Subacromial Impingement Syndrome: An introduction to Shoulder Impingement

By Dan Pope DPT, CSCS - www.fitnesspainfree.com

I recently had the opportunity to speak with one of my colleagues and old professors Mark Butler, a physical therapist I have a lot of respect for. I asked him what he thought was the most common shoulder problem in the world of fitness. His response:

Shoulder Impingement

From my own experience and speaking with other crossfit trainers and therapists, the most common problem area for people in crossfit is the shoulder. Just take a look at the major upper body exercises in crossfit; overhead press, push press, push jerk, pushups, kipping pullups, snatches, dips, muscle-ups and handstand pushups. All awesome exercises, all tough on the shoulder. No wonder we have impingement.

Unfortunately, the term shoulder impingement is thrown around quite a bit to describe every type of shoulder pain. In reality there are several different types of impingement, each with unique aspects. This is why its important to consult a professional if you are concerned you may have an impingement situation. The problem can be very complex and impingement can be coupled with other issues as well.

In understanding shoulder impingement first we'll learn the anatomy.
In this picture we have the shoulder joint. Here are the key structures:

1. The humeral head - This is the top portion of the bone in your upper arm. Normally it should stay snugly fit centered into its socket, the glenoid fossa.
2. Acromion, Coracoid and Coracoacromial ligament - These structures sit above the humeral head and provide a small space aptly named the subacromial space.
3. Supraspinatus Tendon (part of the rotator cuff), long head of the biceps tendon and a bursa. These structures sit between the humerus and the structures labeled above in #2 in the subacromial space. These are the structures that get impinged upon with this syndrome.

In an impingement scenario, the theory is that the rotator cuff and scapular musculature is not holding the humeral head firmly into the socket. Commonly the humeral head translates superiorly (goes up) and the contents of the subacromial space gets pinched (impinged) against either the acromion, coracoid or a combination of the two.

This can occur with all different movements of the shoulder.

Another mentor of mine, Dr. Kietrys has an excellent saying about impingement. He says, "All roads lead to shoulder impingement" What he means by this is that most types of shoulder pain end up causing impingement as a result. So regardless of how you hurt your shoulder (overuse, technical breakdown, overstretch, muscular imbalance, poor posture, dyskinesis) it will most likely end up causing a shoulder impingement. This is why its so important to avoid situations that may damage the shoulder. In a lot of cases shoulder pain can lead to a cascade of additional problems. Now you've got a complex rehabilitation
situation on your hands or in some cases, surgery.

As discussed earlier, the impingement can be occurring in multiple places:

1. Coracoid Impingement
2. Acromial Impingement
3. Internal Impingement (Thrower’s Impingement)

Impingement by the coracoacromial arch (a fancy term for the acromion, the coracoid and the ligament that connects the two) is what we discussed earlier. It’s also commonly referred to as subacromial impingement. The most important thing to remember about this condition is that the humeral head is not being held tightly into the glenoid fossa (ball into socket) in the correct position during exercise. This happens for a variety of reasons we’ll discuss in the next articles. Because of this we get excessive impingement, pain and eventually damage to the structures within the subacromial space.

In subacromial impingement of the shoulder there is typically a painful arc of motion while raising your arms overhead, usually in the 70-120 degree range.

These patients usually have pain when reaching across the body, internal rotation of the shoulder and elevation of the arm into the painful arc of motion as described earlier. These are a few provocative diagnostic tests to rule in subacromial impingement syndrome.
Coracoid Impingement - This guy looks especially happy to be having shoulder problems

Hawkins Impingement Test

Internal impingement is a different beast. This is an impingement common in throwing athletes and occurs with excessive external rotation of the shoulder seen in pitching and in the tennis and volleyball serve. Although this impingement is specific to overhead throwers, the motion that causes internal impingement is very close to crossfit exercises that require external rotation of the shoulder in an overhead position (kipping pullups, muscle-ups). Crossfit athletes are also put at risk in other exercises that require a lot of external rotation of the shoulder such as with back squats, the rack position of front squats and the bottom position assumed before overhead pressing with a barbell. Because of this its important to take precaution to avoid this type of impingement as well, but that’s not the
main focus of this article


References:

Subacromial Impingement Syndrome: Types of Subacromial Impingement

A subacromial impingement can be occurring because of a bony problem which is known as primary impingement. It could also be caused by anterior/superior migration of the humeral head caused by weakness or muscle imbalance of the shoulder muscles. The latter is known as secondary impingement. This is also where we can get impingement by either the acromion or coracoid.

