

# the **CrossFit** JOURNAL ARTICLES

## On the Safety and Efficacy of Overhead Lifting

Mark Rippetoe, Lon Kilgore, and Kelly Starrett  
Daniel Crumback  
Paul Benfanti  
With an Introduction by Greg Glassman

*This month we respond to the oft-heard conjecture that lifting overhead is inherently dangerous—i.e., that it is destructive of the shoulder. Conjecture, by definition, is required neither to comport with fact nor to offer testable proposition, and, as such, it is a ready vehicle for those limited in the skills, focus, or desire required to give thoughtful examination on any topic. (See “Conjecture, Hypothesis, Theory, Law” in CrossFit Journal 64, December 2007.) “Squatting is bad for the knees,” “lying down after a workout is dangerous to the heart,” “swimming shortly after eating causes drowning,” and “overhead lifts are bad for the shoulders” are all conjectures unsupported by data, untested by experimentation, and at odds with fact, yet each has at one time or another been offered as “common knowledge” in athletic communities.*

*Additionally, proving the non-existence of anything is fraught with logical difficulty. If you claim to be in possession of a unicorn, for example, by what process am I to prove the falsity of your claim? The point is that the burden of proof for conjecture lies with those who offer it, not those who are witness to it. No response*

*ought to be required of conjecture until it is supported by data and experimentation—that is, until it is presented as a hypothesis and subsequently elevated by experimentation and data to become a theory. This is a simple protocol of rhetoric required by logic and practicality.*

*Ignoring that principle, despite our own conviction, we asked a handful of experts for their responses to the claim that lifting overhead is inherently dangerous or destructive of the shoulder. Their responses, represented by those on the next few pages, resonate loud and clear.*

—Greg Glassman

Greg Glassman is the founder (with Lauren Glassman) of [CrossFit, Inc.](http://www.crossfit.com) and the publisher of the CrossFit Journal.

## High-Rep Overhead Lifting

Mark Rippetoe, Lon Kilgore, and Kelly Starrett

The overhead press is an important component of upper-body training for several sports, and it is one of the oldest weight-room exercises. It has been used for years as a primary exercise for shoulder strength and rehabilitation because of its balance of anterior/posterior muscle involvement. In contrast to the bench press, which is an inherently anterior-dominant movement, the press locks the weight out overhead to recruit all the musculature on both the front and back of the shoulder. This provides a superior strength stimulus for all the muscles involved in stabilizing the shoulder girdle and handling loads that must be moved through an overhead range of motion. In addition to being functionally necessary, training overhead work capacity is above all safe. In fact, failing to prepare for the rigors of ordinary overhead movement can predispose the shoulder to mechanical dysfunction. The Ammo Lift is a functional version of overhead pressing that uses a common military object and, when done in the form of a max-reps timed test, assesses muscular endurance in a practical, easily administered, easily instructed, and easily assessed manner.

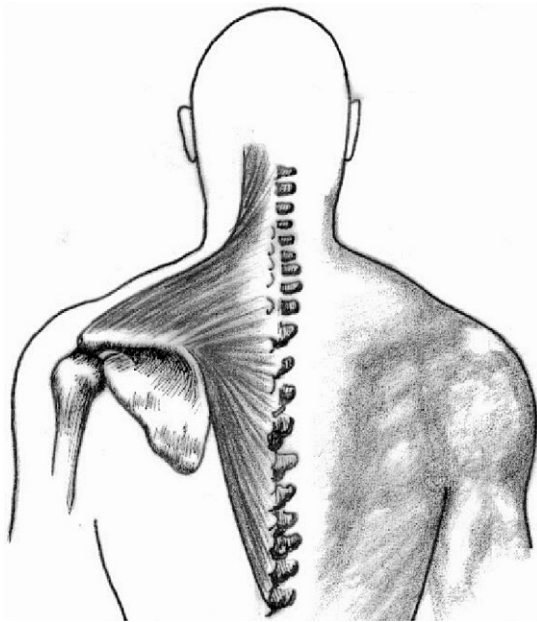


Figure 1. The trapezius muscle attaches the spine, from the top of the neck down to the lower back, to the scapula. The shoulder essentially hangs from the spine by the trapezius.

