Volume 7, Number 1


# JOURNAL OF THE SPINAL RESEARCH FOUNDATION

## Spines of Service

2012

**THE JOURNAL OF THE SPINAL RESEARCH FOUNDATION**
***A multidisciplinary journal for patients and spine specialists***

THE JOURNAL OF THE SPINAL RESEARCH FOUNDATION
Volume 7, Number 1

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# From the Editor

*Brian R. Subach, M.D., F.A.C.S.*

I am not a hero. I get thank you cards and letters, but I am not a hero. I make people feel better by taking away their neck pain or their leg numbness, but I am not a hero. I get people back to their jobs and their families by fixing their backs, but I am not a hero.

The real heroes are the men and women who protect this country and its citizens from crime, fire, terrorism, natural disaster, and foreign threats. These heroes leave their homes and families to venture into the cold and the dark to make sure that we remain safe in our beds.

***"I can't call in sick on Mondays***
***When the weekend's been too strong***
***I just work straight through the holidays***
***And sometimes all night long***
***You can bet that I stand ready when the***
***wolf growls at the door.***
***Hey, I'm solid, hey I'm steady, hey,***
***I'm true down to the core."***

**Toby Keith "American Soldier"**

This issue of the Journal of the Spinal Research Foundation is entitled "Spines of Service" as a means of recognizing the significant contributions made by our military, police officers, firefighters, and other men and women serving the public good. These heroes often make personal sacrifices to protect others, forgoing wealth, family vacations, and even sleep, placing themselves in harm's way to defend our country, protect our families, and preserve our way of life.

We have compiled a collection of Spine Tales which detail the history and presentation of these brave men and women with spinal disorders. Many have experienced repetitive injury while in the service of the United States. Many still experience significant pain despite our best efforts to cure them. Although we could not possibly name each of the patients we have treated over the past 20 years, we acknowledge each of them and their service to this country.

***"Duty—Honor—Country. Those three***
***hallowed words reverently dictate what you***
***ought to be, what you can be, what you***
***will be. They are your rallying points:***
***to build courage when courage seems to fail;***
***to regain faith when there seems to be little***
***cause for faith; to create hope when***
***hope becomes forlorn."***

**General Douglas MacArthur in a speech to the**
**United States Military Academy**
**West Point, New York**
**May 12, 1962**

Not everyone is made to wear a uniform or show courage under fire. Our servicemen and servicewomen deserve our respect and our gratitude for choosing the lives they have chosen. When you see the uniform of a police officer or firefighter, a soldier or a marine, a naval officer or an air force pilot, remember to say "Thank you for your service." It takes less than ten seconds to acknowledge a lifetime of dedication.

***"It is not the critic who counts, nor the man***
***who points out how the strong man stumbled,***
***or where the doer of deeds could have done***
***them better. The credit belongs to the***
***man who is actually in the arena."***

**Theodore Roosevelt**
**Paris, France**
**April 23, 1910**

# From the President

*Thomas C. Schuler, M.D., F.A.C.S.*

## The Transformation of American Medicine

America has the best health care in the world! People from across the world come to the United States when they seek medical care or medical education. Our system has become great by devising treatment plans to solve a patient's specific condition as determined appropriate by that patient and his or her physician. Unfortunately, this process is changing.

Each day brings us one step closer to the implementation of the Patient Protection and Affordable Care Act. With each passing day it is becoming clearer that we are moving away from an "individual centric" model and toward a "society centric" model of medicine. It is important for our patients to understand that the intention of this Act is to cover more lives while at the same time not giving the health care system all the additional resources it needs to provide the same quality of care. Quality of care will be reduced under the coming system. Anything that will decrease the utilization of medical care is being pursued. Superficially this sounds desirable, but in actuality it will be detrimental to many, especially those who are currently insured. The government wants to limit the use of medical care and insurance companies, with the help of the Federal government, will increasingly deny payment for services rendered.

Evidence-based medicine (comparative effectiveness research) is being touted as the answer to what is appropriate treatment. The problem is this research at best is a suggestion of what works for many patients. It does not answer what the solution or treatment is for any outliers. This is where the problem arises. Patients that fall outside common presentations are being denied care by third party payers. This will only worsen as the government bureaucrats in control of health care coverage take what is appropriate care today and push it for, financial reasons, into the non-appropriate category. Already initiated and rapidly worsening, patients are being subjected to one very limited set of treatment guidelines and any variation outside of it results in denial of care. The bureaucrats making the decisions are ignoring the physicians and patients. Insurance companies, spurred on by government mandates and the government, are selectively choosing research data to support their financial objectives. Patients' interests are being ignored in the calculation. This is especially true in the spinal health care arena.

A major paradigm shift is occurring in health care. Physicians are now being asked by our government to disregard what is in the patient's best interest and make decisions for medical treatment for an individual based on what is in society's best financial interest. No longer will physicians be allowed to choose with the patient the appropriate course of action, but instead, the government will mandate through its selective interpretation of research data (paid for by the government) what it will authorize. If an individual's medical condition is an outlier from this mandate, then that will be the individual patient's health and financial problem.

Patients should be armed with the truth about the new health care system coming in the next few years, a system that will severely impact their choices and their physician recommended treatment plans. Our government has shown its willingness to break the bonds between all our social institutions and it will certainly not be concerned about any individual patient's medical concerns. Yes, more patients are entering the health care system but at the expense of patient's quality of health choices, physician recommendations and certainly everyone's freedom to protect their "life, liberty and pursuit of happiness."

# Overview

Marcus M. Martin, Ph.D. and Anne G. Copay, Ph.D.

A well ordered society requires many different elements to support its survival. They facilitate the flow of commerce, education, security, and the maintenance of law and order. Each member makes their own unique contribution to the functioning of the network and while all are important, some individuals provide pivotal services which support the very structure of prosperity and freedoms, particularly those enjoyed in this country. One such group is our servicemen who act as stewards to prevent disruptions to our society. In this issue, we define "servicemen" as the men and women who serve in the military, law enforcement and fire service. In many cases, this service comes with great personal sacrifice; sacrifice to personal relationships, health, and even the ultimate sacrifice—life.

These vocations are both mentally and physically challenging. As a result, many servicemen are often stricken with spine conditions. The current issue of the Journal of The Spinal Research Foundation highlights some of their stories and the unique challenges they face. The outcomes of their treatment are not always positive, however, when they are, we can all revel in the fact that one of society's sentinels has escaped from the grips of spine disease.

For this issue, we are pleased to have received success stories from spine surgeons, physical therapists, and pain management physicians. These highlight how modern interventions have a dramatic impact on the health of our service members. Articles written by distinguished military surgeons explore how the nature of spine treatment and the care of soldiers injured in the theatre of war have changed over the course of warfare history. As we advance further in the field of medical research, our intent is not only to prolong life, but to improve the health and the quality of life for all of humanity. We compiled this issue in an attempt to show our appreciation for the sacrifices made by the men and women in the field of service.

**Marcus M. Martin, Ph.D.**

Dr. Martin's research interests include neuroimmunology, virology, and immunology. He is engaged in collaborative research through the Spinal Research Foundation with the Medical University of South Carolina Children's Hospital, geared toward the development of neuroprotective and neuroregenerative compounds for the treatment of nerve pathology. Dr. Martin's current research collaborations include research initiatives to apply stem cell therapy for tissue preservation, the development of regenerative therapies for intervertebral discs, and the development of novel methods of enhancing bone fusion.

**Anne G. Copay, Ph.D.**

Dr. Copay studies the outcomes of surgical and non-surgical spine treatments. She published several articles on the outcomes of spine fusion. She has ongoing research projects concerning the effectiveness of new spine technologies and the long-term outcomes of surgical treatments.

# Ask the Expert

Michael K. Rosner, M.D., L.T.C., M.C.
Walter Reed National Military Medical Center

## What are some of the unique challenges of treating servicemen in the field?

Treatment of spine pathology on the current battlefield is evolving each year. Challenges are typically related to resources available which are, at times, limited. In addition, treatment must take into consideration the requirement for additional load carrying with body armor and other additional weights of significant magnitude. Though we treat a much younger patient population than the typical civilian spine surgeon, the extra high impact activity compared to a typical civilian job will accelerate the degenerative process in the spinal column.

## How is treatment delivered to military service members who suffer spine injuries in the combat zones?

Spine injuries in the combat zone are typically air evacuated to Germany or stateside for any procedure that requires stabilization. We do have the capability to provide surgical stabilization in the combat zone when absolutely necessary, but the preference is air evacuation to a higher echelon of care.

## How does military surgical training help in treating civilian patients?

Current military conflicts have provided the experience of care for patients with very complex spinal injuries that are not typically seen in the civilian population.

## Have improvements in military technology had an impact on spine injuries of servicemen?

Motion preservation (specifically cervical arthroplasty) has become our standard treatment for cervical disc disease. We have one of the largest cervical Total Disc Replacement (TDR) experiences nationwide.

**Michael K. Rosner, M.D., L.T.C., M.C.**

Dr. Rosner is the Chief of Neurosurgery Integrated Service for the Walter Reed National Military Medical Center. He is also an Assistant Professor at the Uniformed Services University. Dr. Rosner has authored several scientific papers and book chapters, and is considered a national expert in many areas of spine surgery. He has served overseas in Landstuhl Regional Medical Center in Germany and a combat support hospital in Baghdad, Iraq where he was awarded a Meritorious Service Medal. He has also developed and collaborated on new surgical procedures, equipment, and several grant awards. He is currently principal investigator for the Defense Spinal Cord and Column Injury Program and primary investigator overseeing the military's only spine biomechanics lab.

# Springfield, Massachusetts

Elizabeth Comey, M.D. October 22, 2011

THE SPINAL RESEARCH FOUNDATION'S WE'VE GOT YOUR BACK RACE FOR SPINAL HEALTH

The first annual Springfield Area "We've Got Your Back" 5K Race, Walk, and Spinal Health Fair was held on October 22, 2011. The inaugural event was a great success and attracted over one hundred Bay State Area residents who participated in either the 5K race or 1 mile walk. Participants enjoyed a delightful, cool New England morning while running the scenic route through beautiful Forest Park. The heavily wooded route offered some classic New England foliage.

The event provided a chance for Bay State Area residents with back and/or neck pain to join together and support the cause for spinal health. Our goal was to not only raise money for The Spinal Research Foundation, but also to increase community awareness about the devastating effects of back and neck pain. This was the first event of its kind in the Pioneer Valley Region.

Springfield's Mayor Dominic Sarno agreed to kick off the 5K run at 9:00 A.M. and also shared his family Spinal Champion triumphs with the audience. The non-runners participated in a 1 mile family fun run/walk with commemorative medals given to all the children who crossed the finish line.

The event's primary purpose was to celebrate the achievements of patients who have overcome debilitating back or neck pain to regain their lives and share their successes with the community. Two Spinal Champions, Jeff B. and James G., each shared their success stories. Jeff B. has been able to return to an active lifestyle after a lumbar laminectomy and fusion. He celebrated this achievement by completing the 1 mile run on his late father's birthday; a long awaited gift to his dad.

The presenting sponsor and regional host for this event was New England Neurosurgical Associates. A special thanks to all our national and local sponsors for their generosity and to our race volunteers for their willingness to be involved in our first event.


WE'VE GOT


WE'VE
YOU
RACE FOR
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FINISH
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# San Francisco, California

Darlynn G. Slosar, M.B.A. September 17, 2011

THE SPINAL RESEARCH FOUNDATION'S
WE'VE GOT YOUR BACK
RACE FOR SPINAL HEALTH

San Francisco's fog was nowhere to be seen as the second annual "We've Got Your Back" Race for Spinal Health was held on a gorgeous, sunny day on September 17, 2011 at scenic Lake Merced.

More participants, more volunteers, and more inspiration were the themes of this year's event. Almost 200 participants, 30 volunteers, and many friends and family were on hand to run, walk, or provide support.

Two groups of participants made this year's event particularly memorable. The Daly City Police SWAT team organized a group of participants to support their colleague Mike P., a lieutenant who had recently undergone a lumbar fusion. Mike was able to run in the race alongside his colleagues, even beating several to the finish line! The presence of the *official* SWAT truck, parked at the race, was an incredibly exciting addition to the event. Our second large group was the employees from The Presidio Surgery Center. They formed their own team this year, sporting custom-designed "Fine Spine" team shirts.

New to this year's San Francisco event was the *Spinal Champions* booth, where volunteer staff videotaped success stories of the race participants who have undergone successful spine surgery. The determination of these patients who used our race as their rehabilitation goal was inspirational to all.

Dr. Paul Slosar gave a heartfelt thanks to all of the patients who were able to participate in the run or the walk, and acknowledged our generous sponsors. Spinal Champion awards were given to SWAT team member Mike P., and also to Jeff H. who was only 4 weeks post-op!

The presenting sponsor and regional host for this event was the SpineCare Medical Group, whose staff made up the core group of volunteers. Thanks again to all of our national sponsors and local donors for their generosity, which ensured the success of this second annual event. Finally, a very special thanks to those who have been with us since the beginning.

We are looking forward to our 2012 event on September 15!


START


START
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YOUR BACK


WE'VE GOT
YOUR BACK


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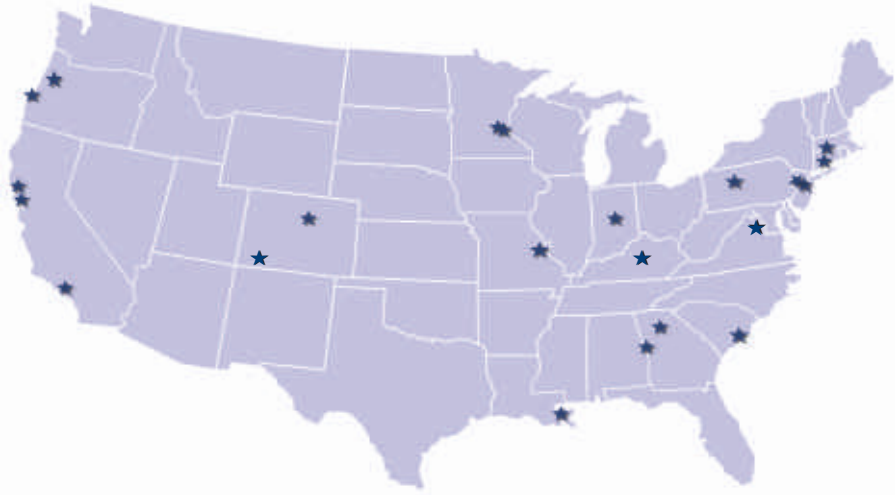
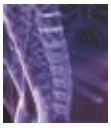
S.W.A.T.

# Spinal Research Foundation Research Partners

*The Spinal Research Foundation has named 24 Research Partners across the country that share one core mission: improving spinal health care through research, education, and patient advocacy. These centers offer the best quality spinal health care while focusing on research programs designed to advance spinal treatments and techniques.*





**Allegheny Brain and Spine Surgeon**
*James P. Burke, MD, PhD*
201 Howard Ave, Building E-1
Altoona, PA 16601
814-946-9150
centralpabrainandspinesurgeons.com

**Atlanta Brain and Spine Care**
*Regis W. Haid, Jr., MD*
2001 Peachtree Rd, NE, Ste 575
Atlanta, GA 30309
404-350-0106
atlantabrainandspine.com

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*George A. Frey, MD*
3277 South Lincoln St
Englewood, CO 80113
303-762-0808
coloradospineinstitute.com

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*J. Kenneth Burkus, MD*
6262 Veterans Parkway
Columbus, GA 31909
706-324-6661
hughston.com

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*Rick C. Sasso, MD*
13225 N. Meridian St
Carmel, IN 46032
317-228-7000
indianaspinegroup.com

**Inova Research Center**
*Zobair M. Younossi, MD, MPH*
3300 Gallows Rd
Falls Church, VA 22042
703-776-2580

**Menlo Medical Clinic**
*Allan Mishra, MD*
1300 Crane St
Menlo Park, CA 94025
650-498-6500

**MUSC Darby Children's Research Institute**
*Inderjit Singh, PhD*
59 Bee St, MSC 201
Charleston, SC 29425
1-800-424-MUSC

**New England Neurosurgical Associates, LLC**
*Christopher H. Comey, MD*
300 Carew St, Ste One
Springfield, MA 01104
413-781-2211

**Oregon Neurosurgery Specialists**
*Robert J. Hacker, MD*
*Andrea Halliday, MD*
3355 RiverBend Dr, Ste 400
Springfield, OR 97477
541-686-8353
oregonneurosurgery.com

**The Orthopaedic and Sports Medicine Center**
*Gerard J. Girasole, MD*
888 White Plains Rd
Trumbull, CT 06611
203-268-2882
osmcenter.com

**The Orthopedic Center of St. Louis**
*Matthew F. Gornet, MD*
14825 N. Outer Forty Rd, Ste 200
Chesterfield, MO 63017
314-336-2555
toc-stl.com

**Princeton Brain and Spine Care**
*Mark R. McLaughlin, MD, FACS*
*Nirav K. Shah, MD, FACS*
1203 Langhorne-Newtown Rd, Ste 138
Langhorne, PA 19047
215-741-3141
princetonbrainandspine.com

**River City Orthopaedic Surgeons**
*David P. Rouben, MD*
9300 Stonestreet Rd, Ste 200
Louisville, KY 40272
502-935-8061
rivercityortho.com

**Rutgers University**
**Department of Biomedical Engineering**
*Noshir A. Langrana, PhD, PE*
599 Taylor Rd
Piscataway, NJ 08854
732-445-4500

**South Coast Orthopaedic Associates**
*Aleksandar Curcin, MD, MBA*
2699 N. 17th St
Coos Bay, OR 97420
541-266-3600
scoastortho.com

**Southern Brain and Spine**
*Najeeb M. Thomas, MD*
4228 Houma Blvd, Ste 510
Metairie, LA 70006
504-889-7200
sbsdocs.net

**Spine Colorado**
*Jim A. Youssef, MD*
*Douglas G. Orndorff, MD*
1 Mercado St, Ste 100
Durango, CO 81301
970-375-3697
spinecolorado.com

**The Spine Clinic of Los Angeles**
*Larry T. Khoo, MD*
1245 Wilshire Blvd, Ste 717
Los Angeles, CA 90017
213-481-8500
spineclinicla.com

**SpineCare Medical Group**
*Paul J. Slosar, Jr., MD*
San Francisco Spine Institute
1850 Sullivan Ave
Daly City, CA 94015
650-985-7500
spinecare.com

**Twin Cities Spine Center**
*James D. Schwender, MD*
913 East 26th St, Ste 600
Minneapolis, MN 55404
612-775-6200
tcspine.com

**University of Minnesota Medical Center, Fairview**
*David W. Polly, Jr., MD*
2450 Riverside Ave, South
Minneapolis, MN 55454
612-672-7575

**The Virginia Spine Institute**
*Thomas C. Schuler, MD, FACS, President*
*Brian R. Subach. MD, FACS*
*Director of Research*
1831 Wiehle Ave
Reston, VA 20190
703-709-1114
spinemd.com

**Virginia Therapy & Fitness Center**
*Richard A. Banton, PT, DPT, ATC*
*E. Larry Grine, PT, MSPT, ATC, CSCS*
1831 Wiehle Ave
Reston, VA 20190
703-709-1116
vtfc.com

# Spine Tales

## Lieutenant Colonel—Michael Melito

Lieutenant Colonel Michael Melito is one of our nation's heroes. He has served two tours in support of OPERATION IRAQI FREEDOM and is currently Commander, 5th Battalion, 5th Air Defense Artillery Regiment. Lt. Col. Melito was first referred to The Virginia Spine Institute (VSI) by Colonel Michael Rosner, M.D., the Chief of Neurosurgery at Walter Reed Army Medical Center, after suffering from back and leg symptoms beginning May 2003. Trauma occurred during a vehicular accident with an enemy automobile during overseas deployment.

