
Strength training modalities:

Combining free weights with hydraulics

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Editor's Note: The NSCA believes that the strength and conditioning coach should be aware of the various modes (types) of resistance methods and equipment on the market. Each has its own unique features which set it apart from the competition.

We have invited numerous equipment companies to "toot their own horn" and explain how their product's training mode achieves a training effect.

This series of articles will help you judge the modes of conditioning and hopefully allow you to make your future purchases based on your strength and conditioning needs.

We would like to extend an open invitation to any equipment company which wishes to contribute to this series.

The name of the game in resistance training is high intensity—the higher the better. By combining the proven concepts of weights (isotonics) with hydraulics (isokinetics or speed control), one effectively increases the intensity by providing the advantages of each and deleting the deficiencies.

Higher intensity guarantees faster neuromuscular development, which results in an athlete reaching his or her potential for size, speed, and power more quickly and to a greater extent than with lower intensity modes of training.

What do we mean by high intensity?

High intensity resistance allows the athlete to train as hard as he or she wishes,

from the beginning to the end of each repetition, for every rep of a set. For this to be possible resistance must:

1. Provide negative tension on the down stroke to stimulate a higher force output on the next positive rep.
2. Provide a high level of resistance before the movement begins and during the early stages.
3. Provide the highest possible resistance after movement begins throughout and including the end. The resistance must match the athlete's force output during every phase of each and every rep throughout the set.
4. Provide resistance specific to sport's application. Speed and resistance must increase together when the athlete's force output increases.

How does combining weights and hydraulics accomplish a higher intensity?

1. Weights provide negative resistance, which keeps tension on the muscle, stretches it into a full range starting position, and causes the important pre-stretch phenomenon, providing greater force output on the next positive rep.
2. Weights also ensure high resistance before and during the first stages of movement. This is clearly seen, as a force greater than the weight must be generated before the weight will move. Also, because of the physical characteristics of accelerating a weight, the faster it is moved, the more force is required.

3. High variable resistance through the middle to the end of the movement is accomplished by adding a hydraulic device. The mechanical characteristics of hydraulics automatically adjust the force and speed to meet the athlete's effort. The harder the effort, the greater the speed and resistance.
4. Resistance at the end of the repetition is ensured by the weight, which keeps tension on the muscle when movement stops.

In summary, weights provide all of the resistance before movement begins and most of the resistance during the first stages. The combination of the two provides the remainder, especially at recommended workout speeds.

If a free weight is put into motion and accelerated by itself, it quickly reaches speeds where much less effort is required to keep it in motion. Toss a pencil or a barbell plate into the air and it becomes obvious that little force is needed after the initial high effort, to keep it moving until it starts downward. The coasting problem is not the only undesirable factor involved with weights if full range resistance is desired. During a movement, changing muscle and skeletal leverages result in varying expressions of force. The muscle has to work harder at some points than others. A consistent, full repetition, high intensity work load, as is provided

by the combination, ensures a balanced development which is highly instrumental in eliminating the natural weaknesses when using weights or hydraulics separately.

With the combination equipment, maximum resistance is provided during each rep by the addition of the hydraulic cylinder which controls the coasting of the weight and provides matching resistance throughout each rep. At the start of the set (when the athlete is stronger), speed will be faster and force and resistance higher. As strength declines, speed slows. For the maximum training effect, the athlete must train as fast as possible without jerking the weight into motion—an excellent condition for athletes.

As you know, different sports require different training applications. When training for speed and power, the hydraulic device needs to be set at a faster speed and when training for bulk, the device needs to be set somewhat lower. Again, best results occur when movement is performed as fast as possible without jerking the weight into motion or using auxiliary muscle groups to provide force.

To provide for a consistently high level of effort, accurate records of the exercise session must be kept. These criteria include weight, repetitions, setting of the hydraulic device, and duration of exercise. An improvement in any of these is indicative of gain as long as one of the other factors did not decrease. It should be emphasized that the hydraulic setting must be the same as the previous setting, as a different setting causes considerable fluctuations in required force, repetitions, and duration of exercise.