An anatomical analysis of the movement reveals several important things. First, the anatomy of the shoulder lends itself best to pressing overhead when the trapezius is engaged at the top of the press. This is because the shoulder blades (the scapula, plural scapulae) support the weight overhead—because the arm bones—the humerus, ulna, and radius—articulate with the scapula, and line up under the load when the arms are locked out. This column of bones is held in place by the muscles of the arms and shoulders, and the weight is transferred down the arms to the scapulae, which hang from the spine by the trapezius muscles. These large muscles originate along the spine from the upper neck vertebrae all the way down to the upper part of the lower back. Their broad origin attaches to the spine of the scapula, the bony ridge along the top of this otherwise flat bone, clearly visible in figure 1 and figures 3c through 3e. What the arms support, either overhead or hanging from the shoulders, the trapezius supports. “Trap” strength is therefore an important component of shoulder stability.

The traps supporting the scapulae, along with the deltoids working on the humerus and the triceps locking out the elbow, hold the load overhead. The proper alignment for the load and the skeleton is a vertical relationship between the load, the scapulae, and the mid-foot (figure 2). Support



Figure 2. The skeletal/load relationships in overhead lifting. The load, the bones of the arm, the scapula, and the mid-foot are vertically aligned when the system is in balance.

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in this overhead position is best provided when the trapezius is actively contracted, producing a “shrug” of the shoulders as the load is locked out by the elbows. This active trapezius contraction results in support of the load by all the component musculature, and it also serves to better place the scapulae directly under the load in the correct vertical relationship. It is for this reason that the instructions for performing overhead pressing should include the cue to “shrug your shoulders at the top,” or to “shrug up into the load,” or any other cue that will elicit this active trapezius contraction.

When the trapezius is actively shrugged, there is an important change in the orientation of the scapula. The most lateral (away from the center of the body) aspect of the scapular spine is the acromion process, a bony protuberance that extends out over the top of the head of the humerus when the shoulder is relaxed (figures 3a and 3b). The term “shoulder impingement” refers to the compression of the muscles and other soft tissue structures between the head of the humerus and the acromion process. Shoulder Impingement Syndrome has been described in athletes whose activities involve placing the humerus overhead, but primarily in throwers and swimmers; it has never been described as being caused by overhead lifting. It can occur when the humerus is raised overhead without a sufficient compensating change in the position of the scapula that gets the acromion process out of the way (figure 3d), and it is prevented when the active trapezius contraction shifts the acromion process up and to the inside, maintaining good clearance between the humerus and the acromion process (figure 3e).

The scapula is rotated up and out of the way by the trapezius contraction, and this rotation is made possible by the activity of the serratus anterior. The serratus attaches to the medial (toward the center of the body) border of the scapula and wraps around the ribcage to attach in front at several places on the ribs under the chest muscles. It pulls the scapula forward around the ribcage; when the shoulder is shrugged forward, the serratus are working, and when the shoulder is shrugged either back or up, the trapezius is working. The serratus anchors the lower aspect of the scapula so that when the traps pull the top of the bone upward and medial, the serratus pulls the bottom of the bone down and lateral, and the acromion process rotates back toward the neck, away from the humerus as it comes up overhead. This preserves the space between