While facing the rear in a Bradley fighting vehicle north of Karbala, Iraq, then Captain Melito experienced a collision in the line of duty. This impact occurred at approximately 25 to 30 miles per hour. For his injuries sustained while in direct combat he was presented with the Purple Heart Medal.

Following the injury, his MRI scan demonstrated significant degeneration of both the L4/5 and L5/S1 disc spaces. Although he was in excellent physical condition, he suffered from significant pain despite physical therapy and the use of several medications. Though he had hoped to avoid surgical intervention, Mr. Melito was frustrated by his inability to perform the activities associated with his military career and personal life.

In June 2008, he underwent a combined anterior and posterior fusion of the lower lumbar spine, which included placement of fixation screws at L4-S1. The following May, this instrumentation was successfully removed.

Lt. Col. Melito has since sent VSI some of his photographs which demonstrate his level of activity. He remains on active duty and is always on the go. He often leads his battalion on 4 mile runs, plays flag football, performs resistance training with weights, and conducts Brazilian Jiu-Jitsu training with his soldiers regularly.

*Post-operative x-ray showing lumbar fusion.*

## Spines of Service

*Pre-operative MRI scan showing degenerative lumbar disc.*

**Brian R. Subach, M.D., F.A.C.S.**

Dr. Subach is a spine surgeon and the Director of Research at The Virginia Spine Institute. He is a nationally recognized expert in the treatment of spinal disorders and an active member of the American Association of Neurological Surgery, the Congress of Neurological Surgeons, and the North American Spine Society. He is an invited member of the international Lumbar Spine Study Group and a Fellow in the American College of Surgeons. He lectures extensively regarding the management of complex spinal disorders in both national and international forums. He is the Director of Research and Board Member for the non-profit Spinal Research Foundation (SRF) and Editor-in-Chief of the Journal of the Spinal Research Foundation (JSRF). He has written 15 book chapters and more than 50 published articles regarding treatment of the spine.

# Firefighter—Keith Roberson, Jr.


Keith Roberson, Jr. is a 42-year old firefighter, who had been working full time for several years until January 2011 when he slipped on an icy step landing and fell on his coccyx (tailbone). He had no prior history of low back pain but was unable to work due to the severe pain following his injury.

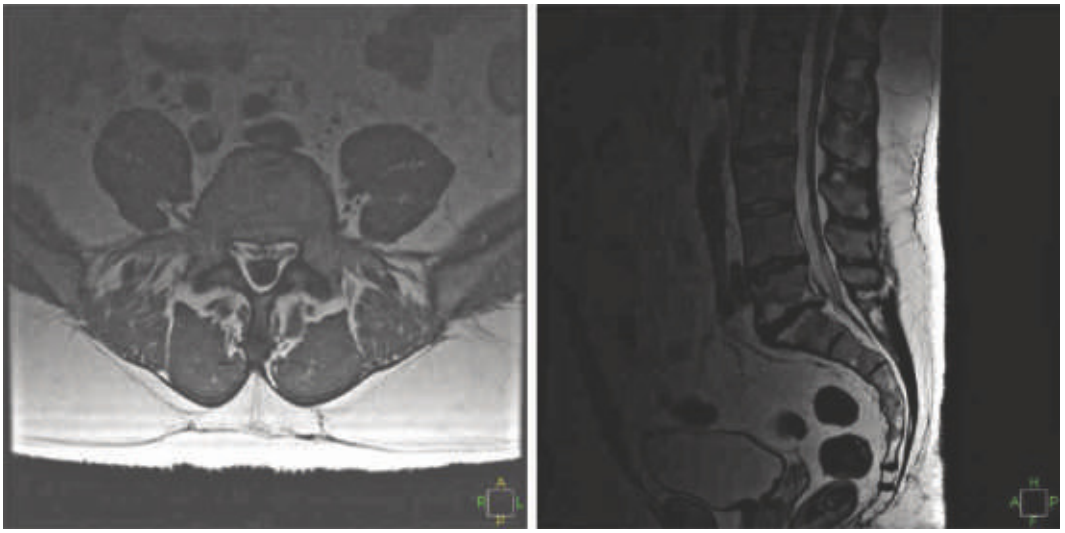
Keith initially presented to The Virginia Spine Institute (VSI) with a chief complaint of low back and coccyx pain, described as a 7/10 on the visual analog scale (0 being the least and 10 being the most amount of pain). He denied any lower extremity pain or weakness at the time of injury. He noted that his symptoms were worse with standing and sitting but were relieved by lying flat on his back. During his visit, he was unable to sit during the examination and appeared moderately uncomfortable due to the intense pain he was experiencing. Physical examination revealed a normal neurological state with normal strength in the lower extremities, normal deep tendon reflexes, and normal sensation. He had negative dural tension signs and normal hip range of motion. He was found to have tenderness to palpation over the spinous processes in the lower lumbar spine and tenderness with palpation of the coccyx. His SI joints were not tender to touch, nor did he have any instability or restriction of the SI joints bilaterally. Lumbar and pelvis x-rays taken on the day of his initial consultation revealed no pelvic obliquity, a slight lumbar curve and normal appearing hip joints and SI joints, decreased disc height of approximately 25% at L4-5 and 50% decreased disc height at L5-S1, and segmental instability at the lower lumbar spine. Coccyx x-rays revealed a subtle abnormality to be further studied with an MRI.

Keith was started on a tapered dose of oral steroids followed by anti-inflammatory and oral short-acting narcotic medications. A coccyx cushion was recommended to alleviate the pressure during sitting. An MRI of the lumbar spine, sacrum, and coccyx were ordered to rule out a sacral or coccyx fracture based on his clinical history, physical examination, and x-rays.

Keith returned for a follow-up appointment 7 days after his initial consultation to review his MRI. His MRI of the lumbar spine revealed marrow edema in the S2 to S4 vertebral bodies suspicious for non-displaced fracture involving the sacrum, as well as degenerative changes at L4-5 and L5-S1. At this visit, he noted that his pain had slightly improved since the previous visit, but was still at a 6/10 on the visual analog scale. He continued to deny any lower extremity pain or weakness with his main complaint being his coccyx pain. He was still relying on narcotic medications as needed to control his pain. He continued to complain of exacerbation with prolonged sitting, walking, lifting, and bending. His physical examination did not change much from his initial consultation, except that he appeared slightly more comfortable and was able to sit for part of the examination. He revealed that he did not obtain the coccyx cushion as recommended, as his pain did improve and that he was able to sit slightly longer without significant discomfort.

Approximately one month after the initial fall, Keith reported to be 20–30% better, but was still off work as a firefighter due to the demanding physical nature of the occupation. He continued to show an interest in getting back to work. At this visit, Keith was given a prescription for physical therapy for lumbosacral strengthening, range of motion, and myofascial release. He was told to continue anti-inflammatory medications. He was placed on light duty tasks and was told to perform activity as tolerated.

Keith returned to VSI two weeks after his initial visit. At this visit, he noted that he could sit for approximately 30 minutes at a time, and did so during the entire visit, which he felt was an improvement from prior encounters. He continued to have tenderness over the sacral region and coccyx, but it was far less intense than previously. For the first time since



*Lumbar MRI.*

his injury, Keith was able to squat repeatedly without any difficulty. He was told to continue with physical therapy to work on core stabilization and an extensive home exercise program. His goal at this visit was to go back to being a full-time firefighter as soon as possible.

Keith returned to VSI, approximately two months from his initial fall, with no complaints. He noted at this visit that after a few weeks of physical therapy and medication management with anti-inflammatories, that his pain had gone down to a 0/10 on the visual analog scale. He had stopped taking all narcotic medications. He had been going to physical therapy three times a week for core strengthening, range of motion exercises, and stabilization techniques. He was motivated on this visit to return to work full-time. His physical examination had greatly improved and revealed no significant tenderness with deep palpation of the coccyx or sacrum. His gait had become non-antalgic and he had no difficulty getting in and out of a chair. After reviewing his work requirements he was advised to return to work full-time as a firefighter with frequent breaks, to continue stretching throughout the day, and to incorporate his home exercise program designed by his physical therapists. Approximately three months after his initial injury, Keith returned to VSI with minimal pain. At this point, he had returned to work for 4 weeks and noted no significant discomfort with the daily duties as a firefighter.

Today, Keith continues to perform duties that require heavy lifting and long work hours. He has returned to work full-time, and with the exception of occasional tightness in his hamstrings, has been doing really well. He no longer complains of coccyx pain or low back pain. The injury that kept him from working for weeks no longer interferes with his work schedule and he is happy to be back to a job that he finds rewarding. Keith is an example of a patient who did not require any invasive treatments such as injections or surgery, but with the proper medications, core exercises, and time, has recovered from severe pain due to a sacral fracture and contusion.

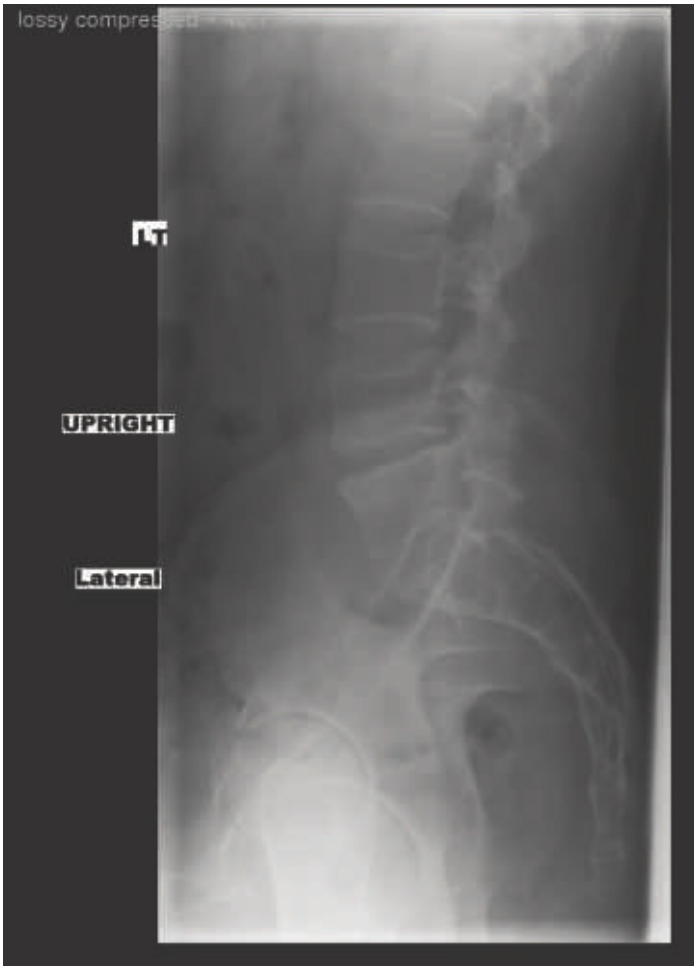
**Neil Chatterjee, M.D.**

Dr. Chatterjee is a board certified, fellowship-trained physician who specializes in the non-operative treatment of spine, joint, neuropathic, and muscle pain. He has expertise in encompassing the treatment of cervical, thoracic, and lumbar spine pain in addition to myofascial pain, pelvic dysfunction, painful neuropathies, lower back pain during pregnancy, adolescent sport and spine injuries, and fibromyalgia. Dr. Chatterjee works with each of his patients to reach the goal of alleviating their pain, restoring and maximizing function, and improving their overall quality of life. A major focus in his treatment approach is education of his patients on methods of preventing degenerative disc disease through smoking cessation, weight loss, proper nutrition, and exercise strategies. He also led several lectures on pain management. Dr. Chatterjee is a Fellow of the American Academy of Physical Medicine and Rehabilitation and an active member of the International Spine Intervention Society and the American Academy of Pain Medicine.

# K-9 Police Officer—Peter Masood

Peter Masood was a 42-year old K-9 police officer when he first visited The Virginia Spine Institute in October 2007. He had complained of low back pain intermittently for years, but it never kept him off work. However, he developed right leg symptoms of pain and numbness after a fall at work. His MRI scan showed a large disc herniation arising from the disc space between L4 and L5. The pain was quite severe and he demonstrated evidence of progressive loss of strength. The biggest concern was the presence of Modic changes in the bones surrounding the L4/5 disc space. Bony changes often indicate a predisposition to progressive degenerative back pain. In his case, the severity of the leg pain led us to discuss surgical options. These included a minimally invasive approach to remove the disc herniation or a fusion procedure, which would take care of the entire disc problem including back pain and leg symptoms. He decided to pursue the less aggressive option, microdiscectomy.

A week later, he underwent a lumbar microdiscectomy in which all of the disc herniation, which was causing the leg pain, was removed. This gave him complete resolution of his leg symptoms, however, he was still bothered by back pain. We put him through an aggressive rehabilitation course and he did quite well until he experienced a recurrent disc herniation at the same L4/5 level. In light of recurrent disc herniation in combination with the previous Modic changes in the bone, we decided to pursue fusion surgery. Officer Masood underwent a combined anterior/posterior approach to fusion at the L4/5 level in April 2008. He did extremely well and went through a course of aggressive physical therapy.


*Post-operative x-ray showing severe disc degeneration.*

*Post-operative x-ray showing fusion hardware.*

He continued to have some discomfort from the screws placed in his back, and these were removed without difficulty in August 2009. By December 2009, he had no back pain and only a small amount of numbness in the right toes. We returned him to work full duty, full time and salute him and his canine companions.

**Brian R. Subach, M.D., F.A.C.S.**

Dr. Subach is a spine surgeon and the Director of Research at The Virginia Spine Institute. He is a nationally recognized expert in the treatment of spinal disorders and an active member of the American Association of Neurological Surgery, the Congress of Neurological Surgeons, and the North American Spine Society. He is an invited member of the international Lumbar Spine Study Group and a Fellow in the American College of Surgeons. He lectures extensively regarding the management of complex spinal disorders in both national and international forums. He is the Director of Research and Board Member for the non-profit Spinal Research Foundation (SRF) and Editor-in-Chief of the Journal of the Spinal Research Foundation (JSRF). He has written 15 book chapters and more than 50 published articles regarding treatment of the spine.

# United States Air Force Veteran—Byron Ater

It is a pleasure to introduce you to Byron Ater, a retired United States Air Force veteran and a patient at The Virginia Spine Institute for the last four years. Byron was drafted into the United States Air Force in 1972 at the age of 20, and he served our country for twenty years. During that time, he was stationed at an Air Force Base in Guam during the Vietnam War, and was responsible for deploying aircrafts involved in the fighting. While on active duty, Byron spent the majority of his time in the South Pacific, but also spent time in Europe and a small portion of time in the United States.

Byron describes his position within the Air Force as a specialist in electronic countermeasures, and while he flew many different aircrafts over the years, the B-52 was always his favorite. Although he spent most of his time in the South Pacific, Byron was no stranger to cold weather. In 1975 he was stationed at Wurtsmith Air Force Base in Michigan and he was also stationed in Greenland, living approximately twenty-five miles off the Arctic Circle. The cold weather played a significant role in shaping Byron's future.