Chart 1 compares the three types of resistance. With the use of combination equipment there is an irrefutable increase in intensity. Any athlete who uses this concept will not only feel and see the difference from the first, but will have taken a major step in attaining the new competitive edge.

Figures 1 and 2 depict actual bench press force curves produced by a computerized weight machine for the three main types of resistance—weights (isotonics), hydraulics (isokinetics), and weights plus hydraulics.

Each curve represents the same individual working as hard as possible during each repetition of the set, at a speed which provides the highest force value. Figure 1 illustrates the first two repetitions of a set with the bar starting on the athlete's chest.

The hydraulic, or isokinetic, mode illustrates the following.

1. Little force is needed to start the movement.
2. An adequate amount of peak force is attained during acceleration.
3. Little or no force can be exerted toward the top as movement slows.
4. No force is exerted at the top. (Force

shown is from actual weight of the handle bars.)

5. There is little negative force.
6. The result is low force at the start of the next movement.

The weight only mode shows a much different profile.

1. There is a high force requirement before movement begins.
2. During the acceleration, there is a high peak force.
3. This is followed by declining force due to the affect of coasting.

4. Force is present at the top of the movement.

5. Nearly as much force is required to lower the weight and to start the next movement, causing the stretch reflex.

Using weight plus hydraulic modes reveals apparent advantages.

1. There is excellent resistance provided by the weights before movement starts.
2. There is more force required during the middle of the movement because of the clearly reduced coasting due to the weight/hydraulic combination.

High intensity requirements for a set of 6-12 repetitions	Hydraulics	Weights	Combination
Resistance at start of repetition		X	X
High mid-repetition resistance	X	X	X
High end-of-repetition resistance			X
Negative resistance		X	X
Maximum resistance every repetition increases/decreases as the athlete fatigues (pyramiding)	X		X
Variable resistance which exactly matches the athlete's profile every repetition (varying variable resistance)	X		X
TOTAL	3/6	3/6	6/6

Chart 1: A comparison of the three types of resistance.

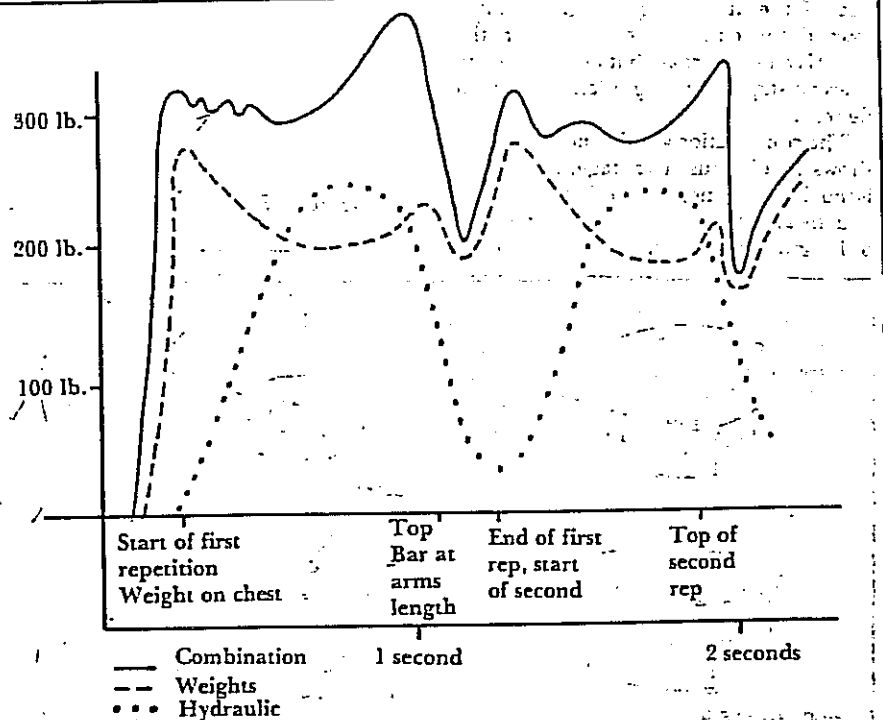


Figure 1: Actual bench press force curves for weights, hydraulics, and weights plus hydraulics for the first two repetitions of a set with the bar starting on the athlete's chest.