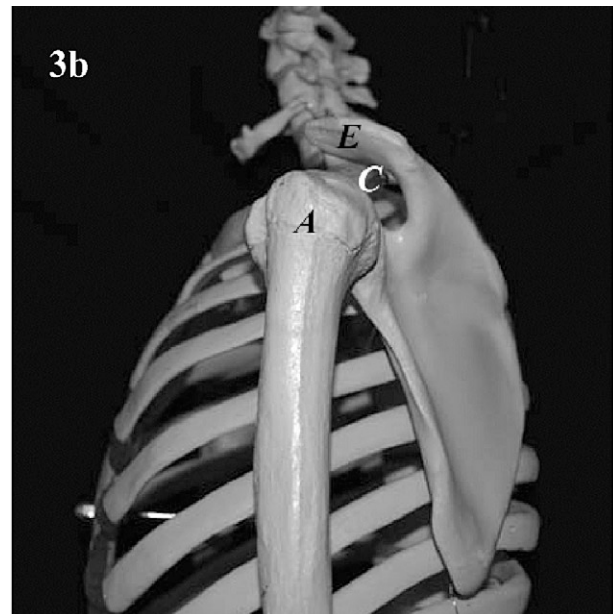
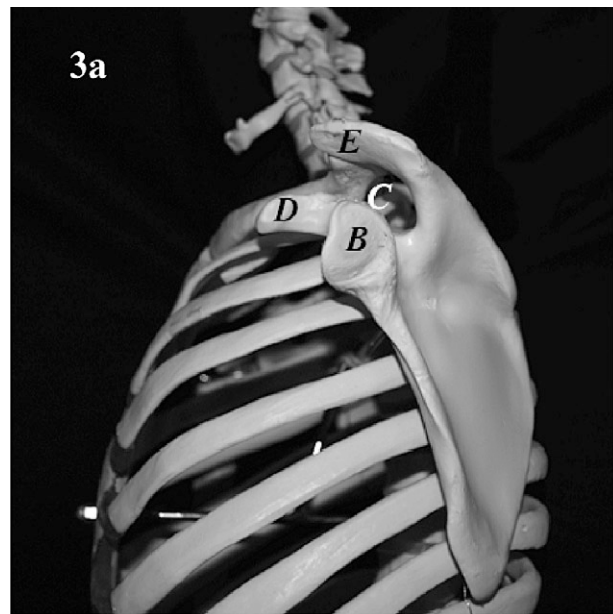
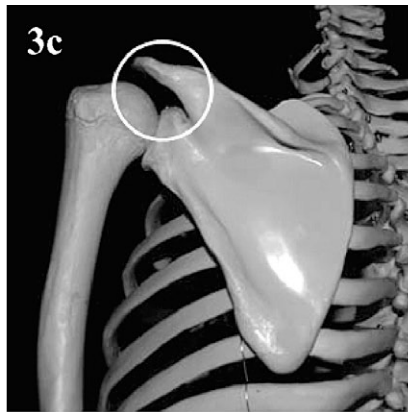


Figure 3. Skeletal orientations relevant to the ammo lift.

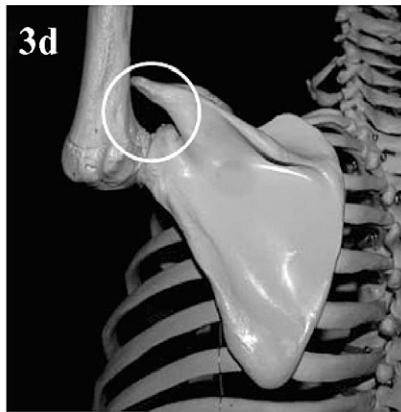
3a. The humerus sits in the shallow concave cup of the glenoid, B. 3b. The acromion process, E, and the head of the humerus, A, and the coracoid process of the scapula, D, are separated by a space, C, through which muscles and connective tissue pass.

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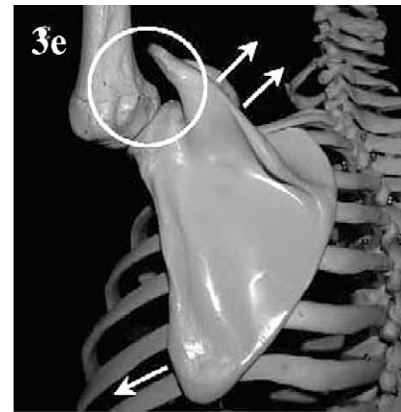
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3c. The spatial relationship between the acromion process and the head of the humerus.



3d. This space closes with an improper overhead movement, and can cause problems with impingement.



3e. The proper space is maintained when the relationship between the scapula and the humerus is protected by the trapezius contraction – the “shrug” – which rotates the top of the scapula up and towards the center, and the serratus anterior, which pulls the bottom of the scapula down and away from the center.

the humerus and acromion. The shrug at the top of the press and a strong serratus act together to avoid shoulder impingement in healthy shoulders.

The Ammo Lift is performed with a 5.56-mm ammo can loaded to thirty pounds. The hands support the can with the palms facing each other and the elbows under the load (fig.4). The can is lifted overhead, keeping the load as close as possible to the face for efficiency of leverage and force transfer. The lockout position is overhead,

with straight elbows and shrugged shoulders (figure 5). The use of leg drive is allowed and encouraged, since this represents an increase in the total output of the movement and a more powerful way to lift more weight. Incorrect lockout (i.e., not overhead, and shoulders not actively shrugged) may occur, as shown in figure 6; correct instruction in the form of simple cue to “shrug the shoulders at the top” and/or “over your ears” will eliminate most of the tendency for this error.