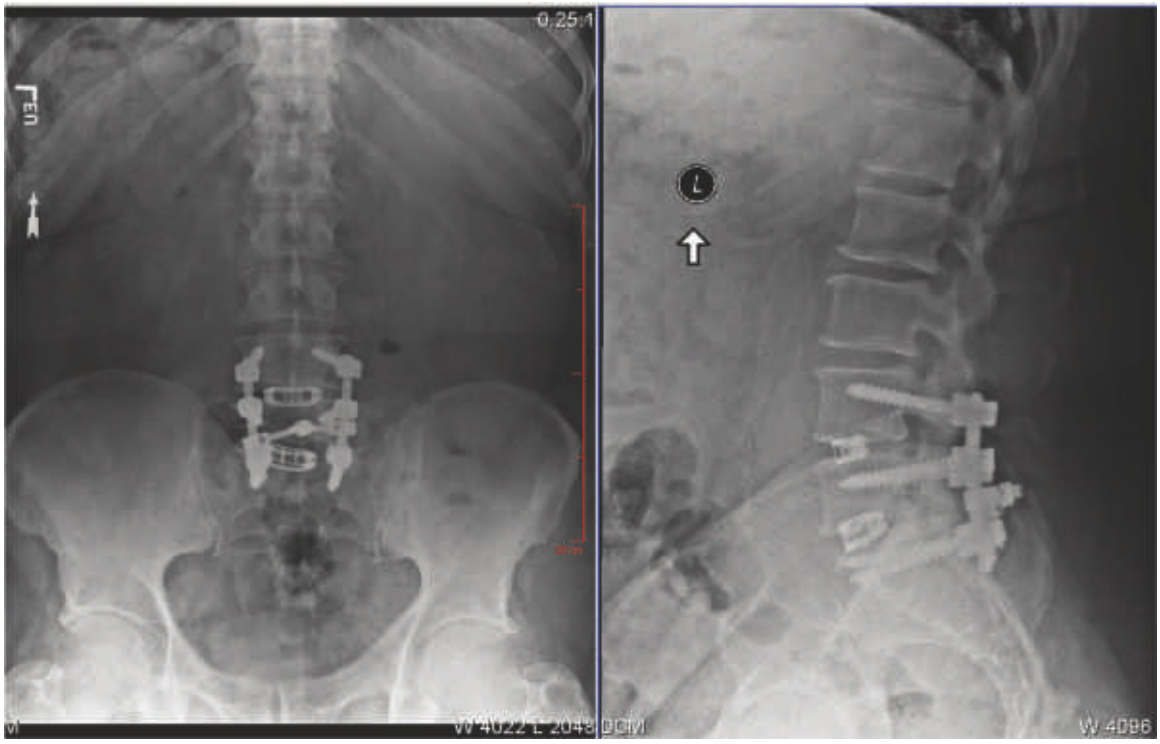
While on duty, deicing the tail of a B-52 in preparation for a flight, Byron's rubber boots slipped on a puddle of antifreeze and he fell off of the plane and onto the tarmac below. He was later told the fall was approximately 52 feet. Amazingly, the only injury he sustained was to his back, and despite the serious nature of his accident, he quickly returned to full duty. Byron continued to fulfill his duties, but from that time on, he had worsening pain in his back and numbness in his legs.

Unfortunately, Byron sustained further injury to his back in Germany in 1978. At that time, he was working on an F-4 aircraft when he noticed that a tractor, which had accidentally slipped into neutral, was suddenly rolling down the runway near his aircraft. Byron saw the tractor rolling straight at him and without time to get out of the way, his body was pinned between the plane and the tractor. Byron still remembers the shooting pain as he describes the feeling that every muscle in his back felt like it was going to pop. He was seen by the doctors on duty and x-rays were performed. He recalls that his main concern, and that of the doctors at that time, was to get back to full duty as soon as possible. He was treated

*B-52 bomber.*

with medications and cortisone shots to control his pain, but they never had a specific diagnosis as to what was causing his pain.

After his second injury, Byron continued to have increasing pain in his back and legs and he eventually had to give up his aircraft duties. He spent the last twelve years of his service in the Air Force as a medical lab technician. He was able to finish his career in the Air Force, but even with this less physically demanding job, his back pain and periodic leg numbness continued to be an issue.



*Post-operative x-rays showing fusion and hardware.*

After his retirement from the Air Force, and as time passed, Byron became more limited due to his symptoms. His back and leg pain steadily worsened and even his neck and arms began to have similar issues. Byron worked hard at physical therapy and getting in shape, but eventually his pain kept him from even simple daily activities and he was unable to keep working.

Byron felt that "no one had ever really treated anything specific" in his back. His primary care physician eventually referred him to The Virginia Spine Institute to see if anything else could be done to help him. In order to further evaluate his pain and numbness, MRI scans of the neck and back were performed. Byron was found to have cervical spinal stenosis (a narrowing of the space around his spinal cord in his neck) as well as lumbar spinal stenosis with spondylolisthesis (a forward slippage of one vertebrae on top of another). Dr. Christopher Good recommended surgery on the neck first in order to prevent further damage to the spinal cord, to be followed by surgery to correct stenosis in his back.

Byron recalls that during his first meeting with Dr. Good they reviewed the non-surgical treatment options to treat his pain but, because of his long-standing symptoms and injury history, Byron was very skeptical that they would work. Despite his concerns, Byron followed the recommendations and was very pleased with the progress of his treatment. Over time, therapy and exercise would not cure his spine problems, but they did help to control his pain and also helped to ensure that he was as healthy as possible when the time came to discuss surgery.

Byron's first surgery was performed through a small incision in the front of his neck. A microscope was used to help remove material from two of his discs which were compressing his spinal cord. Byron spent one night in the hospital after his anterior cervical discectomy and fusion (ACDF) and did great after surgery. He noticed an improvement in his neck pain and balance immediately after surgery.

*Byron Ater early military picture.*

Once he fully recovered from his neck surgery, Byron geared himself up for his back surgery. He was actually more excited about the back surgery because his back had been bothering him for such a long time. Dr. Good counseled him that his recovery after the back surgery would be more painful and that the rehabilitation process would be slower than it had been after the neck surgery. Byron had lower back surgery later that same year and he was treated with a transforaminal lumbar interbody fusion (TLIF). This procedure removed the material pressing on the nerves in his back and also stabilized the spondylolisthesis using screws, rods, and bone graft.

It turned out that Dr. Good was right about his recovery being slower after his lumbar surgery, but despite this, Byron could tell right away that the surgery was going to help. His back pain and leg numbness started to improve almost immediately and Byron worked hard on his rehabilitation and home exercises. With all his hard work, he continued to improve steadily in the months following his surgery. Byron has been able to take his dog to the park and play with her and is even ready to return to work full time. After many years of pain, he never thought he would be able to return, but he is now working toward a job in network engineering.

Overall, Byron feels that he is 100% of what he knows he can be today. He is now able to do many things that he never could do before. He describes his experience at The Virginia Spine Institute as being a great one and describes Dr. Good as someone who listens intently, and explains the treatment course in detail and gives accurate expectations regarding post-operative recovery.

Byron is a perfect example of the never-give-up mentality that is so typical of our men and women in uniform. He always put his duties first, even sacrificing his own health in order to get the job done. He has served our country proudly and even today says that if he was needed, he would be there to defend our Constitution.


**Lindsay Orosz, PA-C, M.P.A.S.**

Lindsay Orosz is a Physician Assistant with The Virginia Spine Institute (VSI). She obtained a Master of Physician Assistant Sciences degree from Seton Hall University and a Bachelor of Biological Sciences from Rutgers University. Her residency and fellowship focused specifically on medical and surgical management of spinal disorders and she holds licenses from both the Virginia and Maryland Boards of Medicine.

**Christopher R. Good, M.D., F.A.C.S.**

Dr. Good is a spine surgeon at The Virginia Spine Institute. He has extensive training and experience in the treatment of complex spinal disorders with special expertise in non-operative and operative treatment of adult and pediatric spinal deformities including scoliosis, kyphosis, flatback, and spondylolisthesis. Dr. Good has co-authored numerous articles and has been invited to lecture nationally and internationally at the Scoliosis Research Society, the International Meeting on Advanced Spinal Techniques, the American Academy of Orthopaedic Surgeons, and the North American Spine Society.

# Federal Air Marshal—Doug McMillan

Doug McMillan first came to The Virginia Spine Institute (VSI) in April 2009. As a Federal Air Marshal, Doug is accustomed to rigorous physical training and the demands of an active law enforcement position. He came to VSI with complaints of neck pain and decreased range of motion. His injury was precipitated by a training drill involving how to handle a hostile attacker. During the exercise, Doug's training partner forced him into a position in which his neck was hyper-extended. The pain was severe when he extended or rotated his neck in any way. Essentially, Doug could no longer perform the duties of his position without considerable restriction. After an initial consultation with his doctor, an MRI scan was ordered to ascertain whether there were any fractures to the neck and he was placed on a brief course of steroids to suppress his body's inflammatory response.

Doug's MRI scan showed degenerative changes with some fluid in the facet joints, most likely inflammation resulting from the trauma of the injury. He was treated with an aggressive physical therapy schedule and medications to control pain. Although Doug talked with his physician about the possibility of surgery, he chose to delay that decision for the immediate future. He continues to have significant neck pain which spans between the cervical and thoracic spine and additional pain radiating toward the shoulder blade, though he has remained able to complete his day to day activities. As a result of the training injury he experienced, he is not able to return to his former position. An old adage states, you train like you fight, but in this case the training changed the nature of the fight. His battleground is now in the offices of the Transportation Security Administration (TSA) providing the vital infrastructure needed to keep the airways safe. We salute Federal Air Marshal Doug McMillan for his dedicated service, both in the skies and on the ground. We appreciate his sacrifice.

*X-ray of the cervical spine.*

*MRI of the cervical spine.*

**Brian R. Subach, M.D., F.A.C.S.**

Dr. Subach is a spine surgeon and the Director of Research at The Virginia Spine Institute. He is a nationally recognized expert in the treatment of spinal disorders and an active member of the American Association of Neurological Surgery, the Congress of Neurological Surgeons, and the North American Spine Society. He is an invited member of the international Lumbar Spine Study Group and a Fellow in the American College of Surgeons. He lectures extensively regarding the management of complex spinal disorders in both national and international forums. He is the Director of Research and Board Member for the non-profit Spinal Research Foundation (SRF) and Editor-in-Chief of the Journal of the Spinal Research Foundation (JSRF). He has written 15 book chapters and more than 50 published articles regarding treatment of the spine.

# Deputy Sheriff—Jennifer Carpenter


## History

Jennifer Carpenter is a 34-year old healthy deputy sheriff. She presented to the clinic three weeks after an anterior lumbar fusion at L4-L5 and L5-S1 with left-sided posterior instrumentation in September 2011. Her injury occurred in February 2011 as the result of a floor combat training exercise. She was fighting a male coworker and was using all of her body weight to get him off her. When she attempted to get up, she felt acute pain in her right low back as she rolled back onto her left side. Before her lumbar fusion, her symptoms included right posterior leg pain and bilateral groin pain. She started physical therapy at another facility and attempted a lumbar epidural, both providing minimal relief of her symptoms.

Post-operative symptoms included left buttock and posterior thigh numbness with pain rated 2 out of 10 on visual analog scale, but increased to 4–5 our of 10 with walking. Pain was alleviated temporarily with narcotic pain medication at night and a muscle relaxer. When she presented to the clinic, she was off duty for three months since returning to work on light duty status was not an option.

## Three Months Post Operation

A combination of manual therapy and stabilization exercise has been shown to produce the best outcome for patients suffering from chronic low back pain.[1] A typical recovery from lumbar fusion can take anywhere from three to five months. Often patients that have careers in civil service face many obstacles in returning 100% to their occupations. In regards to Jen, she had significant doubt in her ability to return to a career in law enforcement and feared that she may reinjure herself during her rehabilitation.

The primary goals during the first three months of rehabilitation following lumbar fusion are to educate the patient regarding their surgery and prognosis, to protect the fusion and promote healing, to regain spine range of motion (ROM), and to minimize pain and swelling. Initially, aquatic therapy is beneficial because it provides a cooling effect to the spine to reduce swelling and it allows for ROM exercises in an un-weighted environment to reduce compressive forces on the spine.

Patients' therapy can be classified into one of four classification groups based upon their symptoms.

1. Stabilization
2. Traction
3. Manipulation
4. Specific Exercise Flexion or Extension

The criteria for the Stabilization Prediction Rules are as follows:[2]

1. Patient's age less than 40
2. Straight Leg Range of Motion greater than 90 degrees
3. Positive Prone Instability Test
4. Aberrant motions present

The presence of three or more factors indicates a high likelihood of responding to a stabilization program. Jen met all of the above criteria except for a

straight leg raise motion greater than 90 degrees, indicating that an exercise program that challenges the stabilizing muscle of her lumbar spine (abdominal muscles, erector spinae and multifidus, and quadratus lumborum), without imposing dangerous compressive loads to her lumbar fusion, would provide the most optimal outcome. Table 1 identifies key muscle groups for spine stabilization and corresponding exercises.[3]

A principle of a post fusion stabilization program is that core activation be combined with progressively increased difficulty in the form of more functional activities, as patient's progress through their rehabilitation. Exercise should always be within the patient is tolerance and within a controlled environment to avoid injury. Fusions with bone morphogenic protein (BMP) are 90% fused within six weeks of surgery. At six weeks post operation, the therapist can begin to introduce spine ROM and stability exercises that will aid in strengthening the bony fusion. Over the next six weeks the bone will remodel and increase tensile strength until it is 98–100% fused at the twelve week milestone.

## Three Months Post Operation

At three months following spinal fusion, many patients start to reenter the workforce. They have many concerns and fears as they try to return to their normal lifestyle. Jen was concerned about whether she would be able to keep up with her co-workers if she returned to the job. She expressed fear about not being able to participate in physical altercations, not being able to

Table 1. Spine Stabilization Therapy

| Muscle | Exercises |
|---|---|
| Erector Spinae and Multifidus | Quadruped single arm or leg lifts<br>Quadruped opposite arm and leg lifts<br>Bridging exercise<br>Bridging with leg lifts |
| Transversus Abdominus | Abdominal hollowing<br>Side support exercise |
| Abdominal Obliques | Trunk curl-ups with rotation |
| Quadratus Lumborum | Side support exercise |
| Gluteals | Single limb balance with head and arm movements |

**Protocol for therapy following lumbar fusion (Virginia Therapy and Fitness Center):**

I. Pre-surgical visit with physical therapy
   a. Core instruction
   b. Post-surgical instructions
      i. Icing
      ii. Wearing brace
   c. Supplies
      i. Shoe horn
      ii. Reacher
      iii. Large lumbar ice pack

II. Minimal Physical Activity, 1–2 weeks
   a. Protect incision to avoid infection
   b. Gentle core isometrics
   c. Regular walking daily
   d. Rest, but avoid sitting longer than 30 min
   e. Icing for pain relief

III. Phase I: Aquatic Therapy, 2–8 weeks (after incision heals)
   a. Gait retraining
   b. Hip range of motion (ROM)
   c. Neural mobility to ease numbness and tingling sensations
   d. Gentle core stabilization and strengthening to patient tolerance

IV. Phase II: Land Therapy, 8–12 weeks
   a. Begin Aerobic exercise program
      i. Biking (recumbent)
      ii. Walking
   b. Postural stabilization and strengthening exercise
   c. Range of motion (ROM) exercises
   d. Soft tissue massage and modalities for pain control
   e. Joint mobilization to restore normal mechanics (above fusion site)

V. Phase III: Functional Land Therapy, 12–20 weeks
   a. Progression of all the above
   b. Begin dynamic lifting program with emphasis on core stabilization
   c. Progression of weights with strengthening program
   d. Work/sports specific training

VI. Phase IV: Discharge from Land Therapy, 20 weeks–1 year
   a. Return to sport ( i.e., golf, tennis, skiing) or work
   b. Begin fitness center program
   c. Maintain healthy lifestyle

transfer out of her car quickly enough to track down criminals, and most of all, wondered if she would regain the trust of her co-workers after being out of work for more than four months.

For many patients facing their return to work, feelings of fear and avoidance begin to overwhelm them. Psychological factors play a key role in the development of chronic musculoskeletal pain, in particular dysfunctional beliefs about pain and fear of pain. She was clearly improved compared to three months prior, however, her persistent left buttock and piriformis pain left doubts in her mind about her ability to return to the job she loved. Based upon her fear avoidance behavior, excellent progression through physical therapy, and a strong desire to return to work, Jen was an excellent candidate for work conditioning.

Work conditioning is an individualized, work-oriented program designed to restore a client's strength, endurance, movement, and flexibility. The objective of the program enabling a safe return to work while improving the patient's confidence in their abilities to perform their job. The components of a successful work conditioning program include:

1. Aerobic Conditioning
2. Strengthening and Flexibility
3. Education
4. Work Simulation

Work conditioning programs need to be, at a minimum, three to four hours per day, four to five days per week. The duration of a work conditioning program should last four to six weeks. The amount of time a patient needs to spend in each component of a work conditioning program should be individualized by the therapist. In Jen's case, she had been a police officer for seven years, therefore needed minimal education in her work conditioning program for her to return to her job. Her primary concerns were regarding her aerobic conditioning, agility, and strength. Jen's work conditioning program was structured to meet her specific requirements.

