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The Affect of Grip Width on Bench Press Performance and Risk of Injury

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summary

Bodybuilders, athletes, and recreational lifters select a grip width during the bench press that they believe will produce a greater force output. Research has demonstrated that a wide grip (>1.5 biacromial width) may increase the risk of shoulder injury, including anterior shoulder instability, atraumatic osteolysis of distal clavicle, and pectoralis major rupture. Reducing grip width to ≤1.5 biacromial width appears to reduce this risk and does not affect muscle recruitment patterns, only resulting in a ±5% difference in one repetition maximum.

Weight training, as an increasingly popular culture, was estimated to attract more than 40 million Americans in 1998 (18), with an increase in the number of athletes and coaches using resistance training to supplement their sport-specific training regime and regular gym users training for aesthetic purposes. The bench press is a very popular exercise, especially for individuals seeking aesthetic improvements. However, due to incorrect technique, individuals are at risk from acute shoulder injuries involving a sudden traumatic episode, such as a rupture of the pectoralis major, during the bench press (4, 20).

The musculoskeletal system of the glenohumeral joint has to provide a base of support for the motion of the barbell during the bench press. The performance of the bench press may place the glenohumeral joint in a position approaching 90° of abduction, and the position may include some external rotation. Ninety degrees of abduction combined with end-range external rotation (Figure 1) has been defined as the "at-risk position" that may increase the risk of shoulder injuries (10). It has been reported that a hand spacing of ≥2 biacromial width (shoulder width as defined by the distance between acromion processes) increases shoulder abduction above 75°, whereas hand spacing <1.5 biacromial width maintains shoulder abduction below 45° (8). However, the level of external rotation is minimal during the flat bench press, but increases in proportion to the angle of inclination during the incline bench press.

Acute injuries (rupture of pectorialis major) and chronic over-use injuries (anterior instability and atraumatic osteolysis of the distal clavicle) are common. The risk of both acute and chronic shoulder injury may be increased by repetitive movements performed with the shoulder close to the 90° of abduction, as seen during the bench press when performed with a grip >1.5 times bi-acromial width (10, 19, 20). This risk may be increased with a greater level of external rotation, leading to the at-risk position.

Mechanism of Injury

During the bench press extension of the shoulder on the descent phase causes increased traction to the acromioclavicular. Technique performance errors (10, 16, 18) increase the risk of anterior instability, atraumatic osteolysis of distal clavicle, and pectoralis major rupture (10, 19, 20). Exercises reported to produce pain include wide-

grip bench press, incline flys, and behind-the-neck military press, all of which position the humerus into abduction and external rotation (10, 16, 18).

The loads, repetitions, and sets performed in weight lifting encourage over-use, chronic-type injuries as athletes will perform 1–12 repetitions with loads of 80–100% of the one-repetition maximum (17). A variety of techniques, such as super sets and compound sets, eccentric contractions, and forced repetitions to muscle failure, are used by athletes (7, 18) combined with a number of different exercises (variations of shoulder press, pec-dec, pectoral flys), leading to muscular fatigue (10). The use of forced repetitions and eccentric repetitions increase the loading on the skeletal and musculo-tendinous structures and further increase the risk of injury, especially if used regularly. Case studies have indicated that ruptures of the pectoralis major may occur during the eccentric loading phase when the musculo-tendinous junction is at its highest point of stretch; therefore, regular use of eccentric repetitions may increase the risk of this injury (4).

The repetitive nature and use of heavy loads in weight training may provide a fertile environment for chronic injuries (18), and it is normal for athletes to push themselves to the highest weight limit possible in spite of pain (16), thereby increasing the risk of injury.

A grip of more than 1.5 biacromial width increases shoulder torque by 1.5 times that of a narrow grip (8), thus increasing the risk of injury. Research has also demonstrated that altering grip width from 100% biacromial width up to 190% does not significantly ($p > 0.05$) affect recruitment of the pectorialis major or the anterior deltoid; however, the narrower the grip, the greater the activation of the triceps brachii (6).

Figure 1. At-risk position.

It is the general consensus that the use of a narrow grip during the bench press produces less stress for the acromioclavicular joint, the inferior glenohumeral ligament, and the pectoralis major (8, 11). By adjusting hand spacing to no more than 1.5 biacromial width, the component angles of abduction can be decreased. This in turn will decrease the peak torque and stress occurring at the shoulder joint (8, 11), thereby potentially decreasing the risk of injuries to these structures. It is interesting to note that one article detailed that the narrow grip caused pain for patients with osteolysis of the distal clavicle (2); however, as this was not noted in any other research and because the exact distance of the grip was not expressed, it is possible that the narrower grip was still greater than 1.5 biacromial width.

The major mechanisms of injury suggested within the literature are:

- Hand spacing >1.5 × biacromial width (1, 8, 13).
- High or intolerable exercise dose or repetitive strain (2, 5, 10, 18).
- Altered proprioception (postinjury) (8, 15).

Common Injuries

Anterior Glenohumeral Instability

Anterior glenohumeral instability, defined as the inability to maintain the humeral head centred in the glenoid fossa, appears to be the most common shoulder injury experienced by competitive weight lifters (19). Anterior shoulder stability is largely dependant on the inferior glenohumeral ligament (IGHL). The IGHL is found attached to the anterior inferior aspect of the humeral head and to the anterior glenoid and labrum. The IGHL is responsible for restraining anterior translation at 90° of abduction; if the IGHL is damaged, the shoulder becomes more susceptible to anterior instability (19).

