure in the x-axis. Knox et al. performed a US military-wide study to compare low back pain incidence rates between service members employed as drivers compared to matched controls. This study revealed a 15 % increased risk of new onset low back pain among occupational drivers compared to controls, however they identified a much higher risk effect in female drivers who experienced a 45 % increased risk compared to females in nondriving occupations [40].

e. Parachuting

Soldiers involved in military parachuting activities are another group worth special mention. Such activities subject the spinal column to significant and place these individuals at increased risk of spinal injury. Spine injuries represent the second most common type of injury after parachute jumps, and comprise 15 % of acute injuries after both training and combat jumps [41]. Injuries primarily occur during landing and are related to axial load force, which often results after a hard landing on the buttocks. Traumatic vertebral fractures from such landings are typically compression fractures and occur primarily about the thoracolumbar junction [42]. In addition, the spine is subjected to deceleration forces during parachute opening.

In addition to acute traumatic events, persons engaged in repetitive parachuting activities are at relatively high risk of chronic thoracic or lumbar conditions. Murray-Leslie et al. reported on the rate of lumbar spine symptomatology as well as radiographic degeneration in ex-military parachutists. Fifty six percent of these individuals reported either current or prior lower back pain with nearly 24 % having lost work time due to back pain. Additionally, 84.8 % had radiographic degeneration of the lumbar spine and 21.7 % had evidence of prior vertebral fractures. Interestingly, 80 % of individuals with prior spine fracture were unaware of the presence of such an injury at the time of the study [42].

Military Factors

a. Branch of service

Due to differences in occupational demands as well as training regimens, differences in spine injury and disability is expected between the branches of service. Few studies have evaluated these differences as the majority of research focuses on particular groups of individuals and few have military-wide study samples. One study that evaluated a military-wide sample demonstrated significant differences in low back pain rates. In this study, the Army carried the highest incidence with a greater than twofold increased risk compared to the Navy and Marine Corps. The Navy and Marine Corps demonstrated the lowest rates with minimal differences between the two services, whereas the Air Force had an intermediate risk with approximately 50 % greater risk than the Navy [6].

b. Rank

Rank is an important consideration in back injuries and has significant implications in the incidence of back disorders in military populations. The primary reason this is a consideration is that as individuals advance in rank, they often acquire more supervisory roles with potentially less rigorous activities required on a regular basis. Additionally, more senior service members often have the capability of self-modifying their training environment. This allows them to stop or decrease certain activities that are creating discomfort, whereas the more junior ranking individuals may be required to continue these activities despite the beginnings of a significant injury.

An important factor to be considered is level of education amongst these individuals. Lower level of education is a contributing factor in rates of low back pain. Individuals with an education level of bachelor's degree or higher experience have lower rates of back pain compared to those with lower levels of education [43]. As higher rank is associated with higher levels of education, this plays a potential role in the different incidence rates between ranks.

This difference in incidence between different ranks has been shown in multiple studies. In a military-wide sample, Knox et al. demonstrated significantly increased rates of low back pain in the more junior-ranking service members. This was consistent across all age groups with the highest rates in junior enlisted (E1–E4) and the lowest rate in senior officers (O4–O9) with a nearly twofold difference in incidence between these groups. MacGregor et al. also showed lower ranking Marines to have significantly higher rates of back pain after deployment to Afghanistan [15].

c. Basic training

The basic training environment represents a period of significant stress to the spinal column. Recruits are subjected to rigorous daily physical training including prolonged running, grenade throwing, marching, often with heavy combat load. In addition, recruits/conscripts are often physically deconditioned and many had led primarily sedentary lifestyles prior to this period. Wang et al. demonstrated that only 10 % of the Chinese conscripts were engaged in regular physical activity or heavy labor prior to entry into basic training [13]. As such, many such individuals lack the physical conditioning and core strength necessary to protect the spine from injury.