In primary impingement, contents of the subacromial space are excessively impinged upon due to the shape of an individual's acromion (4). There are three different types of acromions:

As you can see, a type I acromion has much more space then a type III "hooked" acromion. You can imagine how a type I acromion would have an easier time pressing weights overhead then a type III. Also, studies in those with full thickness rotator cuff tears show that most of the time these individuals have a type III hooked acromion(2).

Unfortunately, there is nothing we can do short of surgery to correct a hooked acromion. We can only really work in the confines of exercises that don't cause pain. In a study of 200 patients with various types of shoulder problems 18% had a type I acromion, 41% had a type II acromion and 41% had a type III hooked acromion (3). So in people with shoulder problems, 41% may really be out of luck. This is a definite subset of people that will have to be careful about how they exercise their shoulders.

Side Note: Keep in mind that bones grow when they are stressed. So this means that working through pain in the gym may be stressing that acromion to become even more hooked or to develop bone spurs in the surrounding areas.
In secondary impingement, due to either a muscular dysfunction or imbalance in the shoulder (4), the humeral head is not being held tightly in place with shoulder movement. The rotator cuff and surrounding scapular musculature is not working properly.

If you don't want the sciency explanation, just understand that the rotator cuff and scapular musculature needs to be strong and operating properly to keep the humerus centered in its socket with movement. If the humeral head is not being centered in its socket by these muscles it will end up moving upward, impinging the contents of the subacromial space against the acromion or the coracoid.

Now, here's the science. If you don't want it feel free to scroll ahead.

In the body, muscles fire together in order to create movement. Raising my arm overhead requires multiple muscles firing at the right times with the right amount of force in order to produce normal movement.

Here's where crap hits the fan in impingement.

Here is a cross section slice of your shoulder. "D" is the deltoid muscle of your arm. "S" is the supraspinatus of your rotator cuff. The white ball is the humeral head and it sits snugly in its socket to the right. The red muscles end in white tendons that attach to the bone. (JRF stands for joint reaction force, the arrow is demonstrating how the supraspinatus pulls the humeral head into the socket when operating properly)

Muscles function by shortening, so if the deltoid shortens or contracts its going to pull the arm overhead. The supraspinatus also raises the arm up a bit because of where it attaches, but as you can see its major job when it contracts is going to be pulling the humeral head securely into the socket. These two muscles working together is known as a force
Notice how close the tendon of the supraspinatus is to the bone above it in the second picture. Well this bone happens to be your acromion. Between 70 and 120 degrees of abduction (raising your arm over your head) this tendon is as close as it will get to the acromion. Not a lot of room for error huh? You can see in the above picture that if the supraspinatus is not firing properly the humerus will migrate upward and bang up against the acromion when you try to raise your arm overhead.

The force couple between the supraspinatus and deltoid can be thrown off if the supraspinatus is either:

1. Firing later then it should
2. Being overpowered by a stronger deltoid
3. Weak and dysfunctional

These can all occur when the supraspinatus is weak or damaged. Now, the subacromial space is small to begin with. There is some degree of impingement that occurs every time you raise your arm overhead but this is normal. Certain shoulder positions and posture, poor exercise technique, poor exercise balance (programming) and general overuse of your shoulder muscles (especially overhead) causes excessive impingement and can increase your risk of developing pain and rotator cuff issues.

What's helpful to understand is that in impingement all of the rotator cuff musculature is important and shouldn't be neglected in an overall shoulder health program. Each of the rotator cuff muscles contribute to depressing the humeral head to help prevent impingement. With impingement, just like in the supraspinatus each of these rotator cuff muscles can become dysfunctional.

For instance, Sahrman has previously described that the subscapularis normally prevents the humeral head from moving anteriorly and superiorly (5). As we learned earlier, humeral migration superiorly and anteriorly decreases the subacromial space. A weak or long subscapularis has been cited as a precursor to impingement syndrome.

There are other players involved in impingement syndrome as well. Weakness of the subscapularis is often accompanied by an overpowering and tight posterior deltoid muscle. This is coupled with tightness in the posterior capsule of the shoulder. Similar to the deltoid/supraspinatus force couple example this altered force couple and tightness will cause superior anterior glide of the humeral head. This all leads to a decreased subacromial space. To make matters more complex, the muscles surrounding the shoulder blade also effect
impingement as well discuss next.

References

Subacromial Impingement Syndrome: How the Shoulder Blades affects Impingement

Patients with impingement have changes in shoulder blade kinematics that differs from healthy patients. Basically this means that the shoulder blade is not moving normally as it should in pain free patients. In the world of shoulder pain and pathology, this is often referred to as scapular dyskinesia.

