Sports Prosthesis

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History of Lower-Limb Prosthetics

[1]

- 424 B.C. to 1 B.C
  -Bronze iron leg with wooden core for below knee
- The Dark Ages (476 to 1000)
  -Peg Leg or aesthetic prostheses
- Mid- to late 1500s
  -Above-knee fixed position prosthetic
- The 17th through 19th centuries
  -first non-locking below knee prosthetic
  -articulate knee and ankle joints on prosthetics
- Modern times
  -flex foot and blade prosthetics

Upper Limb Prosthetics in Sport

[2]

- Baseball
- Cycling
- Fishing
- Golf
- Kayaking
- Skiing

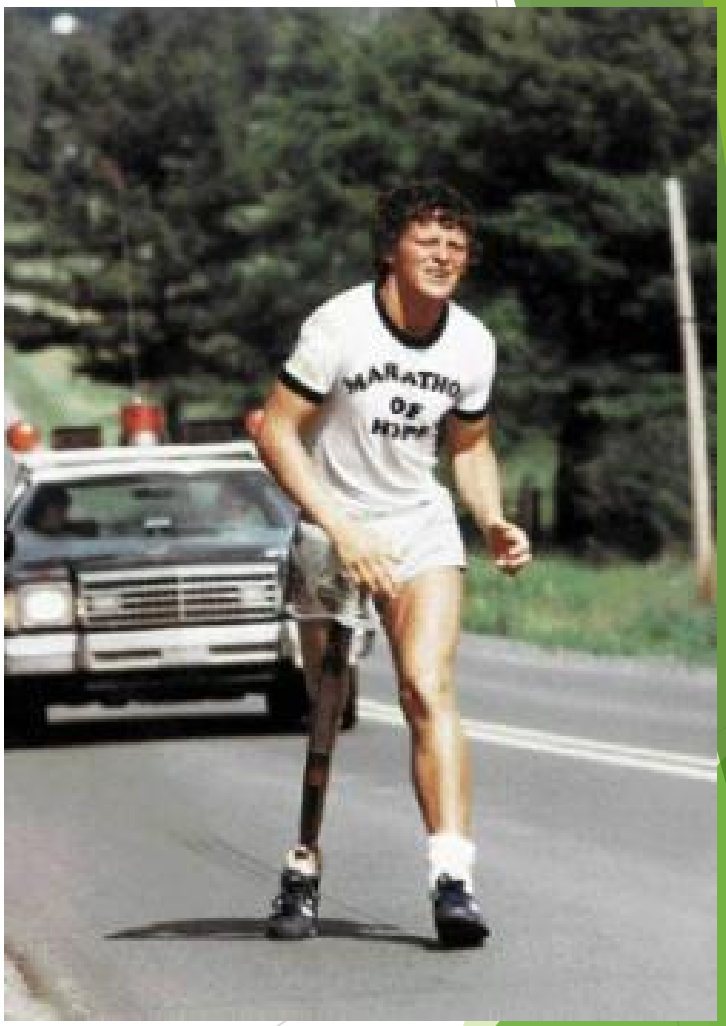
- Most are for transradial or transhumerus amputees
- Consist mainly of gripping and maneuvering apparatuses
- Sometimes the prosthetic may need to help support the athlete
- Often include interchangeable hands for ease of use


MARVEL SPIDERMAN

Lower Limb Prosthetics in Sport

[2]

- Cycling
- Golf
- Skiing/Snowboarding
- Swimming
- Running/Jogging



Cycling

[2]

- Possible for most lower limb amputees
- Used to reduce inter-limb asymmetry that results from one legged cycling
- Depending on location of amputation different joints can be used to allow for the most natural motion

Golf

[2]

- A basic leg prosthetic is normally used for golf
- Due to the rotations involved in a golf swing most amputee's report greater discomfort then generated through everyday activities
- A torsion adapter, a device designed to allow rotation of the limb is used to reduce discomfort
- These are typically for below knee amputees but may also aid above knee amputees with swing follow through

General Sport [2]

- Skiing/Snowboarding
  -below-knee and foot prosthetics may be attached directly to boot
  -Main modifications includes a torsion adaptor like device to allow for more rotation or the use of a flex foot design to better mimic a human ankle.
- Swimming
  -Specific foot of prosthetic designed to mimic the motion and fluid mechanical properties of human foot or specific “flipper feet” may be used

Running & Jogging

- Because of the relative simplicity of the running motions as compared to other sport motions there has been much more innovation in running prosthetics then in other fields
- They have evolved from simple day to day prosthetics to specialised carbon fiber limbs

Running Mechanics

[3]

- Stance Phase

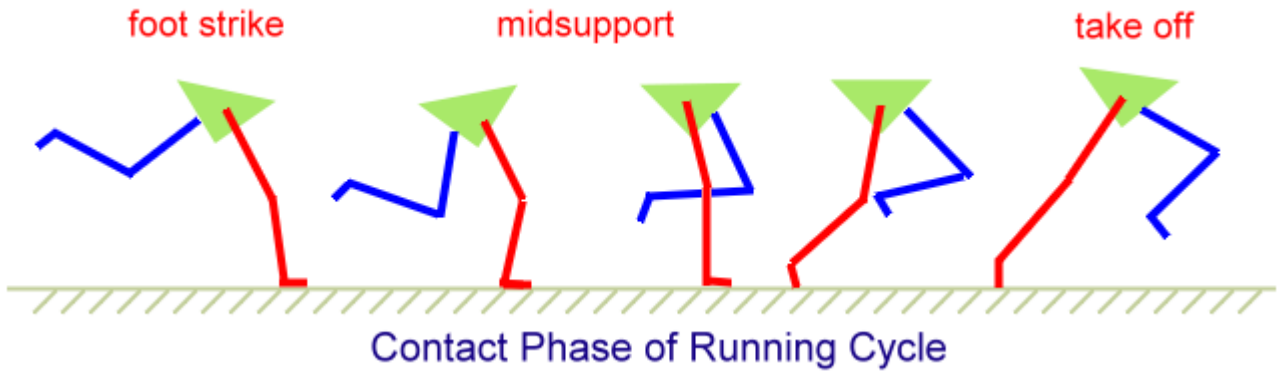
  This is the time when the runners foot is in contact with the ground

- Swing Phase

  When runners leg is off the ground, moving into position to initiate another stance phase

Stages of Stance Phase

[4] [5]

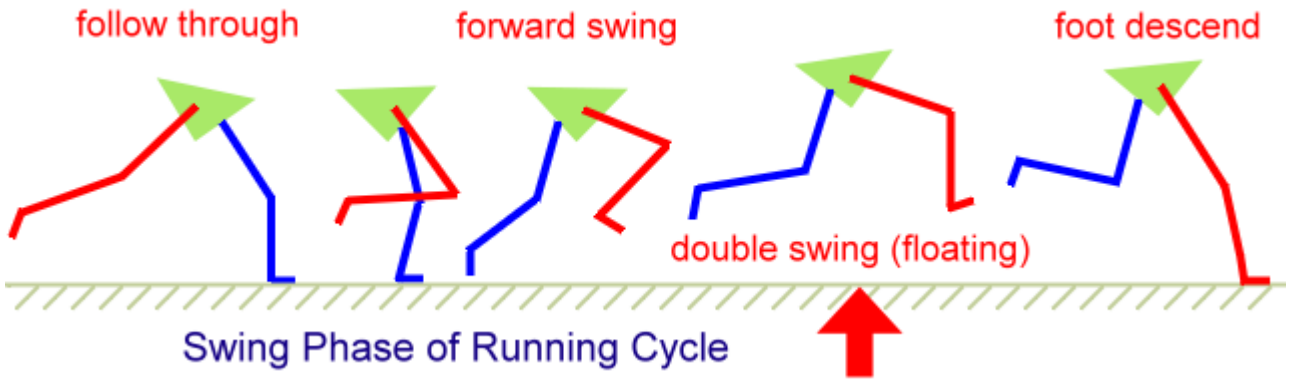


- Absorption
  -Foot strike to midsupport
- Propulsion

  -Midsupport to takeoff

Swing Phase

[4]



- The purpose of this phase is to reset the leg in a position were the stance phase may be reinitiated

Oscar Pistorius

[6]

- Born: November 22nd, 1986
- No fibula in both legs
- Legs amputated halfway between his knees and ankles
- Uses Flex-Foot Cheetah transtibial prosthetic

Van Phillips

[7]

- Water skiing accident in 1976
- Motorboat cut off his left leg
- Decided to build a better prosthesis for himself
- Wanted to remain active (i.e. sports)

Flex-Foot

[7]

- Van Phillips' idea for a better prosthetic
- Inspired by the C-shape of the hind leg of a cheetah

Flex-Foot Inc.

[7]

- Flex-Foot Inc. founded in 1984
- Started developing and testing for Paralympians
- Some variation of original design used by 90% of Paralympian athletes
- Sold to Ossur in 2000 (Ossur is one of the world's leading orthopaedics companies)

Flex-Foot Cheetah

[8]

- The blade used by Oscar Pistorius (also Jerome Singleton, Jonnie Peacock, April Holmes)
- Designed primarily for sporting purposes
- Custom-built, carbon fiber foot
- Both transtibial and transfemoral

Two Breakthroughs

[9]

- Energy storage and release
  - Possible because of the carbon fiber design
- Vertical shock absorption
  - Allows for more natural gait
  - Protects undamaged limb and any remaining joints from excessive shock

EVO™

[9]

- Energy Vector Optimization feature
- Comes from controlling how the ground reaction force is transferred to the prosthetic foot
- Allows for the development of the most natural gait
- Reduces fatigue and pressure on the good limb(if there is one) and back
- Ease of control of ankle in stance phase

Biomechanics of Oscar

[10]

- Swings his legs between strides 20% faster than regular sprinters with the same top speed
- Limbs are 20% lighter
- Approximately 20% lower force on the ground, over a longer period of time
- Slower to start but can sustain speed for longer

Biomechanical Difference

[11]