Because of these numerous factors, the lumbar spine represents a very common site of injury in the basic training environment [44, 45] armies. Glomsaker et al. reported that low back pain represented 18.6 % of all injuries in their population with an incidence of 23.9 per 1000 conscript months. Additionally, 0.7 % of trainees sustained disc herniation with a rate of 0.9 per 1000 conscript months [44]. Taanila et al. evaluated a group of Finnish conscripts over a 6-month period of training. During this period, 16 % developed low back pain with an incidence rate of 1.2 per 1000 person days of training [46]. Similar rates have been shown in other studies as well [47–50].

Despite its frequency, the majority of back pain among basic trainees is self-limiting and 65 % of cases will resolve by the end of the basic training period [47]. George et al. also showed that rates of low back pain with demonstrate a gradual decrease with increasing time in military service. The highest rates were seen in soldiers with less than 5 months of service, who reported back pain rates of over 55 %, however this rate dropped to only 19.1 % after 1 year [51]. This is likely reflective of the strenuous physical training that is encountered during basic training and the physical adaptations that occur.

Thoracic back pain is much less common, representing only 2.1 % of injuries in conscripts with an incidence of only 2.7 per 1000 conscript months [44].

d. Deployment

Deployment also is a period that represents a period at high risk of developing or exacerbating lower back pain or injury. The back is the most common site of injury during deployments, representing 17.4 % of musculoskeletal injuries in a series of 593 soldiers deployed to Afghanistan [52]. Lower back pain was experienced by as many as 77 % of soldiers deployed to Afghanistan and 22 % reported pain rated as moderate or higher [53]. Spine pain/injuries are also a common cause for evacuation representing 7.2 % of evacuations from Operation Iraqi Freedom (OIF) and Operation Enduring Freedom (OEF).

Service members in the deployed environment are subjected to long periods of wearing body armor and combat gear, have increased duration and intensity of work, and are subjected to significant psychosocial stressors. Mydlarz showed that 68 % of individuals with preexisting degenerative disc disorders experienced an exacerbation during deployment [4]. Deployment-related exacerbations were more common in the Army compared to other services, particularly those in the armor/motor transport occupational group where the risk of exacerbation approached 100 %. Males and service members in the youngest (17–19 years) and the oldest (> 40 year) age groups were also more affected. Patients with preexisting disorders are also at nearly twice the risk of all-cause evacuation from theater (Odds Ratio (OR) 1.98), however less than 2 % of these individuals were evacuated for lower back conditions [4].

Roy et al. evaluated the variables associated with increased rate of low back pain in deployed service members and reported body armor wear, lifting activities, walking patrols, and heavy equipment weight to be statistically significant variables associated with increased risk [53]. The most common activities resulting in spine injury resulting in evacuation has been reported to be lifting (15 %), falls (11 %), and driving (8 %) [54]. Work shifts have been implicated in this as well. Nevin et al. demonstrated that helicopter pilots with increased work hours during deployment have significantly higher increases in rates of lower and mid back pain compared to those who maintained the same schedules.

Another significant factor is the load carried by service members. Military forces have seen a dramatic increase in the combat loads with modern combat loads including up to 68 kg of gear depending on the individual's combat role and the mission being performed. Roy et al. demonstrated an average carrying load during deployment of 16.1 % of body weight for females (maximum 32.8 %) and 26.4 % for males (maximum 46.5 %) [52].

Carrying such loads has been shown to have numerous deleterious effects on the spine. Rodriguez-Soto et al. used upright MRI to evaluate kinematic changes in active duty Marines wearing such loads. Their study demonstrated a loss of lumbar lordosis at L4–5 and L5–S1 with an associated loss of anterior intervertebral disc height. More superior levels, however showed an increased lordosis [55]. Roy et al. [53] demonstrated significantly increased rates of low back pain with increased duration of body armor wear in deployed soldiers. In this study, wearing body armor greater than 6 h per day was associated with greater than fivefold rate of low back pain compared to those who did not wear body armor [53]. Also, increased equipment weight directly increased the incidence of back pain in this cohort with a linear increase in risk with higher weights [53]. Additionally, between 29 [56] and 41 % [53] of soldiers who develop back pain during deployment attribute their pain to wearing combat gear [56].

Service members are also subjected to increased psychosocial stressors, which has been shown to be important in the development of lower back pain and conversion to chronic or recurrent pain. Shaw et al. demonstrated that coexisting anxiety disorders, PTSD, or depression significantly increases the risk of acute low back pain becoming chronic.