Why is this happening? Part of the problem lies in what is happening to the musculature that attaches to the shoulder blade. Similar to issues with the rotator cuff in impingement, we’re having these problems in scapular musculature. These dysfunctions can present as:

- Muscle timing issues (Muscles don’t fire as fast or reflexively as they are meant to)
- Force couple imbalances
- Weakness
- Length issues (short and overpowering vs. long and weak)

The problems associated with the scapular musculature is thought to alter the orientation of the humeral head in its socket and decrease the subacromial space. As discussed earlier, a decreased subacromial space can compress the rotator cuff tendons, bursa and the biceps tendon. If we want healthy shoulders we’ve got to address this area.

Here’s what we typically see out of whack in this population:

1. Dominance of the upper trapezius
2. Weakness or delayed activation of the middle, lower trapezius and serratus anterior
3. Scapular Winging and Anterior Tilt of the Scapula
4. Poor Posture
5. Scapular Dyskinesis - Generally the shoulder blade on the painful side moves differently then the pain free side

1. Patients with Impingement had on average greater recruitment of the upper trapezius and less recruitment of the lower trapezius when raising their arms
overhead in the scapular plane. This upper trapezius dominance can cause hiking or shrugging of the shoulder during overhead movement and decrease the ability of the scapula to rotate normally.

Taking a look at where the trapezius originates and inserts (attachment points to bone) you can see that the upper trapezius will be responsible for elevating the scapula and rotating it upward as you elevate them arms overhead. The lower trapezius will be responsible for keeping the shoulder blade stable and keeping it from excessively elevating. The lower trapezius counterbalances the upper trapezius and allows the scapula to rotate normally. Lastly, if the lower trapezius is not doing its job correctly then the upper trapezius will do more hiking/shrugging as opposed to rotating the scapula normally as you raise your arms overhead.
2. Those with impingement typically have either a weakness or delayed activation of the middle/lower trapezius as well as the serratus anterior. These muscles play a large role in stabilizing the scapula flat against the ribcage with movement.

3. Patients with impingement often present with scapular winging or anterior tilt of the scapula at rest and with movement. Scapular winging and anterior tilt of the scapula are two terms for similar conditions. Scapular winging can either be caused by weakness in the mid/lower trapezius and serratus anterior or by tightness in the Pectoralis Minor.

As you can see if the pec minor is tight it will pull the shoulder blade forward, tilting the shoulder blade, protracting the shoulder (bringing the shoulder forward) and decreasing the subacromial space. (bad news bears)
Here's how it might look from behind. Notice how prominent the inferior (bottom) and medial (inside) borders of the scapula become compared to the normal right side. This individual is most likely getting some compression of the subacromial space.

4. Posture is also normally implicated in shoulder pain. We know that a protracted shoulder can decrease the subacromial space, decreasing the amount of blood supply and nutrition the damaged tendons of the rotator cuff receive at rest. Unfortunately the area where we usually acquire supraspinatus tendon tears is also an area of hypovascularity known as "the critical zone". Hypovascularity means that the area has poor blood supply. If we want these damaged tissues to heal and remain healthy then it makes sense to open the subacromial space and get more blood supply to the area at rest. This is where the role of posture comes into play. Posture will be a critical component to allowing our rotator cuff to heal and we'll have to address this all throughout the day and when we sleep and not just at the gym.

Using the commonly cited upper cross syndrome popularized by the late Dr. Janda can illuminate this postural problem.

Janda's upper crossed syndrome demonstrates common postural problems in the upper body (Keep in mind that not everyone with sub-par posture will have the same issues, Janda’s patient’s were predominantly patients with neurological disorders, not active crossfitters). In his model, addressing protracted shoulders will not only take strengthening the lower trapezius, rhomboids and serratus anterior, but stretching tight pectorals. Weak deep cervical flexors, tight/overactive traps and levator scapulae and poor thoracic spine
extension range of motion are also probably culprits. Even the position of your lower body impacts the upper body position as well. (We may have a total body problem on our hands here but that is beyond the scope of this article. It’s already long enough!)

5. Scapular dyskinesis is basically abnormal position of the scapula with movement and at rest. Normally the scapula should slide flat on the ribcage and rotate normally as your bring your arms overhead. This helps keep the shoulder centered in its socket and minimizes stress on the subacromial space. In those with impingement the shoulder blade can be anteriorly tilted, elevated and may not upwardly rotate as much as it should. This becomes evident when you watch these patients raise their arms overhead or do pushups.

Notice how this woman’s shoulders are shrugged up while attempting a pushup against the wall. Also notice her left shoulder blade looks as if it is lifting off the ribcage. This is known as scapular winging and that’s the anterior scapular tilt we were discussing earlier that is associated with impingement.

