

Starting Strength

Gripping Matters: Anatomy 501 for the Press

by

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with Dr. Craig Goodmurphy and Andrew Schneider

The grip for the press and bench press, as described in *Starting Strength: Basic Barbell Training*, creates the most efficient interface for force transfer between a human hand and the barbell. As the author and contributors to this article have confirmed through anatomical dissection and analysis, any other grip would, by definition, be a *less efficient* manner in which to both hold and transfer muscular force to a barbell. Efficiency of effort is important for continuing to see strength increases from training efforts. We'd like to use the correct mechanics for each lift in order to have the highest efficiency possible, which will yield the greatest results over the shortest time.

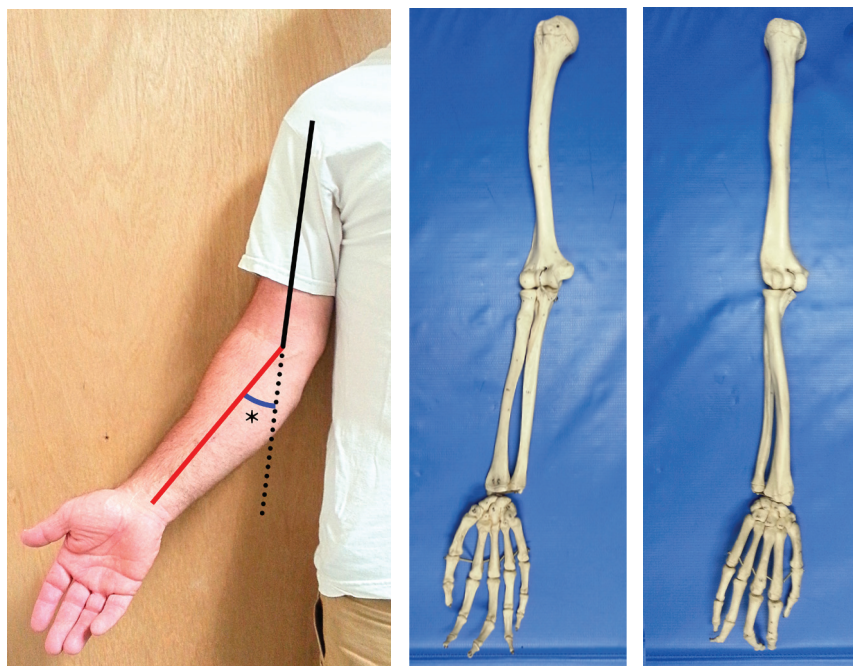
To begin the discussion of the anatomical components of the optimal grip in the press and bench press, we must first describe some basic osteology – the morphology of bones – and the important biomechanical relationships as they relate to this topic. Let's start with the forearm (the *antebrachium*) and work our way down.

The bones comprising the forearm include the *ulna*, the longer bone medial or closest to the midline of the body, and the shorter *radius*, lateral or further from midline of the body with respect to normal anatomical position. An interesting point of normal anatomical position is that the arms are *supinated* (palms forward while standing) and held away from the body so that the hands are not in contact with the legs. This position of the arms, i.e. being held away from the body at an angle, is referred to as the arm's *carrying angle*, and is usually 5-15 degrees. The function of the carrying angle is to prevent contact of the arm and the body during the standard arm-swing that takes place during a normal human gait. Interestingly, the carrying angle tends to vary depending on shoulder and hip width, as persons with narrower shoulders and wider hips (re: women and/or short people) tend to have greater carrying angles than men. Anyone attempting to take a supine/prone-hand alternate grip for a deadlift has had to deal with the carrying angle.

As it turns out, in this supinated position, the humerus and the bones of the forearm are not aligned very well at the elbow. This lack of optimal joint interface prevents maximal force transfer: if you could create a situation in which you artificially lined up the radius, ulna, and humerus in a supinated position and tried to press, you'd have to expend extra muscular energy in order to maintain that relationship when compared to another available strategy, *pronation*, the palms facing backward in

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Figure 1. *Left*, Carrying angle (*) measured between the axis of the humerus (black) and the axis of the forearm (red). *Center*, Supinated. *Right*, Pronated. Note decrease in carrying angle and position of the radius over the ulna in this configuration.



normal anatomical position. A supine grip would have the palms facing back in a press start position, while a prone grip would face them forward. When the forearm is pronated, the radius crosses over the ulna and creates near perfect alignment at the elbow, thus bringing us to our first criterion for the optimal grip based on efficiency: we must **pronate** the forearms in order to eliminate the carrying angle of the elbow.

