The Science of the Core: Lower Back Strength Training for Elite Athleticism

By John Scherger D.C.

• History of Program
  o Early Developers
  o Current Users
  o Programs released for following NSCA Peer review of technology

• Program Science Utilized
  o Muscular Skeletal Lever Systems Biomechanical Physics explained
  o Study of Human Tissue and Forces utilized in Human movement
    ▪ Force of Resistance
    ▪ Force of Effort
    ▪ Resultant Force
  o Study of Resultant Force impacting on joints:
    ▪ Compression Force
    ▪ Shear Force
  o Study of joint tissue utilized to stabilize Resultant Force:
    ▪ Bone
    ▪ Ligament
    ▪ Muscle
  o Program’s two areas of Applied Technology’s development
  o Athletic Performance as Global muscle, bone, joint adaptation program
  o Study of Human development/adaptation of strong Mature Back:
    ▪ Size
    ▪ S-shape Spine
    ▪ Ossification
  o Study of Adaptation relative to Sit-up exercise applied technology for global Strength Training Program
  o Athletic Longevity as Shear Force training of Segmental joint for:
    ▪ Bulged disc
    ▪ Pinched nerve
    ▪ Spinal stenosis
- Study of Shear Force relative to Pelvic-Tilt exercise as applied technology for Segmental joint strengthening
- Study of Athletic Performance Training relative to back’s biological mechanism affecting:
  - Running
  - Jumping
  - Hitting
  - Endurance/Fatigue
- Simple evaluation of back’s muscle, bone, joint complex
- Features/ benefits of applied technology of exercise equipment
The Science of the Core
Strength Training for Elite Athleticism

By: John Scherger, D.C.
Neal Stumpf: Technical Assistant

Unique Human S-Shape Posture

Copyright: Spinal Fitness Center
The Science is Biomechanics

By: John Scherger, D.C.
Neal Stumpf: Technical Assistant

Unique Human S-Shape Posture

Copyright: Spinal Fitness Center
Program Started in 1980’s

- York Barbell
  - Dick Smith

- Olympic Sports Center for Human Performance
  - Bob Beeten
  - Jennifer Stone

- Patriots Football
  - Ron O’Neil, Trainer

- Kennewick Lions Football
  - Ed Troxel, Coach
Current Program Users

- NFL DB Rodney Harrison, New England Patriots
- Dallas Cowboys
- Mike Woicik, Strength Coach
  6 SuperBowl Rings
- Skyview HS
  Steve Keizer, Coach

Rodney Harrison, NFL
Program Organized in 2000

- NSCA 1 year + Peer Review
  - Engineers
  - Physics Professors
  - Strength and Kinesiology Experts
    - Army
    - Collegiate
    - Olympic Ranks
Biomechanics Defined

- Jim Hay: Dept. of Exercise Science
  Iowa State University

Study of Forces:
- Acting Upon
- Produced By
- Impacting Within

- Muscle, bone, joint lever system
Acting Upon

Physics Term: Force of Resistance

- Gravity
- Weights
- Collision
Produced By

Physics Term: Force of Effort

- Muscle
Impacting Within

Physics Term: Resultant Force

Force of Resistance + Force of Effort = Resultant Force
Resultant Forces Stabilized at Joint

- **Compression**
  - Pushes two joint surfaces together

- **Shear**
  - Dislocates bones at joint surface
Compressive: Stabilization Force

- Compression brings parts of joint together
Shear Force: Dislocation

- Shear Force does not bring joints together, it dislocates them
3 Methods of Stabilizing Shear

- **Bone** — Fixed Stabilization
- **Ligament** — Passive Stabilization
- **Muscle** — Active Stabilization
Shear Stabilization: Fixed Bone

Top Vertebra
Stopped by Lower Vertebra’s Facet
Hitting Lower Vertebra’s Upper Facet
Shear Stabilization: Passive Ligament
ACL Ligament
Shear Stabilization: Active Muscle
Professional Olympic Sports
Two Interests in the Back

- Develop Strength Program for:
  - Enhanced Performance
  - Athletic Longevity
Enhanced Performance

- Jumping
- Running
- Hitting
- Reduce Fatigue
Athletic Longevity

REDUCE

- Bulged Degenerative Disc
- Pinched Nerve
- Spinal Stenosis
Enhanced Performance

- Adaptive strength training program for the global muscle/bone/joint complex
Athletic Longevity

- Segmental Power Training
Human Spinal Development

- Humans born with C-Spine: Quadrupeds
Human Spinal Strengthening Program

- S-Shape Spine is result of ±18 year process
  Adapting from C-Shape Spine
18-Year Spinal Strength/Maturing Process

