Altering barbell kinetics to enhance strength-power training

By

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At the Broncos we pursue strength and power. In a typical weekly cycle where movement-oriented training is performed twice per week for the upper- and lower-body, we have one training day that is aimed at developing strength and the other training day is the explosive power training day ~ however these days are not mutually exclusive in terms of content. We have been doing this for 12 years, since I started at the Broncos in 1995. Lately this approach has become popular and some people call it Conjugate periodization with “Max Effort” and “Dynamic Effort” days. Whatever. Below is a brief rationale and description of some of the methods we use or have used at the Broncos to enhance power development.

Maximum strength is defined as the ability to apply force and/or overcome resistances to movement. It is best developed by lifting heavy weights for lower repetitions. When lifting heavy weights in traditional strength exercises (squat, deadlifts, bench presses, chin-ups etc) the movement speed can be quite slow, which is not ideal for power development with more experienced athletes (this will still work to enhance power in less experienced athletes though). But heavy weights and low reps in the basic exercises are best for maximal strength.

Maximum power is defined as the work done per unit of time (strength x speed) and it is best developed by use of a more broader range of resistances ~ however there must be acceleration and high movement speed for power to be fully developed. “True” power training exercises are exercises that entail

acceleration throughout the entire range of movement (eg. olympic lifts, jump squats, throws, etc). Table 1 provides an example of some strength exercises and their counterpart power exercise.

Therefore there may appear to be a quandary between the development of strength and power ~ strength entails heavy weights, typically performed at slower speeds, whereas power entails acceleration throughout the range of movement and faster movement speeds. If you try to lift lighter weights more explosively in a traditional strength training exercise (eg. bench press), then the lift starts off with acceleration but by half way up in the range of motion, the muscles will start to decelerate the weight to stop it "jerking" the muscles/tendons at the end of the range of motion. So instead of teaching/training our body to accelerate, this method actually teaches it to decelerate! For collision-based sports, it is always good to remember the Bruce Lee quote – " don't hit the man, hit through the man", which implies accelerating through the collision or contact.

This would seem to imply that training for strength and power are or can be quite separate in terms of programming exercises, resistances and lifting speeds etc ~ and they are to a large degree for more experienced trainers (lower level athletes readily respond to basic strength training such that it will also increase their power for the first few years of training).

However there are a number of strategies that alter the kinetics (force profile) of exercises to seemingly combine the qualities of strength and power. Consequently we have to do two things to fully embrace power development.

1. Use full acceleration exercises so that force output and acceleration continue through the full range of movement (no deceleration phase at the end of the range of movement).
2. Alter the kinetics (force profile) of traditional strength training exercises so that force/acceleration continue further into the range of movement.

It is this second method that has caused the greatest changes in training methodologies in the last 10 years.

1. Include some full acceleration exercises as power exercises

Performing an exercise whereby acceleration can occur throughout the entire range of movement (such as a bench throw or jump squat in a Smith machine, see Photos 1-2, medicine ball throws, power pushups, power cleans and all the olympic lift variations etc) allows for higher lifting speeds and power outputs (see Table 2). If athletes attempt to lift light resistances explosively in traditional exercises such as bench press and squats, large deceleration phases occur in the second half of the movement, resulting in lower power outputs as compared to power versions of bench throw and jump squats. Table 2 provides an example of power output differences between 1 rep max weights in strength exercises as compared to lighter resistances in power-oriented full acceleration exercised. Thus heavy resistance exercises such as bench press, squat and deadlifts are considered strength exercises whereas bench throws, jump squats and power cleans are considered power exercises.

Training to maximize power output should entail both heavy resistance, slower speed exercises for strength development and exercises that entail higher velocities and acceleration for the entire range of movement for rapid power development. This two-sided approach should result in the musculature being able to contract both forcefully and rapidly, the basis of power production. It may merely be the dosages of each exercise type that varies depending upon the athletes experience and strength levels, sport requirements, stage of the training year and so on.

Table 1. Example of exercises categorized as strength or power exercises. If an exercise entails acceleration throughout the entire range of movement, then it is classified as a power training exercise.

Strength	**Power**
Squat	Jump squat
Split squat	Alternating leg jump squat
Deadlift	Power clean/snatch/pull
Bench press	Bench throw
Military press	Push jerk
Push up	Clap push up

Table 2. Estimated power output during a 100% 1RM and 100% Pmax effort for different exercises for a theoretical athlete with a body mass of 75kg. However, please note that lifting at less than 100% 1RM will result in higher outputs for the strength exercises, due to faster lifting speeds.

Exercise	Mass (kg)	x	Gravity 9.81	x	Height m	= Work J	/ Time s	= Power W
Bench press	100	x	9.81	x	.4	= 392	/ 2	= 196
Bench throw	50	x	9.81	x	.6	= 294	/ .7	= 420
Full squat	140 (75)	x	9.81	x	.65	= 1370	/2.75	= 499
Jump squat	45 (75)	x	9.81	x	.85	= 1000	/.6	= 1668
Deadlift	170 (75)*	x	9.81	x	.5	= 1202	/ 3	= 400
Power clean	90 (75)	x	9.81	x	.85	= 1375	/.8	= 1719

All lifts except the bench press also require the lifting of the body mass (75 kg). The barbell mass and the body mass become the system mass and this combined mass is used to calculate power output. Concentric portion of the lift only.

Photos 1 and 2 show the bench throw exercise in a Smith machine. The loss of hand contact with the barbell in Photo 2 allows for full acceleration throughout the entire range of movement, making this exercise more conducive to power training.

Photo 3. The 1-arm bench throw on an incline bench is a power exercise especially suited for athletes who have to fend off (all collision types of football), punch (boxers/martial artists) or throw (Shot-putt, cricket, baseball).

Photos 4, 5 and 6. The jump squat exercise in a Smith machine is a power exercise because the loss of foot contact from the floor allows the athlete to generate both high forces and high speeds late in the movement range. It can be performed in a parallel (P4 & 5) or split/alternating stance (P6).

Photos 7, 8 and 9. The deadlift exercise is a strength-oriented exercise where heavy resistances can be lifted, but at slower movements speeds.

Photos 10, 11 and 12. The power clean (from the hang in this instance) is a more power-oriented exercise because of the lighter resistance and faster lifting speeds.

2. Alter the kinetics of some strength exercises to more favorably affect rapid-force or power output

Because heavy resistance strength exercises such as bench press or squat typically entail slower movement speeds and lower power outputs as discussed above, these exercises **alone** are not specifically suited to developing maximum power (Pmax) in athletes past the intermediate stages of adaptation. As explained above, faster, more power-oriented exercises must also be performed in training. This phenomenon has been the subject of considerable research attention. There are power specific adaptations in terms of the neural activation, muscle fiber/contractile protein characteristics and muscle architecture that must be considered when choosing power-training exercises.

However, there are a number of strategies that the strength coach can implement to alter the force profile or lifting speeds of strength exercises to make them more suitable to rapid-force development and hence play a key role in Pmax training. In effect we can alter traditional strength exercises to make their force and velocity characteristics much more like the "true" power exercises (faster lifting speeds, acceleration and high force levels late in the movement). However because the resistance is heavier than the typical full acceleration exercises, these kinetically modified exercises can also greatly emphasize strength development.

These strategies are the use of **chains, bands, functional isometrics, partial range reps and weighted hooks/stripping.** These five methods can be used alone or in combination. They can also be used for maximum effort (strength building effect) as well as dynamic explosive power training effect. I will outline their use for the latter, which is how we use them at the Broncos.

2a. Modifying the kinetics by use of chains attached to the barbell.

The use of chains attached to the end of the barbell is gaining some popularity lately in altering the kinetics of a lift. For example, the performance of the bench press can be modified by adding chains to the end of the barbell to alter the kinetics of the exercise so that the acceleration phase can be extended further into the range of movement. When the barbell is lowered to the chest, the chains are furled on the floor and only provide minimal resistance (see Photo 14). As the barbell is lifted, the chains unfurl and steadily increase resistance throughout the range of motion (see Photo 15). This method means that a lighter resistance (eg. 50-75% 1RM) can be lifted explosively off the chest but as the additional resistance (+10-15% 1RM in chains) is added by the constant unfurling of the chain links off the floor, the athlete can continue attempting to accelerate the bar. The bar speed will slow down but this will be due to the increasing mass, rather than the athlete consciously reducing the push against the barbell. This alters the kinetic profile of the strength exercise to become more like a power exercise (acceleration lasts longer into the range of motion and higher force late in the movement).

This method of altering kinetics is one of the Broncos favourite methods on their power oriented training day (the 2nd resistance day in the weekly cycle). Since 1998 (apparently this is way before it became popular) we have been using chains in a power oriented training complex. Basically it entails doing 4 sets of 3 reps with about 70% 1RM barbell resistance + 10% 1RM chain resistance. These sets are alternated with the full acceleration bench throw exercise in the Smith machine using resistances of 40-50% 1RM for 4 x 3 (ie. super-setted with a 1-1.5 minute break between each exercise). This **Contrasting Resistance Complex** allows us to tackle power development through high force (bench press with chains) and high speed (bench throws) avenues. With the chains the athlete

cannot explode the weight off their chest and cruise through to lockout - it just gets heavier and harder as the chains unfurl off the floor and add resistance to the barbell and he must continue to try and accelerate the barbell till the end. When explaining or coaching this exercise I use the analogy of it being like accelerating into the opponent, then having to try to keep squeezing past/against that opponent.

Photos 14 and 15. The bench press exercise kinetically modified to make it more closely resemble a power exercise by adding chains to the sleeves of the barbell. When the chains are furled upon the floor as the barbell is on the chest as in Photo 14 they add no extra weight to the barbell ~ however the unfurling of the chain links adds extra weight to the barbell as it progresses throughout its range of motion (P15). In this case the resistance is 60 kg (barbell only) when at the chest but 75 kg when the chains (7.5 kg of chains on each side) have cleared the floor (before the lockout position).

2b. Modifying the kinetics by use of rubber bands attached to the barbell.

A similar strategy is to use rubber-tubing/band resistance (power bands) on the ends of the barbell to increase resistance throughout the range of motion. In this case the athlete pushes upward in the bench press or squat and stretches the large rubber bands attached to each end of the barbell. The higher into the range, the more stretch and so the greater the elastic resistance. Similar to the chains example, this allows the athlete to explode upwards and continue to apply high force much later into the movement. The exact resistance the bands exert is determined by hanging weights from the band to get it to stretch to the same length that it will during whatever lift you are doing. Simple enough.

In the past I have used physio bands but they are not real strong – now we have the bands from Getstrength, which are great. You need to have strong bands especially if you use them for squat exercises such as box squats or squats from hip height in the racks.

What is the difference or advantages between chains or bands? Well chains wobble around a lot, which can be good or bad. And it is difficult to get the length of chains for squats just right when you train people of markedly different heights ~ this is not so much a problem for bench press due the shorter range of movement in this exercise. Also bands are easier to carry around. So we use bands or chains for bench press type exercises but only bands for squats (mainly due to logistic reasons).

So it may depend upon whether you train lots of athletes at the same time, time/resources etc.

Photos 16-18. Kinetically modified squats with additional rubber band resistance. In P16 the athlete is 1/3 way up and there is no band tension. As the elastic bands stretch they add increasing amounts of resistance to the barbell, but at higher points in the range of movement. In P17 the squat is from hip height in the racks with almost full bands tension complete at the ¾ squat position for more of a strengthening effect. In P18 the tension comes on much higher in the range, allowing for more power output with the lighter weight.

Photos 19-21. Kinetically modified bench press with additional rubber- band resistance. In P19 the athlete is at the bottom of the rep, with no band tension. In P20 at about ½ way up, the elastic bands are stretching and adding increasing amounts of resistance to the barbell. By lockout the bands have added 25 kg of resistance in this case.

2c. Modifying kinetics via functional isometrics

Another strategy is the use of Functional Isometric (FI) training. A FI exercise can be performed for the top half of a movement in a power rack or Smith machine, altering the force characteristics considerably. In FI training high force is generated late in the movement range, typically where force may decrease in traditional strength exercises. For example the lockout portions of squats and bench presses are relatively easy when sub-maximal resistances are being used. Placing a FI stop (via the use of the transverse pin in a power rack) the lockout portion of either of these exercises allow the athlete to develop high forces in this area of the range of movement. This high force, late range isometric strength is of vital importance in rugby union. In fact I think the FI squat is the most specific barbell exercise a rugby union prop can do in the weight room (see Photo 22).

2d. **Altering kinetics via use of partial range movements**.

While full range strength should be the cornerstone of any program, there is also a need for developing sports specific strength, most commonly end range strength. Another method of altering the kinetic profile similar to FI is to merely include some partial repetitions in the lift. Typically it may be the top range (eg. deadlift pulls from knee height in the rack were a weekly staple of Australian lightweight powerlifting champion Ray Hope). Again the idea here is to increase force output at the end of the range of movement, similar to what actually happens in most sports (and power training) movements, but opposite to traditional weight-training kinetics. Common exercises that we use at the Broncos are top range bench presses with a narrow grip (“fending off” width grip) and squat “blast ups” from just above hip height. My other favourite partial for

league is a partial mid-range pulling movement, the power shrug from above the knee ~ this partial movement (the middle potion of a power clean) most closely mimics the triple extension that occurs in the body just prior to impact in rugby league. All our great defensive "hitters" are great at this exercise.

But some partial rep training can also be done in other potions of a lift, not just the top range. For example bottom half squats (bottom to half way only) with very light weights and very high reps are great for activating the quad muscles around the knee and we use them for players with knee problems associated with weak vastus medialus muscles. And typically these players are those who come from other clubs and have not done full range squats before.

2e. Altering kinetics via use of weighted hooks or "stripping"

Weighted adjustable hooks (periscope type design) that are constructed to fall off the barbell when the base of the apparatus contacts the floor during the lowest portion of the bench press, deadlift or squat can also alter barbell kinetics within a repetition. Their use allows for heavier eccentric and lighter concentric phases, conceivably resulting in enhanced concentric lifting velocities. One popular method is to do 1 rep with a 6-second eccentric lowering of the barbell with 60-80% 1RM barbell resistance and another 20-30% in hook resistance. When the hooks falloff the barbell at the bottom of the lift the athlete then explodes the bar back up. This is truly an advanced method and athletes must be very careful, as sometimes the hooks do not drop off simultaneously, leaving the athlete with a largely off-set resistance. We do not have hooks at the Broncos, so we do not use this method.

We do use a conceptually similar method called "stripping", whereby the training partners "strip" the resistance downwards during a set. Typically we do this on plate loaded exercise machines such as lat pulldowns and seated rows.

For example, a set of six reps could consist of 2 reps with 100 kg, the partner immediately strips the weight to 95 for 2 more reps and then to 85 for the final 2 reps. Thus the resistance was reduced throughout the set to accommodate fatigue. The advantage of this method is a very heavy weight is lifted for the first 2 reps, but reductions in the resistance as the athlete fatigues ensure good lifting speed/power output throughout the entire 6 reps.

P22. Functional isometric squat. In the FI squat, the athlete starts with the barbell upon the lower transverse pin and then pushes the barbell hard against the top transverse pins for 2-10 s, allowing for the generation of very high forces in this portion of the movement. This exercise has application to tackling or scrummaging demands for rugby league and union.

Conclusion

Thus a strength coach has a choice of implementing the use of full acceleration power exercises, chains, power bands, FI, partials, hooks/stripping and other devices to alter the resistance/force production (and acceleration) throughout the barbell trajectory. This particularly affects force levels at the end of the range of movement and can be basically applied to any free weight barbell exercise used in power training as well as for many machine exercises.

I would recommend that if resistance training is performed twice per week during a training cycle (eg. 2 upper, 2 lower body or in-season it may be 2 whole body/wk), then one day of the training week could emphasize strength development with heavy resistance training and the other training day emphasize power development with methods described above. I highly recommend using training complexes alternating contrasting sets of medium resistances in full acceleration exercises (eg. 30-50% 1RM) and medium-heavy resistances in kinetically altered strength exercises (eg. 60-75% 1RM + chains or bands). Partial rep movements + bands and chains also offer a fantastic method of enhancing sport specific strength and power. As a general rule the band and chain resistance should be equal to about 10-20% 1RM. Also rotate your methods every 2-4 weeks ~ don't keep using the one method incessantly.