Moving distally, the wrist joint is simply where your hand meets your forearm. However, in anatomical terms the “wrist joint” is made up of a multiple different articulations between the forearm bones (radius and ulna) and the eight carpal bones. For the purposes of this article, we’re primarily concerned with the *wrist joint proper*, which is the articulation between the distal end of the radius, three carpal bones (*scaphoid*, *lunate*, and *triquetrum*), and an articular disk between them. Notice, however, the ulna is not a part of the wrist joint proper, but rather it is the radius that offers the interface between the hand and the forearm at this joint. In addition, the axis of the radius must be vertically oriented from elbow to wrist so that there are no extraneous moment arms created and efficiency is maximized. Interestingly, the “tip of the elbow” is actually the *olecranon process* of the ulna and not the radius, which is located more posteriorly. This brings us to criterion number two, which is that the “**tip of the elbow**” **will be forward** of the center of the barbell from a profile view to create a vertically oriented radius.

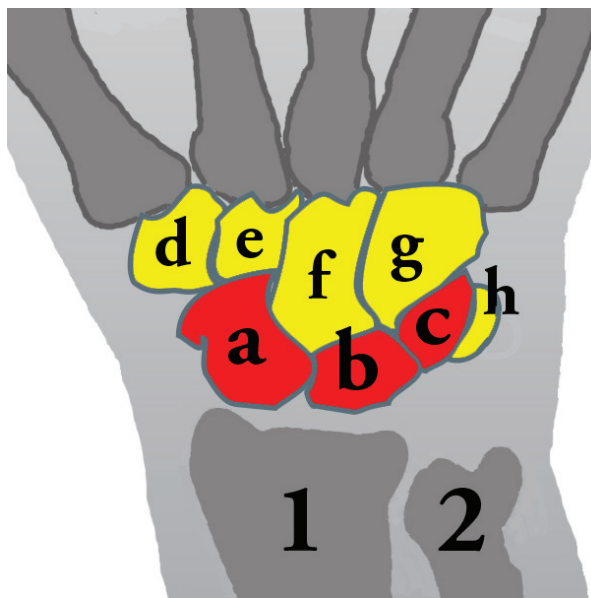


Figure 2. Wrist joint anatomy. Note that the radius articulates with the carpal bones. 1= radius, 2= ulna, a= scaphoid, b= lunate, c= triquetrum, d= trapezium, e= trapezoid, f= capitate, g= hamate, h= pisiform.

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Let's discuss the way the implement we use in the press, the barbell, should be held under optimal circumstances. To maximize efficiency, we'd prefer to hold the barbell directly vertical to the radius, whose axis (it's a slightly curved bone) is directly vertical to the elbow joint with the bar as close as possible to the shoulder. This prevents any extraneous moment arms from being developed between the barbell and elbow as well as between the barbell and the shoulder joint. This is also why the grip width is narrow in the press, thumbs close to the shoulder along the barbell, so that the radius stays vertical in the frontal plane as well. For the bench press, the grip width is about a hand-width wider, to facilitate a vertical radius at the bottom, when the bar touches the chest. This produces a longer ROM around the shoulder, not necessarily what you want for benching the most weight at a meet, but best for general strength training purposes.

We'd like to do all of this boring physics stuff while recruiting the greatest amount of muscle possible into the movement to create the most force, to get the most force production capacity out of our training. So, can we orient the bar in the grip directly over the radius? Sure, but in order to do that the eight carpal bones contributing to the "wrist" joint have configure themselves in such a way that allows the strongest grip, most forearm muscle force production, while still fitting the aforementioned criteria. So, what does that look like?