3 Ways

- Size
- Shape
- Ossification

Ossification

Small C-Shape

Large S-Shape
Human Posture

Newborn  6 Years  10 Years  18 Years Old Age  (Adult)

Revised from:  Biomechanics of Human Movement Adrian MJ, Cooper JM, 1989.
Few kids develop Good Spine = Good Athlete
Most kids Not Good Spine = Not Good Athlete

Good          Hypolordotic     Military     Kyphotic    Reversed Curve

Good Posture

Bad Posture

Strength Training for Proper Posture “Adaptive” Program

- Cause and Effect
Adaptive Training Effects

- Intensity
- Duration
- Frequency
Known Adaptation: Sun and Skin

EFFECT of the sun
body CAUSES melanin adaptation
Known Adaptive Strength Training Program: PMOT

- Progressive Muscle Overload Training
  - Hypertrophy of Muscle
Known Spinal Adaptation

- RELATIVE to EFFECT of Gravity, the body CAUSES Biomechanical Adaptation of S-Shape Spine
Reason for Adaptation

- S-Shape Spine effectively moves against anterior forces from supine and upright position
Ability to Sit-Up
Sit-Up & Crane:
Use Same Lever System
Sit-Up in Human Proper S-Shape
Proper Mechanical Advantage

Direction of Muscle pull (blue arrow)

Good Posture
Sit-Up in Human Poor S-Shape Poor Mechanical Advantage

Direction of Muscle pull (blue arrow)

Poor Posture
Posterior Shear Causes 3 Conditions

- Bulged Disc
- Pinched Nerve
- Spinal Stenosis
Athletic Longevity Training

- Shear Force Strength Training
  - To align the segments
Spinal Core Strengthening “Sit-Up”

- LifeForce PowerCushion™

Using Stabilizing Fulcrum
Spinal Longevity Training
“Pelvic Tilt”
Pelvic Tilt

- Shear force seats vertebrae correctly against facets
How Proper Core Posture Affects Performance

- Running
- Jumping
- Hitting
- Endurance/Reduce Fatigue
Running

Hamstring is the Force of Effort
Hamstrings: Two Different Jobs

Maintain Posture

Vs.

Bipedal Locomotion
Good Posture

No Hamstring Force Required to Maintain Upright Posture

Center of Mass: Balanced over Hip Joint

Hamstring: Zero Effort
Poor Posture
Hamstring Required to Maintain Upright Posture

Human with Poor Posture Has Center of Trunk Mass in Front of Hip Joint (Same as Ape)

To prevent rotation of the Hip, the Hamstring has to work constantly to stop face from hitting floor
Engineering Posture
Leg on Ground at 60°
Hamstring Muscle Effort

Good
Upper body mass aligned over hip

Bad
Upper body forward 4” of hip
Hamstring Muscle Effort Required to Maintain Upright Posture
Good vs. Poor Posture
Planted Leg is at 60°

Good Posture
Hamstring Effort: “0 lbs. of effort”

Poor Posture
Hamstring Effort: “400 lbs. of effort”

To study physics proof of the above, go to locomotion walking running section Dr. Scherger’s text Kinesiological Analysis of Human Core Stability: Spinal Development, Structure and Function.
The Ultimate Demonstration of Speed

- Stride Length
- Propulsion of Force
Hang on kid. S-shaped upright posture is what we need. We need to figure out how to get it and then keep it.

Hamstring Required to Maintain Poor Posture = Poor Mobility

- Slow Twitch Muscle
- No Stretch
- No Fast Firing
- No Stride Length
- No Power

Both have bad hamstring, and can't walk.
Jumping
Good Posture Jumps Vertical
Poor posture displaces upper trunk mass forward of the hip. Lower body involuntarily moves up and forward to maintain balance in the air. This person does not jump upward, they jump forward.
Poor Posture Jumps Forward

Poor jumping due to poor vertical direction is a structural problem. When in the air, the nervous system controls joint activity to maintain balance against gravity (Cooper ’82).
Hitting Physics: Effective Momentum
Effective Momentum
Two Parts

1st Development of Momentum

2nd Stability at Point of Contact
Momentum = Power

Momentum = Mass \times Velocity

Velocity = Acceleration \times Distance
Two cars collide, the winner is?
Most momentum & stability wins!
Greater Range of Motion to Accelerate
Greater Momentum:

**Good Posture**

| **Steel** | 300# |

**Poor Posture**

| **Wood** | 300# |
Momentum and Stability at the Point of Contact

Individuals with identical trunk mass of 100 lbs. hitting each other with 100 lbs of force.
Proper Posture: End Range of Motion Spine has Moved into Ultimate Stabilized Position

- Full stability
- Simple Mechanism

Resultant Forces are in 180° alignment for total compression/stability.

Resistance Force

Muscle/Effort Force

Resultant Force

True Effort Arm
Improper Posture: Poor Stability

Resultant Force Creates Posterior Shear Dislocating Vertebrae

Poor Core Stability

Improper Posture

Resistance Force

+ 

Muscle/Effort Force

= 

The Resultant Force

Direction of True Effort Arm

Shear

Shear causes Joint Dislocation
Posterior Shear Mechanism
Causes: Bulged Disc, Pinched Nerve, Spinal Stenosis
**Borelli Mechanical Advantage Study: Improper Posture**

<table>
<thead>
<tr>
<th></th>
<th>Compression from resultant force TRA</th>
<th>Compression from Multifidus for shear stabilization</th>
<th>Initial force of effort from TRA</th>
<th>Force of effort of multifidus for shear stabilization</th>
</tr>
</thead>
<tbody>
<tr>
<td>T12-L1</td>
<td>172 lbs.</td>
<td>0 lbs.</td>
<td>53 lbs.</td>
<td>0 lbs.</td>
</tr>
<tr>
<td>L1-L2</td>
<td>174 lbs.</td>
<td>0 lbs.</td>
<td></td>
<td>0 lbs.</td>
</tr>
<tr>
<td>L2-L3</td>
<td>174 lbs.</td>
<td>49 lbs.</td>
<td></td>
<td>50 lbs.</td>
</tr>
<tr>
<td>L3-L4</td>
<td>172 lbs.</td>
<td>105 lbs.</td>
<td></td>
<td>58 lbs.</td>
</tr>
<tr>
<td>L4-L5</td>
<td>164 lbs.</td>
<td>443 lbs.</td>
<td></td>
<td>340 lbs.</td>
</tr>
<tr>
<td>L5-S1</td>
<td>151 lbs.</td>
<td>1104 lbs.</td>
<td></td>
<td>665 lbs.</td>
</tr>
<tr>
<td>Total</td>
<td>1007 lbs.</td>
<td>1701 lbs.</td>
<td>53 lbs.</td>
<td>1113 lbs.</td>
</tr>
</tbody>
</table>

Total Compression = 2708 lbs.  
Total Force of Effort = 1166 lbs.
**Borelli Mechanical Advantage Study: Proper Posture**

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</tr>
</thead>
<tbody>
<tr>
<td>T12-L1</td>
<td>203 lbs.</td>
<td>0 lbs.</td>
<td>77 lbs.</td>
<td>0 lbs.</td>
</tr>
<tr>
<td>L1-L2</td>
<td>203 lbs.</td>
<td>0 lbs.</td>
<td></td>
<td>0 lbs.</td>
</tr>
<tr>
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<td>203 lbs.</td>
<td>0 lbs.</td>
<td>77 lbs.</td>
<td>0 lbs.</td>
</tr>
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</table>

Total Compression = 1218 lbs.  
Total Force of Effort = 77 lbs.
Proper Posture vs. Poor Posture

77 lbs Effort

1166 lbs Effort

15 to 1 Mechanical Advantage

1218 lbs vs. 2708 lbs Joint Compression

2 to 1 Mechanical Advantage

Good Core Stability

Poor Core Stability
Science Fact:

• Good Posture outperforms Poor Posture
• Poor Posture expects Injury
This is what you need!

Endurance in Borelli Neck Comparison: Muscle Effort Required to Hold the Head Up

Proper Posture

32 lbs

Muscle Effort Force

CoM

64 lbs

Head Forward Posture

117 lbs

Straight Posture

CoM
Longevity in Borelli Neck Comparison: Resultant Force Created at Each Joint/Disc

Proper Posture

Straight Posture

Head Forward Posture

85 lbs

131 lbs

168 lbs
Examination
Good Posture vs. Poor Posture

Muscles
- Relaxed
- Tense

CORRECT NEUTRAL SPINE  INCORRECT
Sit-up and Pelvic Tilt can be Performed Over Sleeping Bag with Duct Tape or Specially Designed Fulcrum
Power Cushion Protects Against Posterior Shear
Pelvic Tilt

- Cutout portion allows for posterior shear to seat facets for proper segmental alignment
Groove portion allows no pressure on spinous processes so bilateral facets can seat equally, correcting unilateral spinal column to exercise bilateral muscle groups with equal range and direction of pull.

Exercise with This!

Not This…
Spinal Fitness Equipment Creates Artificial Gravitational Force Field for Greater Effects
Spinal Strengthening Program

Sit-up for adapting Global Curve required for strength, speed, endurance & flexibility.

Pelvic tilt exercise for athletic longevity. Strengthening to avoid getting bulged disc, pinched nerve, and spinal stenosis.