Due to dramatic differences in job-related activities, significant differences in injury rates are expected between occupations. MacGregor et al. reported on the rates of post-deployment lower back pain in active duty Marines. They reported the highest rates in the service/supply occupational group (OR 1.3) with Marines involved in construction-related occupations demonstrating the highest rates (8.6 %). In contrast, Marine infantrymen had one of the lowest rates of lower back pain (3.3 %) [15].

Midback pain represents a much less common entity experienced during deployment. While low back pain represents 75.6 % of spine area pain, mid back pain represented only 3.3 % in a recent study by Carragee et al. [57].

e. Reserves

Another population that deserves special mention is that of the reservist. While active duty service members are involved in regular physical conditioning and preparation for their role in their military occupation, reserve service members often lead relatively sedentary lifestyles with significantly different occupations than those performed during their active duty obligation. As such, it could be presumed that these individuals may be at increased risk of injury or development of overuse injuries. Warr et al. reported that back injuries represented 17% of musculoskeletal injuries in deployed National Guardsmen [58]. Additionally, low back pain rates in deployed National Guardsmen (NG) was lower than active duty service members with those in active duty experiencing a 1.45-fold increased risk vs. NG. Similarly, George et al. revealed an increased rate of low back pain in active duty service members compared to reservists with a similar effect size (OR 1.441) [51].

Individual Factors

a. Gender

Gender has been implicated as a factor associated with higher rates of lower back pain in both civilian [59–64] and military service members [6, 8, 11, 15, 51, 65, 66]. Knox et al. revealed an odds ratio for females to males of low back pain resulting in a visit to a health-care provider of 1.45 compared to matched controls [6]. Strowbridge et al. revealed a much higher effect with female soldiers experiencing between 2.71 and 4.97-fold risk compared to males [8, 65]. They also reported that female soldiers more frequently attributed their low back pain to military activities, work, and off-duty activities compared to their male counterparts [8]. Gemmell demonstrated the incidence among female recruits to be significantly correlated to the training regimen. In their series, female recruits engaged in "gender fair" training with separate standards for men and women sustained 4.8-fold rate of back-related medical discharges during basic training compared to male recruits. After implementation of uniform training across genders, this rate increased to a 9.7-fold [67]. In addition to increased incidence rates, George et al. demonstrated a shorter duration to onset of low back pain in female service members [51].

b. Age

Increased age has been associated with increased prevalence of low back pain in numerous studies in civilian populations [60, 61, 63, 68]. This is due to both increased cumulative exposure to potentially injurious activities as well as age-related degenerative changes. Studies in the military setting have also shown age-related differences in back pain rates. An important consideration in the military setting is potential confounding between age and rank. As age and rank are often linked, it is important for studies to control for this to isolate the effects of age.

The age-related differences in low back pain incidence was evaluated by Knox et al., who demonstrated a bimodal distribution of back pain in this population with the highest rates in those over 40 years old as well as those less than 20[6]. This was shown after adjusting for other potential confounders including gender, branch of service, and rank. MacGregor et al. also reported higher rates of low back pain among Marines over 25 years old compared to those younger than this age in a post-deployment sample [15].

c. Race

Race is another important consideration in the epidemiology of back pain and back injury. Multiple studies on civilian populations have demonstrated significant differences in prevalence rates between racial groups. Knox et al. reviewed and evaluated the incidence of low back pain resulting in a visit to a health-care provider between different racial groups of active duty service members [69]. In their series, the lowest incidence was seen in Asian/Pacific Islanders win an incidence rate of 30.7 per 1000 person-years. Conversely, African-Americans had the highest rate of 43.7. These racial differences were present across all age groups and genders, however they showed that the effects of age and race were variable between racial groups.

d. Fitness

Personal fitness is an important consideration in the risk of back injury and subsequent disability/loss of productivity. This is evident from multiple studies that demonstrate the protective effect of core strengthening against lumbar injury and low back pain. While the military represents a population with a higher overall physical fitness, variation in fitness level has been implicated in differences in low back pain rates.

Morken et al. demonstrated low levels of physical activity to be associated with increased risk of thoracic and lumbar spine injuries among Norwegian sailors [9]. More specifically, Taanila demonstrated a higher rate of acute low back pain in conscripts with lower push-up and sit-up scores on physical fitness testing [46]. In a large study of American soldiers, George et al. found no difference in low back pain rates depending on physical fitness test scores or routine exercise. What this study did show was higher pain intensity and more psychological distress among soldiers with lower physical fitness testing scores [51]. Warr et al. also demonstrated a significant correlation between cardiorespiratory fitness (measured by peak oxygen uptake (VO2 peak)) and the number of visits for back complaints in deployed National Guardsmen [58]. Similarly, Feuerstein et al. reported significantly increased risk of low back pain resulting in lost work time in soldiers who report only rare aerobic exercise [66].

e. BMI

Reynolds et al. identified elevated body weight (> 90 kg) to be a significant risk factor for lower back pain in active duty engineers and artillerymen resulting in a 2.5x rate compared to those less than 90 kg [16]. In their study, however, BMI was not found to significantly correlate with back injury. Taanila demonstrated a higher rate of recurrent low back pain in conscripts with elevated BMI [46]. George et al. also reported increased incidence rates with elevated BMI with an increased risk of 1.044 for each point of elevated BMI [51]. Soldiers with increased BMI also had shorter time to first onset of back pain [51].

f. Psychosocial

More recently the importance of psychosocial factors on the pathogenesis of lower back complaints has been emphasized. This remains true in studies within the military and should not be overlooked in this population.

An important consideration in military service members is the effects of psychiatric comorbidities. Concurrent psychiatric illness in evacuees from OIF/OEF results in a 31–56% decreased likelihood of return to duty [54, 70]. Among Gulf War veterans with posttraumatic stress disorder (PTSD), over 95% had continued musculoskeletal complaints [71]. Concomitant anxiety, depression, PTSD resulted in increased risk of transitioning to chronic low back pain [72].

Workplace-related factors are also important considerations in low back pain and the associated disability. Such important factors including lack of supervisor support, perceived effort at work, peer cohesion, and job stress [2, 66, 73]. Job satisfaction is correlated with a decrease in back pain. The availability of social support is also a significant predictor of disability from back pain with those reporting a complete lack of people to turn to reporting over fivefold rate of back-related disability [73].

Another contributing factor, which has been shown to be significant among civilian populations is level of education. Taanila showed higher rates of acute low back pain amongst conscripts with lower levels of education [46]. George et al. showed soldiers with lower education levels (high school or below) to have higher pain intensity, although they did not show significant differences in back pain rates in their series [51].

Combat-Related Spine Trauma

While spine trauma represents a relatively uncommon injury sustained during combat, such injuries have become more common in modern combat engagements. In combat engagements up through the first Persian Gulf War, spine trauma represented only about 1% of injuries with the exception of the invasion of Panama [74, 75]. During the invasion of Panama, this figure reached 6%, which is felt to be related to the use of nighttime parachute operations [76]. During more recent engagements, injury rates reached 5.4% in the Global War on Terror [77] and as high as 8% reported from Afghanistan [78]. While the figures quoted in these studies do not include those killed in action, the true incidence is likely much higher. This was shown recently by Schoenfeld et al., who demonstrated that 38.5% of soldiers killed in action had at least one spinal injury [79]. The dramatic increase in incidence of spinal trauma is likely related to both increased survival of combat injuries attributed to increased use of vehicular and body armor as well as advances in military medical care and the changing nature of combat and tactics used in Iraq and Afghanistan. Current conflicts have seen a dramatic rise in the use of improvised explosive devices and roadside bombs resulting in a dramatic increase in exposure to blunt force trauma and blast injuries.

Of patients with combat-related spine trauma, the majority of injuries are caused by blunt force trauma. The most common mechanism of injury is explosive trauma, which is responsible for between 43 [77, 80] and 83% [81] of injuries. Additional common causes of injury include motor vehicle collisions (29%) and gunshot wounds (15 %) [82]. Possley [80] reported that as many as 17 % of spinal trauma was sustained during non-combat activities.