The configuration that the eight carpal bones and the wrist joint must display to achieve all the components of our model is about 10-15 degrees of *extension*, which is also known as dorsiflexion when talking about the wrist. This slight extension does a host of things that we'll cover very shortly. First we need to visualize this wrist position in a very basic manner. A *neutral* wrist, i.e. one that is neither flexed nor extended, is one where the *dorsum* (back) of the hand is directly in-line with the back of the forearm. As you demo this position yourself it is easy to see that if you were holding a heavy barbell in this position the center of the barbell would actually be forward of the radius, thus creating a moment arm between the bar and the "wrist". This gets more obvious as you *flex* your wrist more, which is the movement of the palm closer to the anterior surface of the forearm in normal anatomical position. At the other extreme, full wrist extension/dorsiflexion, we again can see a moment arm that is generated as the bar is again no longer in line with the radius. There does, however, exist a sort of happy medium between the neutral wrist position and full extension that results in the zero moment arms, and this is our position of 10-15 degrees of extension, i.e. **a slight extension of the wrist**, which is our third criterion of the most optimal grip.

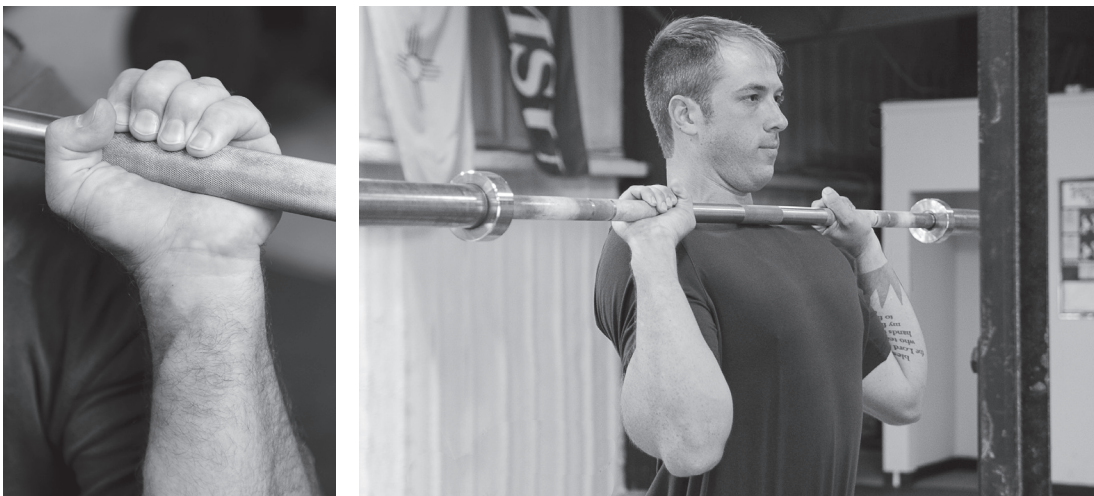


Figure 3. Left, Proper grip with the bar positioned in the hand over the heel of the palm. Right, Elbows in front of the bar and vertical radius at the start of the press. (From *Starting Strength: Basic Barbell Training*, 3rd ed, 2011)

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There are three intimately related muscle physiology concepts governing the optimal grip for the press and bench press: the 3-5-7 rule, striated muscle's length-tension relationship, and passive insufficiency.

First, "The Rule of 3-5-7" describes the *excursion* (in centimeters) of the *musculotendinous* units of the muscles acting on the wrist, carpal, and metacarpal joints. The wrist flexors and extensors – *extensor pollicis brevis*, *palmar and dorsal interossei*, *abductor pollicis longus*, and *flexor carpi ulnaris* – have excursions of roughly 3cm, which means their muscle's contraction results in their tendon moving 3cm. On the other hand, the extensors of the fingers – *extensor pollicis longus* and *extensor digitorum longus* – have excursions of about 5cm. Finally, the flexors of the fingers – *flexor digitorum superficialis* and *flexor digitorum profundus*, have excursions of approximately 7cm. It is not important to memorize the excursion of each individual muscle. However, it *is* important to understand that a muscle's excursion is proportional to the fiber length of the muscle, which correlates to that individual muscle's ability to create force. In sum, the longer a muscle's excursion, the more force it can potentially generate. Thus, we can see that the flexors of the digits, which have the biggest excursion values, also possess the most potential to generate force with respect to the grip.