References:


Subacromial Impingement Syndrome: How the Thoracic Spine and Rib Cage Effect Impingement

If we take a closer look at the shoulder joint and scapula we'll notice that we only have 1 true joint that connects the shoulder to our trunk. The scapula attaches to the clavicle at the acromioclavicular joint and the clavicle attaches to our thorax via the sternum at the sternoclavicular joint. These two relatively small joints are the only real joints that connect our arm to our trunk.

There is also a connection between the scapulae and the posterior element of our ribcage as seen to the right. Although this is not a true joint we refer to this connection as the scapulothoracic joint. The scapula lies directly on top of our rib cage and slides smoothly across the surface of the ribs during shoulder movement. Because of this, efficient and healthy movement at the scapulothoracic joint has everything to do with the orientation of the ribcage that the scapula slides along. If the position of our ribcage is off, it will change the
position of our shoulder blades and as described later, can lend itself to impingement.

Our spine consists of a series of vertebrae stacked on top of each other that extend from the base of our skull down to our sacrum (and a bit lower to our coccyx). The vertebrae that make up our neck are known as cervical vertebrae. The vertebrae in our trunk that attach to our ribs are known as thoracic vertebrae and the vertebrae that make up our lower back are known as lumbar vertebrae. As mentioned previously, the vertebrae in our thoracic spine attach to the ribs. Because of this, the orientation of our ribcage is directly related to the mobility of our thoracic spine.

Food for thought: The thoracic spine’s attachment to the ribs creates stability. This can make it difficult to gain mobility in the thoracic spine when we need to.

When we press a barbell overhead we need full mobility of our gleno-humeral joint (shoulder joint), full mobility of the scapulothoracic joint (scapular motion) and full extension range of motion of our thoracic spine in order to get the weight overhead efficiently. If we don’t have this mobility we run into issues. (Use this simple test to see if you’ve got enough mobility)

Now here is where things get interesting. When compared to patients with healthy shoulders, patients with subacromial impingement syndrome have on average less active thoracic spine extension mobility (1).

Food for thought: Research from McClure et al. 2006 showed that there was no difference in thoracic spine posture at rest between healthy individuals and those with subacromial impingement. This suggests thoracic spine mobility (ability to actively extend the spine) may be more important than static posture (3).

As we learned previously patients with impingement also present with increased anterior tilting of the scapula (2). Anterior tilting of the shoulder blade decreases room in the subacromial space. This impinges on the tissues that lie within the subacromial space and over time can lead to rotator cuff tears.

Food for thought: More recent research has shown that individuals with subacromial impingement syndrome may have increased posterior tilt when lifting their arms overhead. This may be a compensation pattern to help increase subacromial space and decrease pain and impingement on sensitive tissues. (3) If this makes no sense don’t worry, I found this interesting!
Thoracic spine mobility and posterior tilting of the scapula are synonymous. Understanding this concept can be difficult. Think of it this way. As we raise our arms overhead the scapula is supposed to ride flat along the thoracic spine. In healthy overhead motion the scapula will upwardly rotate, elevate and posteriorly tilt. In order to posteriorly tilt properly, the ribcage must create an optimal surface to allow this motion. Adequate thoracic extension creates a more optimal ribcage surface to allow the scapula to do its job and get our arms overhead safely and efficiently. If we have a large kyphosis and decreased ability to extend at the thoracic spine, the surface of the ribcage will make overhead motion much more difficult.

Now here's a little experiment to help explain the above details. Stand with poor posture with your shoulders and head forward with a big round in your upper back. Keep this posture and try to raise your arms overhead as much as you can. Not too good huh?

Now fix your posture. Pull back your shoulders and tuck your chin. Straighten up
your upper back. Now reach overhead again. Better? If we're lacking thoracic spine extension range of motion it's going to make healthy efficient overhead motion impossible.

On top of that, normal overhead elevation of the shoulder is only 165-170 degrees(4). 165 degrees does not get our arms completely overhead. We'll need full range of motion for all exercises that requires us to press weight overhead (Military Press, Push Press, Push Jerk etc). Our body achieves those last degrees of full 180 degrees of overhead motion with thoracic spine extension. As we learned previously a lack of thoracic spine extension opens ourselves up to shoulder injuries and leads to a pretty weak press. To add insult to injury, a lack of overhead flexibility can cause a compensation somewhere down the chain in order to get our arms completely overhead. (Anyone else smell lower back pain?)

