Bridging the Rehabilitation - Performance Training Gap During the Lower Extremity Rehabilitation of the Athlete

Rehabilitation

Strength & Conditioning

EATA

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Thank You

- Don Chu
- Charlie Francis
- Derek Hansen
- Erik Helland
- Al Miller
- Johnny Parker
- Tim Stump
- Al Vermeil
- And so many others
Thank You

• Greg Janik and the EATA Selection Committee for inviting me to present today
Fact vs. Opinion

• “Everyone is entitled to his own opinion, but not his own facts.” Daniel Patrick Moynihan
Fact vs. Opinion

• Sports Rehabilitation and Performance Enhancement Training (PHT) should be based on the scientific evidence. If not:
  – How do you know if a technique/exercise is appropriate to utilize?
  – How do you know it works?
  – How do you progress the technique/exercise?

• There is also an art form to the process
  – i.e. joint mobilization
  – i.e. “eye” of the coach/medical professional
Athletic Performance

• The world class athletes, who run the fastest, jump the highest, throw the hardest, etc. are those who apply the greatest amount of force into the ground surface area in the shortest period of time.

• Work = Force X Distance

• Power = Force X Distance over **TIME!**
  
  – *The fastest athletes spend the least amount of time on the ground (0.07-0.09 sec at sprinting speed)!*
  
  – *Main determinant of achieving maximum sprint speed was in reducing the contact time during the stance phase!*  

  Chu, Miller, Parker, Vermeil

  Mann 1998
By the $8^{th}$ step GCT 0.1 sec and velocity is at 9.4 m/s
Athletic Performance

“Because of the narrow constraints on the minimum swing times and maximum contacts lengths that runners can use, *speed is conferred predominately by an enhanced ability to generate and transmit muscular force to the ground.*”

Weyand J Appl Physiol 2000
Al Vermeil’s Hierarchy of Athletic Development

- Hall of Fame Strength & Conditioning Coach
- 7 World Championships
- Principles are utilized with:
  - Athletic Performance Enhancement Training
  - Sports Rehabilitation
Hierarchy of Athletic Development

- Hall of Fame S&C Coach Al Vermeil’s Heirarchy of Athletic Development

Vermeil’s Hierarchy of Athletic Development

Rehabilitation Modified

- Speed
- Elastic/Reactive Strength
- Explosive Strength
- Strength
- Work Capacity
- Evaluation/Testing
Hierarchy of Athletic Development

• Mobility/Movement
  – Will improve with the proficiency of technical (exercise execution) training

• How will optimal movement occur if the individual cannot apply sufficient levels of force?
  – To the ground surface area
  – Contact with an opponent
Developing the Physical Qualities of Athletic Performance

• Selye’s General Adaptation Syndrome
  – The need for the application of *unaccustomed* stress

![Diagram of the General Adaptation Syndrome]

**Legend:**
- A = Alarm Phase
- B = Resistance Phase
- C = Supercompensation Phase
- D = Exhaustion or Detraining Phase
The Physical Quality of Strength

• Foundation of Sports Rehab & Athletic Performance
• Defined as the mount of force a muscle can exert
  – No time requirement for exercise execution
  – Application of force into the ground surface area
  – Maintenance of proper postural position during ADL and running
  – Muscle and Joint Stiffness (requirement for SSC/Plyometrics)
  – Joint Stability
    • Co-activation index (agonist/antagonist) is at or close to 1:1
  – *The physical quality from where all other physical qualities evolve*
The Physical Quality of Strength

• ACL Reconstructions
• Limb asymmetries in muscle strength and performance are consistently noted following the return to high-level activity
  – Squatting
    Risberg JOSPT 1999
    Meyer JOSPT 2011
  – Jumping
    Neitzel Clin Biomech 2002
  – Landing
    Paterno JOSPT 2011
The Physical Quality of Explosive Strength

- Maximal Strength *must be combined* with either power (explosive strength) and/or reactive strength to enhance optimal athletic performance.

- \[ P = \frac{F \times D}{T} \] Velocity Component

- Time is a factor to the exercise execution
  - Acceleration
  - Rate of Force Production (RFP)
  - The Co-activation index is properly adjusted with high speed training
    - Greater contribution of agonists vs. antagonists
    - Antagonists are trained to become “quiet”

Harris 2000, Tricoli 2005
The Physical Qualities of Strength vs. Power in the ACL Reconstructed Athlete

• ACL Reconstructions

• 6 Months Post –op
  – MVIC (Strength) - 97% Pre-injury level
  – Rate of Force Development (RFD) – 63% Pre-injury level  

• 12 Months Post –op
  – Rate of Force Development (RFD) – attained or exceeded 90% Pre-injury level  

Angelozzi JOSPT 2012
The Physical Quality of Power

• The Rate of Force Development (RFD)

Aagaard Appl Physiol 2006
The Rate of Force Development in Athletics

![Graph showing the rate of force development (RFD) and maximum strength over time. The graph illustrates different training methods and their effects on force production.](image-url)
Peak Power Output

Power (W)

- Power Clean
- Hang Power Clean
- Mid-thigh Power Clean
- Mid-thigh Clean Pull

Comfort JSCR 2011
Clean Pull
Comparison of Peak Rate of Force Development (RFD)