Second, the "Rule of 3-5-7" is also compounded by the fact that muscles can only contract a finite amount in order to generate maximal muscular force, due to the nature of the *sarcomeres* of the muscle fibers. This optimal sarcomere length during active muscular contraction is defined by the length-tension relationship, which is determined by the amount of *myofilament* (actin and myosin) overlap and the resulting contractile force production at these varying degrees of overlap. Simply put, the more overlap between the myofilaments, the more force can be produced by the contracting muscle. The maximum number of active crossbridges within the myofilaments occurs at the *resting length* of the muscle belly. Increased shortening of the muscle (and sarcomere) reduces the amount of cross bridges that can be formed, thus reducing force generation. Similarly, when the muscle is stretched from its *resting length*, the amount of myofilament overlap decreases, and so does force generation. To illustrate this, flex your wrist as much as you can and then try to make a complete fist closing your fingers. You'll find that this is not possible, particularly on the index finger, because the flexor muscles responsible for making a tight fist have already contracted as much as they can, i.e. they're already very short in this position. If muscles could contract indefinitely you would be able to make a complete fist, but in this position the sarcomeres are too short and the actin-myosin crossbridges are too few to generate enough force to make the fist.

So let's break down what happened. By putting the wrist in a position of flexion, i.e. *palmar flexion*, the flexors of the fingers' tendons become slacked, shortened, or "bow stringed." When you actively make a fist, which is a function of the strong flexors of the fingers, *other* muscles are used to remove the slack that would otherwise be in the musculotendinous units of the flexors before your fingers even begin to move into a tight fist. These *other* muscles, the extensors of the digits and wrist, are used to create this optimal scenario for the flexors to have optimal myofilament overlap within the confines of their normal excursion. Note the position of slight extension of your fisted grip.

The third and final piece of this admittedly complex grip puzzle is *passive insufficiency*, defined as when a muscle can only relax and lengthen so much before it begins to develop tension due to its inherent properties. To illustrate this, extend your wrist as much as you possibly can and try to straighten your fingers. Most people cannot do this because of "passive insufficiency" of the finger flexors, which have been stretched so far over the wrist joint in full dorsiflexion that they cannot be stretched any further to allow full finger extension at the same time. While it seems as though this shouldn't make any difference in the optimal musculoskeletal configuration of the grip for the press,

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let us not forget about the 3-5-7 rule and the length-tension relationships. The flexors have an excursion of about 7cm and are very strong, but if some of this excursion gets used to allow for the wrist to extend, which also decreases actin-myosin overlap because the muscle is stretched maximally, they cannot generate the maximum amount of force as when the wrist is held in slight extension – 10-15 degrees.

This is actually a moot point when we consider that *if* we allow the wrist to be in full extension, the bar will not be lined up over the radius and thus, there's a moment arm between the bar and the wrist. On the other hand, we've covered lots of anatomy, kinesiology, and biomechanics in this article over a topic that some other "gurus" would consider an afterthought.

In summary, the most optimal grip for the press and the bench press is a grip with the barbell directly in-line with the radius and wrist in slight extension, about 10-15 degrees.



Figure 4. *Left*, The finger extensors (extensor digitorum and extensor pollicis) become passively insufficient as they are lengthened over the wrist and fingers during wrist flexion. The passive tension that is developed causes extension of the fingers that are resistant to flexion. *Center*, The finger flexors become passively insufficient as they are lengthened over the wrist and fingers during wrist extension. The passive tension developed in the finger flexors causes the fingers to flex and not be able to extend. *Right*, Tight fist with the wrist held in slight extension.

Jordan Feigenbaum is a competitive powerlifter (83kg/93kg raw) in the USAPL with competition bests at 205 (93kg) of 500/358/622. To complement his “in the trenches” experience, Jordan also has an extensive educational background including a Master’s in Anatomy and Physiology, B.S. in Biology, and is working on his MD currently. Professionally, Jordan holds the following certifications: Starting Strength Coach and Staff Member, NSCA-CSCS, ACSM-HFS, USAW Club Coach, and a few others. Jordan runs the nutrition forum on the Starting Strength website in addition to his [personal blog](#) and [website](#). Jordan can be reached by email at coach@dfmfit.com or on Twitter [@DFitnessCoach](#). Finally, look out for Jordan’s book, *Nutrition for the Strength Athlete*, which should be published later this year!

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