The following outlines a typical work conditioning visit for Jen during the first four weeks:

| | |
|---|---|
| 1 P.M.–1:15 P.M. | Arrive and begin warm up walk on treadmill at 3.2–3.5 mph |
| 1:15 P.M.–2 P.M. | Begin aerobic portion of work conditioning program which may include: agility ladder drills, stair climbing, crawling, hopping, running and lateral shuffle drills. |
| 2 P.M.–2:15 P.M. | Rest break |
| 2:15 P.M.–3 P.M. | Strengthening portion of work conditioning program which may include: power lifts, back lifts, overhead lifts, diagonal and rotational medicine balls throws, and upper and lower body plyometrics. |
| 3 P.M.–3:15 P.M. | Rest break |
| 3:15 P.M.–3:45 P.M. | Flexibility portion of work conditioning program which may include: stretches for piriformis, gluteals, latissimus dorsi, upper trapezius, pectorals, hamstrings, hip flexors, quadriceps, gastrocnemius and soleus, and lumbar/thoracic paraspinals. |
| 3:45 P.M.–4:30 P.M. | Pain management or education portion of the work conditioning program which may include dry needling, manual therapy to gluteals and piriformis, and ergonomic education |

Dry needling has been demonstrated to be an effective intervention for patients suffering from myofascial pain syndromes.[4] Dry needling is effective because it releases the chemicals responsible for the altered neuron response resulting in hyperexcitability.[5] Dry needling helps patients by desensitizing to tissues within their pathological segment. Jen's primary pain was located within her L5 myotome, gluteals, and piriformis. Dry needling was an effective intervention for Jen during the first four weeks of work conditioning because it allowed her to place force through her involved myofascial tissues without a significant pain increase in her left gluteals and piriformis.

The following outlines a typical work conditioning visit for Jen during the last two weeks:

| | |
|---|---|
| 1 P.M.–1:15 P.M. | Arrive and begin warm up walk on treadmill at 3.2–3.5 mph |
| 1:15 P.M.–2 P.M. | Begin aerobic portion of work conditioning program which may include, agility ladder drills, stair climbing, crawling, hopping, running and lateral shuffle drills. |

| | |
|---|---|
| 2 P.M.–2:15 P.M. | Rest break |
| 2:15 P.M.–3 P.M. | Strengthening portion of work conditioning program which may include: power lifts, back lifts, overhead lifts, diagonal and rotational medicine balls throws, and upper and lower body plyometrics. |
| 3 P.M.–3:15 P.M. | Rest break |
| 3:15 P.M.–3:45 P.M. | Flexibility portion of work conditioning program which may include: stretches for piriformis, gluteals, latissimus dorsi, upper trapezius, pectorals, hamstrings, hip flexors, quadriceps, gastrocnemius and soleus, and lumbar/thoracic paraspinals. |
| 3:45 P.M.–4:30 P.M. | Work simulation portion of the work conditioning program which may include: prolonged bending and stooping drills to simulate shooting positions and transfers, combat drills to simulate assault, and wearing a weighted vest during conditioning drills to simulate work uniform. |

## Five Months Post Surgery

In February, Jen returned to work without restrictions. Although she still has complaints of left sacroiliac (SI) joint pain, her symptoms are able to be controlled with ice, massage, and exercises. Jen will still require intermittent physical therapy over the next three months, consisting of exercises and manual therapy of her SI joint to maintain normal biomechanics and decrease pain.

Jen reports a 95% overall improvement since she first came to Virginia Therapy and Fitness Center post fusion surgery. She no longer suffers from intractable leg and back pain and can safely perform her job without fear of re-injury and with confidence in her abilities.

Jen represents one of many successful cases that have completed their rehabilitation at Virginia Therapy and Fitness Center. A combination of manual therapy and stabilization exercises provided the best outcome for this patient following lumbar fusion. In addition, a course of work conditioning helped Jen regain confidence in her abilities and face her fears of returning to work and life. Further research is required to determine the benefits of dry needling and manual therapy in conjunction with a stabilization classification or other classification program. It is the opinion of the authors that, for patients under the age of 40 and with positive instability diagnostic tests, a physical therapy regimen consisting of stabilization exercises and manual therapy, in particular dry needling, will produce the best outcome.

**REFERENCES**

1. Richardson CA, Jull GA. "Muscle Control Pain control: what exercises would you prescribe?" *Manual Therapy* 1995;1:2–10.
2. Hicks GE, Fritz JM, Delitto A, McGill SM. "Preliminary development of a clinical prediction rule for determining which patients with low back pain will respond to a stabilization exercise program, *Arch Phys Med Rehabil*. 2005;86:1753–1762.
3. McGill SM. "Distribution of tissue loads in the low back during a variety of daily and rehabilitation tasks." *J Rehabil Red Dev*. 1997;34:448–458.
4. Mense S, MD. "The Pathogenesis of Muscle Pain." *Current Pain and Headache Reports* 2003;7:419–425. Current Science Inc. ISSN 1531-3433.
5. Shah JP, Phillips TM, Danoff JV, Gerber LH. An in vivo microanalytical technique for measuring the local biomechanical milieu of human skeletal muscle. *Journal Appl Physiol* 2005;99:1977–1984.

**Richard A. Banton, P.T., D.P.T., A.T.C**

Richard Banton has served as co-clinic director for Virginia Therapy and Fitness Center since its inception in 2004. He has been practicing physical therapy since 1998, working with a variety of orthopedic, neurologic, and pediatric conditions. His extensive experience includes the treatment of athletes from the high school to collegiate and professional levels, including Olympic athletes, Washington Redskins football players, and other athletes from NASCAR and the LPGA.

**Erin M. Friend, P.T., D.P.T., C.E.A.S.**

Erin Friend is a manual physical therapist at Virginia Therapy and Fitness Center in Reston, VA, treating patients with spinal dysfunction and orthopedic conditions. Since 2008, she has been a Certified Ergonomic Assessment Specialist through the Back School of Atlanta. Erin provides on-site ergonomic assessments in the office, medical, and industrial areas.

# Firefighter—Isaac Faircloth

Isaac Faircloth is a 36-year old man who initially presented to The Virginia Spine Institute at a youthful thirty-four. He endured one to two years of low back pain, which worsened insidiously over time. As a former Marine and full-time firefighter, his low back had experienced significant stress in the past. Like many people who suffer chronic back pain, Isaac had experienced no specific traumatic event. For him, however, the day-to-day stresses of being a firefighter were causing progressive left-sided low back and buttock pain. He recalls that the onset of the pain started in January 2009. Throughout the years he was seen by a wide variety of spinal health care providers. He dutifully tried physical therapy, chiropractic care, and even resorted to pain management in an attempt to resolve his symptoms. Isaac had an epidural steroid injection, which proved to be ineffectual and also tried trigger point injections which provided some short term relief. Generally his average pain score was a 5 on a scale of 0 to 10. He described the pain as being 70% back pain and 30% located in the legs. His physician ordered an MRI scan of his lumbar spine, which demonstrated significant degenerative changes at the L5/S1 level with a central disc extrusion. Additionally, L4/5 showed some mild degenerative changes. To better identify the pain generator responsible for his low back pain, Isaac underwent a lumbar discography. The procedure showed a degenerative change at L3/4 with reproduction of his usual pain. At that point in time however, he decided to hold off on any surgical intervention.

Over the next couple of years, he continued to have increasing discomfort. In January 2012, when it got to the point that the pain was impacting his day to day activities and overall quality of life, he returned to The Virginia Spine Institute. Isaac had essentially failed to respond to medications, injection therapy, and was having significant pain radiating down both the back and legs. He was now living with a daily pain score that was a 6 on the visual pain scale. He found that it had become essentially impossible to do his job with his current level of pain and decided to pursue surgery.

*MRI of the lumbar degenerative discs.*

Isaac successfully underwent a combined anterior and posterior operation, which addresses the lumbar spine from both the front/abdominal side and the lumbar/back side. This allowed for realignment of the spine, restoration of normal disc space height, and stabilization of the degenerative segments. Two weeks after surgery, he stated that his pain was down to a 4. He still reported having some mild discomfort in the left hip and some minor numbness to the left foot, but overall he was feeling much better. Isaac Faircloth is an excellent example of someone who suffered from significant degenerative changes in the lumbar spine which made it impossible for him to pursue his career, let alone be an active member of his family. He made the deliberate choice to undergo surgical intervention after having failed conservative management. I anticipate that in approximately three months following surgery, Isaac will be back doing the job that he loves, as a fully functioning member of his fire department.

*Lumbar x-ray showing fusion hardware.*

*Side view x-rays showing healing fusion at 3 months.*

**Brian R. Subach, M.D., F.A.C.S.**

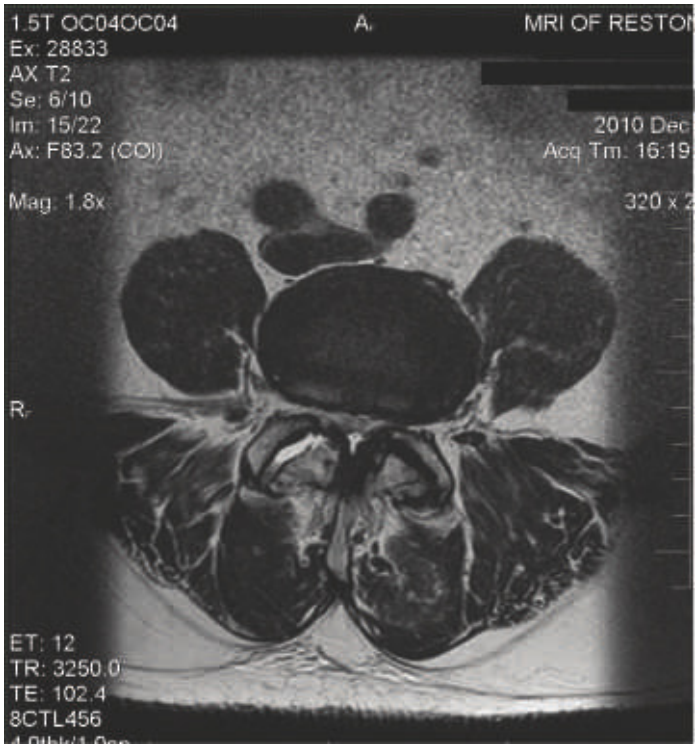
Dr. Subach is a spine surgeon and the Director of Research at The Virginia Spine Institute. He is a nationally recognized expert in the treatment of spinal disorders and an active member of the American Association of Neurological Surgery, the Congress of Neurological Surgeons, and the North American Spine Society. He is an invited member of the international Lumbar Spine Study Group and a Fellow in the American College of Surgeons. He lectures extensively regarding the management of complex spinal disorders in both national and international forums. He is the Director of Research and Board Member for the non-profit Spinal Research Foundation (SRF) and Editor-in-Chief of the Journal of the Spinal Research Foundation (JSRF). He has written 15 book chapters and more than 50 published articles regarding treatment of the spine.

# Central Intelligence Agency Instructor—Robert Malsz

Robert Malsz is an active, lively 69-year old sheep farmer. He is a retired Central Intelligence Agency agent who continues to remain relevant in spreading his wealth of knowledge and experience in the world of secrecy and espionage by teaching their young operatives in the field. Mr. Malsz continues to travel intermittently to various parts of the world as a part of his job with the Agency. Unfortunately, about five years ago, he developed a slow, insidious onset of axial low back pain. His pain gradually worsened with the passage of time to the point where he was not able to stand or walk for any particular amount of time before the onset of severe pain required him to sit and rest for relief. This pain significantly hampered his ability to care for his sheep and take care of his farm. Mr. Malsz found that he was no longer able to walk the entire length of his driveway to get his mail and return to his home without significant back pain.

Mr. Malsz sought consultation with his primary care physician, who recommended initial conservative treatment consisting of oral nonsteroidal anti-inflammatory medications and a course of physical therapy. Without remarkable improvement, his primary care physician ordered diagnostic studies in the form of an MRI of the lumbar spine in April 2007, which showed posterior disc protrusions and disc desiccation at all lumbar levels including L1/2, L2/3, L3/4, L4/5, and L5/S1. T2 weighted sagittal images showed severe foraminal narrowing at L3/4 and L4/5 bilaterally. On T2 weighted axial images, L5/S1 demonstrated a posterior disc protrusion and bilateral facet hypertrophy leading to overall moderate central canal stenosis and bilateral foraminal narrowing. L4/5 had severe spondylosis of facet joints and broad based disc bulge leading to severe central canal stenosis. Effusion was noted on the right L4/5 facet joint. There was bilateral facet hypertrophy and broad based disc bulge leading to bilateral foraminal narrowing at L3/4. Bilateral facet joint hypertrophy and broad based disc bulge was seen at L2/3 with posterior left paracentral high intensity zone leading to mild to moderate central canal stenosis at L2/3. Overall, the MRI was consistent with lumbar spinal stenosis, lumbar facet arthropathy, lumbar spondylosis, and lumbar disc herniations at multiple levels.

Mr. Malsz was subsequently referred to Dr. Subach, a surgical spine specialist, for further evaluation and treatment of his axial back pain. Dr. Subach felt




*MRI showing facet effusion.*


*Lumbar MRI.*

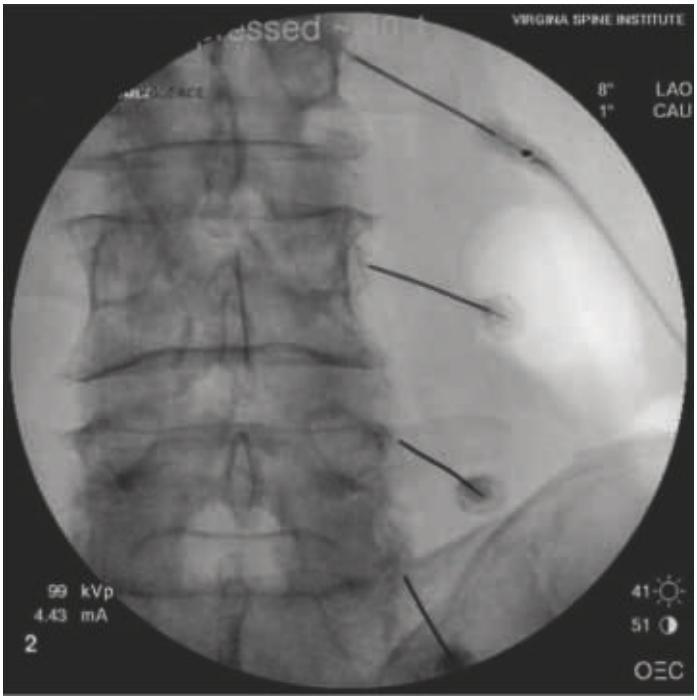
that the patient's multilevel, multifactorial axial back pain and wish to remain active, warranted continued attempts at conservative, non-surgical pain treatments prior to discussing extensive back surgery. Mr. Malsz was subsequently referred for pain management evaluation with Dr. Kancherla, a physiatrist and interventional pain specialist. Mr. Malsz was evaluated by Dr. Kancherla, who recommended spinal injection therapy for diagnostic as well as therapeutic purposes. An epidural steroid injection and lumbar facet joint injections were recommended on separate dates. The purpose of these injections, which deposited local anesthetic and a corticosteroid medication in a particular structure of the spine, was to better identify the patient's pain generator. The quality of relief and overall improvement in activity would allow better identification of the patient's source of pain.

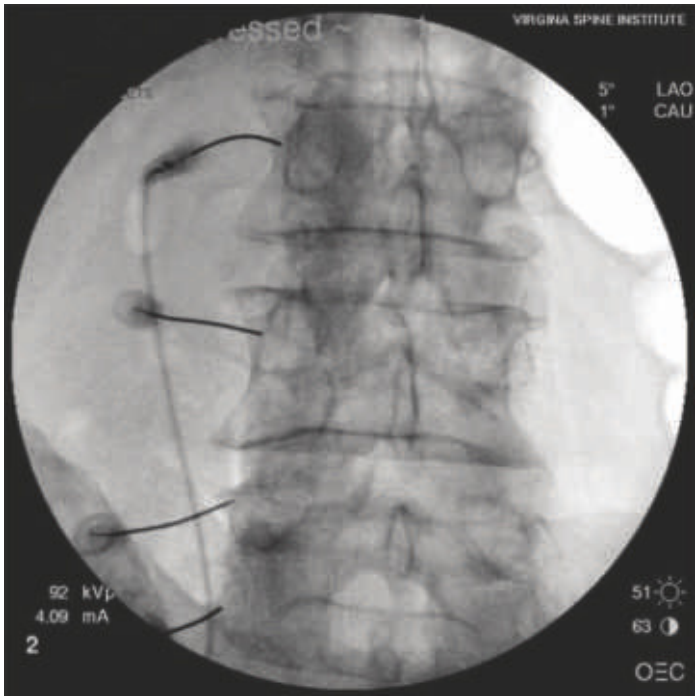
Mr. Malsz was able to report 50% improvement in his back pain following the epidural steroid injection, allowing him improved functionality. He was able to walk longer distances and remain active for longer periods of time before the onset of severe back pain required rest. This effect lasted for approximately three months before the return to his baseline pain. The patient reported greater than 75% improvement of his back pain following bilateral lumbar facet injections with local anesthetic and corticosteroid medication. Unfortunately, this significant benefit was short-lived, lasting only two weeks.

From Mr. Malsz's injections, we were able to identify components of spinal stenosis, both central and foraminal, that contributed to his back pain in the form of neurogenic claudication. Mr. Malsz also had components of lumbar facet syndrome contributing to his mechanical axial back pain. Due to his multilevel disc desiccation and disc bulging, as well as facet hypertrophy, Mr. Malsz had a condition of spinal canal narrowing known as spinal stenosis that caused "pinching" of the nerves at these levels, specifically in the upright position. As his narrowing became worse with the passage of time, the onset of his symptoms came on quicker with activity. Mr. Malsz also had multilevel lumbar facet arthropathy that led to inflammation and pain, most noticeably when his spine was extended or hyper extended. This occurred frequently when walking or standing for long periods.

Complicating Mr. Malsz's treatment was his medical history of diabetes mellitus, as well as a new diagnosis of coronary artery disease requiring stent placement and antiplatelet therapy. Overexposure or too frequent injections of corticosteroid medications can lead to steroid-induced hyperglycemia in a healthy individual or worsening glucose control in a diabetic. The anti-platelet therapy for his coronary artery disease increased his potential risk of bleeding following injections. In addition to these medical considerations, Mr. Malsz expressed a personal preference to avoid any strong narcotic medications due to his ongoing work for the CIA.

Mr. Malsz's care was subsequently transferred to Dr. Thomas Nguyen, an anesthesiologist and pain specialist, for consideration of interventional spine treatments. Upon further evaluation of Mr. Malsz's chronic axial back pain from spinal stenosis and lumbar facet syndrome, it was felt that he would be an appropriate candidate for radiofrequency ablation of the lumbar facet nerves. If successful, this would allow for long-term




*Radiofrequency ablation.*

benefit of up to one year for his lumbar facet-related back pain. This would also lessen his overall exposure to corticosteroid injections, allowing them to be used mainly as epidural injections for spinal stenosis.

He received dorsal rami medial branch nerve blocks of his lumbar facet joints from L3/4 to L5/S1. This was done diagnostically to confirm levels and appropriateness to proceed with radiofrequency ablation of these lumbar facet arthropathic joints. Following reproducible confirmation of his pain generators at these facet levels, we proceeded with radiofrequency ablation of the medial branch nerves in January 2011. Mr. Malsz's treatment course to the present has included repeating the radiofrequency lumbar facet ablation procedure (eleven months later), as well as intermittent caudal epidural steroid injections for his spinal stenosis symptoms. The combination of these interventional treatments with his ongoing home exercise program has allowed Mr. Malsz to remain active and functional. He continues to tend to the many sheep on his farm and work as a part-time instructor for the CIA.

Mr. Malsz lived with chronic axial back pain over the last five years due to multilevel disc desiccation, lumbar spinal stenosis, and lumbar facet arthropathy. The combination of these problems lead to a condition of spinal stenosis, "pinching" of the nerves, and lumbar facet arthritis. He had disabling back pain with any prolonged periods of standing or walking that severely limited his function and activities. Fortunately, with a combination of interventional treatments, Mr. Malsz has been able to regain his life and activities, while avoiding strong pain killers, as well as deferring spinal surgery at this time.


**Thomas T. Nguyen, M.D., D.A.B.P.M.**

Dr. Nguyen specializes in advanced, minimally invasive diagnostic and treatment modalities for acute and chronic pain syndromes. Dr. Nguyen has practiced pain medicine since finishing his pain fellowship at the Mayo Clinic in 1999. He was the founder and medical director of the Comprehensive Pain Management Center in Newport News, VA from 1999–2002. He is an active member of the American Academy of Pain Medicine, the International Spine Intervention Society, and the American Academy of Family Practice. Dr. Nguyen is involved in several national multicenter studies for the treatment of chronic back pain.

# Firefighter—Leslie Johnson


Leslie Johnson is a firefighter who works at Dulles Airport. In January 2007, he slipped and fell from a step on a fire engine. He immediately felt pain in his low back and right leg. His pain was severe enough that he went to the emergency room and, subsequently, was referred to Dr. Hasz at The Virginia Spine Institute.

Mr. Johnson had ongoing severe back pain to the point where he was not able to continue working. He aggressively worked with physical therapy. The physical therapy treatment made him significantly stronger but did not eliminate his pain. He still was not able to return to work as a firefighter.

X-rays and discography showed that Mr. Johnson had spondylolisthesis at L5-S1 and tears in his intervertebral discs at L3-L4 and L4-L5. After failing all nonoperative treatments, Mr. Johnson underwent a lumbar fusion surgery; three levels of his lumbar spine were fused. Postoperatively, he had significant improvement in his symptoms. After a course of healing, a return to physical therapy, and work hardening he was able to return to work full-time as a firefighter once again.

In 2008, Mr. Johnson had a hip replacement surgery which again exacerbated his back pain. X-rays showed that the L5-S1 level of his spine was not stable. The L5-S1 level seemed like it had not fused properly and the S1 vertebra had been fractured. Mr. Johnson underwent a revision surgery to refuse the L5-S1 level in 2009. Again, Mr. Johnson underwent physical therapy and rehabilitation. After some time, he was able to return to full duty at work. He is currently a chief at Dulles Airport, and continues to work in service to his community.


*Pre-op lumbar x-ray showing spondylolisthesis (slippage) at L5-S1.*


*Post-op lumbar x-ray showing multi-level fusion.*

*Post-revision surgery x-ray showing the artificial hip, the lumbar fusion, and the fusion of the sacroiliac joint.*

**Michael W. Hasz, M.D., F.A.C.S.**

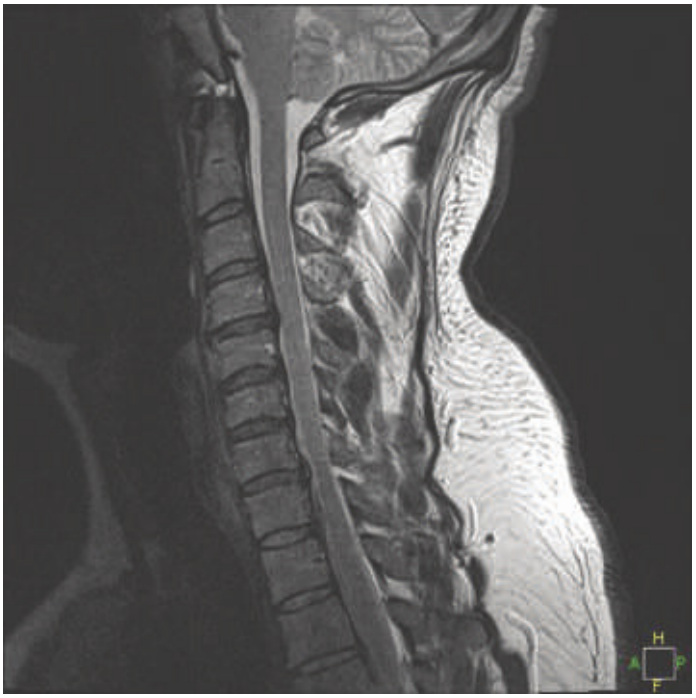
Dr. Hasz is a spine surgeon at The Virginia Spine Institute. He is board certified by The American Board of Spine Surgery, a Fellow in the American Academy of Orthopaedic Surgeons and a member of both the American Association of Orthopaedic Surgeons and the North American Spine Society. He was Chairman of the Department of Orthopaedic Surgery and Director of Spinal Surgery at the Andrews Air Force Base/Malcolm Grow Medical Center in Maryland. He currently holds an appointment as Clinical Instructor of Orthopaedic Surgery and Assistant Professor of Surgery at the Uniformed Services Health Science University in Bethesda, Maryland.

# Culpeper County Sheriff—Chad McKnight

Officer Chad McKnight was only 32 years old when he came to The Virginia Spine Institute with complaints of both low back discomfort and neck pain. Of those two issues, the greatest concern was his neck symptoms. Officer McKnight had mentioned that he had numbness which radiated down into his right arm and hand. Ordering an MRI was the next step in diagnosing his condition. When the scan of his cervical spine was reviewed, the image revealed spinal stenosis, a narrowing of the space around the spinal cord. Essentially, the pulsations of the spinal cord combined with the narrowing of the spinal canal had caused progressive damage. As is frequently the case with stenosis in the neck, it manifested as numbness. Officer McKnight also exhibited decreased dexterity and difficulties with balance. After reviewing the MRI scan with Officer McKnight as well as going over his treatment options, surgery was decided as the best treatment.

A fusion procedure essentially locks all of the bones and discs together. In someone who is younger and active, this can limit their range of motion and can lead to adjacent segment degeneration at the levels surrounding the fusion. Instead, an alternative was discussed, a surgery called a cervical laminoplasty. The laminoplasty procedure essentially removes the backbone from the cervical spine and repositions it so that there is more room for the spinal cord. In doing so, it allows the spinal cord to pulsate freely and allows the symptoms referable to the spinal cord, to resolve.

In September 2011, Officer McKnight underwent a posterior cervical laminoplasty from C3 through C7, essentially relocating the posterior aspect of the cervical bone and giving the spinal cord necessary space. Officer McKnight tolerated the operation extremely well. He stated that his pain level decreased to a 2 on a scale of 0 to 10. He still had some discomfort across the top of his shoulders and some residual numbness into his right hand. As the next step in preparing him for

*Pre-operative cervical MRI showing spinal stenosis around the spine.*

his obligations as a Culpeper County Sheriff, he was advised to pursue a work conditioning program. Work conditioning would allow him to improve fitness and confidence following his injury, before returning to work. I protect his spine so that he may return to his duty—to protect and serve.

*Post-operative cervical MRI showing increased room for the spinal cord.*

*Post-operative x-ray after laminoplasty.*

**Brian R. Subach, M.D., F.A.C.S.**

Dr. Subach is a spine surgeon and the Director of Research at The Virginia Spine Institute. He is a nationally recognized expert in the treatment of spinal disorders and an active member of the American Association of Neurological Surgery, the Congress of Neurological Surgeons, and the North American Spine Society. He is an invited member of the international Lumbar Spine Study Group and a Fellow in the American College of Surgeons. He lectures extensively regarding the management of complex spinal disorders in both national and international forums. He is the Director of Research and Board Member for the non-profit Spinal Research Foundation (SRF) and Editor-in-Chief of the Journal of the Spinal Research Foundation (JSRF). He has written 15 book chapters and more than 50 published articles regarding treatment of the spine.

# American Combat Spine Surgery in the Modern Period (2001–present): A History and Review of Current Literature

Andrew J. Schoenfeld, M.D., M.C., and Paul A. Carey, M.D., M.C.

## Introduction

The history of active surgical attempts to treat soldiers with combat-related injuries to the spinal column or spinal cord reaches back as far as the 4th millennium BC. Medical documentation regarding spine trauma as a result of war is contained in Egyptian papyri and ancient Greek works such as the *Iliad*.[1] Spinal cord injury was appreciated in the setting of combat and claimed the lives of cavalrymen at the battle of Little Big Horn[2] and the life of Admiral Nelson at the battle of Trafalgar.[3] With a few exceptions, however, American military surgeons did not evince much interest in spinal trauma until the 20th century, impeded by limitations in understanding regarding anti-sepsis, the physiology of the nervous system, and surgical technique.[1,3] For example, surgical luminaries such as Harvey Cushing and Joel Goldthwait made little to no mention of combat spinal trauma during their experiences in the U.S. Army of World War One.[1,2] In the American conflicts of the latter 20th century, more attention was given to war-related spinal injuries but the incidence remained relatively low, fluctuating around 1%.[1,4]

Only with the advent of the unconventional warfare typical of the Iraq and Afghanistan engagements,[1,4,5] has a consistent increase in the prevalence of spine injuries sustained during combat been appreciated. Multiple reports now document spinal wounds exceeding incidence rates of 5%,[4,6,7] the highest rates of spine injury in the history of American military medicine. Furthermore, a coupling of advanced personnel protective measures and increased destructive potential of military weaponry has yielded a number of new and challenging injury paradigms, including low lumbar burst fractures and lumbo-sacral dissociations.[8] The goal of this report is to touch on the historical development of spine surgical services within the American military community and to bring to light the recent experiences with spinal trauma in the conflicts in Iraq and Afghanistan.

## The Historical Development of Spine Surgical Services in the U.S. Army

While spine wounds have been documented in every major American conflict since the Civil War, it was not possible to speak of spine surgical services as a dedicated entity within the medical corps of the United States Army, prior to the Korean conflict (1950–1953).[1,2,3] Certainly, spinal injuries were understood and recognized, however, given the state of surgical technology and spinal instrumentation, effective intervention was not always possible.[1,2,3] Spinal injuries occurred in 642 servicemembers during the Civil War, representing less than 1% of all combat casualties.[1] Only 598 cases of spine trauma were recorded on the Western Front of World War One. However, mortality in the face of spinal wounding exceeded 50% for both

*Lt. Col. Paul Philipps, an orthopedic surgeon at Forward Operating Base Salerno, performs surgery on a 14-year-old Afghan. Photo Courtesy of Sgt. Brent Powell.*

conflicts and 1-year survival after spinal cord injury was relatively rare.[1]

Advances in Korea and Vietnam included increased rapidity of medical evacuation and enhanced surgical capabilities.[1,2,5] Nonetheless, the nature of combat was such that spine trauma represented only 1% of all casualties (Figure 1).[1,4,7,8] This figure for the incidence of spinal wounds remained static through the first Persian Gulf War (Operation Desert Storm), with the exception of the invasion of Panama. Here, 6% of all casualties sustained spine trauma, a fact reflective of the nighttime parachute operation synonymous with this engagement.[1,4] At the time of 9/11, the American military was in the process of revising the means by which it provided medical care to injured personnel on the battlefield.[2,5] Furthermore, enhanced training for medics, speed of transport, and equipment such as Kevlar helmets and body armor, were allowing soldiers to survive injuries that would have proven fatal only a decade or two before.[5,8] Nonetheless, no major American military engagement had witnessed spine injury rates exceeding 2% of all combat casualties until the wars in Iraq and Afghanistan. The unconventional tactics employed by the enemy, as well as the nature of warfare in Iraq and Afghanistan, resulted in a marked increase in combat-related spinal casualty rates.[1,2,4–8]

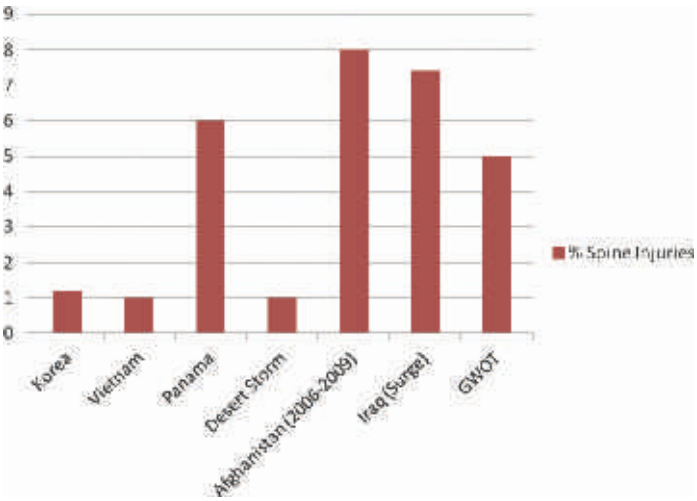



**Figure 1.** Spine combat casualties as a percentage of total combat casualties in American military conflicts from Korea to the present. Information on Korea, Vietnam, Panama, Desert Storm and Iraq (Surge) is obtained from Schoenfeld et al.[4] Details regarding Afghanistan (2006–2009) is from Comstock et al.[7] and data for the GWOT is contained in Blair et al.[6]

## The Administration of Spinal Care to Combat-Wounded Personnel

Since the start of the Global War on Terrorism (GWOT: 2001–present), treatment of spine injuries has been provided within the confines of the *Echelon of Care* system currently employed by the military.[9] In addition, the Joint Theater Trauma System provides two clinical practice guidelines (CPGs) that pertain to the treatment of servicemembers with spine injuries in the theater of operations.[8,10,11] One CPG outlines care for cervical spine injuries[10] and the other addresses thoracic and lumbar trauma.[11]

All injured personnel are initially treated at either a Forward Surgical Team or Combat Support Hospital while in theater.[9] Neither of these units is regularly staffed by an orthopaedic spine surgeon or neurosurgeon, although a single facility in theater may possess neurosurgical capabilities.[8] Nonetheless, surgical intervention for wounded American or NATO servicemembers is performed sparingly and only in the most extreme circumstances due to concerns for sterility and the exigencies of surgery in theater.[8,11] Moreover, many Forward Surgical and hospital elements do not have access to the proper equipment, operating room table, or imaging modalities that would support performance of safe spine surgery.[8] Typically, unless servicemembers present with open spinal wounds, progressive neurological deficit, or incomplete spinal cord injury, surgery will be delayed until the patient is evacuated from the combat zone.[8,12] Soldiers with complex spinal injuries may receive an initial surgery (i.e. irrigation and debridement with application of a wound vacuum device) in theater, followed by repeat procedures and possibly provisional stabilization in Germany. The servicemembers are then transported to Bethesda, MD, San Antonio, TX, or San Diego, CA for definitive treatment.

Fortunately, with the use of rapidly mobile Critical Care Air Transport (CCAT) teams, medical evacuation from theater can be arranged within 24 hours of injury, in many instances.[9]

All individuals evacuated from the theater of operations in Iraq or Afghanistan are brought to Landstuhl Army Regional Medical Center in Germany.[8,9,12] There, personnel with spine wounds can be evaluated by mag-

netic resonance imaging (MRI) and invasive surgical procedures (including instrumentation of spine) can readily be performed.[8,12] Less critically injured personnel are assessed at Landstuhl Medical Center but may not receive spine surgery until their arrival in the United States.[12]

Most combat casualties requiring spinal procedures can be transported to a military treatment facility in the U.S. within 96 hours of their wounding.[12] Soldiers with minimally displaced spine fractures and those without neurologic injury or evidence of instability have been successfully managed non-operatively, even following war trauma.[6,12,13] In some instances, large soft-tissue deficits may even preclude instrumentation of the spine.[12] Patients with neurological deficits and clinical or radiographic instability often are treated with standard modes of decompression and instrumented fusion (Figures 2 and 3), similar to the procedures performed in the civilian setting for comparable injuries.[12]

There is insufficient evidence to develop best practice guidelines regarding the two "characteristic" spinal injuries of the GWOT, low lumbar burst fractures[12] and lumbosacral dissociation.[12,13] A review of the experience at Walter Reed Army Medical Center with these injuries resulted in a recommendation for surgical decompression and instrumented interbody fusion for low lumbar burst fractures presenting with neurologic deficits.[12] A similar treatment approach is entertained for low lumbar burst fractures in the absence of neurologic compromise when the injured servicemember has multiple extremity or axial injuries that require early mobilization and rehabilitation.[12]

Operative fixation of lumbo-sacral dissociation carries a substantial risk of peri-operative complications and infection, especially in the event of open injury or concomitant colonic/rectal wounds.[12,13] If the soldier has concomitant injuries requiring long-term bedrest (i.e., severe traumatic brain injury or multiple extremity fractures), non-operative management is considered.[13] The Walter Reed group advocates internal fixation in the setting of associated zone III sacral injuries (fracture through the body of the sacrum) and kyphotic deformities at the fracture site exceeding 20 degrees.[12] Stabilization is often achieved with a combination of sacro-iliac screws, iliac bolt fixation, and lumbar pedicle screw instrumentation spanning the fractured segments.

**Figure 2.** Sagittal computed tomographic image of a soldier injured by IED blast. The servicemember sustained an unstable spondylolisthesis at L5-S1 secondary to bilateral pars interarticualris fractures at L5.

**Figure 3.** Lateral plain image of the servicemember in Figure 2, obtained three months after surgical intervention for his combat-related spine injury. The soldier was treated with an instrumented posterior spinal fusion from L4 to S1.

Kang and Lehman reported on 25 patients from Walter Reed who were treated for lumbar fractures, 14 of whom had low lumbar burst fractures with neurologic injury.[12] Sixty percent of those with low lumbar burst fractures were treated with operative intervention and an 18% infection rate was appreciated overall. At one-year follow-up, only one patient demonstrated a persistent neurologic deficit and the average visual analog pain score for the low lumbar burst fracture group was 1.6.[12]

Helgeson et al. published the Walter Reed experience with 23 servicemembers treated for lumbo-sacral dissociation.[13] Twenty-six percent of the cohort presented with open fractures of the sacrum. Non-operative management or no internal fixation was utilized in 39% of patients, while 35% received sacro-iliac screw fixation and 22% were treated with lumbo-sacral fusions. Posterior decompression and lumbo-sacral instrumentation was advocated in the setting of sacral nerve root compromise.[13] A 13% infection rate was noted, although reasonable outcomes were achieved at final follow-up especially in light of the nature of wounding.[12,13] While 48% of patients still exhibited residual pain at an average of 1.7 years follow-up, the mean pain score was only 1.7 (range 0–7).[13]

## The Epidemiology and Nature of Spine Wounds in Iraq and Afghanistan (2001–Present)

Iraq and Afghanistan, the two fronts in the eponymous GWOT, are respectively the longest conflicts in the military history of the United States.[1,2,5] Although different in terms of predominant terrain features and combat locations (i.e., substantial parts of the Iraq War are conducted in an urban setting while many of the engagements in Afghanistan occur in rural areas), soldiers on both battlefronts are confronted by an enemy engaged primarily in unconventional warfare.[5] The "non-western" military modalities employed by the enemy in Iraq and Afghanistan include a heavy reliance on ambush attacks, snipers, homicide-bombers, and Improvised Explosive Devices (IED).[5] These armaments, often composed of a combination of military-grade weaponry augmented with more mundane items such as fertilizer and ball bearings, prove to be extremely powerful in terms of explosive potential and lethality.

IEDs are frequently detonated under armored personnel carriers, such that, although the explosive blast is dissipated, the force of the explosion is imparted to the axial skeleton of the soldiers riding within the vehicle.[5,6,12,13,14] The types of restraints used in these carriers fix the torso of the servicemember to the side-walls, while the lower extremities and pelvis can move relatively freely.[13,14] The force of the explosion, combined with this manner of personnel restraint, has been hypothesized to be responsible for the increased prevalence of lumbo-sacral dissociations and other lumbo-pelvic injuries.[12,13]

The wars in Iraq and Afghanistan are comparatively the best documented American conflicts with respect to medical treatments, application of evidence-based medicine, and conduct of scientifically rigorous research (*pace* only one article regarding the epidemiology of combat wounds in Vietnam and Desert Storm, respectively).[5] Still, a global appreciation for the nature of spinal trauma in the GWOT is only possible as these conflicts approach cessation. While a complete assessment is not likely forthcoming for another decade, enough documentation is available to facilitate generalizations and predictive modeling.

Outside of case reports, possibly one of the first publications to address the nature of spine trauma in the GWOT was the effort of Driscoll et al. regarding penetrating cervical spine injuries (Figure 4) presenting

**Figure 4.** A gunshot wound to the cervical region. Picture taken in the trauma bay of a Forward Surgical Element in Afghanistan.

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to Walter Reed.[15] In this series of 52 patients, involvement of the osseous spinal structures was documented in 6% and neurologic compromise was apparent in 17%. Despite survival time sufficient to reach a treatment facility in the United States, a 2% mortality rate was still appreciated while at Walter Reed.[15]

In 2009, Ragel and colleagues described the nature of thoracolumbar spine fractures sustained by servicemembers involved in IED attacks on vehicles.[14] In this series of 12 patients, Ragel et al. reported 6 flexion distraction injuries and associated neurologic compromise in 25%. The most common injury morphology was compression fracture (44%), while lumbar fractures were identified in 19% of the cohort.[14]

Ragel and co-workers further reviewed the neurosurgical experience at the stationary theater hospital at Bagram Airfield from 2007–2009.[16] The Bagram hospital in Afghanistan maintains neurosurgical capabilities on a regular basis.[8,14,16] In the time period under

study, only 2 of 25 NATO personnel with neurological injuries required spine surgical intervention.[16] By contrast, 16 spine procedures were performed on Afghan soldiers, including 13 stabilizations, a dural repair following penetrating trauma, and 2 partial sacrectomies. Among 10 enemy combatants, one individual required spine surgery. In total, 17% of all neurosurgical procedures were performed on the spine. The authors also observed that the majority of injuries resulted from explosive device (54%) as compared to gunshot (38%),[16] a sentiment echoed in most large works regarding combat injuries in Iraq or Afghanistan.[4–7,17]

Comstock et al. documented spinal injuries among Canadian personnel treated at their military hospital in Kandahar, Afghanistan.[7] Between 2006 and 2009, approximately 8% of all Canadian personnel injured in the war sustained spine fractures. Once again, the vast majority (76%) of soldiers with spinal wounds were injured by an IED or landmine.[7] Only 31% of spine injuries were considered inherently stable and mortality approached 3% for personnel wounded by explosive blast. The authors concluded that soldiers involved in blast mechanism attacks were at a significantly increased risk of spine fracture when compared to those who sustained non-blast injuries or blunt force trauma.[7]

While these works represent initial forays into the characterization of spinal trauma as a result of combat, such studies are limited by a narrow focus on experiences at a single center,[7,14,15,16] an unknown population at-risk from which injured personnel were drawn, and a frequent emphasis on certain types of spinal wounding patterns (such as injuries to the thoracolumbar junction).[14] Due to these limitations, no generalizations from the previous studies to the conflict as a whole were possible and efforts reporting the incidence, or epidemiology, of spine trauma in the GWOT were lacking. In 2010, Schoenfeld et al. published the first epidemiological investigation, cataloguing the nature of spine injuries among a large cohort of soldiers, specifically the 4,122 individuals serving in an American Brigade Combat Team (BCT) in Iraq.[4]

The BCT is the basic deployable combat unit of the U.S. Army and the study was conducted over a defined period of deployment time.[4,5] These facts enabled a broader generalization to combat arms units at a

minimum and facilitated estimations regarding the incidence of war-related spine trauma. Schoenfeld and colleagues reported that spinal injuries represented 7.4% of all combat casualties.[4] Thirty percent of personnel with spine injuries were diagnosed with fractures and two soldiers presented with complex, open wounds. Eighty-three percent of all spine traumas resulted from explosive blast mechanisms and the mortality rate approached 10%.[4] The 7.4% spine combat casualty rate reported in that analysis represents the highest determination in the history of American military medicine (Figure 1).[1,4,8]

It should be emphasized, however, that the numbers obtained for the BCT studied by Schoenfeld et al. derived from a combat arms unit deployed to Iraq during the intense operations of the *Iraq War Troop Surge*.[4,5] As such, findings would not generally be applicable to non-combat units (i.e., transportation companies, combat support hospitals) or personnel in the Navy and Air Force. A more complete analysis, encompassing a substantial extent of the GWOT (2001–2009) and capturing all spine injured personnel regardless of branch of service or military specialty, was performed by Blair and co-workers relying on the Joint Theater Trauma Registry (JTTR).[6] The JTTR is a prospective dataset instituted at the start of the Afghanistan invasion.[5,6] Through the participation of facilities at all levels of care in the evacuation chain, robust patient-based information regarding injuries, wounding mechanism, and demographic data are captured by the JTTR and made available to researchers via query.[5,6,17]

Blair et al. found a spine combat casualty rate of 5%, with 67% of all injuries resulting from explosive blasts.[6] Transverse process fractures were the most frequently encountered injury, presenting in 44% of spine injured patients. Compression fractures occurred in 34% and burst fractures in 26% of the cohort. Spinal cord injuries were encountered in 5% of patients and 32% of all combat spine injuries necessitated surgical intervention.[6] A more recent review of JTTR data from 2005–2009 using deployment statistics from the Defense Manpower Data Center estimated a spine combat casualty incidence of 8 per 100,000 deployed personnel per year (unpublished data).

## The Modern Face of Military Spine Surgery and Implications for the Future

As the engagements in Iraq and Afghanistan near their completion, several important conclusions can be drawn from the compendium of works analyzing modern military spine trauma.[1,4,6–8,12–16] Foremost, it would appear that advancements in personnel protective equipment as well as the nature of combat in these "unconventional" conflicts have combined to produce the highest spine combat casualty rates in the history of American warfare.[1,4,6,8] Oftentimes, these injuries are devastating and complex, including novel patterns such as lumbo-pelvic dissociation or low lumbar burst fractures.[8,12,13] In many cases, they are associated with open injury, or other severe wounds to the extremities and head.[6,12,13] Most investigations have shown, however, that the majority of spine injuries are indifferent from those encountered in civilian practice, including transverse process fractures, compression fractures, cervical sprains, and contusions.[4,6,12,16]

It should also be appreciated that, outside of acute and intermediate trauma care, injured personnel (especially National Guardsmen or Reservists) will receive the better part of their spinal treatment from civilian surgeons at the Veterans Administration or in their communities.[4,5,17] A recent study found that more than one-third of combat injured personnel evacuated from theater are ultimately separated from the service[17] and this number may be even higher for those with spine injuries. Cross et al. maintained that spinal conditions

were the second most serious combat related condition in terms of disability and ranked fourth with respect to impact (frequency times percent disability).[17] When viewed in this light, the enormous potential for combat injured servicemembers with spinal wounds to present for care in the civilian sector can readily be appreciated. Our current understanding regarding the nature of spine trauma in war, as well as knowledge derived from forthcoming research, will undoubtedly contribute to the care and rehabilitation of these soldiers who have sacrificed so much in the defense of our nation.

**REFERENCES**

1. Schoenfeld AJ, Belmont PJ, Jr. Weiner BK. A history of military spine surgery. *Spine J* 2012 (In press).
2. Schoenfeld AJ. Orthopaedic surgery in the United States Army: A historical review. *Mil Med* 2011;176:689–695.
3. Hanigan WC, Sloffer C. Nelson's wound: Treatment of spinal cord injury in 10th and early 20th century military conflicts. Neurosurg Focus 2004;16:Article 4.
4. Schoenfeld AJ, Goodman G, Belmont PJ Jr. Characterization of combat related spinal injuries sustained by a U.S. Army Brigade Combat Team during Operation Iraqi Freedom. *Spine J* 2010 (Available online 10 June 2010).
5. Belmont PJ Jr, Goodman GP. The combat environment and epidemiology of musculoskeletal combat casualties. In: Owens BD, Belmont PJ Jr. (Eds.). *Combat Orthopaedic Surgery: Lessons Learned in Iraq and Afghanistan.* Thorofare, NJ: SLACK Incorporated, 2011, pp. 13–22.
6. Blair JA, Patzkowski JC, Schoenfeld AJ, Cross JD, Grenier ES, Lehman RA, Hsu JR. Skeletal Trauma Research Consortium (STReC). Are spine injuries sustained in battle truly different? *Spine J* 2011 (Available online 13 Oct 2011).
7. Comstock S, Pannell D, Talbot M, Compton L, Withers N, Tien HC. Spinal injuries after improvised explosive device incidents: Implications for tactical combat casualty care. *J Trauma* 2011;71: S413–S417.
8. Schoenfeld AJ, Lehman RA Jr, Hsu JR. Evaluation and management of combat-related spinal injuries: A review based on recent experiences. *Spine J* 2012 (In press).
9. Pallis M, Gerlinger T. Echelons of care. In: Owens BD, Belmont PJ Jr (Eds.). *Combat Orthopaedic Surgery: Lessons Learned in Iraq and Afghanistan*. Thorofare, NJ: SLACK Incorporated, 2011, pp. 23–30.
10. United States Army Institute of Surgical Research, Joint Theater Trauma System. Clinical Practice Guideline—Cervical Spine Evaluation (30 JUN 2010). Available at: http://www.usaisr.amedd.army.mil/cpgs.html. Accessed January 25, 2012.
11. United States Army Institute of Surgical Research, Joint Theater Trauma System. Clinical Practice Guideline—Spine Injury Surgical Management and Transport (9 JUL 2010). Available at: http://www.usaisr.amedd.army.mil/cpgs.html. Accessed January 25, 2012.
12. Kang DG, Lehman RA Jr. Spine fractures. In: Owens BD, Belmont PJ Jr. (Eds.). *Combat Orthopaedic Surgery: Lessons Learned in Iraq and Afghanistan.* Thorofare, NJ: SLACK Incorporated, 2011, pp. 297–310.
13. Helgeson MD, Lehman RA Jr, Cooper P, Frisch M, Andersen RC, Bellabarba C. Retrospective review of lumbosacral dissociations in blast injuries. *Spine* 2011;36:E469-E475.
14. Ragel BT, Allred CD, Brevard S, Davis RT, Frank EH. Fractures of the thoracolumbar spine sustained by soldiers in vehicles attacked by Improvised Explosive Devices. *Spine* 2009;34: 2400–2405.
15. Driscoll IR, Hwang PF, Fuenfer MM, Shriver CD, Stojadinovic A, Aydelotte JD. High velocity penetrating wounds to the neck: Lessons learned from the battlefields in Iraq and Afghanistan. *J Am Coll Surg* 2007;205:S67.
16. Ragel BT Klimo P Jr, Kowalski RJ, McCafferty RR, Liu JM, Taggard DA, Garrett D, Brevard SB. Neurosurgery in Afghanistan during "Operation Enduring Freedom": a 24-month experience. *Neurosurg Focus* 2010;28:E8.
17. Cross JD, Ficke JR, Hsu JR, Masini BD, Wenke JC. Battlefield Orthopaedic Injuries Cause the Majority of Long Term Disabilities. *J Am Acad Orthop Surg* 2011;19:S1–S7.

**Andrew J. Schoenfeld, M.D., M.C.**

Dr. Schoenfeld is a spine surgeon and Director of Orthopaedic Research in the Department of Orthopaedic Surgery at William Beaumont Army Medical Center. He is also an Assistant Professor of Orthopaedic Surgery at Texas Tech University Health Sciences Center. Major Schoenfeld has deployed to Afghanistan and served as Orthopaedic Liaison to a Combat Aviation Brigade. He is the author of more than 60 peer-reviewed publications and book chapters. He completed his spine fellowship at the Harvard Combined Orthopaedic Program.

**Paul A. Carey, M.D., M.C.**

Dr. Carey is a graduate of the United States Military Academy and State University of New York-Downstate College of Medicine. He is presently a senior resident in the Department of Orthopaedic Surgery at William Beaumont Army Medical Center. He aspires to a career in the field of spine surgery.

# Spine Injuries in Combat Casualties

Ronald A. Lehman, Jr., M.D., and Adam James Bevevino, M.D.

The care of spine fractures in the active duty soldier presents a unique set of challenges to the military physician. Currently, the United States is involved in one of the longest continuous conflicts in the country's history. Operation Iraqi Freedom (OIF) and the still ongoing Operation Enduring Freedom (OEF) have resulted in greater than 50,000 casualties (wounded and killed).[1] The injuries sustained by our troops are markedly different from those commonly witnessed in the civilian sector. They are rarely isolated and often are of high energy mechanisms, management of which begins in a complex and hostile environment.[2]

## Triage and Transport

At the time of injury, combat casualty care is delivered on the battlefield by combat medics who perform immediate stabilization procedures and rapid transport to the Echelon I/Battalion Aid Station.[3] From here, transport continues to the Echelon II/Forward Surgical Team where general and orthopedic surgeons perform the initial physician evaluation. At this point, a plain radiography is available and, if needed, life or limb saving procedures may be performed before transport continues.[3] Echelon III, which is composed of the Combat Support Hospital, is the first point where a neurosurgeon or spine trained orthopedic surgeon is available for patient assessment. Computer tomography (CT) and urgent spinal decompression can be performed at Echelon III, although permanent implantation is typically withheld in American or coalition troops until after evacuation from theatre.[3] The Echelon IV facility is Landstuhl Regional Medical Center located in Germany. There, an MRI is available and definitive management of spine injuries is conducted.[3] Echelon V is comprised of the U.S. military medical centers, the highest level of care, where the majority of permanent surgical implants are placed. This system of patient transport has become so efficient that it is not uncommon for the casualty to reach Echelon IV or V within 24-48 hours from time of injury.[4]

## Combat Casualties

Improvised explosive devices (IEDs) have been the most common cause of severe injury during the OIF/OEF conflicts.[2,5] The vast improvements in down range care, coupled with advances in body armor for the head, thorax, and abdominal regions have significantly reduced fatality rates.[6] At the same time however, the non-discriminating and devastating effects of these blast injuries have created a new war casualty

*Photo Courtesy of U.S. Army.*

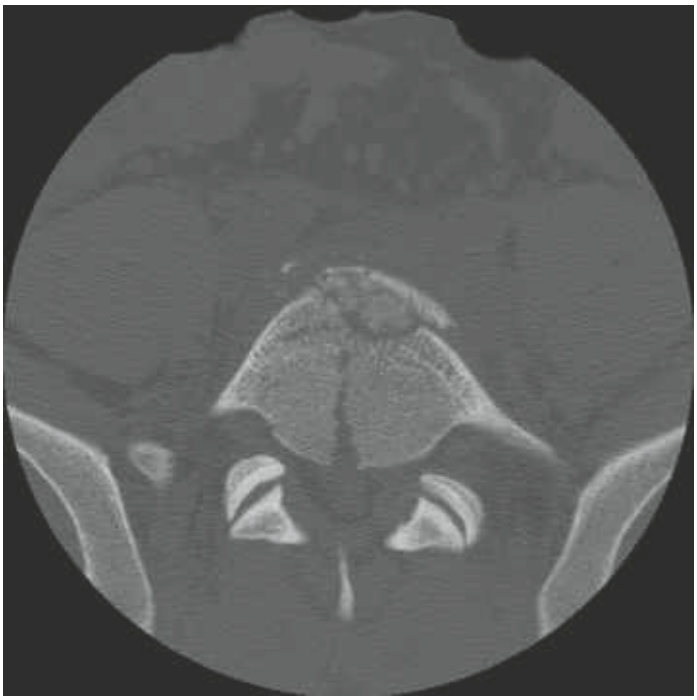


**Figure 1.** Axial view of L5 burst fracture.

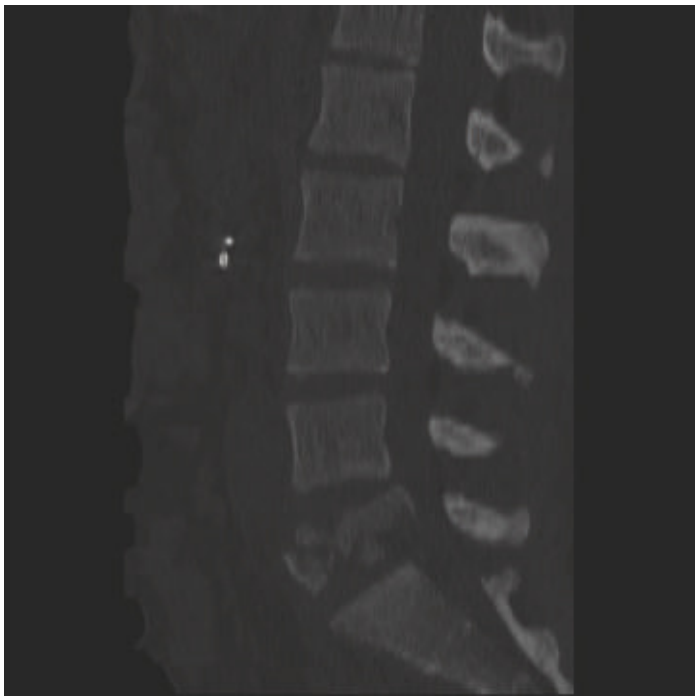


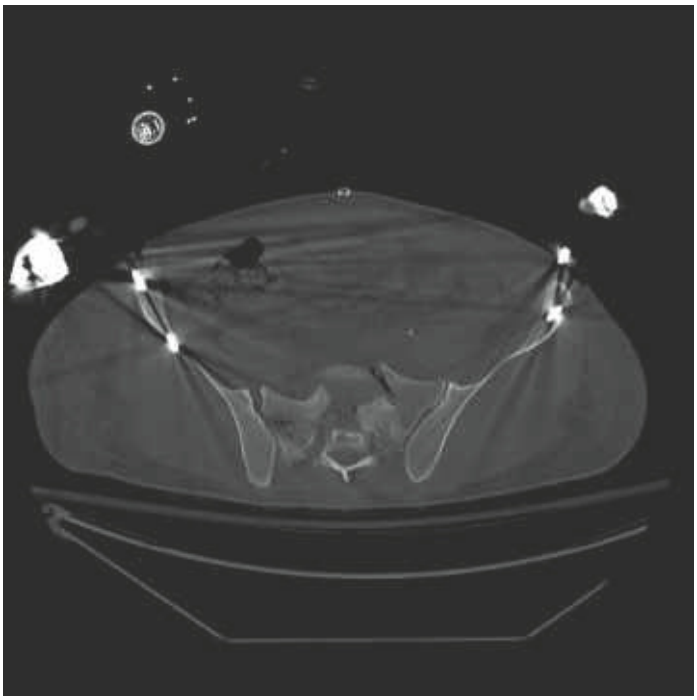
**Figure 2.** Sagittal view of L5 burst fracture.

population which has endured previously unsurvivable injuries, and now lives with patterns of injury never before encountered in modern medicine.

Recently, several reports have been published on the recognition, characterization, and treatment of spine fractures sustained in the combat casualties. Schoenfeld et al.,[4] in 2010, published work on the rate of spine fractures in a U.S. Army Brigade Combat Team. A 7.4% incidence rate was reported; the highest ever documented; a marked increase from the previous 1% incidence reported during the Vietnam War and Operation Desert Storm. They concluded that changes in enemy tactics, most notably the increased use of explosive devices over conventional firearms, was responsible for the elevated incidence of spine fractures.[4] Eighty three percent of the spine fractures observed were a result of an explosive device.[4] In a typical battlefield scenario, an IED is detonated below a vehicle carrying US personnel, transmitting a blast wave upward through the vehicle. The improvements in vehicular and body armor prevent the blast from producing fatal injury; however an incredible amount of force is transmitted through the axial skeleton and can result in injury to the spinal column. The authors predicted that the rate of spine fractures in combat casualties would to continue to increase given the current use of IEDs by the enemy.[4]

Following this report, Blair et al.[7] compared spine fractures that were sustained during battle to spine fractures sustained in non-battle scenarios among active duty soldiers deployed during OIF/OEF. The study reported an overall spine injury (fractures and spinal cord) rate of 5.45% with 83% of all injuries occurring in battle.[7] Echoing the Schoenfeld results, IEDs were the causative mechanism in the majority of cases, 66.7%, indicating that the battle related injuries were secondary to a higher-energy injury mechanism. Furthermore, battle related spine injuries were more likely to receive operative intervention and trended toward a lower rate of neurologic recovery in comparison to non-battle injuries.[7]

The already elevated rate of spine injures in the current conflict appears to be even higher in some casualty cohorts. A spine fracture rate of 13% was reported in a group of combat casualties with concomitant lower extremity amputations,[8] and Ramasamy et al.[9] reported in 2011 a 30% incidence in British soldiers who suffered calcaneus fractures as a result of IED blasts.



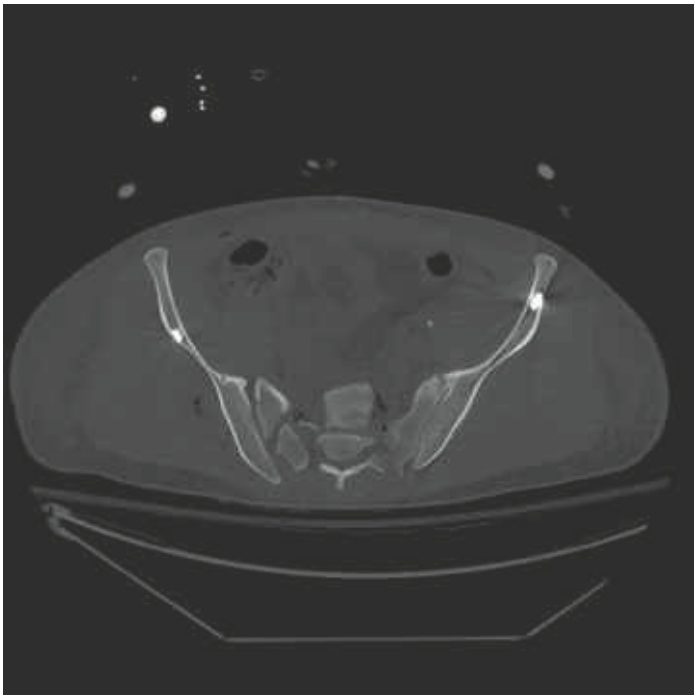


**Figure 3.** Axial views of lumbosacral dissociation. Notice bilateral vertical fracture lines through sacrum with horizontal fracture line connecting the vertical sacral fractures.

Additional reports have been published characterizing the injuries associated with combat spine fractures,[10] the complications seen with their treatment,[11] and the effect that vehicle protection has on the spine injury prevalence.[12] The collective data from these reports highlights the complexity and growing importance of efficient management of spinal fractures in the combat soldier.

**Figure 4.** Coronal reconstruction of lumbosacral dissociation illustrating disconnect between spine and pelvis.

## Management of Spine Injury in Theatre

Clinical Practice Guidelines (CPG) have been developed by the Department of Defense (DoD) to provide guidance and help mitigate the challenge of delivering care to combat casualties. Two of the twenty-five CPGs pertain to the management of spine injuries; a CPG for cervical spine evaluation[13] and a CPG for spine injury surgical management and transport.[14] The guidelines stress that a high degree of caution be used in casualties with high risk injury mechanisms, such as IED blasts or falls from height, and that a cervical collar be applied immediately in all patients with neck pain or neurologic deficit.[13] The one exception is a neurologically stable patient with a penetrating neck wound, so as not to worsen a potentially airway compromising injury. Above all, the CPGs emphasize that the preservation of life is of utmost importance and, therefore, spine immobilization should not delay evacuation from the battlefield.[13]

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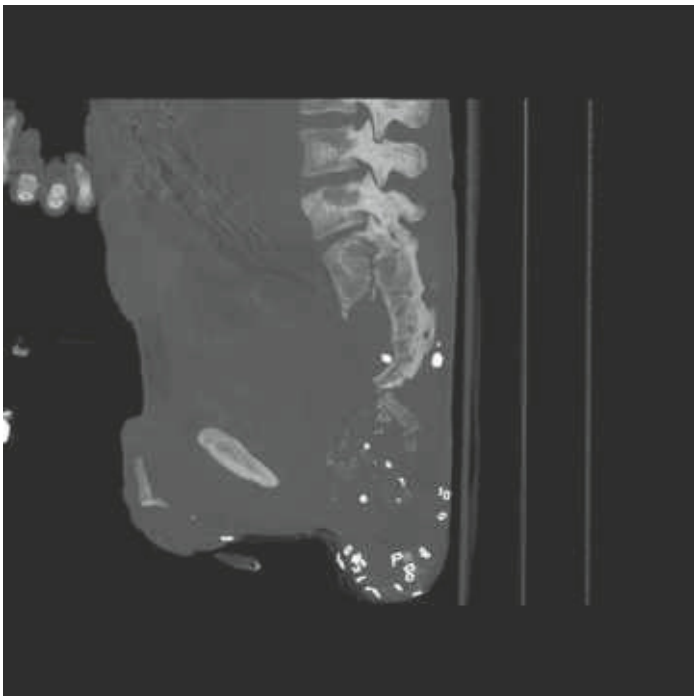

**Figure 5.** Sagittal reconstruction of lumbosacral dissociation with anterior and inferior translation of superior sacral segment.

Per the guidelines, cervical spine clearance is attempted within the first 24 hours after arrival to a field hospital.[13] An algorithm for cervical spine clearance is outlined in the CPG for both the conscious and obtunded patient. In the conscious patient, a CT scan is preferred for clearance, although 3-view plain radiography (AP, lateral, odontoid) is an acceptable alternative in the neurologically intact patient.[13] In spite of negative imaging, the guidelines recommend, what is known intuitively, that the collar remains in place should the patient continue to complain of neck pain or paresthesias. For the obtunded patient, computer tomography is required for clearance over MRI of the cervical spine, due to the latter's insufficient evidence supporting its utility over CT scan and its lack of availability in theatre.[13] In patients with presumed injuries of the thoracic and lumbar spine, scans of these regions should be performed concurrently with the cervical spine CT scan. The guidelines further instruct that CT myelogram is the modality of choice if cord compression or an expanding hematoma is suspected in theatre.

The CPG provides several recommendations for the medical management of the casualty with a spine injury. Patients with "neurologic compromise" should have mean arterial pressure (MAP) maintained above 85 mmHg, and be treated with oxygen and vasopressors to prevent hypoxia and hypotension.[14] The administration of methylprednisolone is not authorized for the treatment of spinal cord injury in the combat wounded.

*Photo Courtesy of U.S. Army.*

*Photo Courtesy of U.S. Army.*

The guidelines state that the lack of convincing evidence on the effectiveness of steroids combined with the high frequency of open wounds outweigh potential benefits of steroids in this population.[14] Penetrating spine wounds without signs of contamination should have prophylaxis with cefazolin, while wounds that traverse the abdominal cavity mandate broad spectrum antibiotics to include coverage of enteric organisms. As is the case in all trauma patients, an aggressive deep vein thrombosis (DVT) prevention protocol is recommended for those with spine injuries. In the CPG, mechanical prophylaxis with pneumatic compression stockings combined with lower molecular weight heparin (LMWH) are the established treatment choices.[14]

The decision to proceed with surgical intervention in theatre is reserved to a limited set of circumstances. The CPG places priority on the neurologic recovery of the patient; as a result, surgery can be considered in the hemodynamically stable patients who has progressive deficits and closed wounds.[14] Additionally, patients with contaminated open wounds should undergo debridement and those with continued cord compression or cauda equina syndrome can be decompressed. However, as stated earlier, spine implants are generally not available in theatre and the need to expedite evacuation from theatre often takes precedence when evaluating the need for further surgical intervention. The guidelines encourage the spine surgeon and hospital's chief of trauma to make a joint decision regarding management of the patient prior to proceeding with surgery.[14] Finally, if surgical intervention is performed it is essential that the spine surgeon meticulously relays the plan of care to the echelon IV and V facilities.[4]

In 2011, the spine related CPGs were reviewed and examined in light of the evolving OIF/OEF conflicts.[4] Recognizing the increasing prevalence of spine fractures, re-analysis of the cervical spine clearance algorithm and the approach to in-theatre surgical intervention was endorsed in the report.[4] Currently, as outlined, a CT scan is the only imaging study that is required for c-spine clearance in the obtunded patient. However, recent evidence favors MRI as the more sensitive modality in the identification of occult cervical trauma. Proponents believe that it should be held as the "gold standard" modality for spine clearance.[15] Based on this new data, it may be wise to consider delaying clearance in the obtunded patient until arrival in Echelon IV/V facilities where MRI is available.[4]

Furthermore, the decision of whether or not to proceed with surgery in theatre presents a therapeutic dilemma for the spine surgeon. The vast majority

*Photo Courtesy of U.S. Army.*

of operative spine injuries are stable enough to allow evacuation prior to intervention. However, just as the rate of spine injury has increased so may the need for operative stabilization in theatre. Currently, the ability to decompress and instrument the spine is limited by several factors including: the availability of implants, the need to expedite casualty flow, and concerns regarding long term infection and neurologic complication.[3] Establishing universally acceptable "in theatre" procedures would assist the surgeon in deciding what pathology should be addressed urgently and what should be triaged to a higher echelon. For example, while a posterior spinal fusion may be warranted in some instances, a multi-level anterior reconstruction is probably better addressed after evacuation from theatre.