Anterior instability is considered a chronic condition that may occur in individuals who regularly perform weight-training exercises with the

Figure 2. Mid-range bar position.

shoulder approaching 90° abduction and may be increased with external rotation (10). However, losing control of a heavy load during a lifting exercise is the most common mechanism for acute subluxation or dislocation and concurrent instability (16).

Atraumatic Osteolysis of the Distal Clavicle

A stress-failure syndrome of the distal clavicle is a pathologic process of bone destruction to the subchondral bone of the distal clavicle (2). The injury appears to be a chronic condition mostly caused by repetitive weight-training exercises, as seen in bodybuilders and powerlifters (20). The weakness of the clavicles makes this area of the shoulder girdle highly susceptible to trauma (11). The extension mechanism of the shoulder during the eccentric phase of the bench press excessively stresses the acromioclavicular joint and is thought to contribute to osteolysis of the distal clavicle (18) caused by repetitive microtrauma during weight lifting (20).

Atraumatic osteolysis of the distal clavicle appears to be caused by repetitive movements performed with the shoulder at 90° abduction, which is approached during the bench press when performed with a grip >1.5 times biacromial width (10, 20) and worsened if external rotation also occurs, as seen in the inline bench press and behind neck press.

The incidence of osteolysis mimics the increase in the number of athletes using strength training, although large numbers of weight-lifting subjects with osteolysis do not seem to exist (2).

Pectoralis Major Rupture

A rupture of the pectoralis muscle occurs mainly during strength training and especially during the bench press (11). It is characterized by a sudden acute injury often occurring during the eccentric loading phase when the musculo-tendinous junction is at its highest point of stretch (4). Due to the twisting orientation of the inferior pectorialis fibers that converge onto the proximal aspect of the humerus, the inferior fibers of the pectoralis major are at a higher risk of trauma (11). The injury occurs during the concentric phase after the eccentric lowering that stresses the inferior pectorialis fibers as the humerus controls the barbell up to finish the press (1). When the glenohumeral joint is in extension during the descent phase where the bar touches the chest, the pectoralis muscle is stretched and contracted and it is the load in this position that forces the inferior pectorialis fibers to tear. The inferior fibers are lengthened disproportionately during the final 30° of humeral extension, creating a mechanical disadvantage during the eccentric phase, resulting in an increased risk of injury (21).

Ruptures occur commonly at the tendinous insertion on the humerus after excessive weight is applied to a maximally contracted muscle (5). Prior research noted that 24 out of 33 subjects suffered a pectoralis rupture during power lifting and bodybuilding with a bench-pressing mechanism (1).

Bench Press Performance

The bench press should be performed with a grip <1.5 biacromial width, lowering the bar in a slow, smooth, controlled manner to the lower portion of the pectorals (Figure 2) to reduce the level of abduction and rotation at the shoulder. The bar should move through the same plane of motion during the lifting phase, but should be more rapid.

The action of the bench press has a varied kinematics pattern (13). The more experienced lifter will control the bar to and from the chest following a path that keeps the lever arm closer to its center of gravity (using a narrow grip <1.5 biacromial width, lowering the bar to the lower portion of the pectorals), which is created by the support base of the glenohumeral joint. The experienced lifter will also take longer to complete the exercise, therefore resulting in a decrease

in force exerted on the musculo-tendinous junction (13).

Research has demonstrated a nonsignificant difference ±5% ($p > 0.05$) in one repetition maximum with a grip width of 100% and 200% biacromial width, (3, 12). Electromyographic results showed that grip width did not significantly affect activity of the sternocostal head of the pectorialis major ($p > 0.05$). However, the narrow grip significantly increased the activity of the clavicular head ($p < 0.01$) and the activity of the triceps brachii ($p < 0.05$) compared to the wide grip (3, 12). Therefore, this demonstrated that force is not dramatically reduced and neither is there a reduction in the contribution of the pectoral muscles when grip width is reduced.

It may also be advisable to avoid incline variations of the bench press, unless the angle is specific for sports performance, as this will lead to a greater level of external rotation and possibly an increase in the risk of injury. Research has also demonstrated that the level of inclination does not alter activation of the clavicular (upper) portion of the pectorals, but does decrease activation of the sternal portion, resulting in a reduction in force (9).

Recommendations

To potentially minimize the risk of injury, the bench press should be performed with a grip ≤1.5 biacromial width to maintain shoulder abduction within 45° (8, 10). It has been suggested that the descent phase should finish 4–6 cm above the chest (11), and the narrower grip width could potentially reduce the risk of injury by reducing the level of stretch on the inferior pectorialis fibers. However, this would only be applicable to the recreational lifter, as competitive power lifters must lower the bar and touch the chest prior to the lifting phase. The adjustments to the grip width will decrease the angle of abduction and possibly external rotation at the shoulder, in turn potentially reducing the risk of shoulder injury without altering the benefits or performance of the exercise (3, 6, 12).

It is also essential that altering technique loads are reduced to allow increased levels of proprioception and perfection of the new technique (10), especially if rehabilitating postinjury, as this can result in reduced proprioception, and the coactivation of rotator cuff muscles can be altered greatly, leading to an increased risk of recurrent instability (15). ♦

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