![Graph showing comparison of peak rate of force development (N/s) for different movements: Power Clean, Hang Power Clean, Mid-thigh Power Clean, and Mid-thigh Clean Pull.](Comfort JSCR 2011)
Comparison of Peak Ground Reaction Forces

![Graph showing comparison of peak ground reaction forces for different movements: Power Clean, Hang Power Clean, Mid-thigh Power Clean, and Mid-thigh Clean Pull. The graph displays force in Newtons (N) on the y-axis and different movements on the x-axis. The forces are color-coded as follows: Power Clean (blue), Hang Power Clean (red), Mid-thigh Power Clean (blue), and Mid-thigh Clean Pull (purple). Comfort JSCR 2011 is indicated on the graph.](image-url)
The Physical Quality of Elastic/Reactive Strength
Vermeil’s Hierarchy Of Athletic Development

• Enhancing the rehabilitation progression for the improvement of the running gait cycle and the athlete’s elastic abilities
The Running Gait Cycle

- Swing Phase
- Stance Phase
- Float Phase

3 Phases

60% No Ground Contact
Side View
Rearview
Knee AROM
The Running Gait Cycle

• The Swing Phase
• Knee AROM is necessary for proper foot positioning at the gluteal fold
• Often Knee PROM is often emphasized in rehabilitation
  – PROM in necessary for soft tissue compliance
The Swing Phase

• Moment arms (distance) of heel to butt
The Swing Phase

- Moment arms (distance) of heel to butt
Restoring AROM of the Knee

• Butt Kicks
• Mach Drills
  – “A” March
  – Mod “A” Skip
  – “A” Skip
  – “A” Run

Butt Kicks

“A” March
The Physical Quality of Elastic Strength

• Elastic Strength = Plyometrics
• Ground Reaction Forces
• Storage/Release of Energy  
  – Power Output  
  – Physiologic Economy
• Short Amortization (GCT)
• Achilles Tendon
Ground Contact Time
Ankling Activities

- Performed early in the rehabilitation process
- Restore familiarity with the ground surface area
- Restore Achilles tendon strength and ground reactive abilities
Ankling Exercise
Speed

• Does your athlete sprint enough?
  – Sports Rehabilitation
  – Athletic Performance Training

• Sprinting is needed for:
  – Optimal Performance
  – Co-activation index
  – Neuro-muscular timing
    • Includes injury prevention

• Performance
  – Higher sprinting velocities
Speed

• Neuro-muscular timing
• Performance
  – Reduction of the co-activation index
  – “quieting” of the antagonist muscle groups
• Injury Prevention
  – Hamstring injuries
  – Biceps femoris
    • Long head – tibial nerve
    • Short head – common peroneal

Bompa, Francis
Bi-lateral Exercise Performance

- Co-activation index – a muscle/muscle groups are activated coordinately with another muscle/muscle group
  - Agonist: Antagonist
- Strength exercise
  - Ratio 1:1
- Power exercise
  - Ratio changes in favor of the agonist
  - The desire is to “quiet” the antagonist
    - Running
      - i.e. Quadriceps/Hamstrings
    - Throwing
    - Boxing
      - i.e. biceps/triceps
What about the physical quality standards of the specific sport(s) of participation?

- College Football Players

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Figure 2 The Physical Qualities of Division I, II, and III Football Players

Fry and Kraemer
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*Figure 2 The Physical Qualities of Division I, II, and III Football Players*

*Fry and Kraemer 1991*
Physical Standards of Sport

NCAA D III Male Soccer

- Bench Press  205 + 24 lbs.*
- Squat  286 + 27 lbs.*
- Power Clean  165 + 20 lbs.*

NCAA D III Female Soccer

- Bench Press 103 + 13 lbs.*
- Squat  186 + 23 lbs.*
- Power Clean 104 + 11 lbs.*

* Averages

Hoffman 2006
How is one physical quality dependent upon another?

- **Sprinting**
- The Physical Quality of Strength
  - Application of force into the ground surface area
  - Achieve running Velocities of 5 m/s  Cavagna

- **The Physical Quality of Elastic Strength**
  - “Rebounding” (SSC) effect into the ground surface area
  - Running Velocities of greater than 5 m/s  Cavagna
Physical Qualities of Athletic Development: Each physical quality is dependent upon it’s predecessor

- Should the emphasis of the training of the elastic abilities of an athlete (i.e. plyometrics) occur during the rehab process when the athlete does not have the ability achieve a sprinting velocity of 6 – 8 m/s?
- If an athlete cannot initially apply optimal levels of force into the ground surface area, how can they possibly apply optimal levels of force at higher velocities?
World Class Sprinters

![Bar chart showing best 100m sprint times and corresponding weights for Bench Press and Back Squat.]

Best 100m Sprint Time (sec):
- 9.78
- 10.16
- 10.28
- 10.32
- 10.62
- 10.87
- 10.96
- 11.03

Weights:
- 350lbs
- 490lbs

Bench Press
Back Squat

Courtesy of Derek Hansen
Thank you for your time and your attention

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