Figure 4. Start position

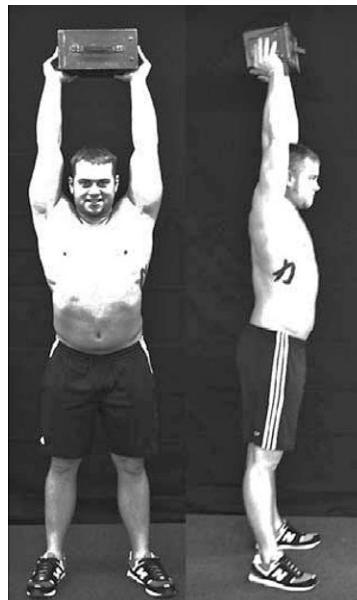
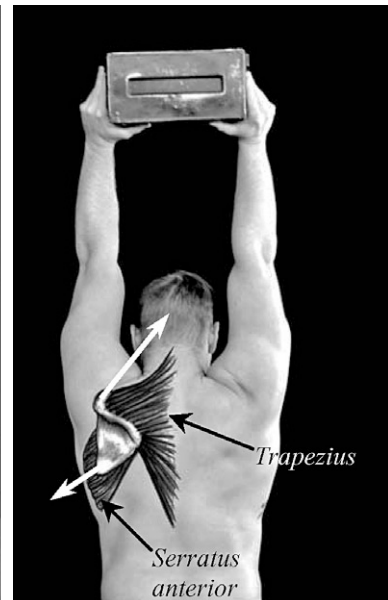


Figure 5. Lockout position. The trapezius and serratus anterior muscles are actively engaged in scapular movement, stabilization, and correct lockout.



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Figure 6. Correct (left) and incorrect (right) lockout positions.

Pressing an object such as an ammo can also places the shoulder into the most advantageous overhead flexion arc of movement. Holding the object at chest height with the arms beneath it forces the shoulders naturally into a more biased scaption plane of overhead upper arm flexion. The scaption plane is functionally in the middle of pure abduction and pure flexion. And, it is in the scaption plane that the head of the humerus has the most room under the overhanging “acromial dome” of the scapula. Teaching athletes to press in this “best fit” shoulder scaption plane further makes overhead movement safe. Dictating this position by making it the only way the load is allowed to be moved, by making it a rule of the test, is a built-in safety mechanism that doesn’t have to be taught.

Even if the lifter were to fail to achieve good vertical alignment after the shrug, risk to shoulders is negligible. Lifting a relatively light weight (30 pounds) for reps is an assessment of—and a good training exercise for

developing—useful muscular endurance rather than absolute strength. Any load that can be lifted overhead for high reps is light enough that it carries only very small risk of injury, even if incorrect mechanics were used. Correct mechanics are preferred, but poor mechanics do not cause overhead lifting to be either dangerous or ineffective. In fact, it is necessary training for anyone who must be prepared for the inevitable necessity of moving loads under the less-than-ideal circumstances that frequently exist in daily life and in the field. Stronger shoulders and better, practiced lifting habits can in fact contribute to a lowered incidence of injury and to the development of all-around better prepared—more functional—bodies.

In examining the safety of overhead work, it should be made clear that pre-existing shoulder pathology is not a function of, nor should it be confused with the lifting itself. For example, it is highly unlikely that someone doing a max-rep overhead lifting test will experience onset of shoulder dysfunction at the middle or end of the test. Rather, predisposing patho-mechanics of the shoulder will be immediately evident on the first or second rep. The exercise is self limiting and therefore not only safe but also diagnostic, in that it can shed light on a potential physical problem that can now be addressed—either medically or with simple movement cueing, depending on the individual situation—before it becomes chronic or mission critical. But it should also be noted that the kind of preexisting shoulder pathology

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that might potentially limit overhead capacity would also limit ability in rope climbs, push-ups, or pullups. If there are existing problems with overhead positioning of the arm and shoulder, they will not be unique to pressing movements, but will be a common denominator of any overhead task, pulling included.