Combining free weights with hydraulics

3. There is higher peak force during acceleration because the athlete has to overcome both the hydraulics and also the weights.
4. There is force at the top because of the weights.
5. There is force during the negative stroke causing the reflex phenomenon.
6. The reflex phenomenon results in high force at the start of the next repetition.

Figure 2 depicts force output for the entire set with hydraulic, weight only, and combination. The differences are obvious. The hydraulic (isokinetic) mode indicates the lack of resistance on each negative repetition, fairly good peak force and resistance which decreases with fatigue. The weight (isotonic) curve shows good peak force at the beginning, less force toward the end, and resistance on the negative downstroke; but as can be seen, exercise stops when fatigue falls to a certain degree.

The combination weight and hydraulics shows an obvious advantage. Peak force is much higher, negative resistance is good and the athlete can train to a greater degree of fatigue than with the weight alone. ●

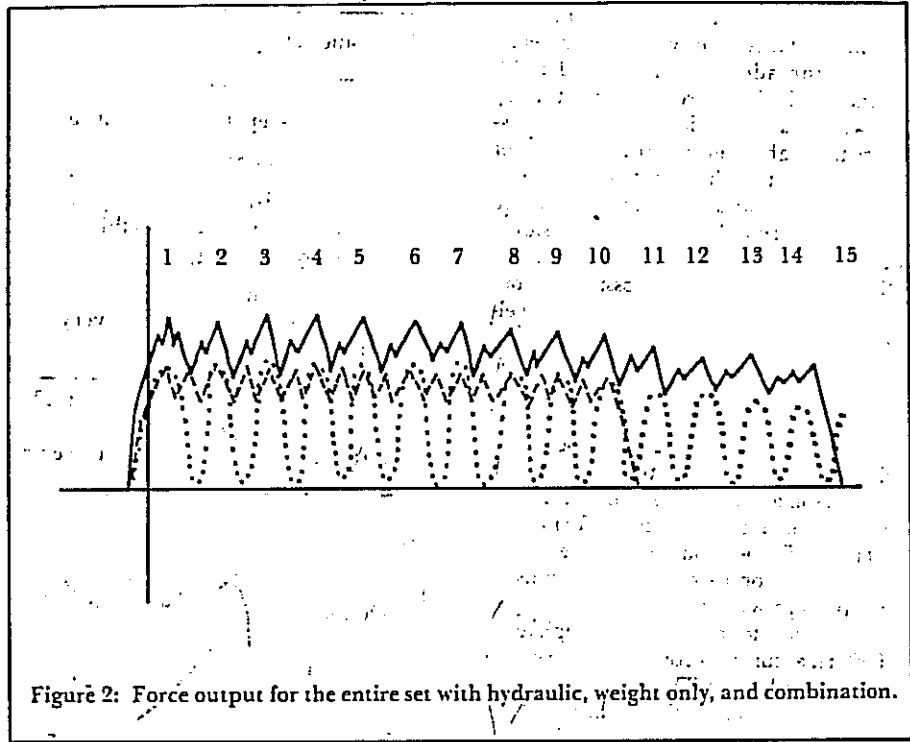
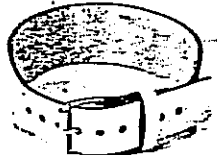
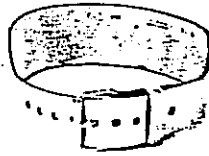


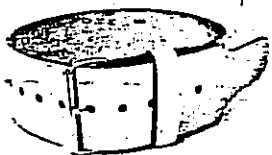
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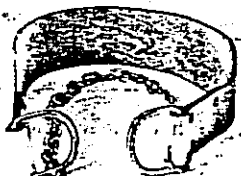
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