The lumbar spine is among the most common sites of injury, involving between 41 [77] and 45 % [81] of spinal injuries. Thoracic spine injuries are less common, however the rates vary between studies. Thoracic spine injuries represent between 6 [81] and 30 % [80] of combat spine injuries.

Blair et al. reported that of 2101 spinal injuries in 598 service members identified in the Joint Theater Trauma Registry, the vast majority of injuries were fractures (91.8 %). A wide spectrum of injury patterns is seen. The most common injury patterns are transverse process fractures [77] and compression fractures [81]. Burst fractures represent another common type of injury, which represented 23 % of injuries in one series [77].

While much less common, there are some specific injury patterns that are seen with disproportionate frequency in combat trauma. Such injuries include low lumbar burst fractures and lumbosacral dissociations [83]. While these are very rare injuries seen in the civilian population, these have been seen from more recent combat engagements. One common scenario that creates such injuries is the Improvised Explosive Device (IED) blast beneath a tactical vehicle. The result is a superior-directed blast force, which lifts the vehicle in the air. Upon landing, a significant axial force is directed to the spinal column. Additionally, service members are typically wearing rigid body armor and vehicular restraints, which provide relative stability to the thoracic and upper lumbar spine but leaves the lumbosacral junction relatively unprotecte (Fig. 12.2).

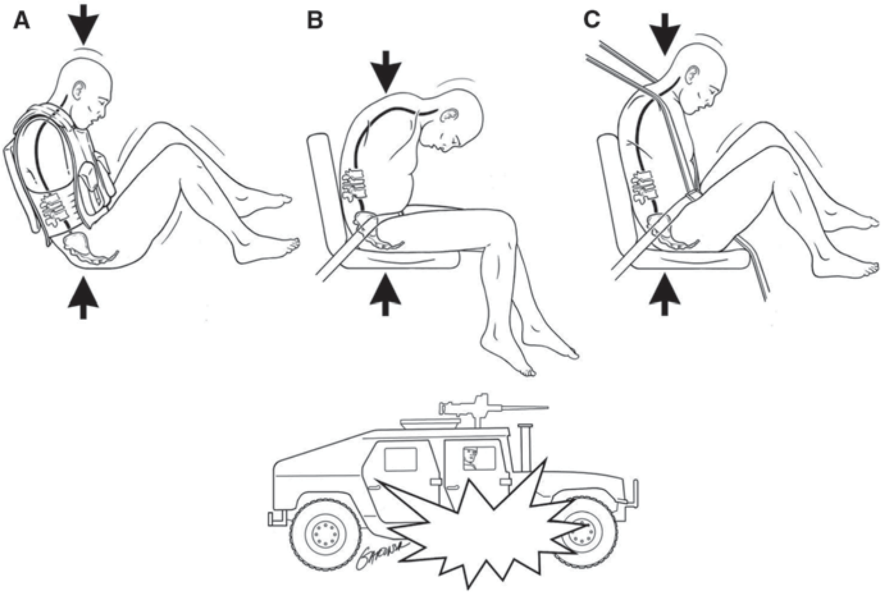

Fig. 12.2 Rigid body armor and vehicular restraints provide relative stability to the thoracic and upper lumbar spine but leaves the lumbosacral junction relatively unprotected

Overall, combat-related spine trauma represents high-energy injuries with high rates of concomitant injuries. Such concomitant injuries include open extremity fractures, traumatic amputations, as well as significant blunt or penetrating thoracic and abdominal trauma. This provides further challenges in managing these already challenging injuries. These injuries complicate both the surgical approach and also the rehabilitation. An area of particular interest specific to these injuries is the soft tissue envelope. Due to the high rate of blast injury, soft tissue injuries are common; including closed degloving injuries and contaminated complex open wounds. Attention to the soft tissue envelope is crucial in planning the approach and timing of surgical intervention as well as the need for external orthoses. Due to these complicating factors, combat-related spine trauma is associated with a significant complication rate. Possley et al. reported a 15 % complication rate, with a 9 % major complication rate in his series [82].

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