THE RESEARCH

Recent peer reviewed studies (Frost 2008 and Frost 2012) have validated the "power" of pneumatics. Let's take a look at what we can learn from both acute and chronic adaptation comparisons between mass and pneumatics.

Acute Comparisons

Acute comparisons help us understand why two distinct resistances will exhibit diverse force, power, and velocity qualities while being utilized to perform the same movement with an equivalent load. Acute comparisons tell us what is happening in real time.

Frost's study, "*A comparison of the kinematics, kinetics, and muscle activity between pneumatic and free weight resistance",* is summarized below. All participants were tested to determine their 1RM (one rep max) on the bench press utilizing both free weights and pneumatics. Once a 1RM was determined, all participants completed sub-maximal testing utilizing both resistances at predetermined loads (15, 30, 45, 60, 75 and 90% of a 1RM). Data points were captured and the results were analyzed to compare various independent mechanical qualities. Results are listed below:

- **FREE WEIGHTS**
  - » Greater Mean Force at every submaximal load except 15% 1RM
  - » Greater Peak Force at loads between 60-90% 1RM

- **KEISER PNEUMATICS**
  - » Greater Peak Force at 15-45% 1RM
  - » Greater Mean and Peak Velocity at every load
  - » Greater Mean and Peak Power at every load
  - » Greater Peak Acceleration at every load
  - » Reduced deceleration phase at every load
  - » Greater velocity contribution to power production at every load
  - » Greater agonist and antagonist muscle activity at every load

Chronic Adaptation Comparisons

Chronic adaptation comparisons aid in identifying the expected changes to force, power, and velocity capabilities while utilizing a mass-based resistance versus a pneumatic resistance. Chronic adaptations help us understand what results we can expect from different forms of resistance.

These chronic adaptation comparisons serve as a synopsis of the force, power, and velocity differences observed in Frost's study, "*Changes in maximal strength, velocity, and power after 8 weeks of training with pneumatic or free weight resistance*". A group of 18 experienced, weight trained men were tested to determine their 1RM (absolute/maximal strength) and corresponding pre-determined sub maximal resistances (15, 30, 45, 60, 75, 90%) while performing a bench press movement. Force, velocity, and power were measured at all resistances on both free weights and the pneumatic-based Keiser rack. This group was then randomly divided into 2 groups and completed identical workouts. Group 1 utilized free weights only, while group 2 utilized pneumatics only. After eight weeks of periodized training were completed, participants were retested on both free weights and pneumatics to establish a new FW 1RM and retest at their original sub maximal loads.

- **FREE WEIGHTS – 1RM RESULTS**
  - » Increased FW 1 RM by 10.4%
- **FREE WEIGHTS – SUBMAXIMAL LOADS**
  - » **Force:** No increase of dynamic force at any resistance
  - » **Power:** The FW Trained Group may have a slight advantage at resistances above 60% 1RM (Note: This falls above optimal max power training zone)
  - » **Peak Velocity:** The FW Trained Group has an advantage at increasing joint velocity at loads greater than 60% 1RM (Note: This falls outside of optimal speed development zone)
- **KEISER PNEUMATICS – 1RM RESULTS**
  - » Increased their FW 1 RM by 11.6%
- **KEISER PNEUMATICS – SUBMAXIMAL LOADS**
  - » **Force:** Substantial increase of dynamic force at 15% and trivial increases between 30-60% 1RM
  - » **Power:** The PN Trained Group saw substantial improvements at max power and loads less than 60% 1RM
  - » **Peak Velocity:** The PN Trained Group has an advantage at increasing joint velocity at loads less than 60% 1RM

Discussion

The specific inherent qualities observed in the acute comparisons give understanding into what happens in real time. These results can also give insight to what unique adaptations may occur. However, long term adaptations can have differing outcomes compared to the acute results. For example, the FW trained group had higher mean force at almost every resistance on the strength continuum but was less efficient in increasing a 1RM FW Bench Press as compared to a PN trained group [10.4% FW, 11.6 % PN]. Selecting the correct resistances for each desired result can be imperative to the performance specialist. Also, consideration must be given to factors unrelated to kinetic and kinematic markers such as the following:

- Safety
- Inability to successfully execute movements at speed (i.e. FW machines)
- Technical efficiency (Lack of technical efficiency reduces the ability to display Force, Power, and Velocity)