Resources:


Subacromial Impingement Syndrome: How Posture and Breathing Effects Shoulder Impingement

Do you guys remember upper crossed syndrome from the last chapter? I like to think of upper crossed syndrome as an example of the most common postural problems. In reality everyone is going to have their own postural variations. Upper crossed syndrome paints a nice picture for understanding what poor posture looks like. It also gives us an understanding of what muscles could be lending to these problems.

So what's going on with poor posture seen in Upper-Crossed Syndrome? (1)

- Forward Head Posture
- Increased Upper Cervical Lordosis (upper neck overarching)
- Rounded Shoulders
- Increased Thoracic Kyphosis (More upper back rounding)

What gets tight and shortened? (1)

- Suboccipitals, Upper Trapezius, Levator Scapulæ
- Pectoralis Major and Minor

What gets weak and lengthened? (1)

- Deep Cervical Flexors
- Rhomboids and Lower Trapezius

So why do we worry about achieving better posture? Once again it all comes back to the subacromial space, or the room between our humeral head and acromion that when decreased can lead to impingement or "pinching" in the shoulder.

_Albeit by a small amount, slouched posture has been shown to significantly decrease subacromial space during elevation of the arms overhead in individuals with rotator cuff disease (2)._
As described above, poor posture can be attributed to tight musculature on the front of our chest. If the pectoralis minor becomes tight and shortened it can end up causing scapular winging and scapular anterior tilting. This combination is associated with decreased subacromial space and impingement (3,9).

Decreased subacromial space = more risk for impingement. Seems to be the trend here.

*Food for thought: I’m making a huge case for posture and shoulder problems but research shows us that static posture might not be as important as we once thought for impingement patients (4). What seems to be important is decreased dynamic mobility (4). This essentially means that people with impingement and normal pain free individuals have similar static postures at rest. The difference is in their mobility once you ask them to start moving their arms overhead, which I personally believe to be even more important for people who want to press heavy things overhead!*

My issue with having poor static posture is that over time it will most likely lead to decreased active mobility over time. We need to nip this in the bud.

**So what causes poor posture?**

1. **Our daily habits:** The postures we assume while working, reading, sitting, standing etc. all form the basis for our posture. On top of that, the exercises we choose to perform in the gym can influence our posture as well.

2. **Our emotions:** I’m far from an expert on this subject but was able to drum up some research that correlates emotion and posture. The research seems to show that our emotions at the moment are related to our posture (5). This is far from cause and effect but it’s certainly an interesting bit of information. That being said, the way we hold our posture on a daily basis has to do with our emotional state and is probably an issue in fixing poor posture.

3. **Breathing** - This one needs a bit of extra explanation...

In order to get oxygen into our body we need to fill the lungs with air throughout the day. We end up taking somewhere between 15,000 to 20,000 breaths every day. Normally, the fatigue resistant diaphragm is the predominant muscle of choice in order to get the job done. When we engage in strenuous exercise we start to call in secondary breathing muscles to expand our rib cage and pull extra air in to help feed more oxygen to hungry muscles.

While traditional quiet breathing (breathing at rest) is supposed to use the diaphragm predominantly to accomplish respiration, research shows us that healthy individuals also get a good deal of thoracic movement in quiet breathing (6). Using a pattern of breathing that causes more movement from the ribcage is a sign that the accessory breathing muscles are
overworking when they're supposed to be quiet.

Accessory breathing muscles are not as fatigue resistant as the diaphragm and they're likely to become hypertrophied and shortened with excessive use.

A list of the accessory breathing muscles - specifically muscles of inhalation (7):

- External Intercostals
- **Upper trapezius**
- **Sternocleidomastoid**
- Scalenes
- Serratus Anterior
- **Pec Major**
- **Pec Minor**
- Abdominals
- **Latissimus Dorsi**

If the bolded muscles become shortened they're going to contribute directly to the postural faults seen in upper crossed syndrome.

The pec minor can cause scapular winging. When the pecs and lats get shortened they'll produce internal rotation of the shoulder.

source: eastcoastabs.com
Remember that internal rotation of the shoulder is usually a provocative position for pain in individuals with impingement. This is due to the greater tuberosity of the humerus banging up against the acromion when we raise our arms overhead (8). If we’ve got increased gleno-humeral (shoulder joint) internal rotation during overhead movements we run the risk of impinging structures in the subacromial space. (Another case for improving your technique when lifting) This is yet another area that must be addressed in order to achieve normal motion at the shoulder.

And that’s it! Hopefully now you’ll have a better understanding of impingement so you can either start modifying your own training or that of your patients and clients! If you’re a therapist hopefully this will allow you to better treat your patients, good luck!

References: