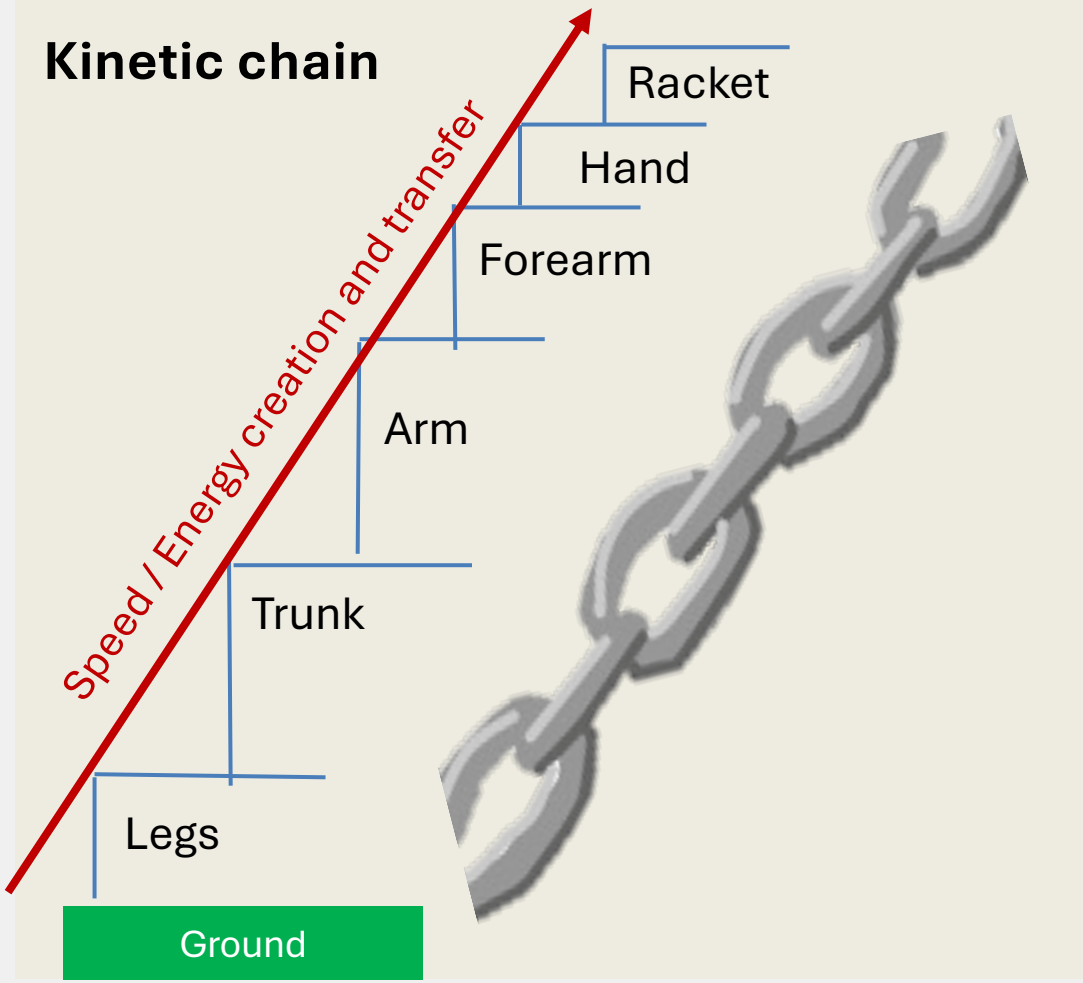
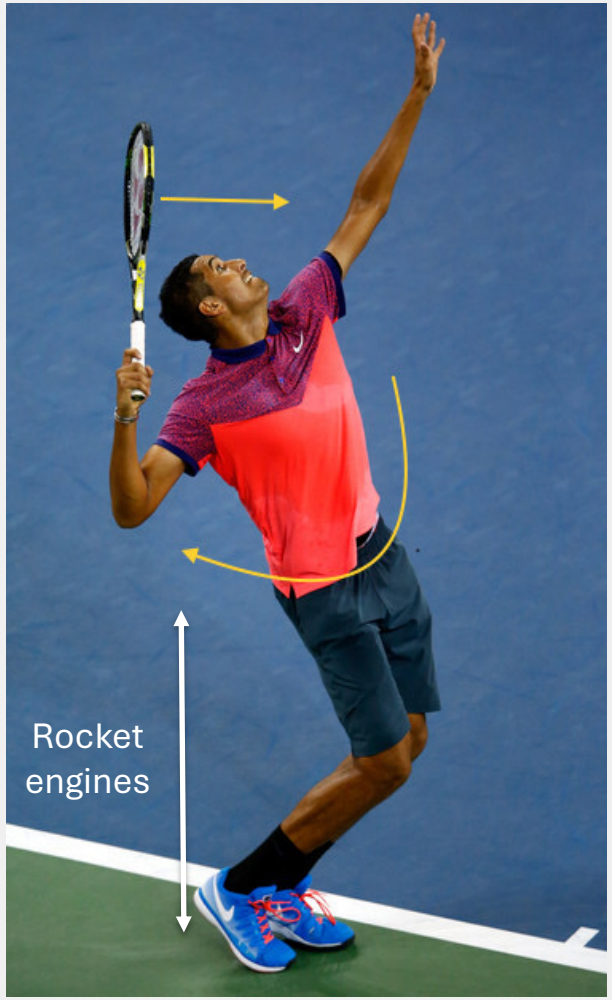
How to improve the serve leg drive performance?

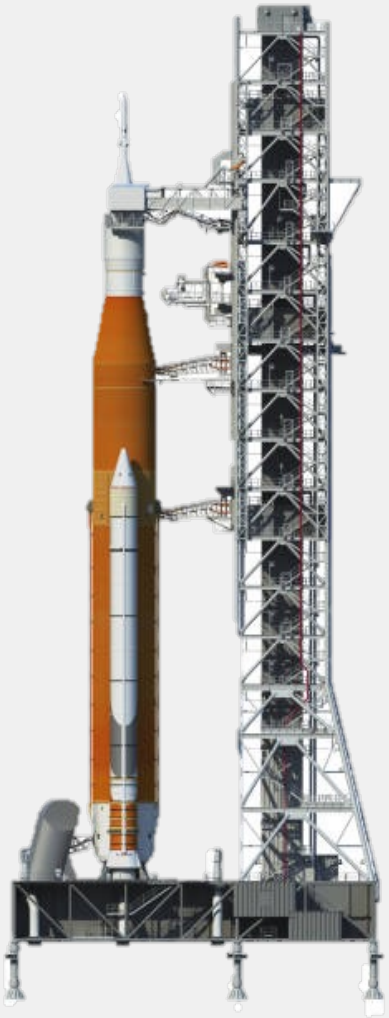
Caroline MARTIN

Vierumäki, Finland, April 2026

GENERAL BIOMECHANICS



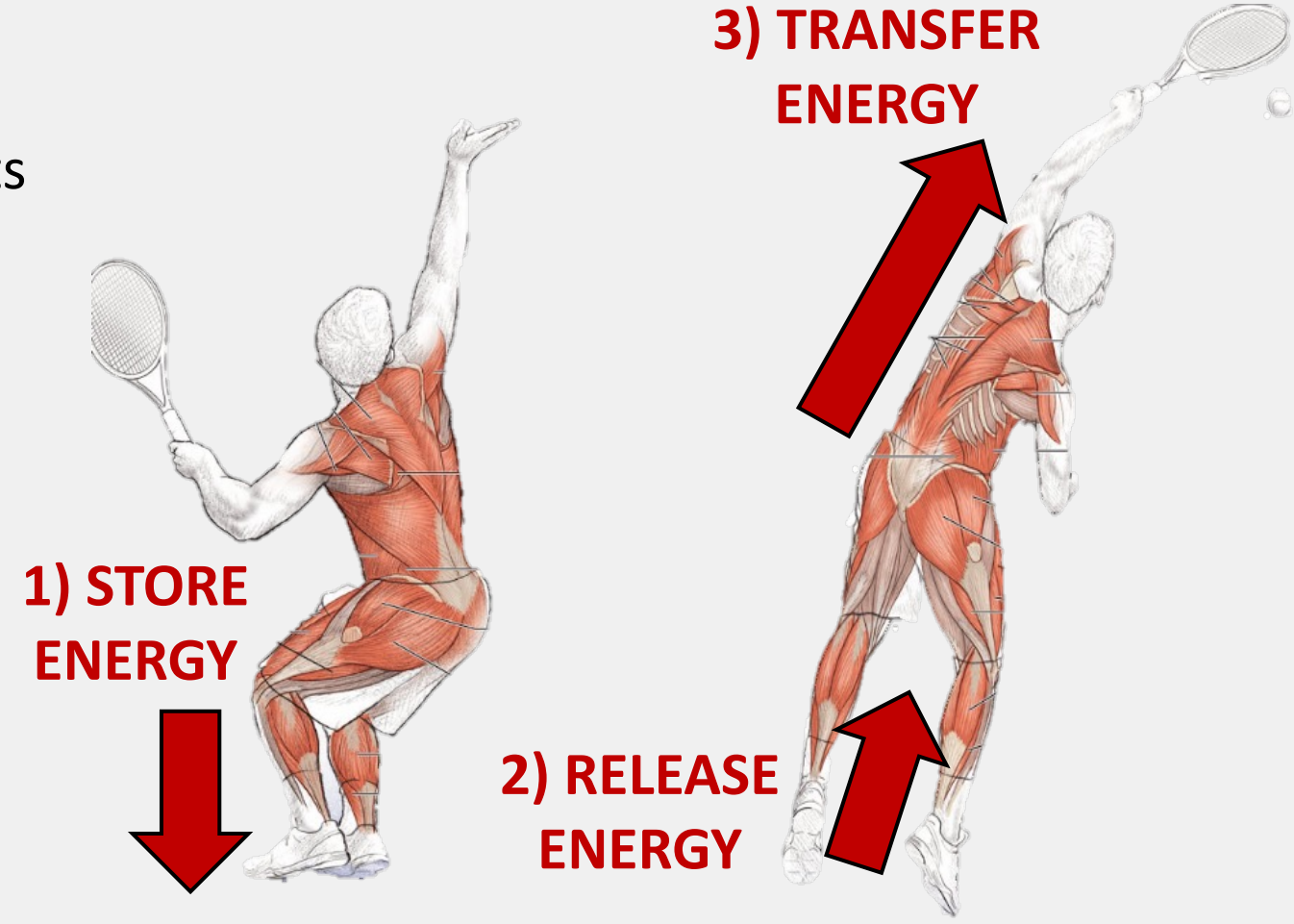




ROLES OF THE LEG DRIVE

1st link of the kinetic chain

Powerful muscles and joints

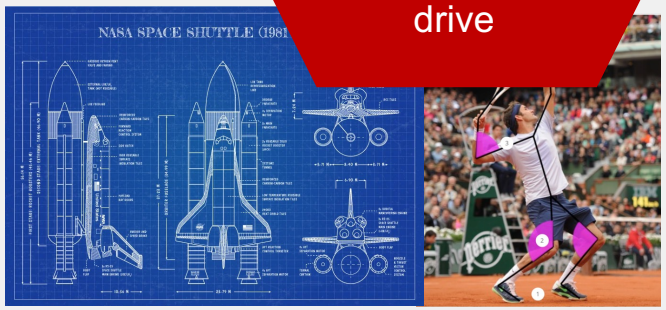


ROLES OF THE LEG DRIVE

STORE ENERGY

STANCE LOADING

Design the shape of the rocket / leg drive



RELEASE ENERGY

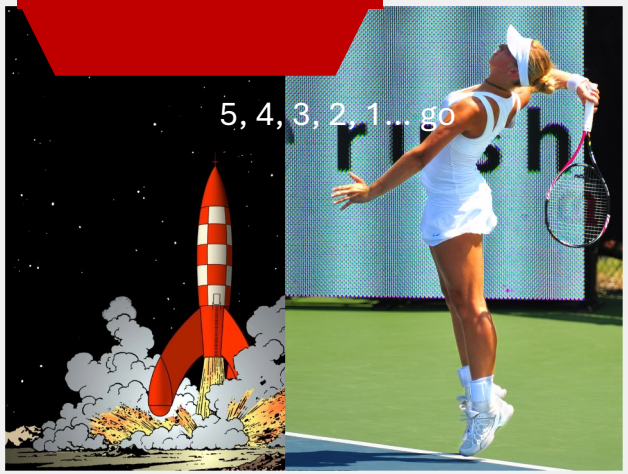
POWER

Build the power of the rocket / leg drive

TRANSFER ENERGY

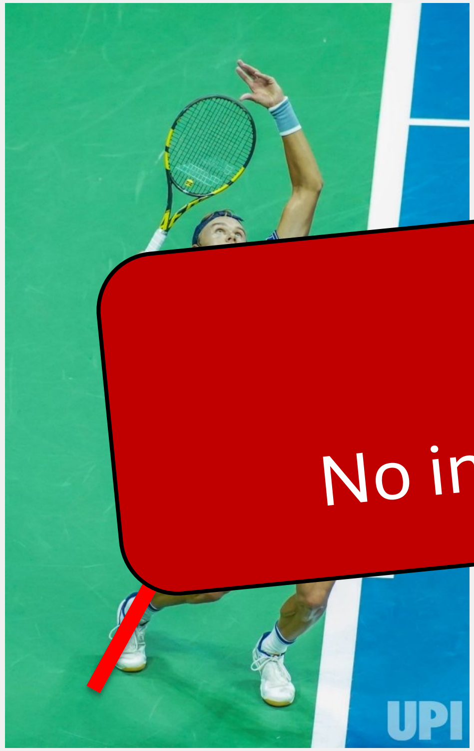
TIMING

To propel the rocket / leg drive at the right time



STANCE

Foot-back / Platform



ADVANTAGE

- Greater forward GRF

...ation
between upper and
lower body

Foot-up / Pinpoint

ADVANTAGE

... vertical GRF (+ 10 %)
...r leg power (+ 20 %)
...o push upwards with
...feet together
...ate impact height
- Greater margin of error over the net

Pro and junior players:
No influence on serve speed
No influence on upper limb joint loadings
(Reid et al., 2008, Touzard, 2021)

Bahamonde & Knudson (2001)
Martin et al. (2012)
Reid et al. (2013)

STANCE: VISUAL KEY POINT

*Take home message

IMPORTANT

Back foot
- behind the front foot
- below the dominant shoulder

Why?
- create a line of force/energy transmission (back foot ➔ back hip ➔ back shoulder)
- raise the back hip and the dominant shoulder
- engage the shoulder-over-shoulder and trunk forward rotations

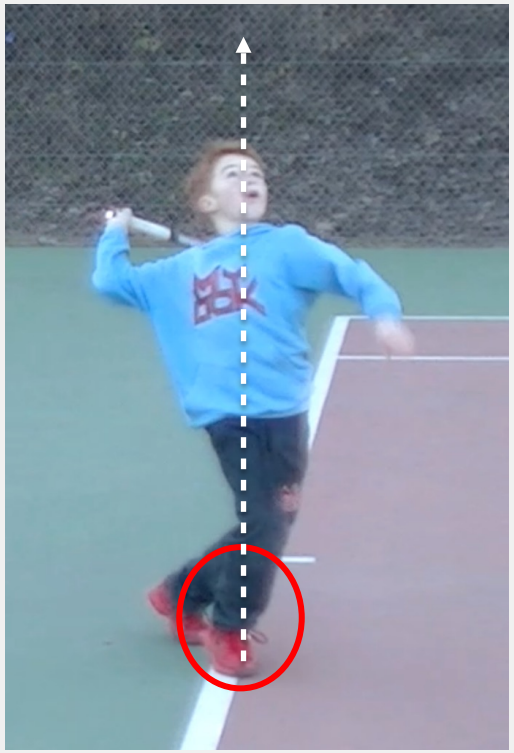
STANCE: VISUAL KEY POINT

Foot-up technique: back leg on the side

25% of top-level female players (Kibler, 2012)

77% of female players and 21% of male club players (Kibler, 2013)

48% of girls and 40% of boys U12 to U16 in France (Touzard, 2021)



STANCE

FU: Back foot on the side

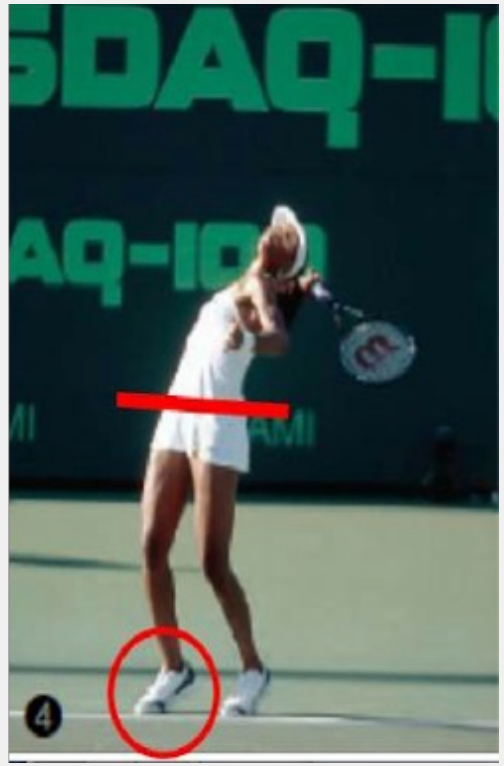
Alignment failure between the back foot, the back hip and the dominant shoulder

Limit the vertical back leg drive, the energy transfer and the shoulder over shoulder rotation

May limit impact height and ball speed

Pull serve (Kibler, 2012)

What consequences for performance?



STANCE

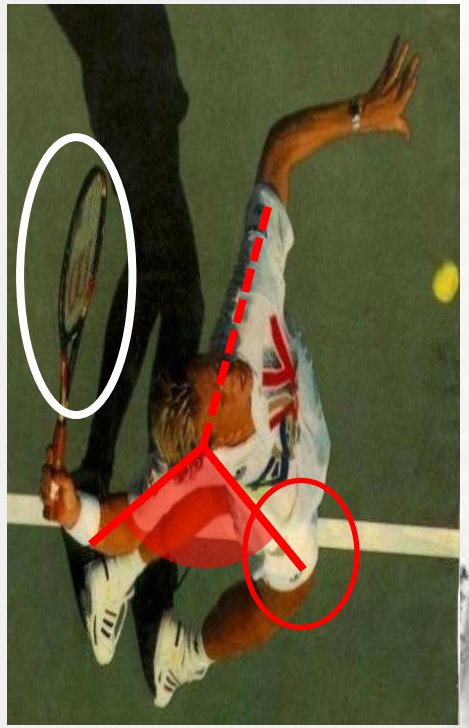
FU: Back foot on the side

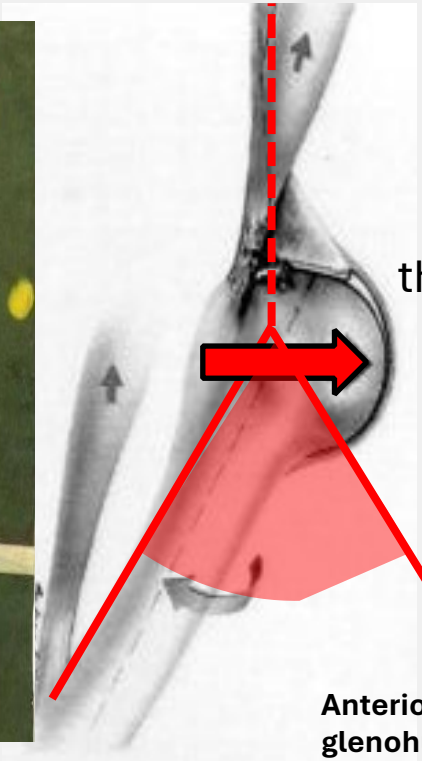
Favors the pelvic rotation ➔ the back hip turns early towards the net

Separation angle between the upper – arm and the back hip

Shoulder hyperangulation ➔ shoulder torn between the advancing back hip and the racket moving back

May increase risks of shoulder, lumbar and abdominal injuries





The humeral head moves forward and rubs against the rotator cuff tendons

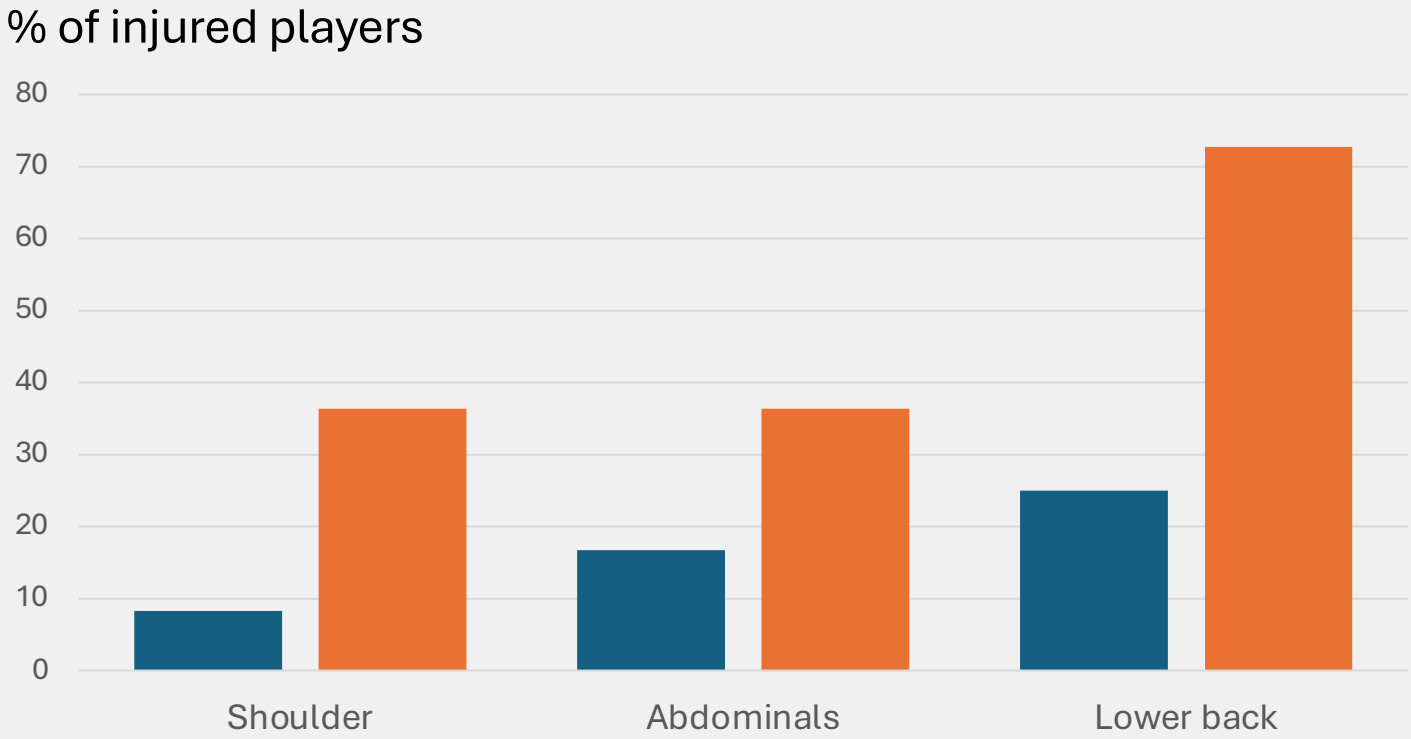
Anterior part of the glenohumeral joint

Martin et al. (2013)

STANCE

Population : 23 female elite junior players (15.0 ± 1.2 years, 12 - 16 years old)
National Tennis Center – Pinpoint / foot-up stance
Medical follow-up : record injuries (12 months before the test)

Good back foot position (n=12) ← Height, weight, age = → Back foot on the side (n=11)



STANCE

What potential causes?

- ✓ Tossing the ball too far forward or too far to the right
- ✓ Lack of leg power/strength ➔ mechanism to create rotational speed
- ✓ Need to face the serve box
- ✓ Wrong tennis instructions

Identify causes before correcting them

DRILLS FOR STANCE

Don’t kick the can!

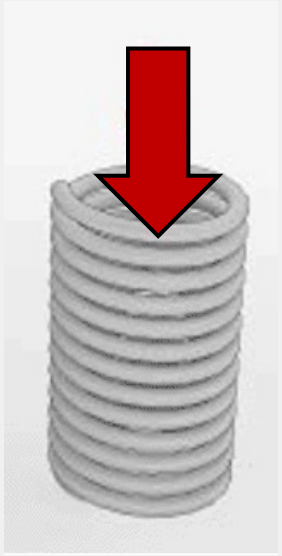
Effective drill for correcting a side foot-up stance

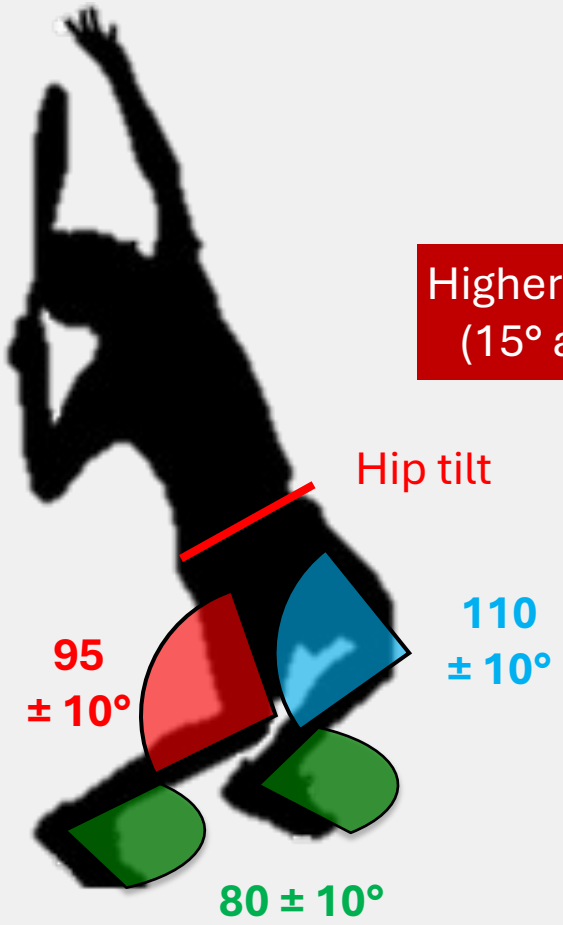
- Place a ball can next to the front foot
- Ask the player to serve without touching the can

LOADING: VISUAL KEY POINT

Push hard against the ground to store energy

STORE ENERGY





Higher flexion of the back knee (15° apart) to engage hip tilt

Heels lift up off the ground
Forefeet in contact with the ground

DRILLS FOR LOADING

Crush the cone

- Use a flexible cone
- Ask the player to press hard against the ground with his back leg forefoot to crush the cone

DRILLS FOR LOADING

The footprints

- Use a memory foam mat
- Ask the player to press hard against the ground (especially with the forefeet) to leave forefoot prints
- Then push up quickly
- Practice the drill with and without shoes

DRILLS FOR LOADING

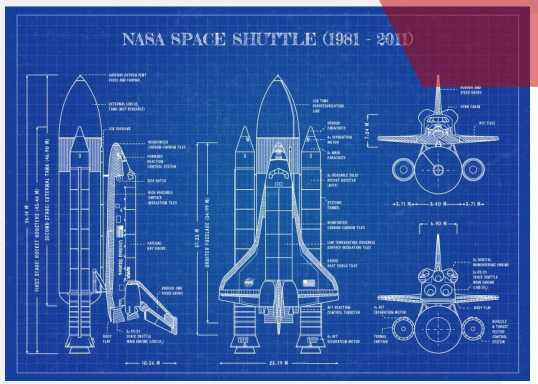
Explode the bubbles

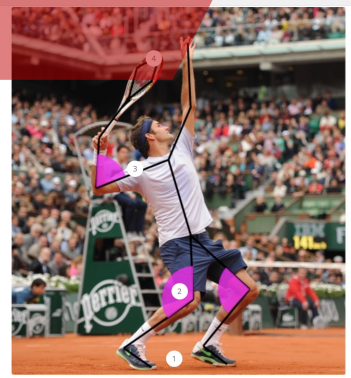
- Use bubble wrap
- Ask the player to press hard against the ground with his forefeet (especially the back leg) to explode the bubbles.

STORE ENERGY

SHAPE

Design the kinematics of the rocket / leg drive

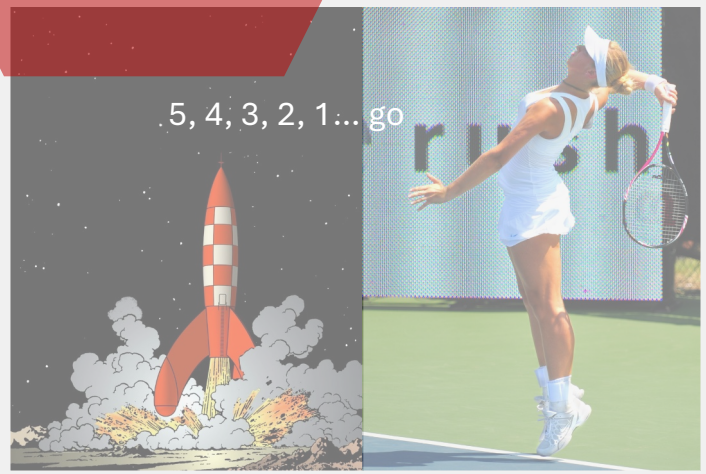




TRANSFER ENERGY

TIMING

To propel the rocket / leg drive at the right time



RELEASE ENERGY

POWER

Build the power of the rocket / leg drive during the extension

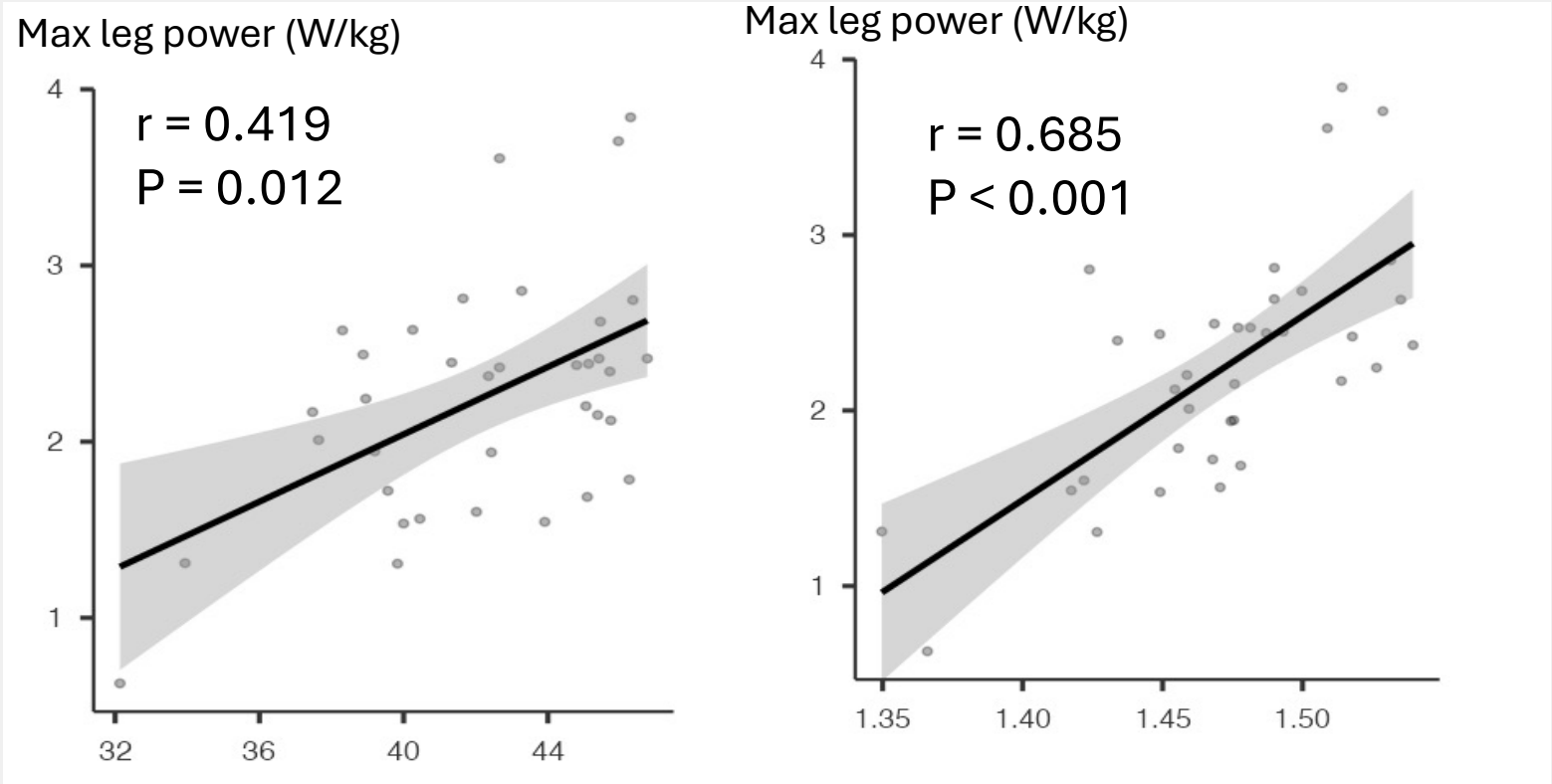
LEG POWER

Relationships Between Force-Time Curve Variables and Tennis Serve Performance in Competitive Tennis Players

July 2024 · The Journal of Strength and Conditi... 38(9)
DOI: 10.1519/JSC.0000000000004848
Lab: M2S Laboratory

Loic Fourel · Pierre Touzard · Maxime Fadier · Show all 7 authors · Caroline Martin

36 expert players (juniors and adults)
Force platforms

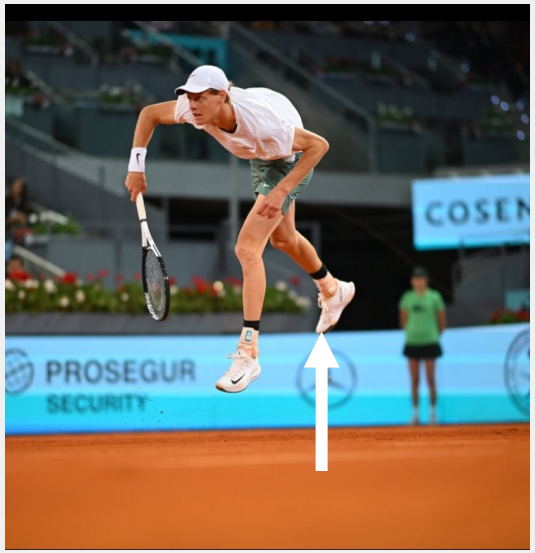


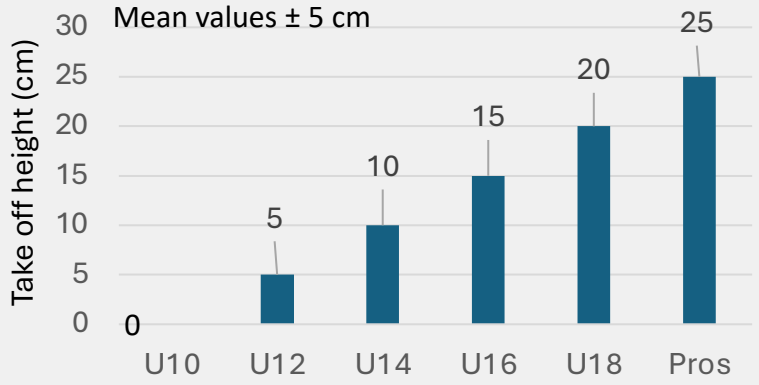
Maximal leg power has a moderate influence on racket speed and a strong influence on impact height

Leg power comes from the triple extension of the hips, knees and ankles

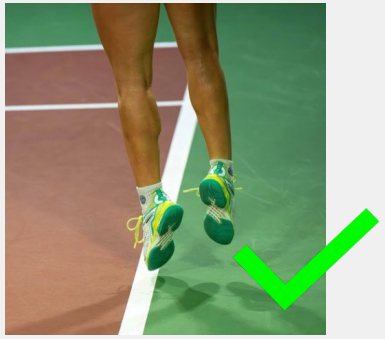
LEG POWER: VISUAL KEY POINT

1 Take-off height





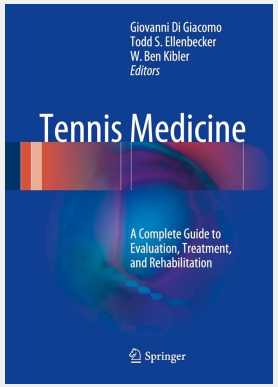
2 Ankle extension



LEG POWER

Improving Tennis Serve Velocity: Review of Training Methods and Recommendations

Joshua Colomar, PhD,[1,2,3] Francisco Corbi, PhD,[4] and Ernest Baiget, PhD[1]
[1]National Institute of Physical Education of Catalonia (INEFC), University of Barcelona (UB), Barcelona, Spain; [2]Sport and Physical Activity Studies Centre (CEEAF), University of Vic–Central University of Catalonia, Vic, Spain; [3]Sport Performance Analysis Research Group (SPARG), University of Vic–Central University of Catalonia, Vic, Spain; and [4]National Institute of Physical Education of Catalonia (INEFC), University of Lleida (UdL), Lleida, Spain



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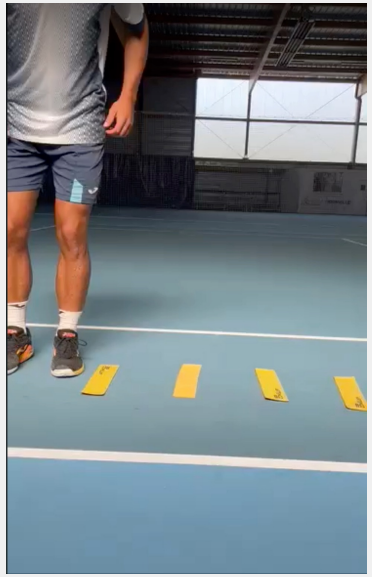
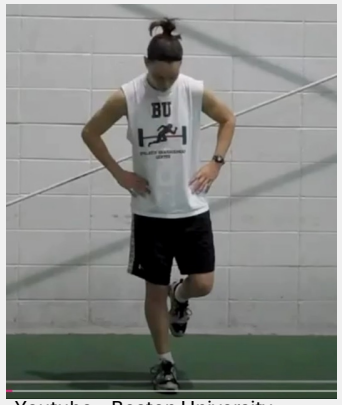
Loic Fourel · Pierre Touzard · Maxime Fadier · Show all 7 authors · Caroline Martin

« **Power-based training and SSC enhanced exercises such as plyometrics** achieve large improvements in **serve speed and impact height** as they **stimulate increases in relevant strength and power** characteristics for serve speed. These positive adaptations may be attained using **medecine ball toss** or any other means of training **if the selected exercises involve the totality of the kinetic chain, include high velocity rotations, and especially if they resemble the technical execution of the serve** »

LEG POWER

Low plyometric drills/ Footwork and ankle work

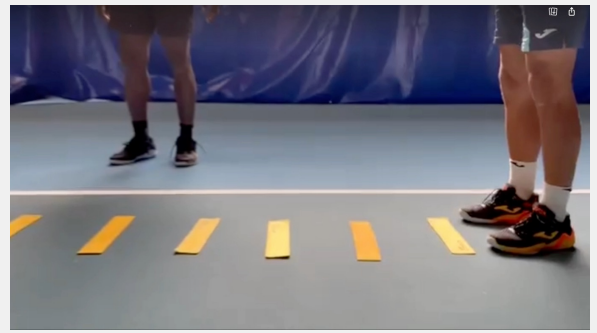




Youtube – Boston University

Unified Fitness System

Relentless Athletics



LEG POWER

High plyometric drills: squat jump, counter movement jump with or without resistance

LEG POWER DRILLS : SHOT PUT

sports

MDPI

Article

Neuromuscular Fitness Is Associated with Serve Speed in Young Female Tennis Players

Zlatan Bilić, Paola Martić, Petar Barbaros, Filip Sinković and Dario Novak *

RESEARCH ARTICLE

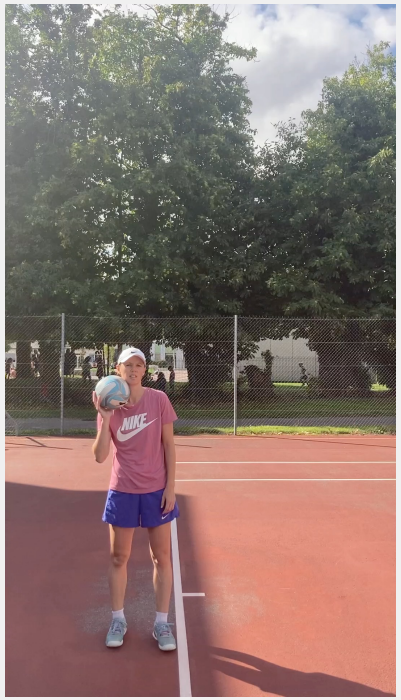
Fitness testing in tennis: Influence of anthropometric characteristics, physical performance, and functional test on serve velocity in professional players

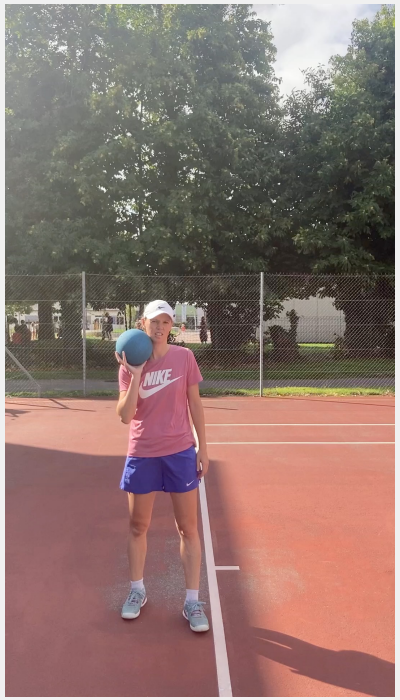
Alejandro Sánchez-Pay[1,2*], Jesús Ramón-Llin[3], Rafael Martínez-Gallego[3], David Sanz-Rivas[4], Bernardino Javier Sánchez-Alcaraz[2], Sergio Frutos[2]

The performance of the shot put is highly correlated with serve speed in pro and junior players.

“Shot-put” with 1) a light ball,
2) a weighted ball
3) a medicine ball (MB - 1 or 2 kg)

- Hold a soccer or a volleyball ball in the dominant hand
- Bring the ball to the side of the neck
- Raise the non dominant arm upwards (as for the ball toss)
- Bend then push powerfully on the legs to throw the ball as high as possible (and forward)





LEG POWER DRILLS : OVERHEAD THROW

RESEARCH ARTICLE

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Alejandro Sánchez-Pay[1,2]*, Jesús Ramón-Llin[3], Rafael Martínez-Gallego[3], David Sanz-Rivas[4], Bernardino Javier Sánchez-Alcaraz[2], Sergio Frutos[2]

Prediction of Service Performance Based on Physical Strength in Elite Junior Tennis Players

Nahoko Koya[1], Tetsu Kitamura[2] and Hiroo Takahashi[3]*

[1] Department of Liberal Arts and Sciences, Daido University, Nagoya, Japan, [2] Faculty of Sports, Biwako Seikei Sport College, Otsu, Japan, [3] Faculty of Sports and Budo Coaching Studies, National Institute of Fitness and Sports in KANOYA, Kanoya, Japan

sports MDPI

Article

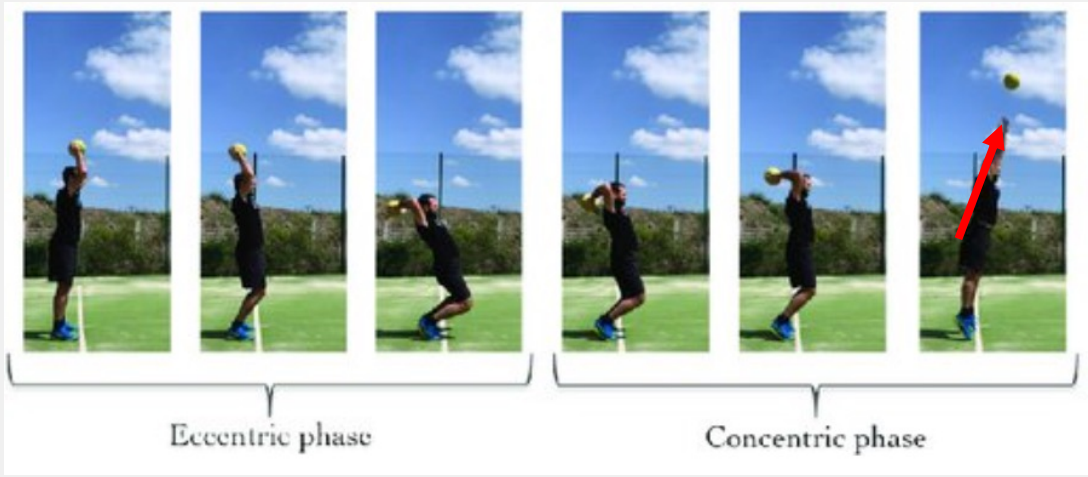
Neuromuscular Fitness Is Associated with Serve Speed in Young Female Tennis Players

Zlatan Bilić, Paola Martić, Petar Barbaros, Filip Sinković and Dario Novak *

The performance of the overhead throw is highly correlated with serve speed and impact height in pro and junior players (male and female).

"Overhead throw" with
1) a light ball,
2) a weighted ball
3) a medicine ball (MB - 1 or 2 kg)

- Hold the ball in the hands
- Bring the ball behind head
- Bend legs
- Push powerfully on the legs to throw the ball as high as possible (and forward)



LEG POWER DRILLS : LATERAL OVERHEAD THROW

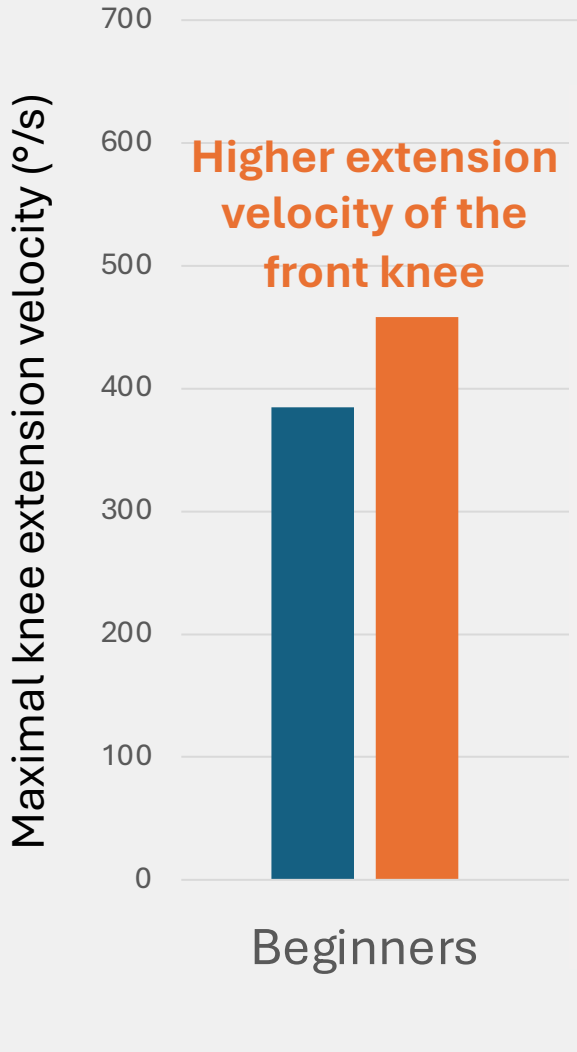
"Lateral overhead throw" with
1) a light ball,
2) a weighted ball
3) a medicine ball (MB - 1 or 2 kg)

- Position in profile behind the baseline
- Feet together (FU) or apart (FB)
- Hold the ball in the hands
- Bring the ball into a trophy position and bend the legs
- Start a loop with the ball
- Push powerfully on the legs to throw the ball as high as possible (and forward)

BACK LEG POWER

Higher extension velocity of the back knee

Back leg = rocket's main engine for creating upwards speed



BACK LEG POWER DRILLS

Flamingo throw

- Coordinated throwing motion (upward motion) using only the back leg
- Weighted ball can be used for juniors
- Back ankle weight can be added for adults / experts

BACK LEG POWER DRILLS

Flamingo serve

- Serve only with the back leg
  - 1) without ball
  - 2) with ball

Source: itf-academy.com

BACK LEG POWER DRILLS

"Shot-put" with a step platform

- Put the front foot on the step and the back foot on the ground behind the step.
- Find a comfortable position
- Throw the ball as high as possible using the leg drive, especially the back leg
- Engage shoulder-over-shoulder rotation
- Land on the step with the front leg

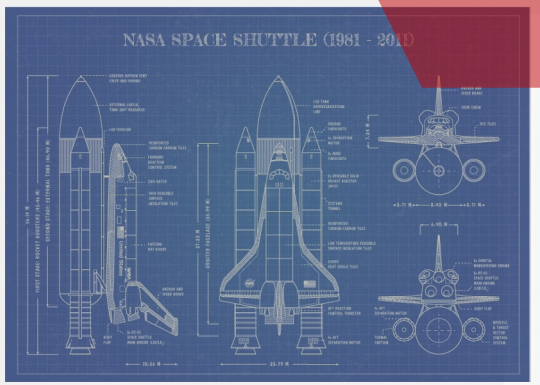
More difficult

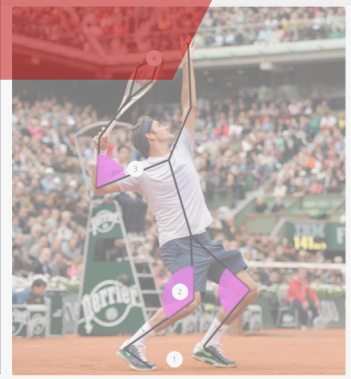
- Jump over the step and land on the ground in front of the step

STORE ENERGY

SHAPE

Design the kinematics of the rocket / leg drive





TRANSFER ENERGY

TIMING

To propel the rocket / leg drive at the right time

RELEASE ENERGY

POWER

Build the power of the rocket / leg drive

LEG DRIVE TIMING

The effect of age on discrete kinematics of the elite female **tennis serve**.
Whiteside D, Elliott B, Lay B, Reid M.
J Appl Biomech. 2013 Oct;29(5):573-82. doi: 10.1123/jab.29.5.573. Epub 2012 Dec 27.
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Evolution of the trophy position along the **tennis serve** player's development.
Tubez F, Schwartz C, Croisier JL, Brüls O, Denoël V, Paulus J, Forthomme B.
Sports Biomech. 2021 Jun;20(4):431-443. doi: 10.1080/14763141.2018.1560493. Epub 2019 Jan 28.
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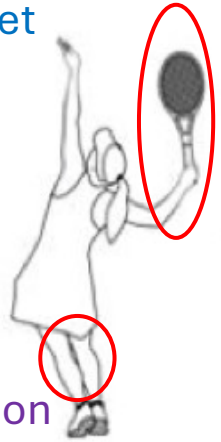
Pro players / Adults

Ball release

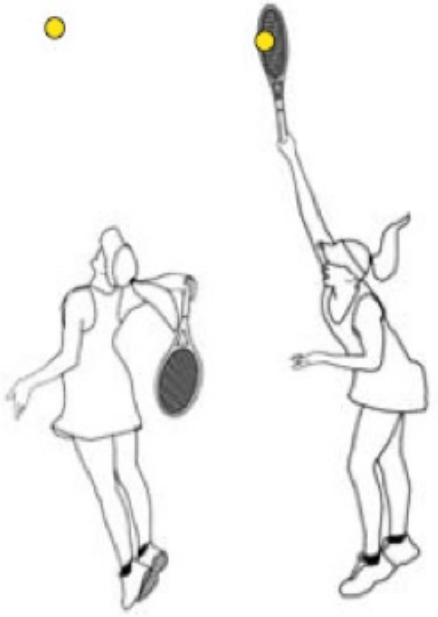
Ball toss zenith

Start of racket acceleration = Racket trophy position

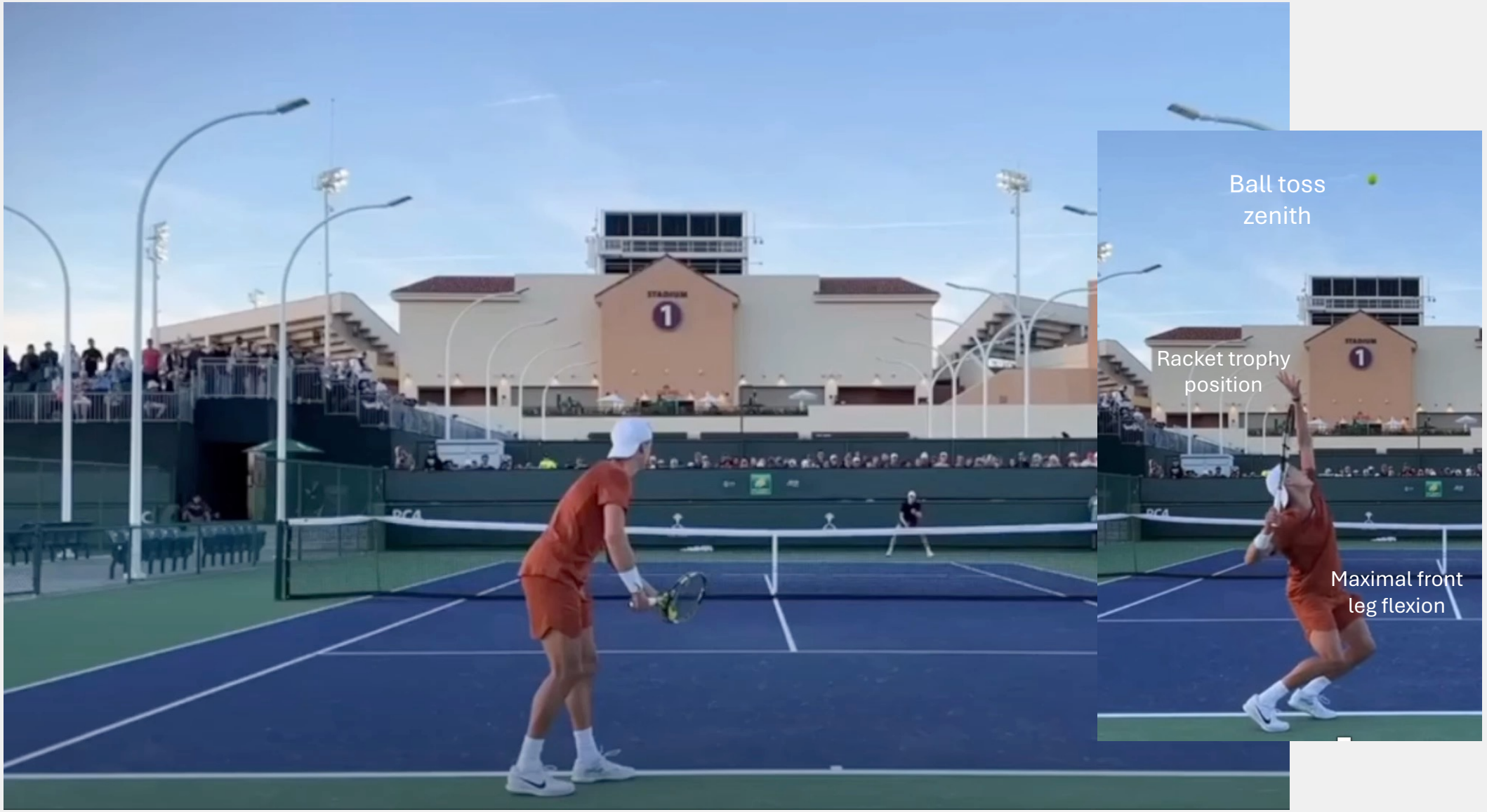


Maximal front leg flexion

Very short delay
mean: 20 ± 90 ms
« Synchronization »



Ball impact


Ball toss
zenith
Racket trophy
position
Maximal front
leg flexion

LEG DRIVE TIMING

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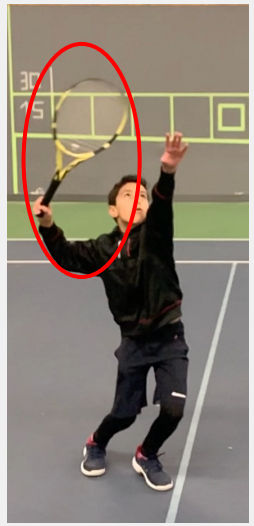
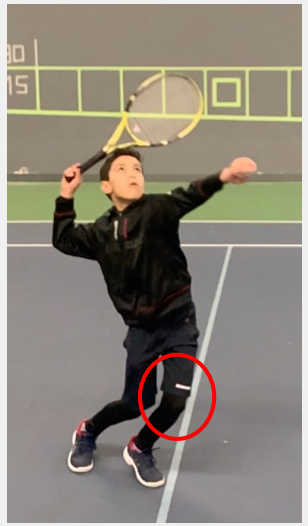
Children and adolescents
Beginner and
intermediate players

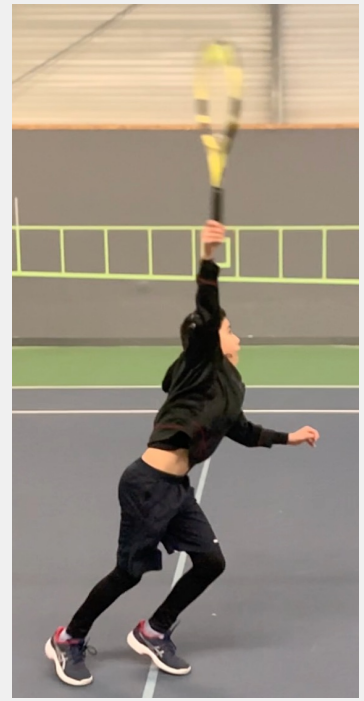
Ball toss zenith

Racket (high)
trophy position

Maximal front
leg flexion







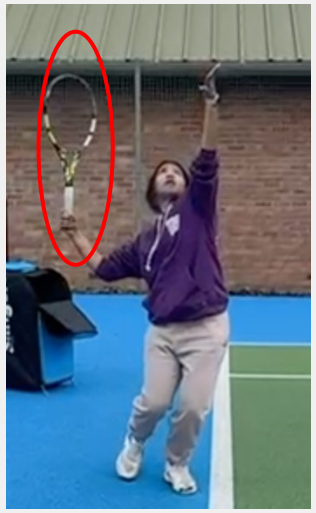
Ball release

Temporal delay
Mean: 180 ± 80 ms
Desynchronization

Ball impact

LEG DRIVE TIMING

Racket (high) trophy position



Maximal leg flexion

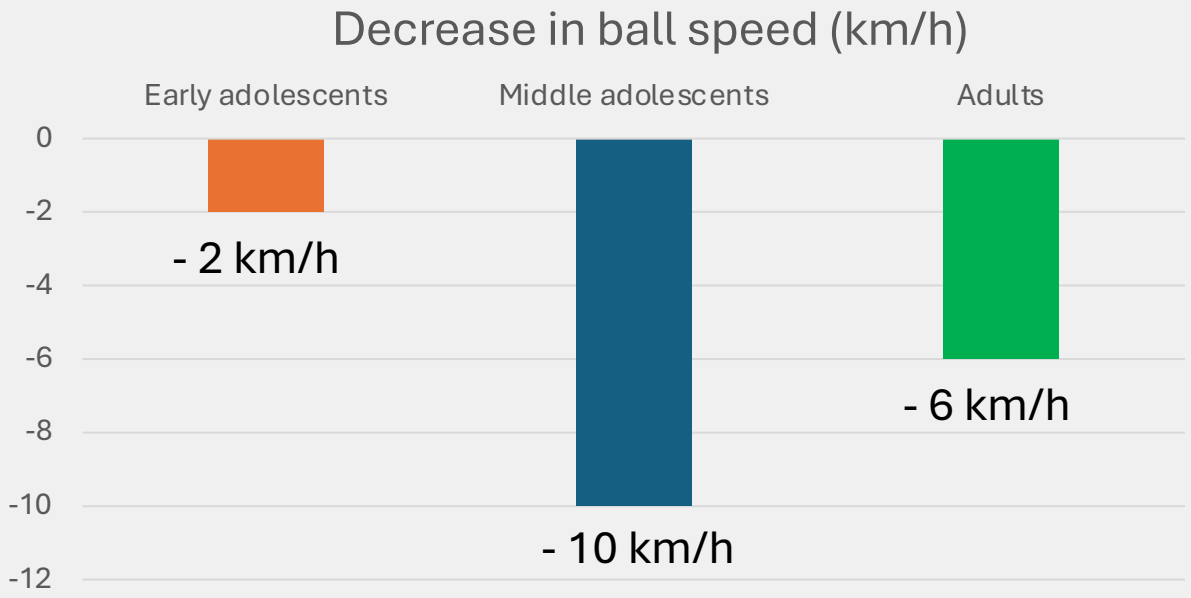
Temporal delay ≈ 300 ms

How does this temporal delay affect the ball's speed?

Population: 199 high level players (115 men and 84 women, 12 – 41 years old)

3 age categories: early adolescents (12 – 14 years), middle adolescents (15-17 years), adults (≥ 18 years)

When the racket is 300 ms ahead of the maximum flexion of the front knee



LEG DRIVE TIMING DRILL

Semi or compact serve

The goal is to synchronize the racket trophy position (start of the racket drop/acceleration) with the maximal front knee flexion (start of the leg extension)

- Start in trophy position
- Racket head pointing towards the sky
- Toss the ball
- Bend the legs
- Don’t move/accelerate your racket before the start of the leg extension.

KIITOS

THANK YOU
FOR YOUR
ATTENTION

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