Finally, it should be noted that overhead pressing that engages hip drive and leg function (e.g., push press or push jerk) should be encouraged as it accomplishes several ends. First, the use of hip drive more greatly reflects the real world, functionally efficient way to get a load overhead. “Jumping

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the weight up drastically improves overhead working capacity and dramatically improves an individual's potential for work output and successful task completion. Second, the facilitation and use of hip and leg drive within the test dramatically unloads the shoulder, since the greatest impulse force during the movement is actually applied by the legs when the shoulder has yet to start to move the load overhead. Teaching lifters to use their legs to move even submaximal loads overhead actually safeguards them when they must handle maximal loads in real-life scenarios. Finally, high-rep overhead pressing is a potent facilitator of midline stabilization—i.e., trunk (or “core”) strengthening. Developing spinal stability and trunk strength in an upright, functional posture is not only safe but necessary for developing applicable strength and function and for training the body to handle load safely and efficiently.



Mark Rippetoe is the owner of [Wichita Falls Athletic Club/CrossFit Wichita Falls](#). He has 28 years experience in the fitness industry and 10 years as a competitive powerlifter. He has been certified as an NSCA Certified Strength and Conditioning Specialist since 1985 and is a USA Weightlifting Level III Coach and Senior Coach, as well as a USA Track and Field Level I Coach. He is co-author, with Lon Kilgore, of the books [Starting Strength: Basic Barbell Training](#) and [Practical Programming for Strength Training](#), and has published a collection of his essays titled [Strong Enough?](#)

Lon Kilgore, Ph.D., is professor of kinesiology at Midwestern State University, where he teaches exercise physiology and anatomy. He has extensive experience as a weightlifter himself, and he has worked as coach and sports science consultant with athletes from rank novices to collegiate athletes, professionals, and Olympians. In addition to publishing articles in numerous scholarly journals, he is co-author, with Mark Rippetoe, of the books [Starting Strength: Basic Barbell Training](#) and [Practical Programming for Strength Training](#).

Kelly Starrett is a Doctor of Physical Therapy and the owner and operator of [San Francisco CrossFit](#). He is also a former member of the U.S. Canoe and Kayak Team and National Champion whitewater paddler.

## Shoulder Impingement and Overhead Pressing

Daniel Crumback

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I was contacted by Coach Glassman to comment on the following commonly repeated yet unfounded belief (read: myth) about the overhead press: “Overhead activities cause shoulder impingement.” I must admit, my initial reaction was laughter, as this statement is akin to asking whether chickens cause scrambled eggs. The answer is *Of course not*.

In order to assess the validity of the statement in question, one must have a basic understanding of what “shoulder impingement” actually means. Shoulder impingement can be broadly divided into two overall categories—primary (direct) and secondary (indirect) impingement.

### Primary impingement

Primary impingement is a direct extra-articular (outside the joint) physical impingement, or pinching, of tissues in the subacromial space, which is the space between the acromion (the uppermost tip of the scapula, or shoulder blade) and the humerus, or upper-arm bone.

The causes of primary impingement are:

- Genetics
  - Shape of the acromion
- Degenerative changes
  - Osteoarthritis
  - Thickening of soft tissue

Primary impingement is most common in people 40 years old and older.

### Secondary impingement

Secondary impingement is an indirect extra-articular physical impingement of tissues in the coracoacromial space, the space between the shoulder blade’s coracoid process and acromion (see figures in the article by Rippetoe, Kilgore, and Starrett, in this issue).

Common causes of secondary impingement include:

- Glenohumeral instability
  - Excessive movement of the humerus in the glenoid (the ball in the socket) secondary to:
    - Genetics (i.e., multiaxial instability)

- Compromised static stability (i.e., ligament laxity)
- Compromised dynamic stability (i.e., rotator cuff weakness or inhibition)
- Some combination of the above
- Scapulothoracic dyskinesia, or postural dysfunction
  - Compromised control/integration of movement of the shoulder blade on the posterior rib cage leading to a dysfunctional positioning of the shoulder

### Cause and effect

The upshot of all this is that, in order to show that overhead pressing causes impingement, we would have to be able to show that overhead pressing causes unfortunate genetics, degenerative changes, glenohumeral instability, scapulothoracic dyskinesia, or poor posture. Clearly, this does not make sense. Any pain experienced in association with properly performed and appropriately prescribed (with respect to load and reps) overhead work must be therefore secondary to a pre-existing dysfunction. Overhead activity does not cause the impingement.