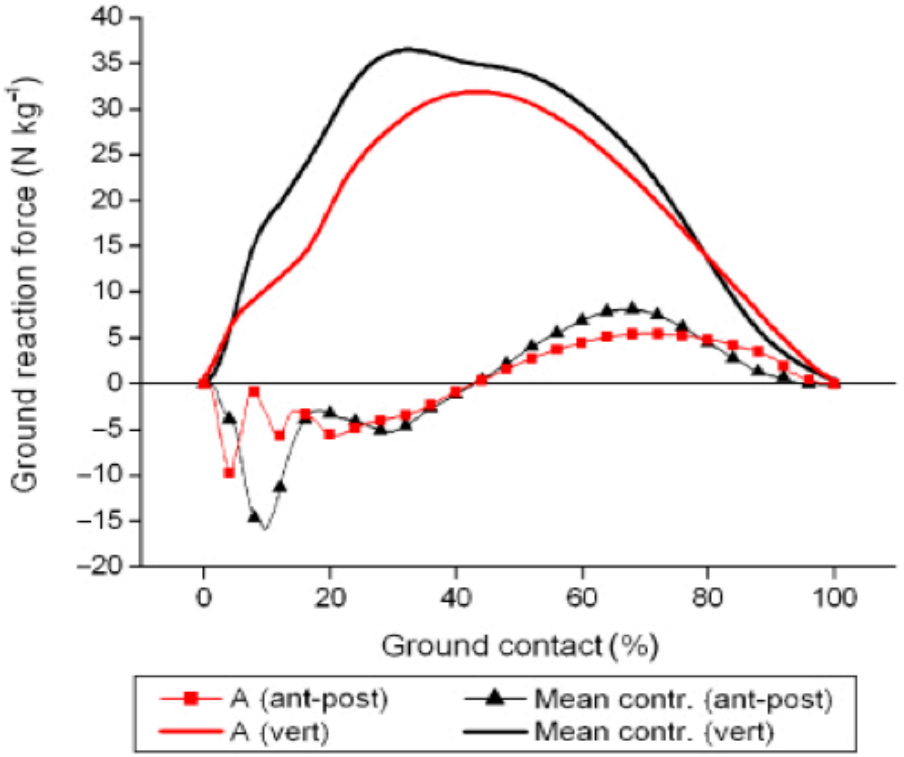
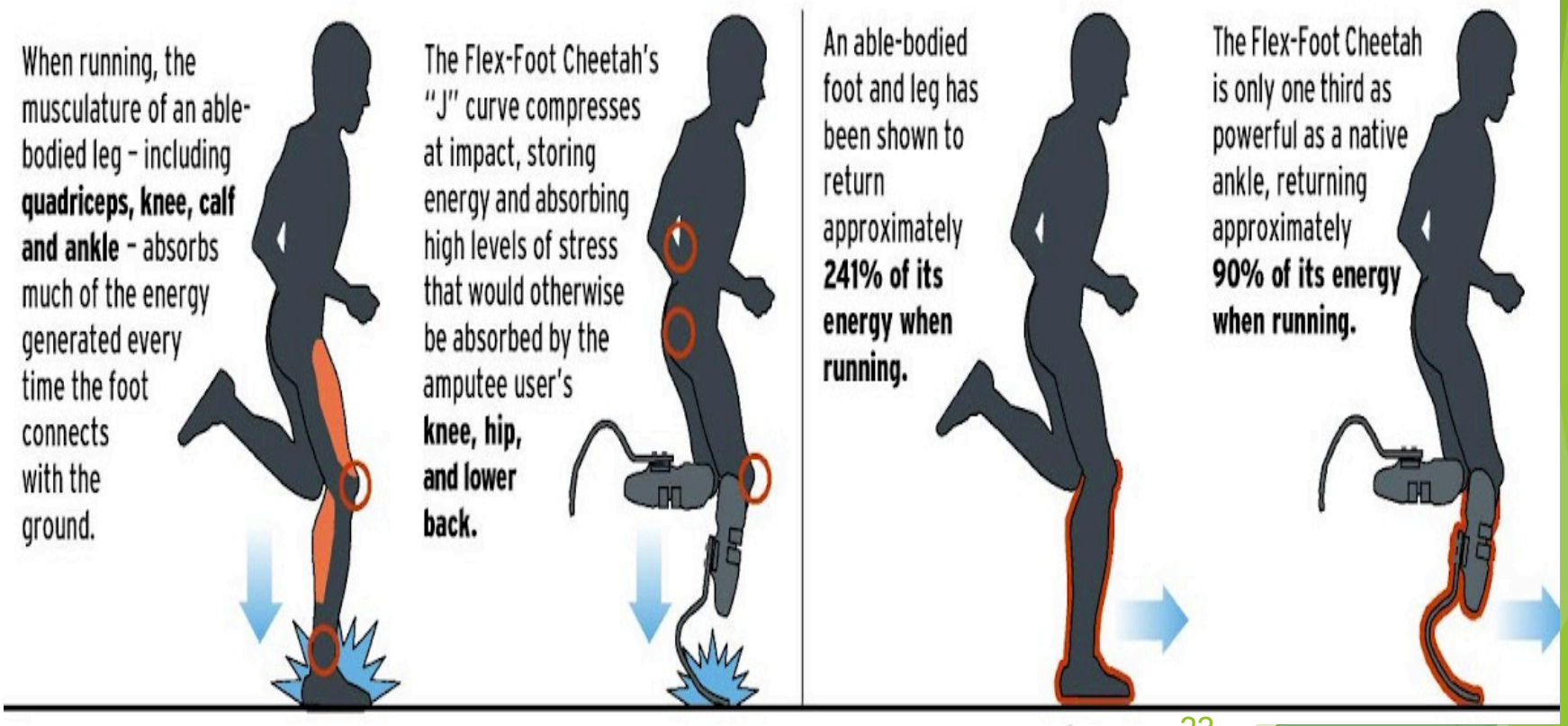


Figure 3. Mean ground reaction forces (vertical and anteroposterior) while sprinting at 9.2–9.5 ms^{-1}. Forces are normalized to body mass and the time (%) is normalized to the stance phase. Data of the transtibial athlete is shown in red, and the forces of the able-bodied controls are in black.

ABLE-BODIED RUNNING VS. "BLADE RUNNING" [12]

Össur's Flex-Foot Cheetah is a J-shaped, high performance carbon composite prosthetic sprinting foot that was designed to mimic the anatomical foot/ankle joint action of able-bodied runners. Since its 1997 introduction, the Flex-Foot Cheetah has been the standard in prosthetic feet for elite and recreational amputee athletes worldwide.



Fair?

[10] [13]

- One analysis says that Pistorius is seven seconds faster over 400m than if his legs were functioning as normal biological limbs
- He has a longer ground contact time
- Can swing his legs faster than biological limbs
- He has a lower ground reaction force
- Because his legs do not tire some think that he could set world records in a 600m race

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