The CPG states that improvements in the access to spinal instrumentation may broaden the surgeon's ability to surgically manage spine trauma in theatre.[14] Should implants become more available in theatre, effort should be made to standardize instruments sets. Doing so would maximize surgeon familiarity with the instrumentation and facilitate revisions, if needed, at Echelon IV/V hospitals.[4] In conclusion, the CPGs provide helpful insight into the management of spine injures in combat casualties. Like all medical protocols, they should be periodically re-evaluated as research and resources on the management of spine injuries continue to advance.[4]

## Unique Injury Patterns and Conditions

With the increasing prevalence of spine fractures, atypical spinal pathology has emerged that was traditionally considered rare in civilian literature. In 2009, Ragel et al.[16] published on a series of thoracolumbar spine fractures resulting from IED blasts. In this small series, the incidence of flexion distraction type injuries, or chance fractures, was 38%; a marked increase from the approximate 3% rate that is accepted in the civilian literature.[16] Recently, our institution has published its experience on care of casualties with unique injury patterns; low lumbar burst fractures, lumbosacral dissociations, and the development of scoliosis in patients with traumatic hemipelvectomies.

Burst fractures most commonly occur with the thoracolumbar junction, while those caudal to L2 account for only 1% of all spine fractures.[17] This disparity can be explained through recognition of anatomical and biomechanical differences between the upper and lower lumbar spine. The thoracolumbar region represents the junction of the relatively rigid thoracic

Photo Courtesy of U.S. Army.

spine and the mobile lumbar spine, creating a fulcrum effect predisposing the area to injury.[18] Additionally, this region lies cephalad to the apex of lumbar lordosis which causes axial forces to preferentially load the anterior column and lead to kyphotic deformity following fracture.[17] On the other hand, the lower lumbar spine is protected from injury by the iliolumbar ligaments, located below the pelvic prim and positioned caudad to the apex of lumbar lordosis resulting in axial forces being evenly distributed across all three columns.[17–19] Furthermore, the spinal canal is widest in the lower lumbar spine and lumbosacral nerve roots resist compression better than the conus medullaris, thus lowering the rate of neurologic deficit with low lumbar burst fractures.[19] All together these features may make low lumbar burst fractures more stable and conducive to non-operative management.[17]

In 2011, of our series of 32 combat casualties with burst fractures, 62.5% had fractures caudad to L2.[17] Improvised explosive devices were the mechanism of injury in 50% of the cases. Fifty six percent of the low lumbar burst fractures had a major neurologic injury compared to 67% in the upper lumbar burst group.[17] As a result of the high energy mechanism and incidence of neurologic deficit, low lumbar burst fractures in this series underwent operative intervention at a much higher frequency (70%) compared to what has been reported in the civilian literature.[18] At time of final follow up, 95% of the lower lumbar burst patients who initially presented with a neurologic injury maintained a persistence of their deficit. This finding is also in stark contrast to previously published work, as most series have cited neurologic improvement in the majority of patients with low lumbar burst fractures.[18,20] The increased rate of operative intervention and persistence of neurologic deficit in our series is likely secondary to the high energy injury mechanism experienced by the combat casualties. Furthermore, it was hypothesized that the current body armor design predisposes the population to low lumbar burst fractures. The rigid nature of the armor potentially shields the thoracic and thoracolumbar spine, and thereby transfers the fulcrum area of highest stress into the lower lumbar spine.[17]

Lumbosacral dissociations (LSD) are most commonly seen following high energy trauma such as motor vehicle accidents or falls from height.[21] Their occurrence is relatively rare and literature regarding treatment is limited. The injuries can be defined as a mechanical separation of the spine from the pelvis that

Photo Courtesy of U.S. Army.

clinically manifests as a sacral fracture with horizontal and vertical components causing complete separation of the ilium from the S1 endplate.[22,23] Helgeson et al.[21] published on a series of 23 combat casualties with LSD and described the management of these injuries at our institution. Fifteen of the patients had a sacral fracture that could be defined as a U or H type pattern, whereas the remaining nine patients had fractures that were too comminuted to classify. Eighty seven percent of patients presented with neurologic injury, half of which were sacral nerve deficits.[21]

The decision to proceed with operative intervention was based largely off of three factors: neurologic status, the condition of the surrounding soft tissues, and the expected period of immobilization. Surgical instrumentation was avoided, if possible, in those patients with open sacral wounds secondary to the risk of implant contamination and chronic infection. Additionally, patients with anticipated immobilization for greater than 3 months, due to other injuries, were considered for non-operative management in hope that the fracture would consolidate over time. Based on this logic, patients with a manageable soft tissue envelope and the potential for mobilization within 3 months were more likely to be surgically stabilized. Exploration of the sacral nerve roots was made on a case by case basis given that some patients had neuropraxias that improve over time and others were associated with contaminated wounds. Altogether, 40% of patients were treated non-operatively, 35% were stabilized with sacroiliac screws, and 22% managed with posterior spinal fusion.[21] Fracture patterns that were amenable to percutaneous fixation were treated with sacroiliac screws, whereas those that required open reduction or nerve root decompression were treated with posterior spinal fusion.

Further analysis of patients with H or U type sacral fractures indicated that 73% initially presented with traumatic kyphosis.[21] Two patients in this group that were treated non-operatively later presented with symptomatic kyphosis progression. Both of these patients initially had greater than 20° of S1/S2 kyphosis and, as a result, patients with deformity of this magnitude are subsequently treated surgically.[21] At time of final follow up, 48% of patients continued to display residual pain, although no difference was appreciated in the rate of pain between the operative and non-operative treated groups.[21] Lumbosacral dissociations represent rare and devastating injuries seen in association with polytrauma that occur in some of the most se-

*Photo Courtesy of U.S. Army.*

verely injured combat casualties. Successful management depends on multi-disciplinary integration and estimation of the patient's functional recovery.

Blast injuries from improvised explosive devices have produced a sizable number of lower extremity amputees,[24] of which, there are a number of hip disarticulations and hemipelvectomies. A small number of reports in the surgical and rehabilitation literature discuss the existence of scoliosis following proximal lower limb amputation.[25,26]

Recently, the development of scoliosis in a casualty with a hip disarticulation and one with a hemipelvectomy was observed and reported.[27] Both patients initially presented with a sitting imbalance and one complained of low back pain. Deformities were similar in each patient, consisting of sharp lumbar curves greater than 20° in magnitude, with the convexity on the side of the most proximal amputation. Treatment in both patients involved observation and the application of a well fitted sitting prosthesis. At time of most recent follow up, neither patient had symptomatic curve progression. The incidence of scoliosis following proximal lower limb amputation in combat casualties is unknown, as are the long term implications. Recognition of scoliosis in these two cases should raise awareness of its existence and encourage providers to look for the diagnosis in patients with proximal amputations and a sitting imbalance. Long term follow up will provide insightful information on curve progression and the development of degenerative symptoms.

## Conclusions

Injury to the spinal column in the OEF/OIF combat casualty population is common. While enhancements in armor and downrange care have improved survivability, the blast injury mechanism has increased the rate of injury. Efficient and effective care from the battlefield to arrival in the U.S. is critical for care in these patients. Once rare injury patterns are now being recognized and are occurring at a higher frequency than previously reported. Continued research and critical analysis of treatment algorithms will prove invaluable for optimizing the outcome of the modern war casualty.

**REFERENCES**


1. Department of Defense Personnel and Military Casualty Statistics. http://siadapp.dmdc.osd.mil/personnel/CASUALTY/castop.htm. Accessed Feb 21, 2012.
2. Owens BD, Kragh JF, Jr., Wenke JC, Macaitis J, Wade CE, Holcomb JB. Combat wounds in operation Iraqi Freedom and operation Enduring Freedom. *J Trauma.* Feb 2008;64(2):295–299.
3. Borden Institute (U.S.). *Emergency war surgery*. 3rd U.S. revision. ed. Washington DC: Office of the Surgeon General, U.S. Army, Borden Institute, Walter Reed Army Medical Center; 2004.
4. Schoenfeld AJ, Lehman RA, Jr., Hsu JR. Evaluation and management of combat-related spinal injuries: a review based on recent experiences. *Spine J.* Jun 1 2011.
5. Belmont PJ, Jr., Goodman GP, Zacchilli M, Posner M, Evans C, Owens BD. Incidence and epidemiology of combat injuries sustained during "the surge" portion of operation Iraqi Freedom by a U.S. Army brigade combat team. *J Trauma.* Jan 2010;68(1):204–210.
6. Gawande A. Casualties of war—military care for the wounded from Iraq and Afghanistan. *N Engl J Med.* Dec 9 2004;351(24):2471–2475.
7. Blair JA, Patzkowski JC, Schoenfeld AJ, et al. Are spine injuries sustained in battle truly different? *Spine J* Oct 13 2011.
8. Bevevino AB, Lehman RA, Tintle SM, Kang DG, Dworak T, Potter BK. The Incidence and Morbidity of Concomitant Spine

Fractures in Combat Related Amputees. *Presented at the Society of Military Orthopedic Surgeons, San Diego CA*. 2011.
9. Ramasamy A, Hill AM, Phillip R, Gibb I, Bull AM, Clasper JC. The modern "deck-slap" injury—calcaneal blast fractures from vehicle explosions. *J Trauma.* Dec 2011;71(6):1694–1698.
10. Patzkowski JC, Blair JA, Schoenfeld AJ, Lehman RA, Hsu JR. Multiple associated injuries are common with spine fractures during war. *Spine J* Nov 2 2011.
11. Possley DR, Blair JA, Schoenfeld AJ, Lehman RA, Hsu JR. Complications associated with military spine injuries. *Spine J* Nov 17 2011.
12. Possley DR, Blair JA, Freedman BA, Schoenfeld AJ, Lehman RA, Hsu JR. The effect of vehicle protection on spine injuries in military conflict. *Spine J.* Dec 15 2011.
13. U.S. Army Institute of Surgical Research. Joint Theatre Trauma System. Clinical Practice Guidlines. Cervical Spine Evaluation. 2010; http://www.usaisr.amedd.army.mil/cpgs/Cervical_Spine_Evaluation_30_Jun_10.pdf. Accessed March 6, 2012.
14. U.S. Army Institute of Surgical Research. Joint Theater Trauma System. Clinical Practice Guidelines. Spine injury surgical management and transport. 2010; http://www.usaisr.amedd.army.mil/cpgs/Spine_Injury_Surgical_Mgmt_and_Transport_09_JUL_10.pdf. Accessed March 6, 2012.
15. Schoenfeld AJ, Bono CM, McGuire KJ, Warholic N, Harris MB. Computed tomography alone versus computed tomography and magnetic resonance imaging in the identification of occult injuries to the cervical spine: a meta-analysis. *J Trauma* Jan 2010;68(1):109-113; discussion 113–104.
16. Ragel BT, Allred CD, Brevard S, Davis RT, Frank EH. Fractures of the thoracolumbar spine sustained by soldiers in vehicles attacked by improvised explosive devices. *Spine (Phila Pa 1976)* Oct 15 2009;34(22):2400–2405.
17. Lehman RA, Jr., Paik H, Eckel TT, Helgeson MD, Cooper PB, Bellabarba C. Low lumbar burst fractures: a unique fracture mechanism sustained in our current overseas conflicts. *Spine J* Oct 7 2011.
18. Butler JS, Fitzpatrick P, Ni Mhaolain AM, Synnott K, O'Byrne JM. The management and functional outcome of isolated burst fractures of the fifth lumbar vertebra. *Spine (Phila Pa 1976)*. Feb 15 2007;32(4):443–447.
19. Dai LD. Low lumbar spinal fractures: management options. *Injury.* Sep 2002;33(7):579–582.
20. Seybold EA, Sweeney CA, Fredrickson BE, Warhold LG, Bernini PM. Functional outcome of low lumbar burst fractures. A multicenter review of operative and nonoperative treatment of L3-L5. *Spine (Phila Pa 1976)*. Oct 15 1999;24(20):2154–2161.
21. Helgeson MD, Lehman RA, Jr., Cooper P, Frisch M, Andersen RC, Bellabarba C. Retrospective review of lumbosacral dissociations in blast injuries. *Spine (Phila Pa 1976)*. Apr 1 2011;36(7):E469–475.
22. Vresilovic EJ, Mehta S, Placide R, Milam RAt. Traumatic spondylopelvic dissociation. A report of two cases. *J Bone Joint Surg Am.* May 2005;87(5):1098–1103.
23. Bellabarba C, Schildhauer TA, Vaccaro AR, Chapman JR. Complications associated with surgical stabilization of high-grade sacral fracture dislocations with spino-pelvic instability. *Spine (Phila Pa 1976)*. May 15 2006;31(11 Suppl):S80–88; discussion S104.
24. Potter BK, Scoville CR. Amputation is not isolated: an overview of the US Army Amputee Patient Care Program and associated amputee injuries. *J Am Acad Orthop Surg.* 2006;14(10 Spec No.):S188–190.
25. Papanastassiou I, Boland PJ, Boachie-Adjei O, Morris CD, Healey JH. Scoliosis after extended hemipelvectomy. *Spine (Phila Pa 1976)*. Nov 1 2010;35(23):E1328–1333.
26. Douglass HO, Jr., Razack M, Holyoke ED. Hemipelvectomy. *Arch Surg.* Jan 1975;110(1):82–85.
27. Kang D, Lehman R, Laufer D, Bevevino A. Development of Scoliosis Following Complex Combat-Related Lower-Extremity Amputations. *Presented at the Society of Military Orthopedic Surgeons, San Diego CA*. 2011.

**Ronald A. Lehman, Jr., M.D.**

Dr. Lehman is Chief of Spine Surgery and Director of Orthopaedic Research at Walter Reed Army Medical Center. He is also Chief of Orthopaedics and Associate Professor of Surgery and Assistant Professor of Neurology at the Uniformed Services University of the Health Sciences. For over ten years, Dr. Lehman has performed orthopaedic and spine surgery for the military. Dr. Lehman is the principal investigator of major research projects concerning spine and orthopedic care. Dr. Lehman has authored numerous scientific publications in peer-reviewed journals. He is an active participant and presenter at several scientific meetings. Dr. Lehman has received many awards for his scientific and military contributions.

**Adam James Bevevino, M.D.**

Dr. Bevevino is an Orthopedic Surgery Resident at Walter Reed Army Medical Center and The National Naval Medical Center. He also serves as an Instructor of Surgery at F. Edward Hebert School of Medicine in Bethesda, Maryland. He has co-authored several articles and textbook chapters about spinal research, surgery and disease. In addition, Dr. Bevevino has lectured throughout America at several organizations including The Society of Military Orthopedic Surgeons and The Congress of Neurological Surgeons.

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| Patient Stories | ☐ | ☐ | ☐ | ☐ | ☐ |
| Ask the Expert | ☐ | ☐ | ☐ | ☐ | ☐ |
| Research Updates | ☐ | ☐ | ☐ | ☐ | ☐ |

What other features/topics are you interested in seeing in future issues?

_____

_____

On a scale of 1 (very bad) to 5 (excellent), how would you rate the following aspects of the *Journal*:

| | 1 (very bad) | 2 | 3 | 4 | 5 (excellent) |
|---|---|---|---|---|---|
| Text Size | ☐ | ☐ | ☐ | ☐ | ☐ |
| Images | ☐ | ☐ | ☐ | ☐ | ☐ |
| Overall Content | ☐ | ☐ | ☐ | ☐ | ☐ |
| Length | ☐ | ☐ | ☐ | ☐ | ☐ |
| Depth of Explanation | ☐ | ☐ | ☐ | ☐ | ☐ |
| Level of Difficulty | ☐ | ☐ | ☐ | ☐ | ☐ |

On a scale of 1 (not interested) to 5 (very interested), how would you rate your overall interest with the *Journal*?

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| ☐ | ☐ | ☐ | ☐ | ☐ |

Have you visited the Spinal Research Foundation's Website (www.spinerf.org) since March 15, 2012?

☐ Yes ☐ No

Which of the following best describes you?

- ☐ I suffer or have suffered from a spine condition
- ☐ I know someone who has suffered from a spine condition
- ☐ I am a medical professional
- ☐ None of the Above

What is your age group?

- ☐ Under 30
- ☐ 30 to 39
- ☐ 40 to 49
- ☐ 50 to 59
- ☐ 60 to 69
- ☐ Over 70

What is your gender?

☐ Male ☐ Female

Do you have any additional comments or concerns about the Journal of the Spinal Research Foundation?

_____

_____

_____

_____

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*"As a military spine surgeon, I have the privilege of providing care to the country's greatest patients. Being able to manage the complex spinal conditions of our wounded warriors is perhaps the most challenging, yet rewarding, aspects of our profession. It is an honor to take care of this nation's heroes."*


# SPINAL HERO

## Michael K. Rosner, M.D.

**Neurosurgery Integrated Service Chief**

**The Spinal Research Foundation recognizes our outstanding clinicians and researchers in the field of spine research and profiles them as Spinal Heroes. These dedicated spine care professionals embrace excellence in both research and education, contributing significantly to improvements in the diagnosis and treatment of spinal disorders. We recognize Michael K. Rosner, MD, LTC(P) MC USA, Neurosurgery Integrated Service Chief at Walter Reed National Military Medical Center as a Spinal Hero.**

# *Thank You!*

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Through the generous support of our donors, The Spinal Research Foundation has been able to significantly expand the scope of our scientific research and educational programs. These gifts have been utilized to establish scholarship programs and embark on projects geared toward understanding the mechanism of spinal diseases, and develop new treatments for these conditions. This work would not be possible without the support of our donors.

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The Spinal Research Foundation
1831 Wiehle Ave, Ste 200
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