In the case of primary impingement, we must respect that fact that there is a direct physical block to movement. These direct impingements must be removed (i.e., surgically) in order for the individual to be able to adopt certain positions.

This is where the rubber meets the road: the question asked should be: Does overhead pressing improve an individual’s capacity to withstand the physical demands required of the individual?

Overhead activities are a necessary part of our daily lives at any age, from putting on a sweater to clearing a wall during a firefight. It is important to understand that we cannot avoid overhead activities without severely limiting our ability to function normally. And our training must aid and strengthen normal functioning, not avoid it.

Overhead activities can, however, be a means of identifying individuals with latent shoulder impingement, since an existing impingement does not allow the activity to be completed without symptoms. In other words, if

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an individual completes an overhead exercise correctly with an appropriate load and has pain, the exercise has helped to identify the need to seek medical attention for an assessment of his or her upper quadrant in order to investigate ways to restore normal function.

Overhead pressing does not cause impingement. This is a normal physiological movement and is required in order for humans to function—and for athletes, first responders, and soldiers to perform their duties safely and effectively.



Daniel Crumback (BSc. PT, Dip Sport PT, CSCS) is a sport physiotherapist working with the Canadian Forces. He has also worked with many high-level athletes in a variety of sports at a national and international level. He specializes in the identification and elimination of physical limitations that restrict performance.

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## An Open Letter on the Safety of the Overhead Press

Paul Benfanti

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To Whom It May Concern:

I am writing in support of the overhead press and its variations as part of a generalized training program or military physical fitness test.

First, the overhead press is an extremely functional movement. We reach overhead many times per day, whether it is to put something on a shelf, change a light bulb, or carry a litter overhead. (By contrast, consider how much less daily functionality the push-up parallels.)

Standing on two feet and using our shoulders to position our hands in space was one of the key developments in human evolution. The shoulder joint is capable of an amazing amount of motion and strength (think, for example, of the feats of gymnasts or Olympic weightlifters). The press requires and develops both of these qualities. It is a multijoint exercise that directly employs the shoulder girdle complex, elbow, wrist, and their supporting structures. It also requires and develops core stabilization, proprioception, and kinesthetic sense. If the simple press is turned into a push press or push jerk, which engage the hips in the motion, the lower extremities are brought into play and the benefits increase even further.

The overhead press can be performed safely for heavy singles or for light or moderate multiple repetitions. A recent PubMed search for shoulder injuries identified very few studies relating to overhead pressing (though there were many articles on pectoralis tears and bench pressing). One study involving elite Olympic weightlifters (Stone, M.H., et al, "Relationship of Maximum Strength to Weightlifting Performance." *Medicine and Science in Sports and Exercise*, June 2006, 37(6):1037-43) noted relatively few shoulder injuries at all. Of the few documented, the vast majority were chronic overuse type and not traumatic (disrupting joint integrity).



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I have learned some of the benefits of the overhead press through personal experience. I was a competitive powerlifter for over 20 years, with a bench press of 400+ pounds. Roughly three years ago my shoulder became very stiff and painful, probably as a result of many years of heavy, limited range of motion bench press and muscle imbalance across the front and back of the shoulders. I couldn't reach my wallet or my opposite shoulder let alone overhead. Surgery revealed significant arthritis, and I was told that I probably wouldn't be able to lift heavy again. By chance I was introduced to CrossFit during my rehab period and learned the benefits of the overhead press and overhead squat. It took well over a year to attain the motion needed to perform these movements. Today, though, my shoulders are entirely pain-free and more mobile than they've ever been. I can overhead press more now than I could during my powerlifting days, and I can perform many many functional exercises that I couldn't before (including overhead squats, kipping pull-ups, and handstand push-ups, to name a few).

In summary, I believe the OHP is an extremely beneficial and safe functional movement that should be incorporated into any training or conditioning program.



Respectfully,

A handwritten signature in blue ink that reads "Paul Benfanti".

LTC(P), MC, USA  
Program Director, Orthopedic Surgery  
Madigan Army Medical Center



Paul Benfanti is a board-certified orthopedic surgeon, fellowship trained in pediatric orthopedics and spinal deformity. He is the program director for the orthopedic surgery residency at Madigan Army Medical Center in Tacoma, Washington. His fitness experience includes 20+ years of competitive powerlifting and three years of CrossFit (including level-I certification), strongman, and Olympic lifting.